



**Sustainability, Innovation,
and ESG in the Digital Era**

Edited by

Anna Ujwary-Gil

María del Carmen Sánchez Carreira

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Volume 21 Issue 4

2025

Journal of Entrepreneurship, Management and Innovation (JEMI) ([e] ISSN 2299-7326, [p] ISSN 2299-7075) is an interdisciplinary, double-blind peer-reviewed journal, emphasizing theoretical and empirical articles on entrepreneurship, management, and innovation. The journal is published in ELECTRONIC (online first) and PRINT (occasionally) formats. See our website: <http://www.jemi.edu.pl>.

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'Cognitione' Foundation for the Dissemination of Knowledge and Science, os. Bohaterów Tobruku 5,
34-400 Nowy Targ, Poland, www.fundacjacognitione.org, e-mail: fundacja@cognitione.org,
KRS: 0000587704. Journal website: www.jemi.edu.pl

JEMI IS INDEXED AND ABSTRACTED IN

ACADEMIC JOURNAL GUIDE (AJG/ABS) (2024); SCOPUS Q2 (2021); WEB OF SCIENCE (2018); Ministry of Science & Higher Education (100 points); ARIANTA; BAZEKON; CABELLS' DIRECTORIES; CEEOL CENTRAL AND EASTERN EUROPEAN ONLINE LIBRARY; CEJSH; CeON Repository; CeON Agregator; CrossRef; DIRECTORY OF OPEN ACCESS JOURNALS (DOAJ); EBSCO - Business Source Corporate Plus; E-JOURNALS.ORG; ERIH PLUS; GALE CENGAGE LEARNING; INDEX COPERNICUS INTERNATIONAL PLC; ITALIAN NATIONAL AGENCY FOR THE EVALUATION OF THE UNIVERSITY AND RESEARCH SYSTEMS (ANVUR); NLU-LIBRARY; NSD Nordic List (Norway); Publication Forum, Finland; RePEc (Research Papers in Economics); Sherpa Romeo; THE ELEKTRONISCHE ZEITSCHRIFTENBIBLIOTHEK EZB (ELECTRONIC JOURNALS LIBRARY); ULRICH'S PERIODICALS DIRECTORY; WORLDCAT; WSB NLU INSTITUTIONAL REPOSITORY

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The original version: Online first

eISSN: 2299-7326 (Online first)

ISSN: 2299-7075 (Print)

Cover: Joanna Pierzchała

Typesetting and printed by:

Wydawnictwo i Drukarnia NOVA SANDEC

ul. Lwowska 143, 33-300 Nowy Sącz, www.novasandec.pl

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DOI: <https://doi.org/10.7341/20252141>
JEL Codes: O32, L83, M21, Q56, Z32

Innovation, digitalization, and sustainability as drivers of performance in tourism MSMEs: A multigroup evidence from the Pacific Alliance

Antonio Luis Duréndez Gómez Guillamón¹ , Domingo García-Pérez-de-Lema² 
Edgar Julián Gálvez-Albarracín³ , Francisney Vera-Jaramillo⁴ 

Abstract

PURPOSE: Based on the resource and capability (RBV), the natural resource-based view (NRBV), and institutional theory, this study analyzes the relationship between innovation and performance and the mediating effects of sustainability and digitalization in tourism micro, small, and medium-sized enterprises (MSMEs) in Pacific Alliance (PA) (Chile, Colombia, Mexico, and Perú). **METHODOLOGY:** This study applies a quantitative approach using survey data from 1,388 tourism MSME entrepreneurs in the Pacific Alliance. Structural equation modeling and multigroup analysis were used to examine key relationships and differences between groups (PA countries). **FINDINGS:** The findings confirm the positive and significant relationship between innovation and performance and the mediating effect of sustainability and digitalization in Pacific Alliance tourist MSMEs. Through MICOM and multigroup analyses, significant differences were identified among Chile, Mexico, and Colombia, with the first two countries demonstrating greater competitiveness in tourism development. **IMPLICATIONS:** The findings offer relevant implications for business management and public policymaking, promoting innovation strategies mediated by digitalization and sustainability. In a competitive tourism environment, digitalization and sustainability are key factors that drive innovation in MSMEs. These strategies strengthen their capacity for adaptation, differentiation, and sustainable growth. **ORIGINALITY AND VALUE:** Unlike most research focused on developed countries, this study contextualizes the phenomenon within tourism MSMEs in emerging economies such as those in the Pacific Alliance, highlighting the influence of the institutional environment on business adaptation. This research contributes to the existing literature by providing the first empirical evidence in the context of the Pacific Alliance on the mediating role of sustainability and digitalization in improving performance through MSME innovation. **Keywords:** innovation, digitalization, sustainability, performance, tourism, MSMEs, Pacific Alliance, emerging economies, resource-based view, institutional theory, competitiveness, multigroup analysis

1 Antonio Luis Duréndez Gómez Guillamón, Ph.D., Department of Economics, Accounting and Finance, Universidad Politécnica de Cartagena, C/Real, 3. 30201 Cartagena, Spain, e-mail: antonio.durendez@upct.es (ORCID: <https://orcid.org/0000-0003-0619-008X>).

2 Domingo García-Pérez-de-Lema, Ph.D., Department of Economics, Accounting and Finance, Universidad Politécnica de Cartagena, C/Real, 3. 30201 Cartagena, Spain, e-mail: domingo.garcia@upct.es (ORCID: <https://orcid.org/0000-0001-6951-4630>).

3 Edgar Julián Gálvez-Albarracín, Ph.D., Department of Administration and Organizations, Universidad del Valle, Cl. 4b #36-00, El Sindicato, Cali, Colombia, e-mail: edgar.galvez@correounivalle.edu.co (ORCID: <https://orcid.org/0000-0003-3972-2310>).

4 Francisney Vera-Jaramillo, Ph.D. Candidate, Department of Administration and Organizations, Universidad del Valle, Cl. 4b #36-00, El Sindicato, Cali, Colombia, e-mail: francisney.vera@correounivalle.edu.co (ORCID: <https://orcid.org/0000-0001-9793-5205>).

Received 9 April 2025; Revised 28 July 2025; Accepted 11 September 2025.

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INTRODUCTION

Innovation is a key element in enhancing business performance (Beltramino et al., 2020; Santarsiero et al., 2024), enabling firms to gain competitive advantages in the market (Bielińska & Hamerska, 2021). The literature generally supports the notion that innovation leads to improved performance, although some studies have reported negative or non-significant relationships (Rosenbusch et al., 2011; Rubio-Andrés et al., 2024). For this reason, numerous researchers have focused on exploring how to operationalize innovation more effectively. In this regard, digitalization and sustainability have emerged as two critical factors for enhancing innovation efficiency (Bilal et al., 2025). Digitalization enables firms to respond more swiftly to environmental demands, innovate, and improve business outcomes (Cucari et al., 2022), while sustainable development practices contribute to the social, economic, and environmental progress of firms, maintaining harmony with their surroundings (Alvarado et al., 2017) and simultaneously boosting performance indicators.

In a highly competitive and dynamic environment, tourism enterprises face the challenge of adapting to new market demands and increasingly discerning customer profiles (Setyawati et al., 2024; Konu & Tyrväinen, 2025). The mediating roles of digitalization and sustainability enhance innovation in tourism SMEs, strengthening their capacity for adaptation, differentiation, and sustainable growth (Kumar et al., 2024; Medrano-Sánchez & Fuster, 2024; Wahyudiono et al., 2024). These strategic factors are essential for competing in a globalized, customer-oriented, responsible, and enduring market. The literature addressing how sustainability through innovation fosters competitiveness in tourism MSMEs has approached the topic from various perspectives, contributing to a better understanding of how this process enhances their competitiveness (Agyabeng-Mensah et al., 2023; Dueñas-Ocampo et al., 2021; Vávrová et al., 2024). Additionally, efforts have been made to analyze this issue within the context of the Pacific Alliance (Zuñiga-Collazos et al., 2025). On the other hand, the relationship between innovation, digitalization, and performance has been widely explored in the literature, yielding diverse results (Zahoor et al., 2023; Coronado et al., 2023; Valdez-Juárez et al., 2024; Espina-Romero et al., 2024).

Despite the existing body of literature, significant research gaps remain, and there is a pressing need to expand studies that support the competitiveness of tourism MSMEs. From a research gap perspective, studies linking innovation and its determinants to performance have primarily focused on developed countries. However, there is limited empirical evidence concerning MSMEs in emerging economies (Al Nuaimi et al., 2024). MSMEs operating in emerging markets are often characterized by weaker institutional environments, which exacerbate the challenges they face (Zahoor et al., 2024). In this context, there is a lack of studies supporting the digitalization process of MSMEs (Skare et al., 2023), as well as a research gap regarding the sustainable behavior of MSMEs and the need to adapt their business models to sustainable development (Cantele & Zardini, 2020; Purnomo & Purwandari, 2025). From a public policy perspective, tourism MSMEs are crucial for regional and economic development, yet there is a shortage of rigorous quantitative studies measuring their impact, particularly in emerging countries, so that they can compete in the international market or seek to increase participation from international customers coming from Latin America or from wealthier economies (Romero-Sánchez et al., 2024; Fernández-Bedoya et al., 2025). Furthermore, there is a need to investigate the main drivers of MSME competitiveness within the framework of the 2030 Agenda for Sustainable Development (UN). Moreover, to date, few applied studies have incorporated RBV and NRBV approaches in research on the tourism industry. For these reasons, this research focuses on the mediating effects of sustainability and digitalization on innovation to improve MSME performance.

Following the previous reasoning and to fill this research gap, the study develops the following research questions (RQs):

- RQ1: Does innovation have a positive and significant relationship on performance in tourism MSMEs in PA countries?
- RQ2: Does sustainability have a mediating effect on the relationship between innovation and performance in tourism MSMEs in PA countries?
- RQ3: Does digitalization have a mediating effect on the relationship between innovation and performance in tourism MSMEs in PA countries?
- RQ4: Are there significant differences among PA countries concerning the relationship between innovation and performance in tourism MSMEs?

To answer these questions, we implement an empirical research design with a dataset of 1,388 MSMEs belonging to the PA. The sample is made up of companies operating in the tourism industry. The research method performed is structural equation modeling (SEM) based on estimations through partial-least squares (PLS-SEM). We also conduct MICOM and multigroup analyses to research differences by country in the PA context.

The context of tourism SMEs within the Pacific Alliance (PA) is particularly relevant for several reasons. First, an analysis of the factors that promote the competitiveness of tourism MSMEs in the PA context is justified by the essential contribution of these enterprises to employment and GDP in Latin America. The countries that comprise the PA—Peru, Chile, Mexico, and Colombia—are considered emerging markets or, in some contexts, developing economies. These are nations undergoing rapid economic growth and transition, yet they have not reached the development levels of more advanced economies. The Pacific Alliance is an economic integration and cooperation initiative formalized in 2011 among Chile, Colombia, Mexico, and Peru, aimed at increasing reciprocal trade and investment, and enhancing competitiveness and productivity (Cuestas & Thoene, 2020; González-Galarza, 2022; Julio-Rospigliosi et al., 2024). The PA has significantly boosted tourism in the region (Prado Lallande & Rouvinski, 2023; Maldonado & Fernández, 2025), fostering economic and social development (Meng et al., 2023; Xiong & Tang, 2023) and generating employment (Albaladejo et al., 2023). Second, basic economic indicators underscore the importance of the tourism industry. Tourism accounts for a significant share of GDP in PA countries: Colombia (2.1%) (MinCIT, 2022), Chile (9.2%) (INEI, 2023), Mexico (8.6%) (INEGI, 2023), and Peru (6.5%) (WTTC, 2023). MSMEs dominate the tourism sector in all these countries, with participation rates ranging from 90% to 98.9% (ANIE, 2022; SERNATUR, 2023; COMEXPERÚ, 2022). Collectively, the PA region has a population of 233 million, a GDP of 2.3 trillion USD, and tourism contributes 6.6% to regional GDP, with 93.48% of tourism enterprises being MSMEs.

Our study contributes to the literature in several ways. From a theoretical perspective, it integrates the Resource-Based View (RBV), Natural Resource-Based View (NRBV), and Institutional Theory to analyze how innovation, digitalization, and sustainability drive the competitiveness of tourism MSMEs in emerging economies. Most existing literature has focused on innovation processes in developed countries, with very limited studies in emerging economies (Al Nuaimi et al., 2024), and even fewer in Latin America. The importance of context and environment in the innovation process is crucial for understanding the success of innovation strategies, particularly in emerging markets (Malik et al., 2024). Institutional theory helps explain how norms, regulations, and social values influence MSME behavior (Jain et al., 2024). In emerging economies, where institutional environments are often unstable or informal, this theory provides a framework to analyze how firms adapt (or fail to adapt) to environmental pressures in order to survive, innovate, and grow (Balzano et al., 2024; Eitrem & Modell, 2024; Galleli & Amaral, 2025). In this regard, our study contributes to contextualizing the literature within the tourism sector in emerging countries. Using a MICOM and multi-group analysis, the results reveal significant differences among Chile, Mexico, and Colombia, indicating that tourism MSMEs in Chile and Mexico are more competitive in tourism development compared to other emerging PA economies.

Secondly, the findings have important implications for the management of tourism enterprises and for policymakers promoting tourism industry development. They can assist managers and business owners in fostering innovation through the mediating roles of digitalization and sustainable practices to gain competitive advantage. Moreover, the results are valuable for guiding more effective public policies and support programs that leverage innovation to enhance the natural, social, and cultural resources of the PA context.

The paper is structured in the following way. First, the respective theoretical and empirical foundations are presented, and then the research methodology is explained. The results are presented and discussed, and finally, the conclusions, limitations, and future opportunities of the research are offered.

THEORETICAL FRAMEWORK AND HYPOTHESES

The theoretical framework of our study is primarily grounded in resource-oriented theories, such as the Resource-Based View (RBV) and the Natural Resource-Based View (NRBV), as well as in context-focused theories, notably institutional theory. In the 1990s, Barney (1991) proposed that businesses must utilize valuable, rare, inimitable, and non-substitutable resources to remain competitive, achieve their proposed objectives, and enhance performance. Thus, the Resource-Based View (RBV) is related to strategic business management (Andrews, 1971; Civelek et al., 2023). Resources can be tangible or intangible. The former are physical in nature, such as buildings, property, plants, equipment, etc. Intangibles are not material and include brand value, organizational culture, policies, and intellectual capital, among others (Grant, 1996). Authors have applied the RBV to explain resource management, performance, and sustained business competitive advantage (Barney, 2018). Barney et al. (2021) considered that to obtain economic value, MSMEs must make co-specialized investments by combining homogeneous resources and capabilities. If these are rare, iterative, and complex, they can be a source of sustained competitive advantage. Capabilities are defined as management's ability to make decisions, manage

resources, and satisfy customers' needs, facilitating heterogeneity, longevity, and the evolution of companies (Teece, 2019). They are divided into ordinary, which refers to those that are easy to imitate, and dynamic, which are essential for facing volatile environments and improving the proposed results (Winter, 2003).

Since the RBV only explains economic aspects and does not consider companies' environmental actions (Lockett et al., 2009), Hart (1995) proposed a Natural Resource-Based View (NRBV) that takes into account the protection of the natural environment and its relationship with sustainable development (Andersen et al., 2020; Zopf & Guenther, 2015). Thus, the NRBV helps implement environmental strategies, allowing MSMEs to obtain competitive results (Mishra & Yadav, 2021; Agyabeng-Mensah et al., 2023; Lichtenthaler, 2021). According to the NRBV, developing and maintaining unique and valuable environmental capabilities is a central axis that permits companies to obtain financial benefits (Albertini, 2019; Agyabeng-Mensah et al., 2023). Therefore, to ensure that environmental management positively affects the company's performance, managers and employees must have adequate skills to incorporate habits into processes and include sustainable routines in the organizational culture (Dubois & Dubois, 2012).

Institutional theory has been key in several areas of knowledge, especially in social sciences (Scott, 1987) and organizational management (DiMaggio & Powell, 1983). This current proposes that organizations do not act in isolation, but rather respond actively to the social, cultural and normative contexts that surround them (Balzano et al., 2024; Eitrem & Modell, 2024; Galleli & Amaral, 2025). Thanks to its multiple approaches, this perspective allows us to understand in greater depth phenomena such as tourism development (Meyer & Rowan, 1977; DiMaggio & Powell, 1983). It is also effective for analyzing the particular behavior of MSMEs in emerging economies, which may be closely linked to their communities (Falaster & Guerrazzi, 2017; Rachmiatie et al., 2024; de Curtò et al., 2025). They are especially sensitive to institutional pressures, such as public policies that impact their operations and regulations that seek to balance local traditions with the demands of the global market (Soares et al., 2021; Bhatti Singh, 2025; Hagsten & Falk, 2024).

The context of the Pacific Alliance

According to the Travel and Tourism Development Index, developed by the World Economic Forum to assess factors that enable the sustainability and resilience of the sector, the Pacific Alliance (PA) countries occupy a mid-range position globally. Chile ranks highest (34), followed by Mexico (40), Colombia (58), and Peru (65).

Tourism in Colombia contributes 2.1% to the national GDP (Ministry of Commerce, Industry, and Tourism, 2022), with micro, small, and medium-sized enterprises (MSMEs) accounting for 90% of the tourism sector (ANIF, 2022). Colombia's strongest pillar is price competitiveness, followed by its natural resources. However, land, port, and air infrastructure, as well as economic conditions, received low ratings. Investment in science, technology, and innovation is recommended to promote sustainable resource use and enhance productivity (Martínez & Poveda, 2021). Digitalization has also facilitated innovation among tourism MSMEs (Rabetino et al., 2023).

In Chile, tourism represents 9.2% of GDP (National Institute of Statistics [INEI], 2023; Ministry of Economy, Development, and Tourism, 2023), and MSMEs constitute 95% of the tourism sector (National Tourism Service, 2023). Chile stands out for its technological preparedness in tourism and price competitiveness. Innovation has been a key driver of MSME competitiveness (Román & Font, 2014); however, challenges persist, including a lack of skilled labor and market information (Canales & Álvarez, 2017; Martínez, 2019). During the pandemic, these businesses mitigated revenue losses through online sales and digital promotion, strengthening their structure and economic performance (Acevedo et al., 2023). This has fostered digital innovation and contributed to the country's economic and social development.

In Mexico, tourism contributes 8.6% to GDP (National Institute of Statistics and Geography [INEGI], 2023; Ministry of Tourism, 2023), and MSMEs represent 98.9% of the tourism sector (Ministry of Tourism, 2023a). Mexico is distinguished by its cultural, gastronomic, and heritage richness, which drives tourism flows and MSME performance (Correia et al., 2013; Rojas et al., 2020). The sector's competitiveness is based on strong air infrastructure and rich natural and cultural resources, though improvements are needed in security, sustainability, and the business environment. Studies in Guanajuato show that information technologies facilitate innovation and enhance business performance (Cuevas-Vargas et al., 2023).

Finally, in Peru, tourism contributes 6.5% to GDP (World Travel and Tourism Council, 2023), and MSMEs account for 90% of the tourism sector (Foreign Trade Society of Peru, 2022). Peru's tourism industry, heavily reliant on its natural and cultural resources, needs improvement in infrastructure, enabling environments, and sustainability. Innovation has generally led to increased sales and productivity, although its impact varies depending on the type of technology, firm size, and the gender of the manager (Seclén et al., 2022). The pandemic accelerated digitalization, but rural community-

based tourism has not progressed at the same pace, affecting destination promotion, employment, and the local market (Maquera et al., 2022).

After establishing the main theoretical framework of our study and offering a brief description of the tourism business environment in the Pacific Alliance, we now present the research model along with the proposed hypotheses, which are detailed below (Figure 1).

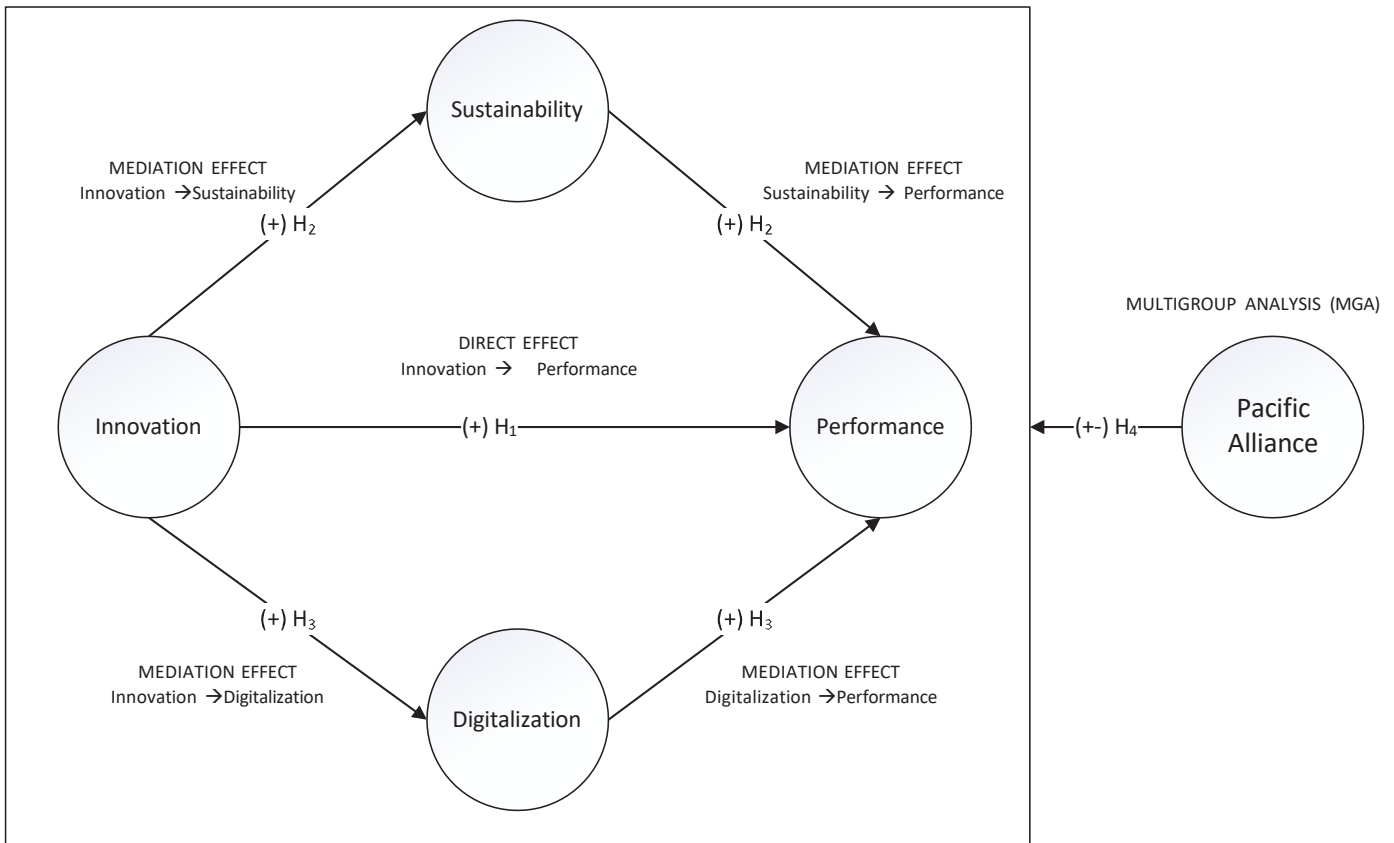


Figure 1. Proposed model. Hypotheses

Innovation and performance

Innovation creates value through novel actions that lead to improved performance (Domi et al., 2019; Valdez-Juárez & Castillo-Vergara, 2021; Verreyne et al., 2019; Sharma et al., 2021; Carrasco et al., 2023; Ferreira et al., 2020). It involves the generation of intangible resources—such as new ideas, policies, and beliefs—that enhance business outcomes (Griseemann et al., 2013; Mattsson & Orfila-Sintes, 2014; Domi et al., 2019). From the perspective of the Resource-Based View (RBV), innovation systems can serve as a source of unique resources and specific capabilities that drive MSME competitiveness and significantly improve their performance (Teece, 2019; Hilman & Kaliappen, 2015).

Previous studies support the positive relationship between MSME innovation and performance (Beltramino et al., 2020; Ferreras-Méndez et al., 2021; Vera-Jaramillo et al., 2024). However, some research has shown that innovation does not always yield the expected results and is influenced by factors such as efficiency, organizational capabilities, and revenue growth. This suggests that, for business model innovation to be effective, firms must strengthen their internal capabilities and align their strategies with clear growth objectives (Latifi et al., 2021).

Innovation has become a key driver in transforming traditional tourism enterprises into regional leaders (Santarsiero et al., 2024). In a market saturated with options, MSMEs that focus on delivering unique experiences—supported by cutting-edge technologies and personalized service—achieve significant differentiation (Wang et al., 2025). This innovative approach not only enhances the customer experience but also values and retains employees as essential contributors to organizational performance (Wang et al., 2025; Santarsiero et al., 2024; Luongo et al., 2023; Azmi et al., 2023). Moreover,

organizational flexibility and support for innovation management significantly influence the performance of tourism enterprises (Zirena-Bejarano et al., 2023; De la Gala-Velásquez et al., 2023). Additionally, the literature has found that tourism MSMEs primarily innovate in response to customer needs; however, they often fall short in R&D investment, which may negatively impact their outcomes (Maldonado-Guzmán et al., 2017; Armstrong & Brown, 2019).

Innovative activity in the tourism sector manifests in various forms. For instance, integrating visitors into local daily life represents product and experience innovation; the implementation of biometric recognition systems for bookings and transactions streamlines the tourist experience and constitutes a significant technological advancement; and the commitment to sustainability—by both service providers and travelers—demonstrates environmental innovation. These and other strategies contribute to improving operational efficiency, increasing revenue, adapting to changing environments, and attracting new markets, thereby strengthening business performance (Alos-Simo et al., 2024; Arici et al., 2024; Hernández-Barahona et al., 2023; Luongo et al., 2023; Wszendybył-Skulska et al., 2024).

In this context, it becomes relevant to focus on the following hypothesis:

H1: Innovation has a positive and significant effect on performance in tourism MSMEs in PA countries.

Mediating effect of sustainability on the relationship between innovation and performance

According to the Natural Resource-Based View (NRBV), promoting the conservation of strategic resources entails implementing business models oriented toward their reuse and protection. Simultaneously, it emphasizes the importance of establishing cross-sector collaborations and fostering the creation of hybrid enterprises committed to cooperation and the development of collective well-being within the communities in which they operate. Such practices encourage the efficient use of resources, promote socially responsible investments, and strengthen financial risk management. The growing need to address environmental, economic, and social impacts drives companies to develop innovations in their products, services, and processes (Agyabeng-Mensah et al., 2023; Dueñas-Ocampo et al., 2021).

In this regard, various studies focused on tourism MSMEs have highlighted that sustainability acts as a driver of organizational performance by attracting a segment of conscious tourists willing to pay premium prices for responsible experiences. Moreover, adopting sustainable practices enables these businesses to access green financing, establish public-private partnerships, and gain international recognition (Chang & Cheng, 2019; Arsawan et al., 2022; Vávrová et al., 2024). Innovation driven by environmental sustainability practices facilitates market expansion and enhances business performance (García-Lopera et al., 2022). For example, innovation through sustainability practices can reduce the negative environmental impact of tourism activities in natural destinations, respect cultural diversity and frameworks, and increase stakeholder outcomes (De et al., 2020; Tajeddini & Mueller, 2018).

In the context of the Pacific Alliance countries, significant progress and limitations have been identified regarding sustainability in the tourism sector. In Chile, there is growing interest in the development of the tourism industry, ranging from eco-efficient accommodations to digital platforms for measuring carbon footprints. This suggests that sustainability stimulates innovative solutions (Sourvinou & Filimonau, 2018; Lenzen et al., 2018), with business practices guided by public policies such as the preservation of protected areas (Rivas-Ortega & Rojas-Gutiérrez, 2020). However, the effective adoption of these practices is often constrained by the perception of short-term economic benefits, which limits innovation and its impact on performance (Aldeanueva-Fernández & Cervantes-Rosas, 2019).

In Mexico, although there are governmental efforts to promote sustainability in tourist destinations and foster innovation through it, some MSMEs still lack concrete strategies to mitigate the environmental impact of their operations (López-Argota et al., 2023).

In Colombia, particularly in rural areas, tourism enterprises have progressively integrated sustainability as a competitive development strategy, promoting alternative forms of tourism such as ecotourism, agritourism, and adventure tourism. Community-based tourism has also been encouraged, involving local communities to generate shared value, foster economic resilience, and contribute to ecosystem protection (Serrano-Amado et al., 2018; Zuñiga-Collazos et al., 2025).

In Peru, sustainability concerns are primarily concentrated in urban areas, with actions focused on the responsible consumption of natural resources. Although eco-efficient practices aligned with innovative policies have been promoted, their adoption by tourism MSMEs remains partial, partly due to a limited perception of their competitive impact, which reduces the willingness to implement them (Huamán, 2022).

Based on the above considerations, the following hypothesis is proposed:

H2: Sustainability has a mediating effect on the relationship between innovation and the performance of tourism MSMEs in PA countries.

Mediating effect of digitalization on the relationship between innovation and performance

In a competitive and constantly evolving environment, innovation has become a key driver for MSMEs to create competitive advantages (Varadarajan et al., 2022; Melović et al., 2020). However, previous studies confirm that innovation alone is not always sufficient and requires the integration of new technologies to be more effective (Latifi et al., 2021; Paunovic et al., 2022; Valdez-Juárez et al., 2024; Florek-Paszowska & Ujwary-Gil, 2025). For companies to innovate through the use of emerging technologies—such as artificial intelligence (AI), machine learning, big data, or blockchain—it is essential that both organizational leaders and their teams possess the technological skills necessary to understand and strategically apply these tools (Varadarajan et al., 2022; Melović et al., 2020; Civelek et al., 2023).

In this regard, prior research has demonstrated that digital orientation enhances both innovation processes and financial and non-financial outcomes (Zahoor et al., 2023). Other studies also emphasize that integrating digitalization into a proactive and flexible organizational strategy is particularly relevant in disruptive scenarios, such as the COVID-19 pandemic, where its adoption was crucial for the recovery of tourism businesses, especially small and medium-sized restaurants and hotels (Cruz-Cárdenas et al., 2021; Kanaan et al., 2023).

In the Pacific Alliance region, certain MSMEs have successfully configured their VRIN (Valuable, Rare, Inimitable, and Non-substitutable) resources through digital technologies to implement innovations in new markets (Guo et al., 2020; Coronado et al., 2023). Nevertheless, structural and perceptual barriers persist. For instance, in Chile, tourism MSMEs perceive digitalization as costly, which limits their capacity to innovate (Oyarzún et al., 2020). In Mexico, although internet access and websites are common, a lack of understanding of the strategic benefits of digitalization reduces its impact (Yañez & López, 2022). In Colombia, imitative strategies prevail, driven by technological deficiencies (Donawa-Torres & Morales-Martínez, 2019; López-Rodríguez & López-Rodríguez, 2018), while in Peru, rural MSMEs face limitations due to a lack of connectivity and digital training (Espina-Romero et al., 2024; Maquera et al., 2022).

Based on the literature review, the following hypothesis is proposed:

H3: Digitalization has a mediating effect on the relationship between innovation and performance in tourism MSMEs in PA countries.

Multigroup analysis considering innovation and performance

Within the context of the Pacific Alliance (PA), tourism MSMEs operate in diverse environments that reflect structural, institutional, and technological differences, which directly influence their innovation capabilities and business performance (Rachmiatje et al., 2024; de Curtò et al., 2025). From an explanatory perspective, institutional theory suggests that regulations and norms in each country shape the environment in which MSMEs operate (Zucker, 1987).

Given that the availability and use of strategic resources vary across PA countries, it is reasonable to expect differences in how tourism MSMEs manage their operations. These variations can be attributed both to the structural conditions of each country's institutional framework and to the specific capabilities of individual firms (de Curtò et al., 2025). For example, Chile stands out for its high level of digitalization and institutional coordination, which has enabled the integration of digital tools that enhance innovation and performance among tourism MSMEs. This has boosted their competitiveness and economic dynamism through the strategic involvement of the state, the business sector, academia, and civil society (Farías & Cancino, 2021; Castillo-Vergara et al., 2025; Ibarra & González, 2023).

In contrast, Mexico continues to face significant challenges in digitalization. Although technological adoption has advanced and supports innovation, its implementation remains limited due to a lack of resources for technological infrastructure, low levels of digital training among entrepreneurs, and limited progress in peripheral areas. These factors hinder the ability of firms to strengthen their digital and innovation processes (Cuevas-Vargas et al., 2023; Braunerhielm & Hoppstadius, 2025).

In Colombia, digitalization has progressed significantly in recent years (Martínez & Poveda, 2021; Rabetino et al., 2023; Vera et al., 2022; Bowen, 2021). However, challenges remain, such as limited internet access in rural areas and cultural resistance to technological change among some local populations (Aïdi & Fabry, 2024; Zuñiga-Collazos et al., 2025; Kochuma et al., 2024). In Peru, tourism MSMEs face digitalization challenges. Recent studies indicate that only about

30% of small and medium-sized enterprises have adopted digital technologies, due to obstacles such as limited financial resources and connectivity issues. Additionally, many of these businesses continue to operate with manual processes, restricting their capacity for innovation and competitiveness (Paiva et al., 2024; Maquera et al., 2022; Gutiérrez et al., 2025).

In terms of sustainability, a similarly diverse landscape is observed. In Chile, structural challenges persist. For instance, although approximately 40% of the country's electricity comes from renewable sources, there remains a significant dependence on fossil fuels, limiting its contribution to sustainable development (Gaete-Morales et al., 2018; Gallego-Schmid et al., 2025). Regarding social sustainability, there is limited incorporation of traditional knowledge, reflecting a lack of recognition of local communities. Moreover, several studies have identified socio-spatial inequalities in Santiago, particularly in the distribution of social, economic, and environmental services, which affect business innovation and organizational outcomes (Livert & Gainza, 2014; Nikolakis et al., 2022).

In Mexico, sustainability is gaining prominence in the business sphere, acting as a key component that directly influences the performance of tourism MSMEs (León-Gómez et al., 2025; Akdemir & Erkasap, 2025). Despite progress, these businesses still face significant barriers such as technical knowledge gaps, difficulties accessing financing for sustainable initiatives, and pronounced territorial inequality, with rural communities at a disadvantage due to limited institutional support (Espinoza-Rodríguez et al., 2025; Villavicencio et al., 2025).

Colombia faces similar issues. Tourism MSMEs struggle with low levels of technical knowledge in sustainable practices, limited operational capacity, and territorial inequality that restricts access to resources in rural areas. Additionally, the lack of tourism planning has led to negative environmental impacts, such as water pollution and excessive solid waste (Flórez et al., 2022; Higuera, 2023; Pineda, 2023). A different scenario is observed in Peru, where the government has promoted initiatives focused on rural tourism, environmental protection, and cultural appreciation as pillars of tourism development. However, various studies warn that the reach of these policies remains limited in regions where Indigenous communities prevail, reducing their effectiveness in promoting sustainable practices (Polas et al., 2022; Bunclark & Barcellos, 2021; Esparza-Huamanchumo et al., 2024; Esenarro et al., 2024).

Therefore, when considering the differences among PA countries, these can be explained by structural factors, consumer preferences, and strategic decisions in tourism management, which affect dimensions such as technological capacity, sustainability, innovation, and performance efficiency (Al-Romeedy & Alharethi, 2025; Yin et al., 2024). It is also important to consider other determining factors such as macroeconomic conditions, regulatory frameworks, access to financing, and the level of international integration, all of which can directly influence business performance in each country (Julio-Rospigliosi et al., 2024; Reyes & Useche, 2018; Deaza & Vivas, 2016).

Moreover, regional integration with more developed economies may represent a strategic advantage by facilitating access to new markets, skilled talent, and institutional support. A useful example is the European Union, where previous research has shown that SMEs have benefited from common policies and integrated regulatory frameworks in the tourism sector, which could serve as a reference for PA countries. However, in emerging economies, challenges such as corruption and economic and political instability persist (Estol et al., 2018; Martey, 2025).

Based on the review of the literature for each PA country, the following hypothesis is proposed:

H4: Tourism MSMEs in Pacific Alliance countries exhibit significant differences in the mediating role of sustainability and digitalization between innovation and performance.

METHODOLOGY

Sample method

The study uses the Ibero-American Mipyme Observatory Database, the original source for the "Mipyme Report 2022: Digitalization and Sustainable Development of MSMEs in Ibero-America." This is an FAEDPYME Network initiative. The FAEDPYME Network is a non-profit organization composed of a large number of researchers from universities throughout Latin America and Spain. The sample used in this study consists of 1,388 tourism MSMEs with between 5 and 250 employees.

The addresses and telephone numbers of the firms were obtained from official directories: in Peru, from the Directory of Tourism Service Companies (PROMPERÚ); in Chile, from the Federation of Tourism Companies of Chile (FEDETUR); in Mexico, from the National Tourism Business Council (CNET); and in Colombia, from the Statistical Business Directory

(DEE), compiled by DANE. Based on these directories, a simple random sampling method was applied to select the sample for each country analyzed. Data collection took place between February and May 2022. The questionnaires were administered to managers and/or business owners, as they are typically responsible for making key decisions in MSMEs (Van Gils, 2005) and directly influence the strategic behavior of their organizations (O’Regan & Sims, 2008).

Personalized phone calls were organized according to the needs of each participant. During these conversations, the purpose of the study was explained in detail, and any additional information requested by participants was provided (Rosique-Blasco et al., 2018). This strategy aimed to minimize potential biases and increase the response rate (Carter et al., 2014). Respondents were assured of the confidentiality of their answers (Kariv et al., 2009), and controls were implemented to prevent data entry errors. Participants who declined to complete the questionnaire were randomly replaced by firms of similar size within each country. Approximately 19% of the contacted MSMEs refused to participate in the survey.

The characteristics of the sample are presented in Table 1. The study focuses exclusively on Pacific Alliance countries (Chile, Colombia, Mexico, and Peru) and on firms operating within the tourism industry. Specifically, the total sample comprises 1,388 firms, distributed as follows: 55 from Chile, 654 from Colombia, 574 from Mexico, and 105 from Peru. All firms are engaged in various tourism-related activities. By size, the sample includes 706 micro, 412 small, and 245 medium-sized enterprises. Additionally, the firms have an average age of 11 years, with ages ranging from 1 to 155 years. The data analysis was conducted using a structural equation modeling technique, complemented by a multigroup comparative analysis.

Table 1. Statistics of the sample

Variables	N	%
<i>Number of firms</i>	1.388	100
Chile	55	4
Colombia	654	47.1
Mexico	574	41.4
Peru	105	7.6
<i>Size of firms</i>		
Micro	706	51.8
Small	412	30.2
Medium	245	18

Note: Descriptive data.

To assess the quality of the questionnaire data, both non-response bias and common method variance bias were examined. In line with the approach proposed by Vitell and Nwachukwu (1997), late respondents were used as a proxy to test for non-response bias. Specifically, responses from the first wave (75%) were compared with those from the later wave (25%). The results of t-tests and chi-square tests indicated no statistically significant differences between the two groups (Vitell and Nwachukwu, 1997). Given that data for both dependent and independent variables were collected from the same source, there is a potential risk of common method bias (Achidi-Ndofor & Priem, 2011), which may artificially inflate the observed relationships (Zhang et al., 2022). To address this concern, Harman’s single-factor test was conducted (Podsakoff & Organ, 1986). This technique evaluates whether a single factor accounts for the majority of the variance in the data, which would suggest the presence of bias. The analysis yielded a Kaiser-Meyer-Olkin (KMO) value of 0.917 and a significant Bartlett’s test of sphericity ($p < 0.000$), confirming the adequacy of the data for factor analysis. The total variance explained was 58.17%, with the first factor accounting for only 29.324%, indicating that common method variance is not a major concern in this study.

Research model and variables

The research method is based on structural equation modeling (SEM) through partial-least squares estimations (PLS-SEM). This is a robust and extended methodology for researching social sciences with datasets that are not normally distributed. SEM (Structural Equation Modeling) is usually applied to explain multiple statistical relationships simultaneously through

visualization and model validation. Complex models can be discussed simply through this technique. It is an extension of traditional linear modeling techniques.

A questionnaire was administered to the managers of tourism MSMEs in the PA context to gather information. The design of the study was developed through a literature review and the Ibero-American MSMEs Observatory 2022. The questionnaire was designed with items measured using a Likert scale from 1 to 5, where 1 is total disagreement or unimportant, and 5 is total agreement or very important. To understand how the innovation, performance, sustainability, and digitalization variables were measured, it is essential to describe how the items below were formed.

Innovation

To assess the importance of innovation, tourism MSME entrepreneurs were asked about the following activities: changes or improvements in existing products/services, market launches of new products/services, changes or improvements in production processes, acquisition of new capital goods, new changes or improvements in organization and/or management, new changes or improvements in purchases and/or supplies, and new changes or improvements in marketing and/or sales. The measurement of this variable has been taken from the Oslo Manual (OECD, 2005) and has been used in previous studies (Arsawan et al., 2022; Beltramino et al., 2020; Ferreras-Méndez et al., 2021; Latifi et al., 2021).

Sustainability

To examine sustainability in tourism SMEs, we asked about the degree of agreement or disagreement regarding environmental criteria in the selection of suppliers; environmental criteria in the management of plastic packaging and derivatives; environmental criteria in process design; environmental criteria for energy management; environmental criteria in water management; environmental criteria in waste management; and environmental certifications (e.g., ISO14001/EMAS) (Agyabeng-Mensah et al., 2023; Cantele & Cassia, 2020; Aina & Atan, 2020; Denicolai et al., 2021).

Digitalization

To calculate the level of digitalization in tourism MSMEs, entrepreneurs were approached with topics related to the possibilities and advantages of digitalization, such as the investment required for digitalization, the training that managers and employees need to incorporate digitalization, and training for digital transformation. The eight items have been previously studied by Bhimani et al. (2019), Zahoor et al., (2023), Madrid-Guijarro et al. (2023) and Avelar et al. (2024).

Performance

To evaluate the performance of tourism MSMEs, it was necessary to check internal results, such as the quality of a company's products and the efficiency of its production processes, external results, such as customer satisfaction and rapid adaptation to change, and the results referring to rationality and human talent by measuring profitability, employee satisfaction, and work absenteeism. This scale was developed in depth by Quinn and Rohrbaugh (1983) and used by Beltramino et al. (2020), Latifi et al. (2021), and Prado et al. (2022).

RESULTS AND DISCUSSION

Measurement model (outer)

To assess the reliability and validity of the measurement model (see Figure 2), the results of Cronbach's Alpha and composite reliability were evaluated. They were above the minimum threshold, which confirms the internal consistency of the constructs. The Convergent validity effects (AVE) are also satisfactory (Hair et al., 2019). Regarding the variance inflation factor (VIF), the values are close to 3 or less; that is, the variables do not have multicollinearity problems (Hair et al., 2014). The results of the predictive power indicator (Q^2) are greater than 0 and represent the good predictive capacity of the model (Hair et al., 2019) (Table 2).

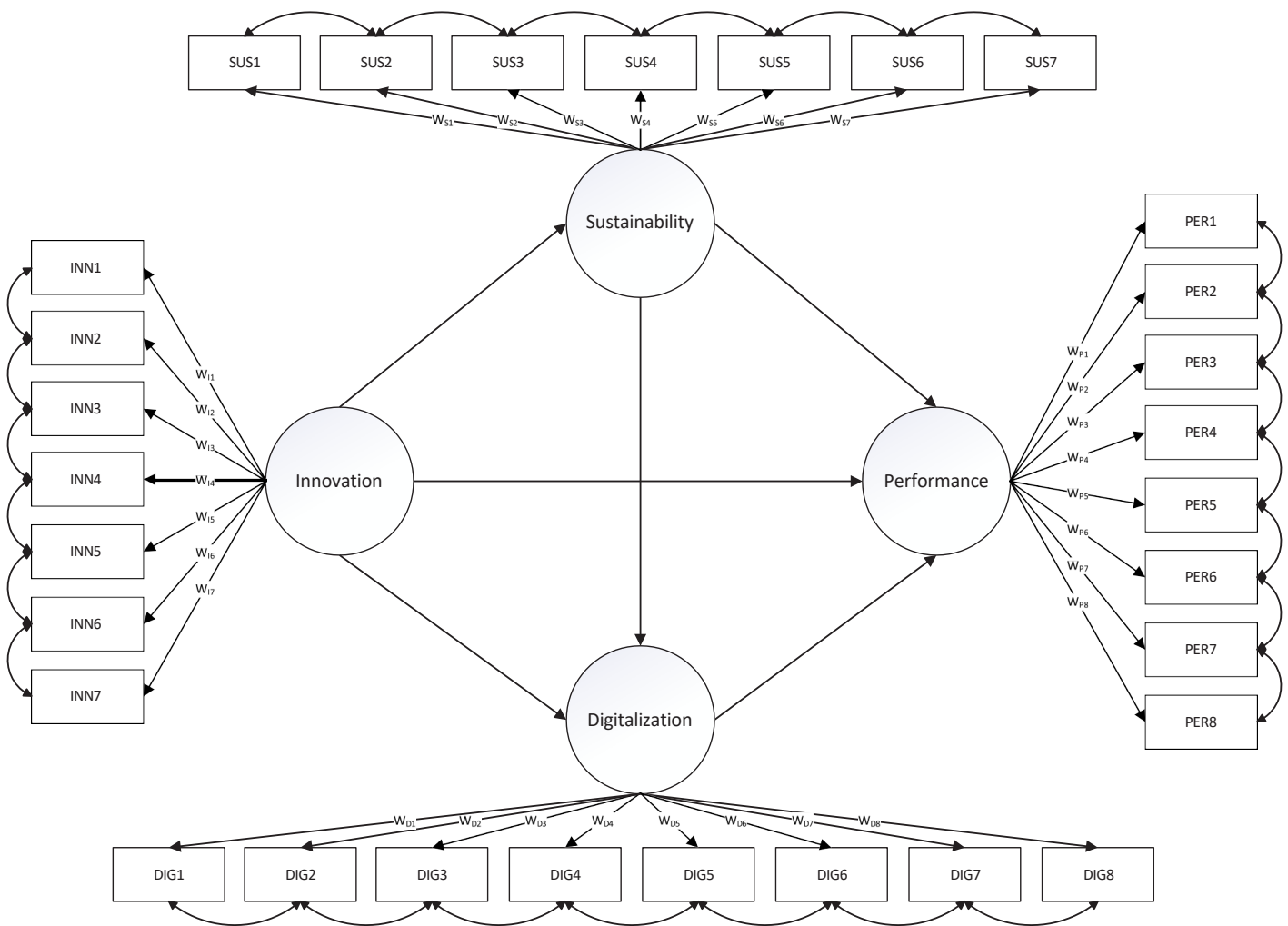


Figure 2. Measurement model

Table 2. Measurement model assessment

Constructs/Indicators	Loadings	VIF	Q ²
Innovation activity			
Changes or improvements to existing products/services	0.747	1.899	
Launching new products/services on the market	0.742	1.985	
Changes or improvements in production processes	0.828	2.511	
Acquisition of new capital goods	0.740	1.801	
New changes or improvements in organization and/or management	0.834	2.673	
New changes or improvements in purchases and/or supplies	0.799	2.268	
New changes or improvements in commercial and/or sales	0.819	2.26	
AVE: 0.621, Cronbach's Alpha: 0.898, CR: 0.920, rho A: 0.900.			
Sustainability			
Environmental criteria in the selection of suppliers	0.786	2.128	0.157
Environmental criteria in the management of plastic packaging and derivatives	0.841	2.674	0.137
Environmental criteria in process design	0.878	3.206	0.160
Environmental criteria for energy management	0.865	3.224	0.122
Environmental criteria in water management	0.868	4.091	0.102

Constructs/Indicators	Loadings	VIF	Q ²
Digitalization			
Environmental criteria in waste management	0.842	3.218	0.102
Environmental certifications (e.g., ISO14001/EMAS)	0.649	1.439	0.046
AVE: 0.675, Cronbach's Alpha: 0.918, CR: 0.935, rho A: 0.921.			
Digitalization			
We know the possibilities and advantages of digitalization well	0.628	1.553	0.066
We allocate important resources to digitalize the business	0.830	2.921	0.108
The business model is evaluated and updated in terms of digitalization	0.837	2.917	0.099
Our employees are prepared for the digital development of the company	0.817	2.54	0.074
Our managers are well-trained in digitalization	0.789	2.263	0.087
The degree of process automation is high	0.829	2.832	0.094
We use digitalization in the organizational management of the company	0.852	3.401	0.101
In our company, training for digital transformation is regularly organized	0.829	2.916	0.091
AVE: 0.647, Cronbach's Alpha: 0.921, CR: 0.936, rho_A: 0.924			
Performance			
Product quality	0.729	1.99	0.143
Efficiency of production processes	0.756	1.919	0.122
Customer satisfaction	0.763	2.196	0.149
Speed of adaptation to changes in the market	0.781	1.972	0.174
Sales growth rate	0.775	2.198	0.170
Cost-effectiveness	0.761	2.079	0.155
Employee satisfaction	0.743	1.793	0.145
Degree of absenteeism from work	0.563	1.326	0.050
AVE: 0.543, Cronbach's Alpha: 0.878, CR: 0.904, rho_A: 0.885.			

Note: AVE > 0.50; rho A > 0.80; Cronbach's alpha (α) > 0.70; VIF ($X < 5$) and $Q^2 > 0$. (Hair et al., 2019).

Structural model (inner)

The structural model, expressed in the theoretical framework, provides the values that explain the relationships of the hypotheses (Henseler et al., 2014). A total of 5,000 permutations were applied to assess the statistical significance of the path coefficients (Hair et al., 2019). From this evaluation, discriminant validity was identified, and the conditions of the Fornell and Larcker (1981) test and the Heterotrait-Monotrait (HTMT) test of Henseler and Dijkstra (2015) were displayed (Table 3). The relationship between the square root of the AVE and the other constructs (see Table 3) meets the Fornell and Larcker (1981) criterion. Likewise, the discriminant validity of the HTMT relationship is below the maximum level of acceptance (0.90) (Franke and Sarstedt, 2019), which indicates that the items in the model are unidimensional.

Table 3. Discriminant validity Fornell & Larcker and HTMT ratio

	Fornell & Larcker				HTMT			
	1	2	3	4	1	2	3	4
Digitization	0.804							
Innovation	0.376	0.788			0.412			
Performance	0.406	0.510	0.737		0.451	0.571		
Sustainability	0.370	0.422	0.354	0.822	0.401	0.461	0.396	

Note: Based on the criteria of Fornell and Larcker (1981) and the Heterotrait-Monotrait (HTMT) test. Fornell & Larcker and HTMT < 0.90 (Henseler and Dijkstra, 2015).

It was necessary to analyze the estimated values to evaluate the global fit of the model. The results show that SRMRs (0.051) are below the desired threshold (0.08), suggesting a good approximation between the observed and estimated matrices. Additionally, the dULS (1.226) and dG (0.418) values are within the 95% and 99% percentile ranges (1.489 and

0.444, respectively), indicating that the distances between the involved matrices do not show significant deviations (Hair et al., 2017). Collectively, these indicators support the validity of the proposed model and confirm that the theoretical structure aligns well with the empirical data (Henseler et al., 2016), see Table 4.

Table 4. Global adjustment of the model

	Estimated model	Saturated model	Limit	
			95%	99%
SRMR	0.051	0.058	0.032	0.097
dULS	1.226	1.288	0.467	1.489
dG	0.418	0.428	0.138	0.444

Note: SRMR: standardized root mean square = SRMR<0.08; d_ULS unweighted least squares discrepancy; d_G geodesic discrepancy with bootstrap-based 95% percentiles and 99% percentile.

In the case of R² as a coefficient of determination, the results show that the value of the endogenous variable (Performance R² = 0.323) is between 0 and 1 (Shmueli & Koppius, 2011), which allows us to affirm that the predictive power between the variations of the dependent and independent variables is moderate (Hair et al., 2014) (see Table 5).

Table 5. Structural research model results

Research hypotheses (Paths)	β (t-value)	95% confidence interval	p-value	F ²	Results
H1: Innovation-> Performance	0.380 -11.213	[0.324 – 0.435]	0.000***	0.163	Supported
H2: Innovation ->Sustainability -> Performance	0.047 -3.738	[0.027 – 0.068]	0.000***		Supported
H3: Innovation ->Digitalization -> Performance	0.060 -6.383	[0.045 – 0.075]	0.000***		Supported
Endogenous variable	R²	Adjusted R²			
Performance	0.323	0.322			

Notes: Path coefficients and t-Student distribution (in parentheses) value, p-value (significance) and confidence intervals are shown in the table. The F² value indicates the relative size of each incremental effect added to the structural mode. R² is an individual measure that determines the predictive power and relevance of the structural model and represents the amount of variance of the endogenous constructs that are expressed by the exogenous constructs. Additionally, we present an adjusted R² that controls the fictitious increase of the predictive power of the model when extra explanatory variables are added. Significance: *p < 0.10. **p < 0.05.***p < 0.01.

Results of the structural models are shown in Figure 3 and Table 5. The findings suggest that the relationship between innovation and performance (β = 0.380, p < 0.01) (F² = 0.163, the strength of the effect is above average (Cohen, 1988), has a significant and positive impact on the tourism MSMEs studied, which is in line with other research indicating that having new ideas or modifying them allows companies to develop knowledge, acquire information, and improve the context of organizational culture to increase performance (Beltramino et al., 2020). Results confirm a significant and positive effect of innovation on sustainability (β = 0.422, p < 0.01) (F² = 0.217, the strength of the effect is above average) and digitalization (β = 0.268, p < 0.01) (F² = 0.073, the strength of the effect is weak) for tourism MSMEs in the context of the PA. Additionally, we found positive and significant direct effects of sustainability on performance (β = 0.111, p < 0.01) (F² = 0.014, the strength of the effect is weak) and digitalization on performance (β = 0.222, p < 0.01) (F² = 0.059, the strength of the effect is weak).

Further analysis reveals that sustainability has a positive significant mediating effect on the relationship between innovation and performance (β = 0.047, p < 0.01) for tourism MSMEs. This result agrees with studies carried out in sectors like manufacturing, where it was demonstrated that innovation through environmental care and social management promotes favorable results benefiting the economic sustainability of all business stakeholders (Chang & Cheng, 2019; Aina & Atan, 2020; Denicolai et al., 2021). We also find a positive significant mediating effect of digitalization on the relationship between innovation and performance (β = 0.060, p < 0.01) for tourism MSMEs. The previous literature supports the idea that digitalization has mediating effects on this relationship, with studies affirming that talented employees and executive management are required to define technological strategies that benefit innovation and business performance (Varadarajan et al., 2022; Melović et al., 2020).

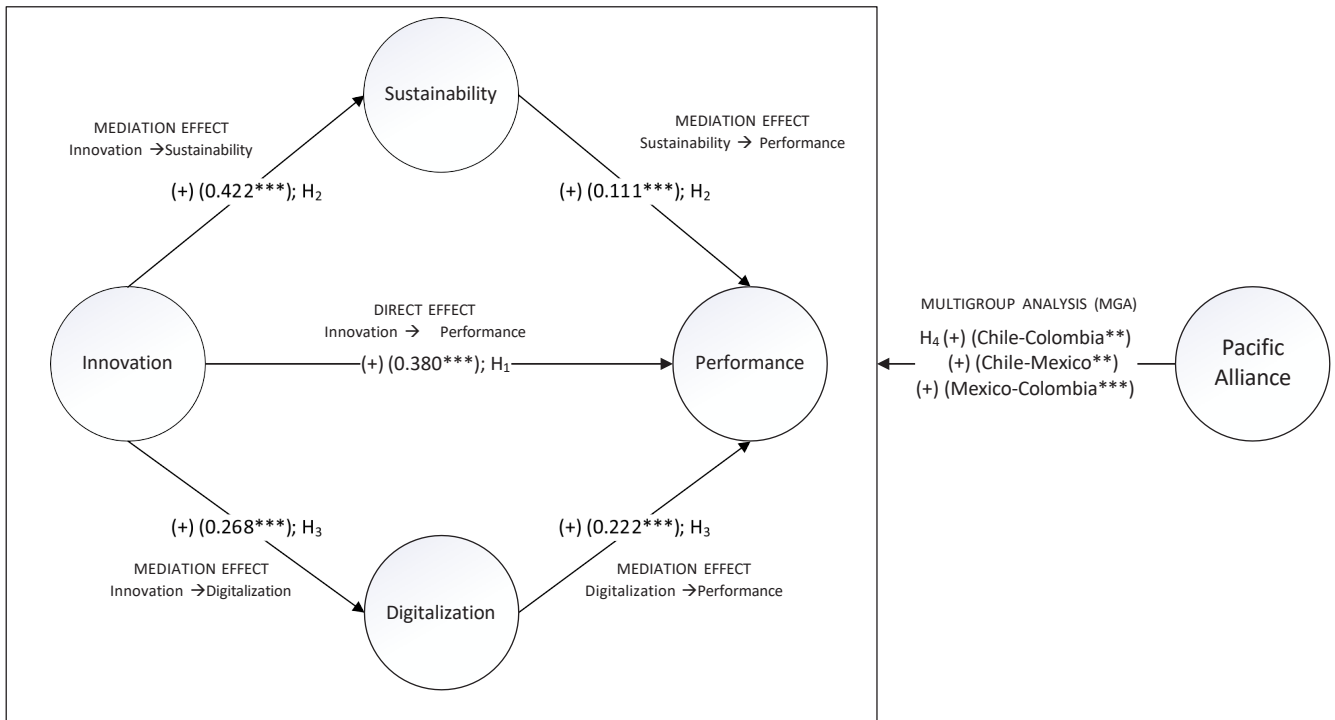


Figure 3. Results of the structural model (variables and mediators)

Measurement model invariance assessment MICOM by country

The measurement invariance of the composite models (MICOM) was estimated to ensure the quality of the multigroup analysis by evaluating the configural and compositional invariance, and the equality of composite mean values and variances was calculated (Henseler & Dijkstra, 2015). The assessment of configural invariance was above 5%, which indicated that the distribution scores, data treatment, and algorithm criteria of all the groups were identical. Likewise, to test the compositional variance, a test of 5,000 permutations was applied. The results confirm that the composition of the constructs is identical for all the groups because the compositional invariance data exceed 5% (Hair et al., 2018). Regarding the evaluation of model invariance, the results of the equality of the composite means and the variances were not equal among some PA countries. However, a multigroup analysis (MGA) was feasible since the configural and compositional invariance had been evaluated, which allowed partial measurement invariance to be assumed (see Table 6).

Table 6. MICOM analysis by country

Measurement Model	Configural invariance	Compositional invariance assessment			Full measurement model invariance assessment					
		Original correlation	0.05	Compositional invariance (Partial measurement invariance)	Mean difference	Confidence interval	Equality means	Variance difference	Confidence interval	Equality of variances
Panel A: Chile_Colombia										
Digitalization	Verified	0.994	0.993	Verified	-0.305	(-0.237; 0.234)	Yes	-0.291	(-0.307; 0.235)	Yes
Innovation	Verified	0.999	0.994	Verified	0.061	(-0.236; -0.225)	No	-0.100	(-0.500; 0.349)	Yes
Performance	Verified	0.989	0.989	Verified	-0.006	(-0.239; 0.225)	No	-0.262	(-0.446; 0.371)	Yes
Sustainability	Verified	0.996	0.992	Verified	-0.442	(-0.229; 0.231)	Yes	-0.023	(-0.352; 0.240)	Yes
Panel B: Chile_Mexico										
Digitalization	Verified	0.992	0.988	Verified	-0.500	(-0.230; 0.230)	No	-0.112	(-0.352; 0.253)	Yes
Innovation	Verified	0.999	0.992	Verified	-0.026	(-0.239; 0.224)	Yes	0.162	(-0.513; 0.363)	Yes

Measurement Model	Configural invariance	Compositional invariance assessment			Full measurement model invariance assessment					
		Original correlation	0.05	Compositional invariance (Partial measurement invariance)	Mean difference	Confidence interval	Equality means	Variance difference	Confidence interval	Equality of variances
Panel B: Chile_Mexico										
Performance	Verified	0.982	0.983	Verified	-0.134	(-0.239; 0.228)	Yes	-0.116	(-0.435; 0.360)	Yes
Sustainability	Verified	0.994	0.992	Verified	-0.407	(-0.236; 0.225)	No	0.032	(-0.342; 0.241)	Yes
Panel C: Chile_Peru										
Digitalization	Verified	0.993	0.993	Verified	-0.393	(-0.270; 0.266)	No	-0.080	(-0.370; 0.316)	Yes
Innovation	Verified	1.000	0.996	Verified	0.056	(-0.276; 0.271)	Yes	-0.027	(-0.569; 0.505)	Yes
Performance	Verified	0.986	0.982	Verified	0.003	(-0.279; 0.278)	Yes	-0.228	(-0.452; 0.400)	Yes
Sustainability	Verified	0.995	0.985	Verified	-0.540	(-0.274; 0.264)	No	0.331	(-0.394; 0.356)	Yes
Panel D: Mexico_Colombia										
Digitalization	Verified	1.000	0.999	Verified	0.162	(-0.093; 0.095)	No	-0.178	(-0.116; 0.114)	Yes
Innovation	Verified	1.000	0.999	Verified	0.094	(-0.094; 0.092)	No	-0.272	(-0.168; 0.165)	Yes
Performance	Verified	1.000	0.999	Verified	0.124	(-0.097; 0.094)	No	-0.142	(-0.169; 0.168)	Yes
Sustainability	Verified	1.000	0.999	Verified	-0.047	(-0.096; 0.091)	Yes	-0.048	(-0.118; 0.115)	Yes
Panel E: Mexico_Peru										
Digitalization	Verified	1.000	0.996	Verified	0.123	(-0.176; 0.173)	Yes	0.031	(-0.204; 0.245)	Yes
Innovation	Verified	1.000	0.997	Verified	0.085	(-0.166; 0.175)	Yes	-0.188	(-0.286; 0.340)	Yes
Performance	Verified	0.997	0.994	Verified	0.161	(-0.170; 0.177)	Yes	-0.122	(-0.287; 0.312)	Yes
Sustainability	Verified	0.998	0.997	Verified	-0.133	(-0.179; 0.183)	Yes	0.283	(-0.208; 0.254)	No
Panel F: Colombia_Peru										
Digitalization	Verified	1.000	0.997	Verified	-0.046	(-0.174; 0.171)	Yes	0.211	(-0.179; 0.225)	Yes
Innovation	Verified	1.000	0.998	Verified	-0.014	(-0.170; 0.176)	Yes	0.085	(-0.269; 0.341)	Yes
Performance	Verified	0.998	0.996	Verified	0.029	(-0.175; 0.177)	Yes	0.014	(-0.275; 0.334)	Yes
Sustainability	Verified	0.998	0.997	Verified	-0.078	(-0.175; 0.175)	Yes	0.334	(-0.205; 0.249)	No

Note: Results are computed on a one-tailed permutation test at 5% confidence level.

Table 7. Multigroup analysis by country

Paths	Panel A: Chile_Colombia				Panel B: Chile_Mexico				Panel C: Chile_Peru			
	Path difference	PLS-MGA p-value	parametric test p-value	Welch-Satterthwait Test p-value	Path difference	PLS-MGA p-value	Parametric test p-value	Welch-Satterthwait Test p-value	Path difference	PLS-MGA p-value	Parametric test p-value	Welch-Satterthwait Test p-value
Digitalization -> Performance	0.074	0.267	0.291	0.548	0.212	0.056	0.065	1.554	0.072	0.340	0.360	0.395
Innovation -> Digitalization	0.200	0.037	0.097	1.864	0.199	0.037	0.080	1.864	0.189	0.108	0.148	1.220
Innovation -> Performance	-0.064	0.576	0.370	0.290	-0.160	0.751	0.154	0.735	-0.043	0.543	0.430	0.170
Innovation -> Sustainability	-0.054	0.667	0.348	0.440	0.046	0.319	0.372	0.374	-0.055	0.637	0.366	0.359
Sustainability -> Digitalization	-0.063	0.693	0.345	0.509	-0.140	0.878	0.159	1.144	-0.218	0.920	0.099	1.393
Sustainability -> Performance	-0.097	0.715	0.277	0.522	-0.194	0.870	0.095	1.045	-0.110	0.695	0.316	0.485

Note: p-value < 0.05 (Henseler et al., 2016).

Continued Multigroup analysis by country

Paths	Multigroup analysis by country											
	Panel D: Mexico_Colombia				Panel E: Mexico_Peru				Panel F: Colombia_Peru			
	Path difference	PLS-MGA p-value	Parametric test p-value	Welch-Satterthwait Test p-value	Path difference	PLS-MGA p-value	Paramettest p-value	Welch-Satterthwait Test p-value	Path difference	PLS-MGA p-value	Parametric test p-value	Welch-Satterthwait Test p-value
Digitalization -> Performance	0.138	0.007	0.007	2.467	-0.139	0.844	0.106	1.028	-0.002	0.516	0.494	0.013
Innovation -> Digitalization	-0.001	0.505	0.495	0.011	-0.010	0.554	0.464	0.079	-0.011	0.556	0.464	0.084
Innovation -> Performance	-0.096	0.920	0.084	1.401	0.117	0.204	0.159	0.839	0.021	0.455	0.441	0.147
Innovation -> Sustainability	0.100	0.041	0.040	1.747	-0.101	0.825	0.174	0.949	-0.001	0.510	0.498	0.006
Sustainability -> Digitalization	-0.077	0.897	0.105	1.262	-0.077	0.753	0.237	0.682	-0.155	0.913	0.097	1.351
Sustainability -> Performance	-0.097	0.941	0.060	1.566	0.084	0.275	0.231	0.591	-0.013	0.543	0.460	0.087

Note: p-value < 0.05 (Henseler et al., 2016).

In Table 7, the comparison of the results for PA tourism MSMEs reveals significant differences in certain relationships among countries. These findings support H4 of our research. The results of the multigroup analysis test the existence of significant differences among the tourism MSMEs of the countries that comprise the Pacific Alliance: Chile, Colombia, Mexico, and Peru, according to the country of origin. Specifically, differences depending on the country of analysis were studied when the results were compared two by two. Thus, a statistically significant difference is observed in the influence of innovation on the digitalization process of tourism MSMEs, according to their origin, in the cases of Chile and Colombia. The results show that the effect of innovation on the digitalization process of MSMEs in the tourism sector is greater in Chilean companies than in Colombian ones (β (Path difference Chile-Colombia) = 0.200; $p = 0.037$). This result aligns with Acevedo et al. (2023), who found that businesses in Chile have gained advantages by innovating in digital exploration. Furthermore, this result can be explained in accordance with Institutional Theory, as the development and quality of the institutional environment are critical to shaping economic activity and firm behavior (Gelbuda et al., 2008). Thus, the finding reveals that public policies and private initiatives are more prominent in Chile to foster innovation and digital transformation among Chilean tourist companies.

In the multigroup analysis of tourism MSMEs comparing Chile's and Mexico's innovation and digitalization processes and their effect on performance (β (Path difference Chile-Mexico) = 0.212; $p = 0.056$), (β (Path difference Chile-Mexico) = 0.199; $p = 0.037$), the results show significant differences. These differences may be consistent with studies such as those by Acevedo et al. (2023), who affirm that Chilean MSMEs have high levels of innovation through digital technologies, which allows them to achieve better business results. Chilean MSMEs may be more competitive in these terms than their Mexican counterparts, as confirmed by Casalet (2023), who describes the internal and external challenges faced by Mexican manufacturing companies during the digital transition process. Again, findings reveal that according to Institutional Theory, a more established and developed institutional context of Chile provides reductions in transaction and production costs, which are conducive to the efficient operations of a firm (Gelbuda et al., 2008) and provide Chilean companies with a better environment to develop innovation through digital technologies than the case of analog touristic companies in Mexico. These findings confirm cross-national differences according to Institutional Theory (Henisz, 2000).

There are significant differences in digitalization and its effects on performance between Mexican and Colombian tourism MSMEs (β (Path difference Mexico-Colombia) = 0.138; $p = 0.007$). The results align with studies by Van Klyton et al. (2021) and López-Rodríguez and López-Rodríguez (2018), who have affirmed that Colombian firms are in a maturation process in concepts such as mobile banking and digital money, especially in rural communities. Previous studies revealed that digitalization creates benefits that contribute to business results in the Colombian context (Cuevas-Vargas et al., 2023). Additionally, the innovation of tourism MSMEs and the mediating effect of sustainability in Mexico are significantly different than in Colombian tourism companies (β (Path difference Mexico-Colombia) = 0.100; $p = 0.041$), coinciding with the Standard & Poor's Global (S&P) Sustainability Yearbook (2023), which states that Colombia is making better progress in promoting the protection of natural resources and is more interested in social well-being through innovatively developing tourist destinations than Mexico. These differences in results confirm that a more developed set of protection rules for natural resources in Colombia is a consequence of an institutional context that is more established in Colombia

compared to Mexico, according to Institutional Theory. Finally, the tourism MSMEs of Peru do not differ significantly from those of other PA countries in terms of innovation, performance, and the mediating effects of digitalization and sustainability. Previous literature has identified that the success or failure of new industrial policies in Latin American experiences depends on both institutional and political economy factors (Ricz et al., 2024).

CONCLUSION

In the context of the tourism industry, the main interest of this study is to investigate the significant differences in the influence of innovation on performance and the mediating effect of sustainability and digitalization. With this aim, 1,388 tourism MSMEs from PA countries were analyzed. The findings demonstrate significant differences in innovation, sustainability, digitalization, and performance among tourism MSMEs in Chile, Mexico, and Colombia but not in businesses in Peru. These results show that Chile and Mexico are more competitive in tourism development than the other emerging economies of the PA. The tourism industry in Chile has advanced in digital infrastructures that enhance its connectivity in the digital era. Tourism MSMEs in Mexico have taken advantage of natural, social, and cultural resources to innovate and develop favorable environments that facilitate their growth. In the case of Colombia, the tourism industry is experiencing a period of advancement and recovery. This destination has made progress in prioritizing environmental issues and is trying to innovate by installing the internet in common tourist spaces. Peru has worked to innovate through the cultural, historical, and natural diversity of the destination by improving the conditions under which Peruvian tourism companies offer their services. However, although their services are similar to those of the other PA countries, these efforts are still not reflected in Peruvian SME performance.

This research has implications for entrepreneurs of tourism MSMEs (Micro, Small, and Medium Enterprises) in the Pacific Alliance (PA) countries, as it highlights the importance of incorporating sustainability aspects such as environmental protection particularly responsible management of water, organic and plastic waste, and the use of renewable energy in business operations (Molina-Sánchez et al., 2024); supporting the communities where their businesses operate; and promoting economic balance by hiring local labor and suppliers (Vávrová et al., 2024; Agyabeng-Mensah et al., 2023). It also underscores the need to implement digital transformation strategies to generate competitive advantages, for which increasing investment in research and development is essential, as well as training both managers and employees in the use of digital tools (Cucari et al., 2022), including those based on artificial intelligence (Maldonado-Cueva and Fernández-Bedoya, 2025).

The results can also be helpful for public policymakers in promoting the competitiveness of tourism MSMEs, in accordance with each country's specific characteristics (de Curtò et al., 2025; Rachmiatie et al., 2024; Molina-Sánchez et al., 2024). In this way, PA governments can seek mechanisms to coordinate and integrate political, economic, and cooperation efforts, and take advantage of the opportunities offered by the regional bloc. Among these opportunities is the strengthening of tourism mobility promotion through the free movement of tourists among PA member countries, which could reduce costs and increase tourism flows (Fairlie & Collantes, 2022). Likewise, knowledge transfer in best practices could be fostered—for example, Chile could share innovations in digitalization and institutional coordination with Colombia and Mexico (Castillo-Vergara et al., 2025; González-Martínez et al., 2023; Acevedo et al., 2023; Farías & Cancino, 2021), and in turn receive contributions from Mexico in environmental sustainability (Gallego-Schmid et al., 2025) based on initiatives emerging in that country's tourism sector (León-Gómez et al., 2025; Akdemir & Erkasap, 2025). Colombian tourism MSMEs could also contribute successful sustainability experiences to their Mexican counterparts (Cuevas-Vargas et al., 2023). In this regard, it is evident that the cooperation structure established by the PA is an excellent enabler for the implementation of organizational strengthening strategies by both governments and entrepreneurs, and it serves as a catalyst for improving outcomes not only nationally but throughout the region (Giacalone, 2023).

This study has certain limitations that may represent opportunities for future research. The study is cross-sectional in nature, which may limit the ability to infer causality from the results. While cross-sectional studies are widely used in the literature and can identify patterns and associations, they do not allow for strong causal conclusions. Therefore, future studies based on longitudinal data could provide greater robustness to the findings obtained. Furthermore, the research explored the relationship between innovation, performance, and sustainability across the nations of PA. Replicating this study in other countries with diverse intercultural realities could yield valuable insights for regional development, particularly in emerging economies (Abdul-Hamid et al., 2022; David et al., 2025).

From a management perspective, promising future research lines also emerge. The current analysis focused on how digitalization mediates the relationship between innovation and performance. However, to deepen understanding of the interactions among these variables, it is crucial to examine the specific role of emerging technologies such as artificial intelligence, big data, and the Internet of Things within the context of PA countries (Zhang et al., 2025; Castillo-Vergara et al., 2025). This approach would help broaden the study's scope and strengthen the validity of the proposed research model. Additionally, studying the adoption of sustainable practices, whether social, environmental, or economic, through the lens of organizational culture may offer key insights into how innovation and performance can be enhanced in MSMEs operating within the PA framework (Assoratgoon & Kantabutra, 2023; Cuevas-Pichardo et al., 2024).

Acknowledgment

This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

References

- Abdul-Hamid, S. H., Pien, L. S., Rahimi, N. A., Balang, R. V., & Yuniarti, F. A. (2022). The impact of Covid-19 lockdown towards social media usage and body-esteem among adolescents in Kuantan, Pahang. *International Journal of Care Scholars*, 5(3), 44-51. <https://doi.org/10.31436/ijcs.v5i3.268>
- Acevedo, J., Diaz-Molina, I., Johan, S., & Valenzuela, P. (2023). Business advisory services and innovation during crises: Evidence from small businesses in Chile. *Journal of Business Research*, 168, 114202. <https://doi.org/10.1016/j.jbusres.2023.114202>.
- Achidi Ndofo, H., & Priem, R. L. (2011). Immigrant entrepreneurs, the ethnic enclave strategy, and venture performance. *Journal of Management*, 37(3), 790-818. <https://doi.org/10.1177/014920630934502>
- Agyabeng-Mensah, Y., Afum, E., Issau, K., Baah, C., Dacosta, E., Essandoh, E., & Agyenim Boateng, E. (2023). The missing links of sustainable supply chain management and green radical product innovation between sustainable entrepreneurship orientation and sustainability performance. *Journal of Engineering, Design and Technology*, 21(1), 167-187. <https://doi.org/10.1108/JEDT-05-2021-0267>.
- Aidi, N., & Fabry, N. (2024). Beyond the certification of smart tourism destination: Insights from the city of Medellín in Colombia. *International Journal of Tourism Cities*, 10(2), 577-603. <https://doi.org/10.1108/IJTC-03-2022-0056>
- Aina, R. & Atan, T. (2020). The impact of implementing talent management practices on sustainable organizational performance. *Sustainability*, 12(20), 1-21. <https://doi.org/10.3390/su12208372>.
- Akdemir Ömür, G., & Erkasap, A. (2025). Impact of digitalization, technological innovation, and ICTs on sustainability management and strategies. *Sustainability*, 17(12), 5351. <https://doi.org/10.3390/su17125351>
- Al Nuaimi, F. M. S., Singh, S. K., & Ahmad, S. Z. (2024). Open innovation in SMEs: A dynamic capabilities perspective. *Journal of Knowledge Management*, 28(2), 484-504. <https://doi.org/10.1108/JKM-11-2022-0906>.
- Albaladejo, I. P., Brida, J. G., González-Martínez, M. I., & Segarra, V. (2023). A new look to the tourism and economic growth nexus: A clustering and panel causality analysis. *New Challenges in International Economics and Finance*, 46(9), 2835-2856. <https://doi.org/10.1111/twec.13459>.
- Albertini, E. (2019). The contribution of management control systems to environmental capabilities. *Journal of Business Ethics*, 159(4), 1163-1180. <https://doi.org/10.1007/s10551-018-3810-9>
- Aldeanueva-Fernández, I. & Cervantes-Rosas, M. (2019). Sustainable development as a strategic imperative: The context of Latin American small and medium-sized enterprises. *Revista Lasallista de Investigación*, 16(2), 28-43. <https://doi.org/10.22507/rli.v16n2a3>
- Al-Nuaimi, M. N., & Al-Emran, M. (2021). Learning management systems and technology acceptance models: A systematic review. *Education and Information Technologies*, 26(5), 5499-5533. <https://doi.org/10.1007/s10639-021-10513-3>.
- Alos-Simo, L., Verdu-Jover, A. J., & Gomez-Gras, J. M. (2024). How use of knowledge sources influences eco-innovation in the tourism sector through product innovation and/or process innovation. *Journal of Sustainable Tourism*, 32(5), 1053-1076. <https://doi.org/10.1080/09669582.2023.2199349>.
- Al-Romeedy, B. S., & Alharethi, T. (2025). Leveraging green human resource management for sustainable tourism and hospitality: A mediation model for enhancing green reputation. *Discover Sustainability*, 6(1), 67. <https://doi.org/10.1007/s43621-025-00829-2>
- Alvarado, A., Bigne, E., Aldas, J. & Curras, R. (2017). A scale for measuring consumer perceptions of corporate social responsibility following the sustainable development paradigm. *Journal of Business Ethics*, 140(2), 243-262. <https://doi.org/10.1007/s10551-015-2654-9>.
- Andersen, J., Jansson, C., & Ljungkvist, T. (2020). Can environmentally oriented CEOs and environmentally friendly suppliers boost the growth of small firms? *Business Strategy and the Environment*, 29(2), 325-334. <https://doi.org/10.1002/bse.2366>.
- Andrews, D. F., Gnanadesikan, R., & Warner, J. L. (1971). Transformations of multivariate data. *Biometrics*, 27(4), 825-840. <https://doi.org/10.2307/2528821>
- ANIF. (2022). *Ideas for the national development plan: Competitiveness, infrastructure, digital world, tourism and housing. Third report*. <https://www.anif.com.co>
- Arici, F. (2024). Investigating the effectiveness of augmented reality technology in science education in terms of environmental literacy, self-regulation, and motivation to learn science. *International Journal of Human-Computer Interaction*, 40(24), 8476-8496. <https://doi.org/10.1080/10447318.2024.2310921>
- Armstrong, M., and Brown, D. (2019). Strategic human resources management: Back to the future. *Reports of the Institute of Employment Studies*, 1(1), 1-36. [https://doi.org/10.1016/S1470-2045\(19\)30569-8](https://doi.org/10.1016/S1470-2045(19)30569-8)
- Arsawan, I. W. E., Koval, V., Rajiani, I., Rustiarini, N. W., Supartha, W. G. & Suryantini, N. P. S. (2022). Leveraging knowledge sharing and innovation culture into SMEs sustainable competitive advantage. *International Journal of Productivity and Performance Management*, 71(2), 405-428. <https://doi.org/10.1108/IJPPM-04-2020-0192>.
- Avelar, S., Borges-Tiago, T., Almeida, A., & Tiago, F. (2024). Confluence of sustainable entrepreneurship, innovation, and digitalization in SMEs. *Journal of Business Research*, 170, 114346. <https://doi.org/10.1016/j.jbusres.2023.114346>

- Azmi, E., Che Rose, R. A., Awang, A., & Abas, A. (2023). Innovative and competitive: A systematic literature review on new tourism destinations and products for tourism supply. *Sustainability*, *15*(2), 1187. <https://doi.org/10.3390/su15021187>
- Balzano, M., Marzi, G., & Turzo, T. (2024). SMEs and institutional theory: Major inroads and opportunities ahead. *Management Decision*, *63*(13), 1-27. <https://doi.org/10.1108/MD-05-2023-0734>
- Barney, J. B. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120. <https://doi.org/10.1177/014920639101700108>.
- Barney, J. B., Ketchen Jr, D. J., & Wright, M. (2021). Resource-based theory and the value creation framework. *Journal of Management*, *47*(7), 1936-1955. <https://doi.org/10.1177/01492063211021655>
- Barney, J.B. (2018). Why resource-based theory's model of profit appropriation must incorporate a stakeholder perspective. *Strategic Management Journal*, *39*(13), 3305-3325. <https://doi.org/10.1002/smj.2949>
- Beltramino, N. S., García-Perez-de-Lema, D., & Valdez-Juárez, L. E. (2020). The structural capital, the innovation and the performance of the industrial SMES. *Journal of Intellectual Capital*, *21*(6), 913-945. <https://doi.org/10.1108/JIC-01-2019-0020>.
- Bhatti, K. K., Saxena, U. D., & Singh, R. K. (2025). Impact of innovation and talent development on innovative business approach. *International Journal of Process Management and Benchmarking*, *19*(4), 462-483. <https://doi.org/10.1108/TR-05-2019-0153>.
- Bhimani, H., Mention, A. L., & Barlatier, P. J. (2019). Social media and innovation: A systematic literature review and future research directions. *Technological Forecasting and Social Change*, *144*, 251-269. <https://doi.org/10.1016/j.techfore.2018.10.007>.
- Bielińska-Dusza, E., & Hamerska, M. (2021). Innovative activity of Polish enterprises – a strategic aspect. The similarity of NACE divisions. *Journal of Entrepreneurship, Management and Innovation*, *17*(2), 53-98. <https://doi.org/10.7341/20211723>.
- Bilal, M., Xicang, Z., Jiying, W., Sohu, J. M., Akhtar, S., & Hassan, M. I. U. (2025). Digital transformation and SME innovation: A comprehensive analysis of mediating and moderating effects. *Journal of the Knowledge Economy*, *16*, 1153-1182. <https://doi.org/10.1007/s13132-024-02054-0>.
- Bowen, R. (2021). Cultivating coffee experiences in the Eje Cafetero, Colombia. *International Journal of Culture, Tourism and Hospitality Research*, *15*(3), 328-339. <https://doi.org/10.1108/IJCTHR-08-2020-0184>
- Braunerhielm, L., & Hoppstadius, F. (2025). The relationship between technology and place in tourism. *Anatolia*, *36*(2), 363-377. <https://doi.org/10.1080/13032917.2024.2417434>
- Bunclark, L., & Barcellos, P. L. (2021). Sustainability reporting for sustainable supply chain management in Peru. *Sustainable Production and Consumption*, *27*, 1458-1472. <https://doi.org/10.1016/j.spc.2021.03.013>
- Canales, M., & Álvarez, R. (2017). Impact of obstacles to knowledge on innovation in Chilean companies. *Journal of Technology Management & Innovation*, *12*(3), 78-85. <http://dx.doi.org/10.4067/S0718-27242017000300008>
- Cantele, S., & Cassia, F. (2020). Sustainability implementation in restaurants: A comprehensive model of drivers, barriers, and competitiveness-mediated effects on firm performance. *International Journal of Hospitality Management*, *87*, 102510. <https://doi.org/10.1016/j.ijhm.2020.102510>
- Cantele, S., & Zardini, A. (2020). What drives small and medium enterprises towards sustainability? Role of interactions between pressures, barriers, and benefits. *Corporate Social Responsibility and Environmental Management*, *27*(1), 126-136. <https://doi.org/10.1002/csr.1778>.
- Carrasco-Carvajal, O., Castillo-Vergara, M. & García-Pérez-De-Lema, D. (2023). Measuring open innovation in SMEs: An overview of current. *Review of Managerial Science*, *17*(2), 397-442. <https://doi.org/10.1007/s11846-022-00533-9>.
- Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, *41*(5), 545-547. <https://doi.org/10.1188/14.ONF.545-547>
- Casalet, M. (2023). Challenges and opportunities of digitalization in Mexico. Digital and sustainable transformations in a post-COVID World. In *Economic, Social, and Environmental Challenges* (pp. 451-474). Springer Nature. https://doi.org/10.1007/978-3-031-16677-8_17
- Castillo-Vergara, M., Duarte Valdivia, D., Muñoz-Cisterna, V., Álvarez-Marín, A., Geldes, C., & Ortiz-Henriquez, R. E. (2025). Digital capabilities of SMEs: Driving the industry 4.0 revolution and measuring its innovative effects. *Academia Revista Latinoamericana de Administración*, *38*(1), 74-105. <https://doi.org/10.1108/ARLA-08-2023-0137>
- Chang, A. Y., & Cheng, Y. T. (2019). Analysis model of the sustainability development of manufacturing small and medium-sized enterprises in Taiwan. *Journal of Cleaner Production*, *207*, 458-473. <https://doi.org/10.1016/j.jclepro.2018.10.025>.
- Civelek, M., Krajčík, V., & Fialova, V. (2023). The impacts of innovative and competitive abilities of SMEs on their different financial risk concerns: System approach. *Oeconomia Copernicana*, *14*(1), 327-354. <https://doi.org/10.24136/oc.2023.019>
- Cohen, J. (1988). *Statistical power analysis for behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Co-operation and Development (OECD) & Eurostat. (2005). *Oslo Manual: Guidelines for collecting and interpreting innovation data* (3rd ed.). OECD Publishing. <https://doi.org/10.1787/9789264013100-en>
- Coronado-Medina, A., Arias-Pérez, J., & Perdomo-Charry, G. (2023). Effect of technological turbulence generated by artificial intelligence on product innovation: The role of strategic orientation toward digitalization. *Innovar: Journal of Administrative and Social Sciences*, *33*(89), 37-50. <https://doi.org/10.15446/innovar.v33n89.107036>
- Corredor, R. (2018). The Pacific Alliance: Adding value to the global intellectual property rights regime? In P. De Lombaerde, L. R. Peña, & S. Khorana (Eds.), *The Pacific Alliance in a world of preferential trade agreements: Lessons in comparative regionalism* (pp. 203-214). Springer International Publishing. https://doi.org/10.1007/978-3-319-78464-9_11
- Correia, A., Kozak, M., & Ferradeira, J. (2013). From tourist motivations to tourist satisfaction. *International Journal of Culture, Tourism, and Hospitality Research*, *7*(4), 411-424. <https://doi.org/10.1108/IJCTHR-05-2012-0022>
- Cruz-Cárdenas, J., Zabelina, E., Guadalupe-Lanas, J., Palacio-Fierro, A., & Ramos-Galarza, C. (2021). COVID-19, consumer behavior, technology, and society: A literature review and bibliometric analysis. *Technological Forecasting and Social Change*, *173*, 121179. <https://doi.org/10.1016/j.techfore.2021.121179>
- Cucari, N., Lagasio, V., Lia, G., & Torriero, C. (2022). The impact of blockchain in banking processes: The Interbank Spunta case study. *Technology Analysis and Strategic Management*, *34*(2), 138-150. <https://doi.org/10.1080/09537325.2021.1891217>.
- Cuestas-Zamora, E., & Thoene, U. (2020). The Pacific Alliance as a regional trade agreement: Analysis from an ius internationalist approach. *Colombia International*, *104*, 131-156. <https://doi.org/10.7440/COLOMBIAINT104.2020.05>.
- Cuevas-Vargas, H., Parga-Montoya, N., Lozano-García, J. J., & Huerta-Mascotte, E. (2023). Determinants of openness activities in innovation: The mediating effect of absorptive capacity. *Journal of Innovation & Knowledge*, *8*(4), 100432. <https://doi.org/10.1016/j.jik.2023.100432>
- De Curtò, J., de Zarzà, I., Fervier, L. S., Sanagustín-Fons, V., & Calafate, C. T. (2025). An institutional theory framework for leveraging large language models for policy analysis and intervention design. *Future Internet*, *17*(3), 96. <https://doi.org/10.3390/fi17030096>
- David, L. K., Wang, J., Brooks, W., & Angel, V. (2025). Digital transformation and socio-economic development in emerging economies: A multinational analysis. *Technology in Society*, *81*, 102834. <https://doi.org/10.1016/j.techsoc.2025.102834>

- De la Gala-Velásquez, B., Hurtado-Palomino, A., & Arredondo-Salas, A. Y. (2023). Organizational flexibility and innovation performance: The moderating role of management support. *Global Journal of Flexible Systems Management*, 24(2), 219-234. <https://doi.org/10.1007/s40171-023-00336-1>
- De Lema, D. G. P., Gálvez-Albarracín, E. J., & Maldonado-Guzmán, G. (2016). Effect of innovation on growth and performance of SMES in the Pacific Alliance. An empirical study. *Estudios Gerenciales*, 32(141), 326-335. <https://doi.org/10.1016/j.estger.2016.07.003>
- De, D., Chowdhury, S., Dey, P. K., & Ghosh, S. K. (2020). Impact of lean and sustainability oriented innovation on sustainability performance of small and medium sized enterprises: A data envelopment analysis-based framework. *International Journal of Production Economics*, 219, 1-14. <https://doi.org/10.1016/j.ijpe.2018.07.003>
- Denicolai, S., Zucchella, A., & Magnani, G. (2021). Internationalization, digitalization, and sustainability: Are SMEs ready? A survey on synergies and substituting effects among growth paths. *Technological Forecasting and Social Change*, 166, 120650. <https://doi.org/10.1016/j.techfore.2021.120650>
- Domi, S., Keco, R., Capelleras, J. L., & Mehmeti, G. (2019). Effects of innovativeness and innovation behavior on tourism SMEs performance: The case of Albania. *Economics & Sociology*, 12(3), 67-85. <https://doi.org/10.14254/2071-789X.2019/12-3/5>
- Donawa-Torres, Z. A., & Morales-Martínez, E. C. (2019). Estrategias de innovación en la gerencia de las MiPyME del distrito de Santa Marta, Colombia. *Teuken Bidikay: Revista Latinoamericana de Investigación En Organizaciones, Ambiente y Sociedad*, 10(14), 157-170. <https://doi.org/10.33571/teuken.v10n14a7>
- Dubois, C. L., & Dubois, D. A. (2012). Strategic human resource management as a social design for environmental sustainability in organizations. *Human Resource Management*, 51(6), 799-826. <https://doi.org/10.1111/j.1365-2966.2011.20236.x>
- Dueñas, X., Rodríguez, M., & Pérez, L. M. (2021). Asymmetric importance-performance analysis: Measuring classification changes of destination attributes into basic, performance and excitement factors according to the segmentation criterion. *Tourism and Hospitality Research*, 21(4), 418-425. <https://doi.org/10.1177/14673584211002603>
- Eitrem, A., Meidell, A., & Modell, S. (2024). The use of institutional theory in social and environmental accounting research: A critical review. *Accounting and Business Research*, 54(7), 775-810. <https://doi.org/10.1080/00014788.2024.2328934>
- Esenarro, D., Cho, A., Vargas, N., Calderon, O., & Raymundo, V. (2024). Chinchero as tourism hub and green corridor as a social integrator in Cusco Peru 2023. *Sustainability*, 16(7), 3068. <https://doi.org/10.3390/su16073068>
- Esparza-Huamanchumo, R. M., Villalba-Condori, K. O., Botezán, I., & Sánchez Jiménez, R. (2024). Ecotourism, sustainable tourism and nature-based tourism: An analysis of emerging fields in tourism scientific literature. *Geojournal of Tourism and Geosites*, 54(2), 953-966. <https://doi.org/10.30892/gtg.542spl19-1270>
- Espina-Romero, L., Ríos Parra, D., Gutiérrez Hurtado, H., Peixoto Rodriguez, E., Arias-Montoya, F., Noroño-Sánchez, J. G., & Vilchez Pirela, R. A. (2024). The role of digital transformation and digital competencies in organizational sustainability: A study of SMEs in Lima, Peru. *Sustainability*, 16(16), 6993. <https://doi.org/10.3390/su16166993>
- Espinoza-Rodríguez, I. J., Heckel, G., Chávez-Dagostino, R. M., Moncada-Cooley, R., Aguirre-Ayala, D., & Cupul-Magaña, A. L. (2025). Compliance to whale watching regulation in Mexico: Implications for the activity's sustainability. *Ocean & Coastal Management*, 269, 107798. <https://doi.org/10.1016/j.ocecoaman.2025.107798>
- Estol, J., Camilleri, M. A., & Font, X. (2018). European Union tourism policy: An institutional theory critical discourse analysis. *Tourism Review*, 73(3), 421-431. <https://doi.org/10.1108/TR-11-2017-0167>
- Falaster, C., Zanin, L. M., & Guerrazzi, L. A. (2017). Institutional theory in tourism research: New opportunities from an evolving theory. *Revista Brasileira de Pesquisa em Turismo*, 11(2), 270-293. <https://doi.org/10.7784/rbtur.v11i2.1310>
- Fariás, A., & Cancino, C. A. (2021). Digital transformation in the Chilean lodging sector: Opportunities for sustainable businesses. *Sustainability*, 13(14), 8097. <https://doi.org/10.3390/su13148097>
- Fernández-Bedoya, V. H., Ruiz-Palacios, M. A., Meneses-La-Riva, M. E., & Suyo-Vega, J. A. (2025). Tourism entrepreneurship in Latin America: A systematic review of challenges, strategies, and post-COVID-19 perspectives. *Sustainability*, 17(3), 989. <https://doi.org/10.3390/su17030989>
- Fernando, Y., Jabbour, C. J. C., & Wah, W. X. (2019). Pursuing green growth in technology firms through the connections between environmental innovation and sustainable business performance: Does service capability matter? *Resources, Conservation and Recycling*, 141, 8-20. <https://doi.org/10.1016/j.resconrec.2018.09.031>
- Ferreira, J., Coelho, A., y Moutinho, L. (2020). Dynamic capabilities, creativity and innovation capability and their impact on competitive advantage and firm performance: The moderating role of entrepreneurial orientation. *Technovation*, 92, 102061. <https://doi.org/10.1016/j.technovation.2018.11.004>
- Ferreras-Méndez, JL, Olmos-Peñuela, J., Salas-Vallina, A., & Alegre, J. (2021). Entrepreneurial orientation and new product development performance in SMEs: The mediating role of business model innovation. *Technovation*, 108, 102325. <https://doi.org/10.1016/j.technovation.2021.102325>
- Florek-Paszkowska, A., & Ujwary-Gil, A. (2025). The Digital-Sustainability Ecosystem: A conceptual framework for digital transformation and sustainable innovation. *Journal of Entrepreneurship, Management and Innovation*, 21(2), 116-137. <https://doi.org/10.7341/20252127>
- Foreign Trade Society of Peru. (2022). Quarterly tourism performance report in Peru: Results as of the third quarter of 2022. Ministerio de Comercio Exterior y Turismo. <https://www.gob.pe/institucion/mincetur/informes-publicaciones/2776388-peru-compendio-de-cifras-de-turismo-enero-2022>
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39-50. <https://doi.org/10.2307/3151312>
- Franke, G., & Sarstedt, M. (2019). Heuristics versus statistics in discriminant validity testing: A comparison of four procedures. *Internet Research*, 29(3), 430-447. <https://doi.org/10.1108/INTR-12-2017-0515>
- Gaete-Morales, C., Gallego-Schmid, A., Stamford, L., & Azapagic, A. (2018). Assessing the environmental sustainability of electricity generation in Chile. *Science of the Total Environment*, 636, 1155-1170. <https://doi.org/10.1016/j.scitotenv.2018.04.346>
- Gallego-Schmid, A., Vásquez-Ibarra, L., Guerrero, A. B., Henninger, C. E., & Rebolledo-Leiva, R. (2025). Circular economy in a recently transitioned high-income country in Latin America and the Caribbean: Barriers, drivers, strengths, opportunities, key stakeholders and priorities in Chile. *Journal of Cleaner Production*, 486, 144429. <https://doi.org/10.1016/j.scitotenv.2018.04.346>
- García-Lopera, F., Santos-Jaén, J. M., Palacios-Manzano, M., & Ruiz-Palomo, D. (2022). Exploring the effect of professionalization, risk-taking and technological innovation on business performance. *PLoS ONE*, 17(2), e0263694. <https://doi.org/10.1371/journal.pone.0263694>
- Giacalone, R. (2023). The private sector's role in and contribution to the Pacific Alliance, 2012-2021. *Latin American Policy*, 14(1), 109-124. <https://doi.org/10.1111/lamp.12283>

- González-Galarza, J. L. (2022). Trade facilitation and customs cooperation: a challenge for the Pacific Alliance and Mercosur. *Venezuelan Journal of Situation Analysis*, 28(2), 09–34. <https://doi.org/10.54642/rvac.2022.28.2.1>.
- Gonzalez-Tamayo, L. A., Maheshwari, G., Bonomo-Odizzio, A., Herrera-Avilés, M. & Krauss-Delorme, C. (2023). Factors influencing small and medium size enterprises development and digital maturity in Latin America. *Journal of Open Innovation: Technology, Market, and Complexity*, 9(2), 100069. <https://doi.org/10.1016/j.joitmc.2023.100069>
- Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(S2), 109-122. <https://doi.org/10.1002/smj.2460171110>
- Griseemann, U., Plank, A. & Brunner-Sperdin, A. (2013). Enhancing business performance of hotels: The role of innovation and customer orientation. *International Journal of Hospitality Management*, 33(1), 347-356. <https://doi.org/10.1016/j.ijhm.2012.10.005>.
- Guo, H., Yang, Z., Huang, R., & Guo, A. (2020). The digitalization and public crisis responses of small and medium enterprises: Implications from a COVID-19 survey. *Frontiers of Business Research in China*, 14(1), 10 <https://doi.org/10.1186/s11782-020-00087-1>.
- Gutierrez, A., Aguilar, J., Ortega, A., & Montoya, E. (2025). Sentiment analysis on social networks for defining innovation problems in organizations. *Technology in Society*, 81, 102804. <https://doi.org/10.1016/j.techsoc.2024.102804>
- Hagsten, E., & Falk, M. T. (2024). Membership duration of tourism firms in the United Nations Global Compact Programme. *Journal of Sustainable Tourism*, 1-24. <https://doi.org/10.1080/09669582.2024.2382855>
- Hair, J. F., Babin, B. J. & Krey, N. (2017). Covariance-based structural equation modeling in the journal of advertising: Review and recommendations. *Journal of Advertising*, 46(1), 163–177. <https://doi.org/10.1080/00913367.2017.1281777>.
- Hair, J. F., Hult, G. T. M., Proksch, D., Sarstedt, M., Pinkwart, A., & Ringle, C. M. (2018). Addressing endogeneity in international marketing applications of partial least squares structural equation modeling. *Journal of International Marketing*, 26(3), 1-21. <https://doi.org/10.1509/jim.17.0151>
- Hair, J. F., Risher, J.J., Sarstedt, M., & Ringle, C.M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>.
- Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, 26(2), 106–121. <https://doi.org/10.1108/EBR-10-2013-0128>.
- Hart, S. L. (1995). A natural-resource-based view of the firm. *Journal of Management*, 37(5), 1464-1479. <https://doi.org/10.1177/0149206310390219>.
- Henseler, J., & Dijkstra, T.K. (2015). Consistent partial least squares path modeling. *MIS Quarterly*, 39(2), 297-316. <https://doi.org/10.25300/MISQ/2015/39.2.02>
- Henseler, J., Ringle, C. M., & Sarstedt, M. (2016). Testing measurement invariance of composites using partial least squares. *International Marketing Review*, 33(3), 405–431. <https://doi.org/10.1108/IMR-09-2014-0304>.
- Henseler, J., Sarstedt, M., Ringle, C.M., & Hair, J.F. (2014). On the emancipation of PLS-SEM: A commentary on Rigdon (2012). *Long Range Planning*, 47(3), 154-160. <https://doi.org/10.1016/j.lrp.2014.02.007>
- Hernández-Barahona, J., San Román, E., & Gil-López, Á. (2023). Bricolage and innovation in the emergence and development of the Spanish tourism industry. *Enterprise & Society*, 24(4), 1119-1161. <https://doi.org/10.1017/eso.2022.28>
- Higuera, H. J. G., Rogelja, T., & Secco, L. (2023). Policy framework as a challenge and opportunity for social innovation initiatives in eco-tourism in Colombia. *Forest Policy and Economics*, 157, 103076. <https://doi.org/10.1016/j.forpol.2023.103076>
- Hilman, H., & Kaliappen, N. (2015). Innovation and performance strategies: Are they really linked? *World Journal of Entrepreneurship, Management and Sustainable Development*, 11(1), 48-63. <https://doi.org/https://doi.org/10.1111/lamp.12284>.
- Huamán, C. Á. (2022). El impacto de las prácticas ecoeficientes en hoteles urbanos de 5 estrellas en el Perú. *El Periplo Sustentable: Revista de Turismo, Desarrollo y Competitividad*, (42), 463-493. <https://doi.org/10.36677/elperiplo.v0i42.14437>
- Ibarra, M., & González M., M. (2023). El despliegue del espacio urbano en la comprensión de los procesos sociales y económicos. Una mirada desde las revistas especializadas en Chile durante la década de 1970. *Autoctonía (Santiago)*, 7(2), 1154-1188. <https://doi.org/10.23854/autoc.v7i2.372>
- Instituto Nacional de Estadística e Informática (INEI). (2023). *Panorama de la economía peruana: 1950–2022*. Dirección Nacional de Cuentas Nacionales. <https://www.gob.pe/institucion/inei/informes-publicaciones/4295805-panorama-de-la-economia-peruana-1950-2022>
- Julio-Rospigliosi Porretti, V. D., Borda Mendoza, V., Bosmans Flores, F. G., Hermoza Peralta, A., Mejía Mendivil, Á. M., & Moscoso Cuaresma, J. R. (2024). Competitiveness, labour market and protection of the right to work in the member countries of the Pacific Alliance. *Cogent Social Sciences*, 10(1), 2376170. <https://doi.org/10.1080/23311886.2024.2376170>
- Kanaan, K., Abuhjeeleh, M., Darabseh, F., Taha, O., & Aljawarneh, N. M. (2023). How digital marketing and innovative performance contribute to hotel restaurant revenue growth: The mediating role of knowledge sharing. *Cogent Social Sciences*, 9(1), 2209985. <https://doi.org/10.1080/23311886.2023.2209985>.
- Kariv, D., Menzies, T. V., Brenner, G. A., & Filion, L. J. (2009). Transnational networking and business performance: Ethnic entrepreneurs in Canada. *Entrepreneurship and Regional Development*, 21(3), 239-264. <https://doi.org/10.1080/08985620802261641>
- Kochuma, I., Hranovska, V., Demko, V., Dzhumurat, V., & Horiashchenko, M. (2024). Digital inclusion of tourism business in the conditions of global smartization: Potential, mechanisms and strategic tools. *Polish Journal of Sport and Tourism*, 31(4), 33-45. <https://doi.org/10.2478/pjst-2024-0025>
- Konu, H., Leino, P., & Tyrväinen, L. (2025). Tourism firms' attitudes and willingness to contribute to payments for ecosystem services in tourism. *Tourism Recreation Research*, 50(3), 478-492. <https://doi.org/10.1080/02508281.2024.2312349>.
- Kumar, S., Kumar, V., Devi, N., Attri, K., & Bhatt, I. K. (2024). Unveiling the evolutionary trajectory of SMEs in the tourism and hospitality domain: A comprehensive review and prospective insight. *International Journal of Hospitality and Tourism Systems*, 17(4), 112. <https://doi.org/10.21863/ijhts/2024.17.4.010>
- Latifi, M.A., Nikou, S., & Bouwman, H. (2021). Business model innovation and firm performance: Exploring causal mechanisms in SMEs. *Technovation*, 107, 102274. <https://doi.org/10.1016/j.technovation.2021.102274>.
- Lenzen, M., Sun, Y. Y., Faturay, F., Ting, Y. P., Geschke, A., & Malik, A. (2018). The carbon footprint of global tourism. *Nature Climate Change*, 8(6), 522–528. <https://doi.org/10.1038/s41558-018-0141-x>.
- León-Gómez, A., Santos-Jaén, J. M., Palacios-Manzano, M., & Garza-Sánchez, H. H. (2025). Unlocking sustainable competitive advantage: Exploring the impact of technological innovations on performance in Mexican SMEs within the tourism sector. *Environment, Development and Sustainability*, 27(2), 3481-3511. <https://doi.org/10.1007/s10668-023-04025-y>.
- Lichtenthaler, U. (2021). Digitainability: The combined effects of the megatrends digitalization and sustainability. *Journal of Innovation Management*, 9(2), 64–80. https://doi.org/10.24840/2183-0606_009.002_0006.

- Livert Aquino, F., & Gainza, X. (2014). Understanding density in an uneven city, Santiago de Chile: implications for social and environmental sustainability. *Sustainability*, 6(9), 5876-5897. <https://doi.org/10.3390/su6095876>
- Lockett, A., Thompson, S., & Morgenstern, U. (2009). The development of the resource-based view of the firm: A critical appraisal. *International Journal of Management Reviews*, 11(1), 9-28. <https://doi.org/10.1111/j.1468-2370.2008.00252.x>.
- López-Argota, M. A., Anieva, M. B. M., Olvera, J. V. B., & Pérez, M. B. B. (2023). Prácticas de turismo sostenible desde la gobernanza en las mipyme de Jardín (Colombia) y Tepoztlán (México) en el período 2019-2021. *Revista CEA*, 9(19), e2253 <https://doi.org/10.22430/24223182.2253>
- López-Rodríguez, A. L. & López-Rodríguez, S. A. (2018). Impact of ICT on tourism: Colombian case. *Cuadernos de Turismo*, 41, 399-418. <https://doi.org/10.6018/turismo.41.327081>.
- Luongo, S., Sepe, F., & Del Gaudio, G. (2023). Regional innovation systems in tourism: The role of collaboration and competition. *Journal of Open Innovation: Technology, Market, and Complexity*, 9(4), 100148. <https://doi.org/10.1016/j.joitmc.2023.100148>
- Madrid-Guijarro, A. M., Duréndez, A., & Dieguez-Soto, J. (2023). The influence of CEO's financial literacy on SMEs technological innovation: The mediating effects of MCS and risk-taking. *Financial Innovation*, 9(1), 15. <https://doi.org/10.1186/s40854-022-00414-w>.
- Maldonado-Cueva, P. D., & Fernández-Bedoya, V. H. (2025). Political and trade dynamics of the pacific alliance: challenges and sustainability. *Sustainability*, 17(13), 5950. <https://doi.org/10.3390/su17135950>
- Maldonado-Guzmán, G., Garza-Reyes, J.A., Pinzón-Castro, S.Y., & Kumar, V. (2017). Barriers to innovation in service SMEs: Evidence from Mexico. *Industrial Management and Data Systems*, 117(8), 1669-1686. <https://doi.org/10.1108/IMDS-08-2016-0339>
- Malik, M. S., Ali, K., Amir, M., Tariq, K., & Ramzan, M. (2024). Green transformational leadership, environmental strategy, and green innovation: Mediated moderation of knowledge sharing and green absorptive capacity. *Pakistan Journal of Commerce and Social Sciences*, 18(2), 503-526. <https://hdl.handle.net/10419/301677>
- Maquera, G., da Costa, B. B. F., Mendoza, Ó., Salinas, R. A., & Haddad, A. N. (2022). Intelligent digital platform for community-based rural tourism—a novel concept development in Peru. *Sustainability (Switzerland)*, 14(13), 7907. <https://doi.org/10.3390/su14137907>.
- Martey, E., Etwire, P. M., & Abdoulaye, T. (2025). Agricultural commercialization and sustainable land management practices in Ghana. *Environment, Development and Sustainability*, 1-26. <https://doi.org/10.1007/s10668-025-06121-7>
- Martínez C., I. P., & Poveda, A. C. (2021). The importance of science, technology, and innovation in the green growth and sustainable development goals of Colombia. *Environmental and Climate Technologies*, 25(1), 29. <https://doi.org/10.2478/rtuct-2021-0003>
- Martínez R., P. (2019). Tourist spaces: Production, experiences and imaginaries. The case of the Chilean Andean-lacustrine Araucanía, 1900-1940. *Cuadernos de Turismo*, 44, 219-246. <https://doi.org/10.6018/turismo.44.404821>
- Mattsson, J. & Orfila-Sintes, F. (2014). Hotel innovation and its effect on business performance. *International Journal of Tourism Research*, 16(4), 388-398. <https://doi.org/10.1002/jtr.1933>
- Melović, B., Jocočić, M., Dabić, M., Vulić, T. & Dudić, B. (2020). The impact of digital transformation and digital marketing on the brand promotion, positioning and electronic business in Montenegro. *Technology in Society*, 63, 101425. <https://doi.org/10.1016/j.techsoc.2020.101425>
- Meng, G., Wang, K., Wang, F., & Dong, Y. (2023). Analysis of the tourism-economy-ecology coupling coordination and high-quality development path in karst Guizhou Province, China. *Ecological Indicators*, 154, 110858. <https://doi.org/10.1016/j.ecolind.2023.110858>
- Ministerio de Comercio, Industria y Turismo (2022). Tourism services would contribute 45 billion dollars to GDP in 2022, according to Mincomercio estimates. <https://www.mincit.gov.co/prensa/noticias/turismo/servicios-turisticos-aportarian-45-billones-al-pib>. Recuperado el 01 de julio de 2024.
- Ministry of Tourism (2023). Fifth Work Report 2022 - 2023.
- Ministry of Tourism (2023a). Results of Tourist Activity January 2023.
- Ministry of Economy, Development and Tourism (2023). Seventh Microentrepreneurship Survey (EME 7).
- Mishra, P., & Yadav, M. (2021). Environmental capabilities, proactive environmental strategy and competitive advantage: A natural-resource-based view of firms operating in India. *Journal of Cleaner Production*, 291, 125249. <https://doi.org/10.1016/j.jclepro.2020.125249>
- Molina Sánchez, R., Hernández Vargas, C. J., & Medina Mata, I. (2024). Impacto de las tecnologías digitales y estrategias sustentables en la rentabilidad de las Mipyme del sector turístico en México. *Acta Universitaria*, 34, e4119. <https://doi.org/10.15174/au.2024.4119>
- Nikolakis, W., & Roberts, E. (2022). Wildfire governance in a changing world: Insights for policy learning and policy transfer. *Risk, Hazards & Crisis in Public Policy*, 13(2), 144-164. <https://doi.org/10.1002/rhc3.12235>
- O'Regan, N., & Sims, M. A. (2008). Identifying high technology small firms: A sectoral analysis. *Technovation*, 28(7), 408-423. <https://doi.org/10.1016/j.technovation.2008.02.010>
- Paiva, L. E. B., Nassif, V. M. J., de Lima, T. C. B., & Rebouças, S. M. D. P. (2024). Between sustainability and innovation: Relations with an entrepreneurial intention in Brazil and Spain. *Contaduría y Administración*, 69(1), 247-275. <https://doi.org/10.22201/fca.24488410e.2024.5034>
- Paunović, M., Lazarević-Moravčević, M., & Mosurović, M. (2022). Business process innovation of Serbian entrepreneurial firms. *Economic Analysis*, 55(2), 66-78. <https://doi.org/10.28934/ea.22.55.ppch66-78>
- Pineda, F., Padilla, J., Granobles-Torres, J. C., Echeverri-Rubio, A., Botero, C. M., & Suarez, A. (2023). Community preferences for participating in ecotourism: A case study in a coastal lagoon in Colombia. *Environmental Challenges*, 11, 100713. <https://doi.org/10.1016/j.envc.2023.100713>
- 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>
- Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management*, 12(4), 531-544. <https://doi.org/10.1177/014920638601200408>
- Polas, M. R. H., Tabash, M. I., Afshar Jahanshahi, A., & Ahamed, B. (2022). Consumers' sustainable online purchase behaviour during Covid-19 pandemic: The role of relational benefit and site commitment. *Foresight*, 24(34), 476-503. <https://doi.org/10.1108/FS-01-2021-0012>
- Prado L., J. P., & Rouvinski, V. (2023). Transnationalism: The fifth element of the Pacific Alliance, *Latin American Policy*, 14(1), 1-15. <https://doi.org/10.1111/lamp.12284>
- Prado, L. P., Carrazedo, R., & El Debs, M. K. (2022). Interface strength of high-strength concrete to ultra-high-performance concrete. *Engineering Structures*, 252, 113591. <https://doi.org/10.1016/j.engstruct.2021.113591>
- Purnomo, S., & Purwandari, S. (2025). A comprehensive micro, small, and medium enterprise empowerment model for developing sustainable tourism villages in rural communities: A perspective. *Sustainability*, 17(4), 1368. <https://doi.org/10.3390/su17041368>
- Quinn, R. E. & Rohrbaugh, J. (1983). A spatial model of effectiveness criteria: Toward a competing values approach to organizational analysis. *Management Science*, 29, 363-377. <https://doi.org/10.1287/mnsc.29.3.363>
- Rabetino, R., Kohtamäki, M., and Huikkola, T. (2023). Digital services innovation (DSI): A multidisciplinary (re)view of its origins and progress using bibliometric and text mining methods. *Journal of Service Management*, 35(2), 176-201. <https://doi.org/10.1109/FES57669.2023.10182564>

- Rachmiatie, A., Setiawan, E., Zakiah, K., Saud, M., & Martian, F. (2024). Halal tourism ecosystem: Networks, institutions and implementations in Indonesia. *Journal of Islamic Marketing*, 15(11), 3247-3265. <https://doi.org/10.1108/JIMA-09-2023-0286>
- Rojas, R. A., Rauch, E., Unterhofer, M., Gualtieri, L., Woschank, M., & Matt, D. T. (2020). A maturity level-based assessment tool to enhance the implementation of industry 4.0 in small and medium-sized enterprises. *Sustainability*, 12(9), 3559. <https://doi.org/10.3390/SU12093559>
- Romero-Sanchez, A., Collazos, A. Z., & Obando, J. F. R. (2024). Determining factors of regional tourism development based on public policy management. *Journal of Infrastructure, Policy and Development*, 8(12), 1-18. <https://doi.org/10.3390/su17030989>
- Rosenbusch, N., Brinckmann, J., & Bausch, A. (2011). Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. *Journal of Business Venturing*, 26(4), 441-457. <https://doi.org/10.1016/j.jbusvent.2009.12.002>
- Rosique-Blasco, M., Madrid-Guijarro, A., & García-Pérez-de-Lema, D. (2018). The effects of personal abilities and self-efficacy on entrepreneurial intentions. *International Entrepreneurship and Management Journal*, 14(4), 1025-1052. <https://doi.org/10.1007/s11365-017-0469-0>
- Rubio-Andrés, M., Linuesa-Langreo, J., Gutiérrez-Broncano, S., & Sastre-Castillo, M. Á. (2024). How to improve market performance through competitive strategy and innovation in entrepreneurial SMEs. *International Entrepreneurship and Management Journal*, 20(3), 1677-1706. <https://doi.org/10.1007/s11365-024-00947-9>
- S&P Global. (2023). Standard & Poor's Global (S&P) Sustainability Yearbook 2023. Recuperado de: https://portal.s1.spglobal.com/survey/documents/SPGlobal_Sustainability_Yearbook_2023.pdf
- Santarsiero, F., Carlucci, D. y Schiuma, G. (2024). Impulsando la transformación digital y la innovación en modelos de negocio en turismo mediante laboratorios de innovación: Un estudio empírico. *Journal of Engineering and Technology Management*, 74, 101841. <https://doi.org/10.1016/j.jengtecman.2024.101841>
- Scott, W. R. (1987). Institutional theory. *Administrative Science Quarterly*, 32(4), 493-511. <https://doi.org/10.2307/2392880>
- Seclén D., M. B., Guerra M., D. P. M., Ortiz C., P. C., & Huamanchumo R., M. E. (2022). Experiential marketing and brand value in a company in the gastronomic sector. *Venezuelan Management Magazine: RVG*, 27(98), 696-712. <https://doi.org/10.52080/rvgluz.27.98.20>
- Serrano-Amado, A. M., Montoya-Restrepo, L. A., & Cazares, I. (2018). Analysis of the sustainability and competitiveness of tourism in Colombia. *Gestión y Ambiente*, 21(1), 99-109. <https://doi.org/10.15446/ga.v21n1.69395>
- Servicio Natural de Turismo (SERNATUR). (2023). Dataturismo Chile. <https://www.sernatur.cl/daturismo/>. Recuperado el 14 de julio de 2024.
- Setyawati, A., Sugangga, R., Sulistyowati, R., Narmaditya, B. S., Maula, F. I., Wibowo, N. A., & Prasetya, Y. (2024). Locus of control, environment, and small-medium business performance in pilgrimage tourism: The mediating role of product innovation. *Heliyon*, 10(9), e29981. <https://doi.org/10.1016/j.heliyon.2024.e29981>
- Sharma, A., Shin, H., Santa-María, M. & Nicolau, J. (2021). Hotels' COVID-19 innovation and performance. *Annals of Tourism Research*, 88, 103180. <https://doi.org/10.1016/j.annals.2021.103180>
- Shmueli, G., & Koppius, O. R. (2011). Predictive analytics in information systems research. *MIS Quarterly*, 35(3), 553-572. <https://doi.org/10.2307/23042796>
- Skare, M., de Obesso, M. D. L. M., & Ribeiro-Navarrete, S. (2023). Digital transformation and European small and medium enterprises (SMEs): A comparative study using digital economy and society index data. *International Journal of Information Management*, 68, 102594. <https://doi.org/10.1016/j.ijinfomgt.2022.102594>
- Soares, A. L. V., Mendes-Filho, L., & Gretzel, U. (2021). Technology adoption in hotels: Applying institutional theory to tourism. *Tourism Review*, 76(3), 669-680. <https://doi.org/10.1108/TR-05-2019-0153>
- Sourvinou, A., & Filimonau, V. (2018). Planning for an environmental management program in a luxury hotel and its perceived impact on staff: An exploratory case study. *Journal of Sustainable Tourism*, 26(4), 649-667. <https://doi.org/10.1080/09669582.2017.1377721>
- Tajeddini, K., & Mueller, S. (2018). Moderating effect of environmental dynamism on the relationship between a firm's entrepreneurial orientation and financial performance. *Entrepreneurship Research Journal*, 9(4), 1-25. <https://doi.org/10.1515/erj-2018-0283>
- Teece, DJ (2019). A capability theory of the firm: An economics and (Strategic) management perspective. *New Zealand Economic Papers*, 53(1), 1-43. <https://doi.org/10.1080/00779954.2017.1371208>
- Torres-Flórez, D., Rincón-Ramírez, A. V., & Medina-Moreno, L. R. (2022). Competencias digitales de los docentes en la Universidad de los Llanos, Colombia. *Trilogía Ciencia Tecnología Sociedad*, 14(26), 1-22. <https://doi.org/10.22430/21457778.2246>
- Valdez-Juárez, L., & Castillo-Vergara, M. (2021). Technological capabilities, open innovation, and eco-innovation: Dynamic capabilities to increase corporate performance of SMEs. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(1), 1-19. <https://doi.org/10.3390/joitmc7010008>
- Valdez-Juárez, L. E., Ramos-Escobar, E. A., Hernández-Ponce, O. E., & Ruiz-Zamora, J. A. (2024). Digital transformation and innovation, dynamic capabilities to strengthen the financial performance of Mexican SMEs: a sustainable approach. *Cogent Business & Management*, 11(1), 2318635. <https://doi.org/10.1080/23311975.2024.2318635>
- Van Gils, A. (2005). Management and governance in Dutch SMEs. *European Management Journal*, 23(5), 583-589. <https://doi.org/10.1016/j.emj.2005.09.013>
- Van Klyton, A., Tavera-Mesías, J. F., & Castaño-Muñoz, W. (2021). Innovation resistance and mobile banking in rural Colombia. *Journal of Rural Studies*, 81, 269-280. <https://doi.org/10.1016/j.jrurstud.2020.10.035>
- Varadarajan, R., Welden, R. B., Arunachalam, S., Haenlein, M., & Gupta, S. (2022). Digital product innovations for the greater good and digital marketing innovations in communications and channels: Evolution, emerging issues, and future research directions. *International Journal of Research in Marketing*, 39(2), 482-501. <https://doi.org/10.1016/j.ijresmar.2021.09.002>
- Vávrová, J., Červová, L., Brandová, B., & Pacheco, J. (2024). Assessing sustainable practices and managerial approaches in the hotel industry: A comparative case study. *Journal of Entrepreneurship, Management and Innovation*, 20(3), 46-61. <https://doi.org/10.7341/20242033>
- Vera Jaramillo, F., Gálvez Albarracín, E., & Collazos, A. Z. (2024). Efectos moderadores de la edad y el tamaño del negocio en la relación entre la capacidad dinámica de absorción, las actividades de innovación y el desempeño: un estudio desde la perspectiva de género del empresario aplicado a las mipymes turísticas de Cali, Colombia. *Journal Technology Management Innovation*, 19(3), 97-112. <http://dx.doi.org/10.4067/S0718-27242024000300097>
- Verreynne, M., Williams, A., Ritchie, B., Gronum, S. & Betts, K. (2019). Innovation diversity and uncertainty in small and medium sized tourism firms. *Tourism Management*, 72, 257-269. <https://doi.org/10.1016/j.tourman.2018.11.019>
- Vitell, S. J., Nwachukwu, S. L., & Barnes, J. H. (1993). The effects of culture on ethical decision making: An application of Hofstede's typology. *Journal of Business Ethics*, 12(10), 753-760. <https://doi.org/10.1007/BF00881307>
- Wahyudiono, A., Aini, N., Murni, S. A., & Rosyid, A. (2024). Maintaining sustainable growth of micro and small enterprises: Antecedents of management orientation and digital business. *Sustainability*, 16(15), 6638. <https://doi.org/10.3390/su16156638>

- Wang, M., Hill, A., Liu, Y., Hwang, K. S., & Lim, M. K. (2025). Supply chain digitalization and agility: How does firm innovation matter in companies? *Journal of Business Logistics*, 46(1), e70007 <https://doi.org/10.1111/jbl.70007>
- Wszendybył-Skulska, E., Najda-Janoszka, M., Jezierski, A., Kościółek, S., & Panasiuk, A. (2024). Exploring resilience of the hotel industry using the example of Polish regions: The case of COVID-19 pandemic, *Sustainability*, 16(19), 8485. <https://doi.org/10.3390/su16198485>
- Yin, J., Li, Y., Ma, Z., Chen, Z., & Guo, G. (2024). Impact of entrepreneurship on technological innovation in the digital age: A knowledge management perspective. *Journal of Knowledge Management*, 28(9), 2750-2772. <https://doi.org/10.1108/JKM-07-2023-0602>
- Zahoor, N., Zopiatis, A., Adomako, S., & Lamprinakos, G. (2023). The micro-foundations of digitally transforming SMEs: How digital literacy and technology interact with managerial attributes. *Journal of Business Research*, 159, 113755. <https://doi.org/10.1016/j.jbusres.2023.113755>
- Zhang, B., Pan, L., Chang, X., Wang, Y., Liu, Y., Jie, Z., & Wang, L. (2025). Sustainable mix design and carbon emission analysis of recycled aggregate concrete based on machine learning and big data methods. *Journal of Cleaner Production*, 489, 144734.
- Zhang, W., Yuan, G., Xue, R., Han, Y., & Taylor, J. E. (2022). Mitigating common method bias in construction engineering and management research. *Journal of Construction Engineering and Management*, 148(9), 04022089. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0002364](https://doi.org/10.1061/(ASCE)CO.1943-7862.0002364)
- Zirena-Bejarano, P. P., Tancayllo Yana, G., & Caryt Málaga, A. K. (2023). The moderating effect of adaptability on the relationship between cognitive social capital and innovation capacity. *Journal of Facilities Management*, 19(1). [https://doi.org/10.21511/im.19\(1\).2023.13](https://doi.org/10.21511/im.19(1).2023.13)
- Zopf, C., & Guenther, E. (2015). Corporate environmental performance. *Annals in Social Responsibility*, 1(1), 131-194. <https://doi.org/10.1108/asr-12-2014-0006>
- Zucker, L. G. (1987). Institutional theories of organization. *Annual Review of Sociology*, 13, 443-464. <https://doi.org/10.1146/annurev.so.13.080187.002303>
- Zúñiga-Collazos, A., Gálvez-Albarracín, E. J., Vera-Jaramillo, F., & Patiño-Giraldo, L. V. (2025). Digitalization, innovation, sustainability and performance: A causal analysis applied to tourism MSMEs. *International Journal of Innovation Studies*, 9(1), 46-59. <https://doi.org/10.1016/j.ijis.2024.12.001>
- Zuorro, A., Moreno-Sader, K. A., & González-Delgado, Á. D. (2021). Inherent safety analysis and sustainability evaluation of chitosan production from shrimp exoskeleton in Colombia. *Water*, 13(4), 553. <https://doi.org/10.3390/w13040553>

Biographical notes

Antonio Luis Duréndez Gómez Guillamón received a Ph.D. in Economics and Business Administration from the University of Murcia (Spain). Professor of the Department of Economics, Accounting and Finance at the Polytechnic University of Cartagena-Spain. Coordinator of the University Máster in Agribusiness Management. Principal Investigator R&D Group.

Domingo García-Pérez-de-Lema received a Ph.D. in Economics and Business Administration (Financial Economics and Accounting). Professor of the Department of Economics, Accounting and Finance at the Polytechnic University of Cartagena-Spain. He belongs to the Accounting and Financial Information Group. He is currently Secretary of the Innovation Ecosystem of the Region of Murcia.

Edgar Julián Gálvez-Albarracín received a Ph.D. in Administration from the Polytechnic University of Cartagena in Spain, a Master's in Business Creation and Management of Innovative Projects from the University Montesquieu Bordeaux IV in France, and a Business Administrator degree from Universidad del Valle. Currently, he is a professor in the Department of Management and Organizations at the Faculty of Management Sciences of the Universidad del Valle. He is an active member of the Humanism and Management Research Group and coordinates the Research Line Entrepreneurship and Management of MSMEs.

Francisney Vera-Jaramillo is a Ph.D. Candidate in Administration, Máster in Administration, with Specialization in Strategic Marketing from Universidad del Valle; Business Administrator from Universidad Libre de Cali, Colombia. She is an active member of the Humanism and Management Research Group. She possesses a capacity for teamwork and an excellent service attitude and is open to acquiring new skills in various administrative areas through work and academic experience. She has the ability to transfer knowledge and skills to different business, academic, and social settings.

Author contributions statement

Antonio Luis Duréndez Gómez Guillamón: Proofreading and Editing, Writing Original Drafts, Software, Resources, Research, Formal analysis, and Conceptualization. **Domingo García-Pérez-de-Lema:** Literature Investigations, Visualization, Validation, Supervision, Formal Analysis, Conceptualization. **Edgar Julián Gálvez-Albarracín:** Writing, Revising and Editing, Writing Original Drafts. **Francisney Vera-Jaramillo:** Writing Original Drafts, Methodology, Research, Formal Analysis, Data Curation, Conceptualization.

Conflicts of interest

The authors declare no conflicts of interest.

Citation (APA Style)

Duréndez Gómez Guillamón, A.L., García-Pérez-de-Lema, D., Gálvez-Albarracín, E.J., & Vera-Jaramillo, F. (2025). Innovation, digitalization, and sustainability as drivers of performance in tourism MSMEs: A multigroup evidence from the Pacific Alliance. *Journal of Entrepreneurship, Management and Innovation*, 21(4), 5-29. <https://doi.org/10.7341/20252141>

Integrating artificial intelligence competencies into the theory of planned behavior: Explaining sustainability-oriented entrepreneurial intentions

Son Tung Ha¹ , Thi Thanh Hoa Phan² , Thi Viet Nga Ngo³ 
Cong Doanh Duong⁴ , Ngoc Thang Ha⁵ 

Abstract

PURPOSE: Sustainability-oriented entrepreneurship plays a pivotal role in addressing global environmental and social challenges by aligning economic activity with sustainable development goals. While the theory of planned behavior has been widely applied to explain entrepreneurial intentions, limited attention has been given to the influence of artificial intelligence-related competencies on such intentions. This study aims to examine how knowledge of artificial intelligence and confidence in using artificial intelligence tools influence university students' intentions to engage in sustainability-oriented entrepreneurship, thereby extending the theory of planned behavior. **METHODOLOGY:** A cross-sectional survey was conducted with a sample of 217 undergraduate students from five universities in Vietnam, selected using a stratified random sampling approach. Multiple linear regression was used to test the direct effect, while the PROCESS macro approach was employed to test the mediation effect. Polynomial regression and response surface analysis were employed to investigate how attitudes towards sustainability-oriented entrepreneurship and perceived behavioral control are congruent or incongruent with each other in triggering sustainability-oriented entrepreneurial intentions. **FINDINGS:** The results demonstrate that a positive attitude toward sustainability-oriented entrepreneurship and a strong sense of control over entrepreneurial actions are significant predictors of entrepreneurial intentions. Intentions are highest when both attitude and perceived behavioral control are simultaneously strong, indicating a synergistic effect. However, imbalances between these two factors do not significantly reduce intention. Knowledge of artificial intelligence and self-confidence in using AI tools. Moreover, subjective norms do not directly influence intentions. **IMPLICATIONS:** The study advances theoretical understanding by incorporating emerging technological competencies into the theory of planned behavior framework. For practitioners and educators, the findings suggest that enhancing artificial intelligence capabilities among students may indirectly foster stronger intentions to engage in sustainability-oriented entrepreneurship. **ORIGINALITY AND VALUE:** This research is among the first to integrate artificial intelligence-related constructs into a well-established psychological framework for explaining sustainable entrepreneurship. It offers novel insights into how technological competencies contribute to entrepreneurial motivation through established cognitive pathways.

1 Son Tung Ha, Ph.D., Associate Professor at the Faculty of Business Management, School of Business, National Economics University, 207 Giai Phong, Hanoi, Vietnam, e-mail: tunghs@neu.edu.vn (ORCID: <https://orcid.org/0000-0002-5475-8365>).

2 Thi Thanh Hoa Phan, Ph.D., Faculty of Business Management, School of Business, National Economics University, 207 Giai Phong, Hanoi, Vietnam, e-mail: hoaptt@neu.edu.vn (ORCID: <https://orcid.org/0000-0001-5984-138X>), corresponding author.

3 Thi Viet Nga Ngo, Ph.D. at the Faculty of Business Management, School of Business, National Economics University, 207 Giai Phong, Hanoi, Vietnam. Email: nganv@neu.edu.vn (ORCID: <https://orcid.org/0000-0003-2758-7991>)

4 Cong Doanh Duong, Ph.D., Associate Professor at the Faculty of Business Management, School of Business, National Economics University, 207 Giai Phong, Hanoi, Vietnam, e-mail: doanhdc@neu.edu.vn (ORCID: <https://orcid.org/0000-0003-4431-9761>).

5 Ngoc Thang Ha, Ph.D., Faculty of Business Management, School of Business, National Economics University, 207 Giai Phong, Hanoi, Vietnam. Email: hangocthang@neu.edu.vn (ORCID: <https://orcid.org/0000-0001-9812-4092>).

Received 16 April 2025; Revised 10 July 2025; 13 September 2025; Accepted 17 September 2025.

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Keywords: *AI knowledge, AI self-efficacy, sustainability-oriented entrepreneurial intention, theory of planned behavior, response surface analysis, artificial intelligence competencies, sustainability-oriented entrepreneurship, entrepreneurial intentions, sustainable development, university students, technological competencies, attitude-behavior-control framework, mediation analysis*

INTRODUCTION

Sustainability-oriented entrepreneurship (SOE) has become a crucial strategy for confronting pressing worldwide issues such as climate change, resource scarcity, and social inequity (Srivastava et al., 2024a). It differs from traditional entrepreneurship by emphasizing a triple-bottom-line approach that integrates economic, environmental, and social objectives (Hopp et al., 2025). SOE is broadly defined as pursuing entrepreneurial ventures to achieve sustainable development while balancing profitability with societal and environmental welfare (Lazarte-Aguirre, 2024). In recent years, this form of entrepreneurship has gained increasing prominence as a means to contribute to the United Nations' Sustainable Development Goals (SDGs) through innovative solutions to socio-environmental problems (Agu et al., 2021). This trend reflects the critical role of SOE in driving long-term societal change and highlights the need to understand what motivates individuals to engage in such ventures. Although the importance of SOE is widely recognized globally, there remains a knowledge gap regarding the factors that encourage aspiring entrepreneurs to adopt sustainability-oriented initiatives (Srivastava et al., 2024a). Bridging this gap is particularly relevant in emerging economies like Vietnam, where rapid industrialization has led to complex sustainability challenges and a pressing need for entrepreneurial solutions (Duong, 2025). Understanding the drivers of SOE intentions in such contexts is crucial for advancing both theory and practice in sustainable entrepreneurship.

Artificial intelligence (AI) has rapidly become a transformative force in entrepreneurship, offering new avenues to support and enhance SOE (Al-Romeedy & El-Sisi, 2024). Entrepreneurs increasingly leverage AI technologies – including machine learning, predictive analytics, and generative AI – to process large volumes of data, gain actionable insights, and improve decision-making (Bickley et al., 2024). These capabilities can significantly benefit sustainability-focused ventures. AI-driven analytics enable entrepreneurs to identify sustainable opportunities and innovative business models that might remain hidden from human analysis alone. By reducing uncertainty in highly dynamic markets, AI tools help entrepreneurs better evaluate the feasibility of projects that balance economic and environmental goals (Duong & Nguyen, 2024). In practical terms, AI applications have been shown to optimize energy usage, improve waste management, and promote circular economy practices – all of which directly contribute to the environmental mission of SOE (Gupta et al., 2023). Moreover, AI can streamline operations and automate routine tasks, freeing entrepreneurs to focus on the creative and strategic aspects of their sustainable venture (Roundy, 2022). By providing data-driven evidence of success, AI may strengthen an individual's positive attitude toward starting a sustainable enterprise and their perceived control over achieving sustainability goals (Bickley et al., 2024). Thus, emerging research suggests that AI technology contributes directly to sustainable outcomes and influences entrepreneurs' mindsets, making sustainable entrepreneurship more appealing and attainable (Bonfanti et al., 2024).

However, this optimistic view of AI warrants greater scrutiny. Critics point out that AI technologies themselves consume considerable energy and resources, raising concerns about their environmental footprint (Ueda et al., 2024). Moreover, access to AI tools is often unequal, exacerbating digital divides and creating barriers for under-resourced entrepreneurs (Imjai et al., 2025). These ethical and structural challenges highlight the need to consider both enabling and constraining roles of AI in sustainable entrepreneurship. To date, few studies have critically examined these dualities, resulting in a gap in understanding the full implications of AI for sustainability. Our study acknowledges these tensions and focuses on the cognitive influence of AI-related competencies while recognizing the broader socio-technical discourse. Moreover, despite growing interest in digital entrepreneurship and sustainability (Duong, 2025), little attention is paid to the role of such technological enablers in shaping sustainability-oriented entrepreneurial intentions.

In considering the influence of AI on SOE at the individual level, two personal factors are particularly salient: AI knowledge and AI self-efficacy. AI knowledge refers to an individual's understanding of and proficiency with AI tools (Chiu et al., 2024) and concepts relevant to business (Imjai et al., 2024), while AI self-efficacy denotes one's confidence in their ability to use AI technologies effectively (Bewersdorff et al., 2025). AI-literate and AI-confident individuals could have an edge in recognizing and acting on sustainable opportunities, suggesting a direct positive effect of these qualities on their entrepreneurial intentions. These expectations align with broader findings in entrepreneurship research that

domain-specific knowledge and self-efficacy bolster entrepreneurial intent and action (Al Issa et al., 2025; Renko et al., 2012). Nonetheless, the extent to which AI knowledge and self-efficacy independently drive SOE intentions remains to be empirically tested. To address the aforementioned gaps, our study adopts the theory of planned behavior (TPB) (Ajzen, 1991) to explore how AI drivers (AI knowledge and AI self-efficacy) foster individuals' sustainability-oriented entrepreneurial intention underlying cognitive mechanisms formed by core components in the TPB, including attitude towards sustainability-oriented entrepreneurship (ATS) and perceived behavioral control (PBC), and subjective norms (SN). Particularly, this study aims to address the following research questions (RQs):

- RQ1: How do AI knowledge and AI self-efficacy influence the cognitive antecedents of sustainability-oriented entrepreneurial intentions (attitude toward SOE and perceived behavioral control) and, ultimately, sustainability-oriented entrepreneurial intentions themselves?
- RQ2: How do attitudes toward SOE and perceived behavioral control interact under congruent and incongruent conditions (i.e., when both are similarly high or low versus when one is high and the other low) to affect sustainability-oriented entrepreneurial intentions?
- RQ3: To what extent do attitude and perceived behavioral control mediate the relationship between AI-related factors (AI knowledge and AI self-efficacy) and sustainability-oriented entrepreneurial intentions?

The remainder of this paper reviews the relevant literature and develops the research hypotheses. This is followed by a description of the methodology, including data collection procedures, measurement instruments, and analytical techniques. The subsequent section presents the empirical results, which are then discussed in relation to existing literature. Finally, the paper concludes by outlining key theoretical and practical implications, acknowledging limitations, and offering directions for future research.

LITERATURE REVIEW

Sustainability-oriented entrepreneurship

SOE refers to entrepreneurial activities that explicitly aim to achieve sustainable development goals by balancing economic success with positive environmental and social impact (Duong, 2025). SOE extends the traditional profit-oriented venture creation process to encompass a broader set of objectives, often described as the triple bottom line of "people, planet, and profit" (Bonfanti et al., 2024). Entrepreneurs in this domain seek innovative solutions to problems such as climate change, resource scarcity, and social inequality, integrating sustainability considerations into their business models from inception. This approach to entrepreneurship has gained momentum as stakeholders increasingly call for businesses to contribute to sustainable development (Srivastava et al., 2024a). Governments and international bodies encourage entrepreneurial action on sustainability issues, recognizing SOE as a means to help meet targets like the United Nations Sustainable Development Goals (Kwilinski et al., 2024). Likewise, consumers have shown rising interest in supporting companies with environmental and social missions, creating market opportunities for sustainability-driven startups (Bellver et al., 2022). By addressing urgent global challenges through enterprise, SOE is crucial in facilitating systemic change toward sustainability and creating economic value (Ip, 2024). This dual value creation is what sets SOE apart from conventional entrepreneurship, which has historically prioritized financial performance, often at the expense of environmental or social considerations.

Research on sustainability-oriented entrepreneurship has grown over the past decade, yielding insights into the motivations and factors that drive individuals to engage in this form of venture creation. One line of inquiry has examined sustainable entrepreneurs' personal values and ethics. Studies suggest that entrepreneurs who prioritize altruistic, pro-environmental values are more likely to pursue sustainability-oriented ventures, even when uncertain profit potential (Kuckertz & Wagner, 2010). For instance, Vuorio et al. (2017) found that among Finnish entrepreneurs, biospheric values (concern for nature and the ecosystem) significantly influenced sustainability-oriented entrepreneurial intentions, primarily via shaping positive attitudes toward sustainable business. Another line of research has focused on cognitive and educational factors. Entrepreneurial intention models, including the TPB, have been applied in the context of sustainability to identify key antecedents of intentions to start a sustainable enterprise (Romero-Colmenares & Reyes-Rodríguez, 2022). These studies confirm that the same psychological drivers are important in general entrepreneurship and relevant for SOE, though sometimes with differing magnitudes.

Some work shows that perceived social pressure (subjective norms) can be particularly salient for social or sustainable ventures due to normative expectations around “doing good,” whereas in classic profit-driven entrepreneurship, it might be less critical (Sharma, Bulsara, Bagdi, et al., 2023; Srivastava et al., 2024b). Other research emphasizes self-perception of capability: individuals are more inclined to start a sustainable venture if they feel competent in entrepreneurship and knowledgeable about sustainability issues (Wang et al., 2023). An important contextual factor is entrepreneurship education with a sustainability focus. Exposure to sustainability concepts in academic or training programs has been shown to raise awareness of environmental problems and enhance students’ commitment to addressing them through entrepreneurship (Alimehmeti et al., 2025). In a recent study of university students, those who received education in sustainable development and social responsibility reported higher sustainable entrepreneurial intentions, mediated by stronger pro-sustainability attitudes (Duong, 2025). Moreover, there is ongoing debate regarding the limitations of technology-driven approaches to sustainability, particularly concerning unintended consequences, rebound effects, or the risk that digital and AI tools are deployed in ways that ultimately support unsustainable business models.

Recent years have witnessed a surge of interest in how digital technologies—and particularly artificial intelligence—can drive or support sustainable entrepreneurship. Studies have shown that digital skills, information and communication technology (ICT) applications, and data analytics capabilities are associated with greater entrepreneurial intention and success (Duong et al., 2024; Fazio et al., 2024). For instance, mastery of ICT tools can help entrepreneurs identify market opportunities, design innovative products, and reach new customer segments, while data-driven decision-making can enhance operational efficiency and strategic agility. In the context of sustainability, AI can facilitate resource optimization, enable the tracking and reduction of environmental impact, and support the development of new business models such as the circular economy (Giuggioli & Pellegrini, 2022; Imjai et al., 2024). However, there is also evidence that technological sophistication alone is insufficient to guarantee positive sustainability outcomes.

Critics have raised important concerns regarding the ethical, environmental, and social risks of digital technologies. For example, AI systems can consume significant amounts of energy, contribute to electronic waste, or be harnessed for purposes that are at odds with social or environmental goals (Guo et al., 2025). The diffusion of AI and other advanced technologies may also exacerbate existing inequalities or lead to unintended negative consequences if not aligned with broader sustainability principles (Vinueza et al., 2020). These counter-narratives underscore the importance of adopting a critical and holistic perspective when assessing the role of AI in SOE, acknowledging both its enabling and potentially problematic aspects. Empirically, research remains limited on the direct and indirect pathways through which AI knowledge and self-efficacy influence sustainability-oriented entrepreneurial intention, particularly in understanding how these effects manifest within different institutional, social, and cultural contexts. This study aims to address these gaps by not only examining individual cognitive mechanisms but also acknowledging the broader social and technological landscape in which SOE emerges.

Theory of planned behavior

The TPB provides a robust theoretical lens for understanding entrepreneurial intentions (Ahmed et al., 2025), including those oriented toward sustainability (Sharma, Bulsara, Bagdi, et al., 2023). According to Ajzen (1991), the intention to perform a behavior is jointly determined by: Attitude toward the behavior – the individual’s overall evaluation (favorable or unfavorable) of performing the behavior; Subjective norms – the perceived social pressures or support to perform (or not perform) the behavior; and Perceived behavioral control– the perceived ease or difficulty of performing the behavior, which reflects one’s sense of capability and control over the action. TPB posits that a more positive attitude, stronger supportive norms, and higher perceived control will each contribute to a stronger intention to engage in the behavior (Relente & Capistrano, 2024). The applicability of TPB to entrepreneurship is well-established: entrepreneurship is considered a planned, intentional act that often involves significant forethought and personal agency (Krueger et al., 2000). Indeed, TPB has been one of the most widely used models to predict **entrepreneurial intentions** (Ahmed et al., 2025; Relente & Capistrano, 2024). Meta-analyses and reviews show that the TPB constructs collectively explain a substantial portion of the variance in intentions to start a business (Zaremohzzabieh et al., 2019), making it a useful framework for identifying key motivational levers.

Despite its value, the TPB has also attracted criticism for its focus on individual-level cognitive antecedents, with less emphasis on external or contextual factors such as institutional support, policy, or collective action (Abu Shriha et al., 2024; Ahmed et al., 2025). Some scholars argue that entrepreneurial intentions—and especially those relating to sustainability—are not only shaped by attitudes, subjective norms, and perceived control, but also by the broader structures and systems

within which entrepreneurs operate (Lortie & Castogiovanni, 2015). As such, integrating perspectives from institutional theory, practice theory, or socio-technical transitions literature could enrich understanding of how individual intentions interact with enabling or constraining contexts. In the specific context of sustainable entrepreneurship, TPB has also proven insightful. Sharma, Bulsara, Bagdi, et al. (2023) applied TPB to study sustainable entrepreneurial intentions and found that attitudes towards sustainable entrepreneurship and PBC were significant predictors of students' intentions to create sustainable enterprises, while subjective norms had a smaller effect. Similar results were reported by Heredia-Carroza et al. (2024) in a study on entrepreneurship intentions, where personal attitudes and perceived behavioral control were found to be crucial, while social norms were not. These findings suggest that while all three TPB factors can matter, individuals' own positive evaluations and confidence in performing sustainable entrepreneurship may be especially critical in driving their intention.

A person with a favorable attitude towards starting a sustainable venture is likely to view such entrepreneurship as personally rewarding or worthwhile, which should increase their intention to pursue it. By contrast, if they view sustainable entrepreneurship as unattractive or unimportant, their intention will be weaker. Prior research consistently shows that attitude is one of the strongest predictors of entrepreneurial intention in general (Ahmed et al., 2025; Relente & Capistrano, 2024). In sustainable entrepreneurship, attitude often encapsulates one's commitment to sustainability values and excitement about entrepreneurial opportunity. When individuals genuinely care about sustainable development and believe that creating a venture is a meaningful way to contribute, they are more inclined to form intentions to do so (Waris et al., 2021). For example, a student who is passionate about clean energy and sees business as an effective vehicle for impact will likely hold a strong positive attitude towards launching a solar energy startup, which drives their intention. Empirical studies support this logic: attitudes have been found to significantly and positively correlate with sustainability-oriented entrepreneurial intentions (Sharma, Bulsara, Trivedi, et al., 2023; Vuorio et al., 2017). Therefore, we expect a similar positive relationship in our context.

H1: Attitude towards sustainability-oriented entrepreneurship is positively correlated with sustainability-oriented entrepreneurial intentions.

According to TPB, greater PBC should strengthen intention, especially for behaviors that require skill and effort (Ajzen, 1991). In entrepreneurial settings, PBC is often operationalized similarly to entrepreneurial self-efficacy – belief in one's entrepreneurial capabilities (Zhao et al., 2005). Numerous studies have demonstrated that entrepreneurial self-efficacy, or PBC, strongly predicts the intention to start a business (Krueger et al., 2000; Neneh, 2020). The reason is intuitive: those who feel competent and in control are more willing to initiate entrepreneurial action, as they expect to manage the process effectively, whereas those who doubt their abilities are hesitant to commit. In the sustainability context, perceived behavioral control may encompass general business skills and the perceived ability to achieve sustainability outcomes (Sharma, Bulsara, Trivedi, et al., 2023; Vuorio et al., 2017). Tan et al. (2020) found that perceived feasibility (akin to PBC) of social entrepreneurship significantly contributed to intention among participants – when individuals believed they had the know-how and resources to start a social enterprise, their intentions solidified. Likewise, in green entrepreneurship research, PBC (such as confidence in implementing green practices or obtaining needed resources) correlates with stronger entrepreneurial intentions (Srivastava et al., 2024a). Thus, we anticipate that students who feel a high sense of control over founding a sustainability-oriented venture will be more inclined to do so.

H2: Perceived behavioral control is positively correlated with sustainability-oriented entrepreneurial intentions.

As several scholars have noted, sustainability-oriented entrepreneurship is not just an individual act but is embedded within social contexts, community values, and shared norms (Truong et al., 2022). The omission of subjective norms risks ignoring how perceived support from family, peers, and professional networks may shape the intention to pursue sustainability goals. This is particularly salient in collectivist cultures such as Vietnam, where social conformity and communal expectations often play a central role in decision-making processes (Duong, 2024). In entrepreneurial research, subjective norms may operate as a gatekeeping mechanism by signaling whether a new venture is seen as legitimate or supported by relevant reference groups (Ahmed et al., 2025). In the sustainability domain, such norms might involve approval from environmental peers, educators, or professional mentors who advocate for sustainable innovation (Truong et al., 2022). Thus, including subjective norms enhances the theoretical fidelity of TPB and enables a more nuanced

understanding of intention formation. Recent studies have also reported meaningful associations between subjective norms and sustainability-related behavioral intentions. For instance, Truong et al. (2022) found that students' perception of peer and family support significantly shaped their willingness to engage in social enterprises. Likewise, in the context of green and prosocial entrepreneurship, social expectations have been shown to exert a direct influence on intention, particularly in societies with strong communal values (Srivastava et al., 2024a). When individuals believe that important referents—such as family, friends, or academic mentors—support their pursuit of sustainability-oriented ventures, they are more likely to develop strong entrepreneurial intentions. This may be especially relevant in collectivist societies, where conformity to social expectations and familial encouragement play a central motivational role (Hofstede, 2001). Consequently, we posit that:

H3: Subjective norms are positively correlated with sustainability-oriented entrepreneurial intentions.

Recent theoretical arguments suggest examining how these two factors might combine to influence entrepreneurial intentions (Duong, 2025). Both attitude and PBC are essential, but is having both at strong levels especially potent? Conversely, if one is high and the other low, does that mismatch undermine one's intention? In entrepreneurial behavior models, there is an implicit notion that for someone to intend and ultimately act, they should both *want* to do it (attitude/desirability) and *feel able* to do it (PBC/feasibility) (Krueger et al., 2000; Shapero & Sokol, 1982). When both conditions are met – that is, an individual highly values the sustainable venture and also feels highly capable of executing it – the intention to proceed should be strongest. This situation can be described as a congruence of high attitude and high PBC. On the other hand, if there is an incongruence – for example, the person is very enthusiastic about the idea (high attitude) but has low confidence in their ability, or vice versa – the lack of one component may temper their overall intention. Individuals who love the concept of a sustainable startup but feel unqualified or powerless may hesitate to form a firm intention because they foresee difficulties.

Similarly, someone who is confident in their entrepreneurial skills but not personally invested in sustainability may not be strongly motivated to start a sustainable venture, as the drive or purpose is missing. Therefore, their interplay could matter beyond the additive effects of attitude and PBC. We expect that when both attitude and PBC increase together (congruent increase), they reinforce each other, resulting in especially elevated SOE intentions. In contrast, when one increases without the other (incongruent) – essentially a misalignment – the positive effect of the one might be offset by the deficiency of the other, potentially leading to a reduction in intentions compared to the congruent case. It is important to note that Ajzen (1991)'s TPB model is linear and does not explicitly posit an interaction between attitude and PBC; however, the entrepreneurial context invites the possibility that both favorable mindset and capability perceptions need to align for maximal intention. This perspective aligns with the entrepreneurial event model (Shapero & Sokol, 1982), which argued that both *perceived desirability* (similar to attitude) and *perceived feasibility* (similar to PBC) are required triggers for new venture initiation. We, therefore, hypothesize an interaction effect in terms of congruence/incongruence:

H4: A congruent increase in attitude towards sustainability-oriented entrepreneurship and perceived behavioral control would increase sustainability-oriented entrepreneurial intentions.

H5: An incongruent increase in attitude towards sustainability-oriented entrepreneurship and perceived behavioral control would reduce sustainability-oriented entrepreneurial intentions.

The role of AI knowledge

While TPB identifies proximal determinants of intention, it also acknowledges that background factors (such as personal traits, knowledge, and situational influences) affect intentions indirectly through those determinants (Ajzen, 1991). In the context of this study, AI knowledge is one such background factor that may influence sustainability-oriented entrepreneurial intentions by shaping attitude and perceived control. We define AI knowledge as an individual's awareness of and ability to understand AI tools and their potential applications (Chiu et al., 2024). This includes being aware of the available AI technologies, understanding how they can be utilized, and having some experience or proficiency in using them. Individuals vary widely in their AI knowledge: some tech-savvy students might be familiar with machine learning algorithms or have used AI platforms (like predictive analytics or content creation tools), whereas others have only a cursory awareness of AI. We propose that those with more excellent AI knowledge will exhibit more positive attitudes toward engaging in sustainability-oriented entrepreneurship and a higher sense of control, which can spur their entrepreneurial intentions.

Firstly, AI knowledge can enhance attitudes toward SOE by illuminating AI's possibilities for achieving sustainability goals. A knowledgeable individual is more likely to recognize how AI can make a sustainable venture more effective or innovative (Füller et al., 2022). For example, they might see that using AI for energy management in buildings can significantly cut emissions or that AI-driven analysis of farming data can improve crop yields in an eco-friendly way. This recognition can lead to a more favorable evaluation of starting a venture that leverages AI for sustainability – essentially, they perceive the venture as more promising and impactful. Moreover, familiarity with AI might reduce fear or skepticism about technology in business, leading to a more enthusiastic outlook. Someone who can “speak the language” of AI is apt to have higher confidence in the benefits it can bring, thereby bolstering the appeal (attitude) of an AI-enhanced sustainable business (Gupta et al., 2023). In contrast, individuals with low AI knowledge may feel that integrating advanced tech into a startup is daunting or may underestimate the potential upside, potentially dampening their attitude toward such an endeavor.

Secondly, AI knowledge is likely to increase perceived behavioral control. Knowledge is power: knowing how to use AI tools or at least understanding their logic can make the task of starting a tech-enabled sustainable venture seem more attainable. For instance, a founder who knows how to utilize AI for supply chain optimization will feel more capable of managing operational challenges in an eco-commerce startup. They may anticipate fewer difficulties in implementing AI solutions or be better prepared for troubleshooting issues, contributing to a sense of control. Prior research on technological competencies in entrepreneurship supports this link – entrepreneurs with greater technical knowledge often report higher self-efficacy in related entrepreneurial tasks (Hsu et al., 2019; van der Westhuizen & Goyayi, 2019). In our context, AI knowledge can serve as a resource that lowers perceived barriers: the individual might think, “I know how AI works, so I can handle that aspect of the business”, thus elevating their PBC regarding a sustainability-oriented venture that uses AI.

Beyond these indirect pathways, one might expect that higher AI knowledge could also have a direct positive effect on entrepreneurial intention. If a person is very knowledgeable about AI, they may be inherently more inclined to start a venture exploiting that knowledge – particularly given the current enthusiasm around AI-driven startups. They might see a clear market opportunity or feel a personal drive to capitalize on their AI expertise, which could directly fuel their intention to launch an AI-related sustainable business. While TPB would argue this effect is mediated by attitude and control perceptions, some residual direct influence is possible if, for example, AI knowledge also correlates with other unmodeled factors like an innovative mindset or network access that independently encourage entrepreneurial action. In addition, aligning with the TPB rationale that the influence of background factors on intentions occurs through the proximal factors (Ahmed et al., 2025; Relente & Capistrano, 2024), we expect mediation by attitude and PBC. This mediated relationship acknowledges that even if AI knowledge correlates with intention, the psychological mechanism likely runs through making the individual more optimistic (attitude) and confident (PBC) about starting a sustainable venture. Consequently, drawing these arguments together, we hypothesize a positive relationship between AI knowledge and the key TPB components and outcome:

H6: AI knowledge is positively correlated with (a) attitude towards sustainability-oriented entrepreneurship, (b) perceived behavioral control, and (c) sustainability-oriented entrepreneurial intentions.

H7: AI knowledge is indirectly correlated with sustainability-oriented entrepreneurial intentions via (a) attitude towards sustainability-oriented entrepreneurship and (b) perceived behavioral control.

The role of AI self-efficacy

Another crucial AI-related personal factor in our model is AI self-efficacy, which we define as one's belief in their capability to use and leverage AI technologies for tasks or projects effectively. This concept is rooted in Bandura's social cognitive theory (Bandura, 1986), where self-efficacy in a specific domain (here, AI) influences how people think, feel, and act in that domain. AI self-efficacy differs from AI knowledge in that it is more about confidence and judgment of one's abilities than about the factual understanding of AI itself. It is possible to have considerable knowledge yet low confidence (or vice versa), so this construct adds a psychological dimension to the individual's AI readiness. We posit that AI self-efficacy will shape entrepreneurial attitudes and perceived behavioral control related to SOE, similar to AI knowledge, but through the lens of confidence.

First, high AI self-efficacy should foster a positive attitude toward launching a sustainable venture that uses AI. If individuals feel capable of handling AI tools, they are more likely to favorably view a tech-integrated sustainable business

idea. Confidence in using AI can translate into optimism about the outcomes – they trust that they can implement AI solutions successfully, which could make the prospect of the venture more exciting and less intimidating. For instance, a person who is confident in their ability to develop predictive models might be enthusiastic about a sustainable agriculture startup that relies on data analytics to reduce waste because they foresee themselves managing the AI part effectively. This positive outlook feeds into their attitude toward the venture. On the other hand, someone with low AI self-efficacy might harbor doubts, which can impart a more negative or hesitant attitude toward starting that business (Duong, 2025). By analogy, higher AI self-efficacy should engender a more favorable evaluation of an AI-enabled entrepreneurial endeavor.

Second, AI self-efficacy is expected to bolster perceived behavioral control when starting a sustainability-oriented venture strongly. AI self-efficacy can be seen as a domain-specific extension of entrepreneurial self-efficacy. If a person believes “I can use AI tools to solve problems”, this contributes to their overall sense that they can control the tech aspect of their venture. Starting a new business, especially involving advanced technology, often comes with uncertainty about managing all facets. High self-efficacy acts as an assurance: those individuals feel they have what it takes to integrate AI into their business processes, which raises their perceived behavioral control over launching the venture. Prior work shows that self-efficacy in relevant skills tends to increase the perceived feasibility of entrepreneurial activities (Fuller et al., 2018). Latikka et al. (2019) found that people with greater robot-use self-efficacy were more accepting of and open to using AI-driven robots, which implies they felt more in control of interacting with that technology. Translating to our scenario, a budding entrepreneur confident in AI might think, “using AI in my startup is within my abilities”, thereby elevating their PBC. Additionally, AI self-efficacy can reduce anticipated external barriers; confident individuals might be less worried about needing external experts or excessive resources for the AI component, further boosting their sense of control.

Furthermore, prior research indicates that higher levels of self-efficacy enhance an individual’s perception of opportunity recognition and risk management, which are key drivers of entrepreneurial behavior (Aboobaker et al., 2023). Specifically, individuals with strong AI self-efficacy are more likely to view AI not as a source of uncertainty but as a resource that can be strategically leveraged to address sustainability challenges. This perception can strengthen their intention to pursue sustainability-oriented entrepreneurial activities, as they feel more capable of integrating AI solutions into innovative business models. Moreover, AI self-efficacy can mitigate perceived barriers to entrepreneurship by enhancing individuals’ control over technical and operational aspects, which aligns with the determinants of entrepreneurial intentions outlined in the theory of planned behavior (Ajzen, 1991).

Finally, we consider the direct effect: individuals with high AI self-efficacy may be generally more inclined to pursue ventures that involve AI, which could directly nudge their entrepreneurial intentions upward. They might relish the challenge or see it as an opportunity to apply their skills, thereby independently motivating them to plan a startup. Indeed, self-efficacy is known to have a direct positive effect on entrepreneurial intentions in many studies (Al Issa et al., 2025; Zhao et al., 2005). In our model, we anticipate that much of this effect will be channeled through attitude and PBC – as AI self-efficacy makes one more optimistic and confident, which then increases intention – but a residual direct link is plausible. Accordingly, the following hypotheses are formulated.

H8: AI self-efficacy is positively correlated with a) attitude towards sustainability-oriented entrepreneurship, (b) perceived behavioral control, and (c) sustainability-oriented entrepreneurial intentions.

H9: AI self-efficacy is indirectly correlated with sustainability-oriented entrepreneurial intentions via (a) attitude towards sustainability-oriented entrepreneurship and (b) perceived behavioral control.

The conceptual framework is summarized in Figure 1.

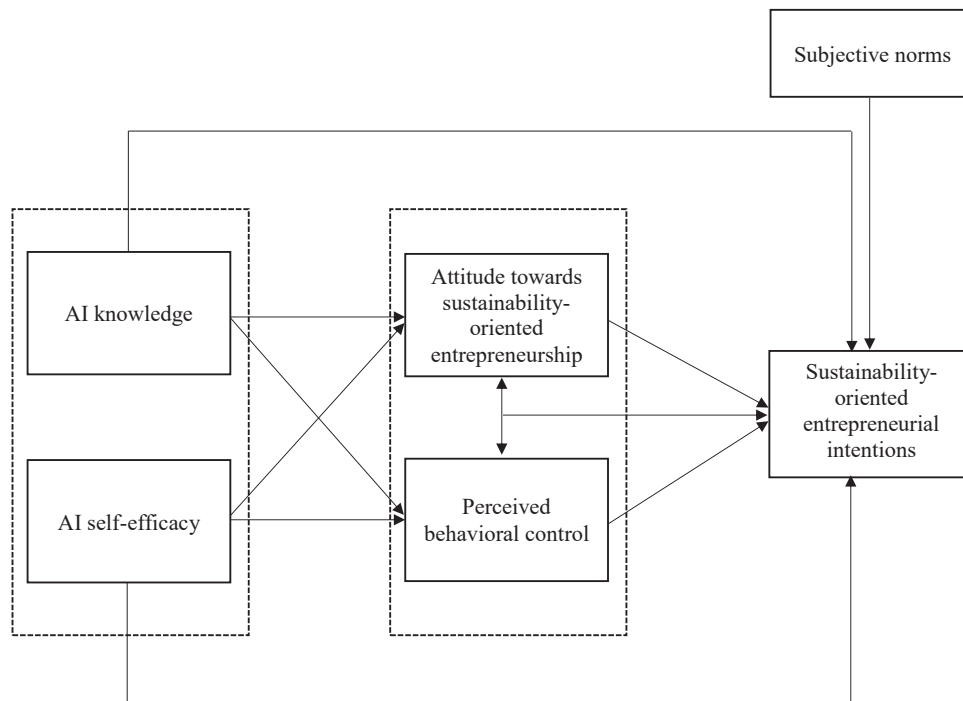


Figure 1. Hypothesized model

METHODOLOGY

Research sample

Undergraduate students were selected as the research sample for several reasons. Prior studies suggest that university students are a particularly suitable population for examining entrepreneurial intentions, as they are typically at a career decision stage where entrepreneurship is a viable and actively considered option (Adam et al., 2025; Al Issa et al., 2025). University students tend to be more homogeneous in terms of prior entrepreneurial experience compared to the general adult population, which reduces potential biases and enhances internal validity (Ahmed et al., 2025). Furthermore, the dynamic economic environment in Vietnam, which has shifted from an anti-entrepreneurial to a pro-entrepreneurial orientation (Nguyen, 2023), provides an ideal backdrop for studying entrepreneurial aspirations. In addition, recent evidence suggests that nearly 90% of university students have actively engaged with AI tools and GenAI platforms, such as ChatGPT, BingAI, Grammarly, and DeepSeek, for their academic learning activities (Pan et al., 2025). This widespread exposure to AI technology among university students further justifies their selection, as it aligns closely with the study's focus on AI knowledge, AI self-efficacy, and sustainability-oriented entrepreneurial intentions.

A purposive cluster sampling approach with gatekeeper selection was employed. In the first stage, the selection process was concentrated in two major regions of Vietnam, the Northern and Southern regions, where 224 higher education institutions are located (123 in the North and 101 in the South). Data were collected from undergraduate students at five universities in Vietnam between 20th February and 20th March 2025. In the first stage, two major regions of Vietnam, the Northern and Southern regions, were identified as the geographic frame. In the second stage, three universities in the North and two universities in the South were chosen based on their prominence in the Webometrics "impact" rankings (Webometrics, 2023), which served as a pragmatic stratification criterion. In the third stage, Student Affairs Officers and representatives from the Departments of Training Management acted as gatekeepers to identify students who met the inclusion criteria: those currently enrolled in, or who had completed, at least one entrepreneurship-related course. Lecturers and assistants then facilitated the distribution of questionnaires and provided clarification when needed. In the final stage, questionnaires were distributed directly to students. Participation was entirely voluntary, and informed consent was obtained from all respondents. Confidentiality and anonymity were strictly assured. Institutional approval

for the survey procedures was obtained prior to data collection. However, given the purposive and convenience-based nature of the sampling strategy, the findings should be interpreted with caution. Claims of generalizability are limited to entrepreneurship-exposed university students in Vietnam and may not extend to the broader population of young people or entrepreneurs.

A total of 500 questionnaires were distributed, yielding 225 returned responses. After excluding eight incomplete questionnaires, a final sample of 217 valid responses was retained for further analysis. Regarding age distribution, most participants (77.4%) were between 20 and 23 years old, while 7.8% were aged 18 to 19 years, and 14.7% were older than 23 years. In our study, Age was coded as a categorical variable with three groups: 1 = 18–19 years, 2 = 20–23 years, and 3 => 23 years. In terms of gender, 46.1% of the respondents were male, and 53.9% were female. Gender was coded as a binary variable: 1 = Male, 2 = Female. Concerning their fields of study, 57.1% were enrolled in business-related disciplines, and 42.9% were pursuing non-business fields. field was coded as 1 = Business-related, 2 = Non-business-related.

Scales

The measurement scales used in this study were adapted from validated instruments developed in prior research. All items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). AI knowledge was measured using four items from Chiu et al. (2024), while AI self-efficacy was assessed through four items adapted from Latikka et al. (2019). Attitude towards sustainability-oriented entrepreneurship and perceived behavioral control were each measured with four items based on Sharma, Bulsara, Bagdi, et al. (2023). Sustainability-oriented entrepreneurial intentions were captured through five items following the scale developed by Sharma, Bulsara, Bagdi, et al. (2023). The sources and detailed information for each construct are presented in Table 1.

Analytical approach

To examine the relationships proposed in the conceptual framework, we employed a multi-step analytical strategy. First, we conducted confirmatory factor analysis (CFA) to assess the validity and reliability of the measurement model, including the constructs' internal consistency, convergent validity, and discriminant validity. CFA was chosen to ensure that each latent variable was accurately represented by its observed indicators, a prerequisite for meaningful hypothesis testing. After establishing measurement validity, we used polynomial regression with response surface analysis (PSA) to test the interaction effects between ATS and PBC on SOI. Polynomial regression and PSA enable the modeling of congruence and incongruence effects between two predictors, providing a nuanced understanding of their joint impact beyond traditional linear models (Anders et al., 2023). Following the guidance of Shanock et al. (2010), all variables in Model 3 of Table 3 were mean-centered before creating the squared and cross-product terms to improve interpretability and reduce multicollinearity. Variance inflation factors (VIFs) were computed for all predictors, and the values were below the conventional threshold of 5, confirming the absence of problematic collinearity. This approach is particularly well-suited for exploring how alignment (or misalignment) between cognitive factors influences entrepreneurial intentions.

To further explore direct and indirect relationships among the constructs, including the mediating roles of ATS and PBC, we employed the PROCESS macro (Model 4) for mediation analysis with bootstrap confidence intervals. Specifically, 5,000 bootstrap resamples were used to generate confidence intervals, ensuring robust estimation of indirect effects. In addition, we clarify that all PROCESS effects were estimated in an unstandardized form, consistent with Hayes's (2018) guidelines. This technique enables the testing of multiple mediation paths in a statistically rigorous manner, providing insight into the mechanisms through which AI knowledge and AI self-efficacy influence SOI. Moreover, to ensure the robustness of our results, we additionally conducted structural equation modeling (SEM) using SmartPLS 4.0. The SEM approach allowed us to simultaneously estimate all hypothesized relationships and test the overall fit of the conceptual model. Furthermore, SmartPLS was used to assess the potential interaction effects between AI knowledge and AI self-efficacy, as well as to perform nested model comparisons for evaluating the robustness and parsimony of the findings. The consistency of results across these multiple analytical techniques reinforces the credibility of our conclusions.

Scale assessment

Confirmatory factor analysis (CFA) was conducted to assess the reliability and validity of the measurement model. One item from the AI self-efficacy construct (AIS4) was removed due to a low standardized loading of 0.402, which did not

meet the minimum threshold of 0.50 (Brown, 2006). After eliminating the unsatisfactory item, the revised five-factor model demonstrated an acceptable fit to the data: $\chi^2(204) = 292.295$, $p < 0.001$; $\chi^2/df = 1.433$; GFI = 0.901; AGFI = 0.866; CFI = 0.968; TLI = 0.960; NFI = 0.902; and RMSEA = 0.045, SRMR = 0.0534, indicating good model fit according to conventional criteria (Hair et al., 2021) (see Figure 2). The CFA was estimated using maximum likelihood (ML), and the five-point Likert items were treated as ordinal but approximated as continuous, consistent with common practice when distributions do not severely deviate from normality.

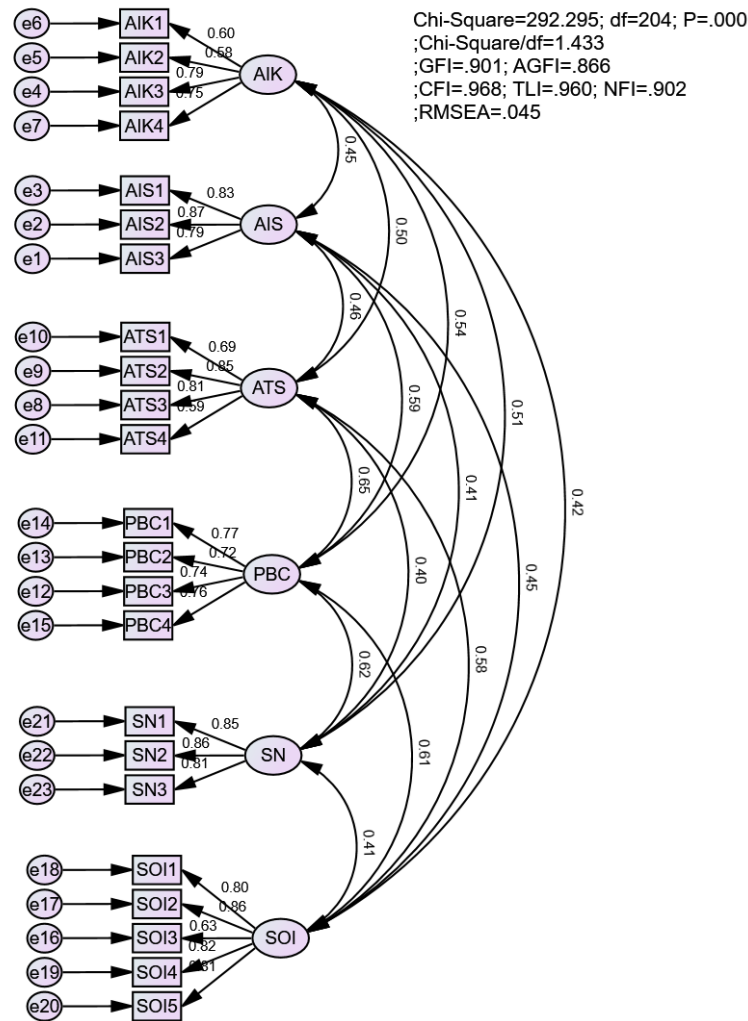


Figure 2. Measurement model

As shown in Table 1, all constructs achieved satisfactory reliability, with α values exceeding 0.70 and CR values above 0.70. Convergent validity was supported as all constructs' AVE exceeded the 0.50 threshold (Anderson & Gerbing, 1988), except for AIK. Although AVEAIK only accounted for 0.472, its CRAIK is 0.779, which is greater than 0.7; it is thus acceptable for further analyses (Brown, 2006). Discriminant validity was confirmed, as the square roots of the AVE values, presented along the diagonal of Table 2, were greater than the corresponding inter-construct correlations (Chin, 1998).

Common method bias

Harman's single-factor test was conducted to assess potential common method bias (CMB). The unrotated first factor accounted for 37.675% of the total variance, which is below the recommended threshold of 50% (Harman, 1976), suggesting that common method bias is not a major concern. Second, we implemented a common latent factor (CLF) approach to more rigorously assess the possibility of method bias. In this model, a latent method factor was added to

capture the variance shared across all items, following current best practices. The comparison of standardized factor loadings between the model with and without the CLF revealed that the differences were all below 0.20, which is within the acceptable range (Kock, 2021). This result indicates that common method variance did not substantially bias the estimates in our study. Finally, we also employed procedural remedies to mitigate the risk of CMB further. These included ensuring respondent anonymity, separating measurement of predictor and criterion variables in the questionnaire design, and randomizing item order to reduce consistency motifs.

RESULTS

Hypothesis testing

Multiple linear regression, polynomial regression, the PROCESS macro, and response surface analysis (RSA) were performed to examine the proposed hypotheses. The detailed results are presented in Tables 3 and 4 and visualized in Figure 3.

The findings first confirm the positive effects of ATS and PBC on SOI. As shown in Model 3 of Table 3, ATS ($\beta = 0.361$, $p < 0.001$) and PBC ($\beta = 0.338$, $p < 0.001$) were both significant predictors of SOI, supporting H1 and H2. In contrast, SN did not have a significant effect on SOI ($\beta = 0.045$, $p = 0.489$); thus, H3 was not supported. The response surface analysis revealed significant effects along the congruence line (ATS = PBC). The slope ($\ddot{\epsilon}_1$) along this line was positive and significant ($\ddot{\epsilon}_1 = 0.700$, $p < 0.001$), and importantly, the curvature ($\ddot{\epsilon}_2$) was also significant ($\ddot{\epsilon}_2 = 0.150$, $p = 0.024$), indicating a nonlinear relationship. This suggests that SOI increases more rapidly when both ATS and PBC are simultaneously high. This finding supports H4, confirming that SOI reaches its peak when ATS and PBC are aligned and high. As illustrated in the response surface plot (see Figure 3), the highest levels of SOI are observed at the back corner of the graph, where both ATS and PBC are high, while the lowest levels are found where both variables are low. In contrast, the analysis of the incongruence line (ATS \neq PBC) indicated that neither the slope ($\ddot{\epsilon}_3 = 0.020$, $p = 0.879$) nor the curvature ($\ddot{\epsilon}_4 = 0.330$, $p = 0.133$) was significant. These results imply that discrepancies between ATS and PBC do not significantly diminish SOI, thus failing to support H5. The response surface plot demonstrates that SOI remains relatively stable even when ATS and PBC are misaligned, suggesting that individuals may maintain entrepreneurial intentions despite a moderate imbalance between attitude and perceived behavioral control.

The direct effects of AIK and AIS on ATS and PBC were also significant. As indicated in Model 1 and Model 2 of Table 3, AIK positively influenced ATS ($\beta = 0.341$, $p < 0.001$) and PBC ($\beta = 0.306$, $p < 0.001$), while AIS also positively influenced ATS ($\beta = 0.234$, $p < 0.001$) and PBC ($\beta = 0.371$, $p < 0.001$), supporting H6a, H6b, H8a, and H8b. However, neither AIK ($\beta = 0.053$, $p = 0.513$) nor AIS ($\beta = 0.082$, $p = 0.196$) had a significant direct effect on SOI, failing to support H6c and H8c. Mediation effects were further examined using bootstrap analyses, as reported in Table 4. The indirect effects of AIK on SOI through ATS ($\beta = 0.189$, 95% CI [0.081, 0.308]) and through PBC ($\beta = 0.142$, 95% CI [0.056, 0.247]) were both significant, supporting H7a and H7b. Similarly, AIS exhibited significant indirect effects on SOI through ATS ($\beta = 0.137$, 95% CI [0.060, 0.225]) and through PBC ($\beta = 0.120$, 95% CI [0.042, 0.211]), supporting H9a and H9b.

Table 1. Internal consistency and convergent validity

Constructs/Scales	Codes	Measures	Sources	Loading	α	CR	AVE
AI knowledge	AIK1	I can distinguish whether a tool is AI-based or not	Chiu et al. (2024)	0.604	0.798	0.779	0.472
	AIK2	I can create content with AI		0.581			
	AIK3	I can explain what AI is		0.790			
	AIK4	I know how to choose the right AI tools to effectively complete a task		0.750			
AI self-efficacy	AIS1	I feel confident in understanding how AI caregiving robots works	Latikka et al. (2019)	0.829	0.864	0.870	0.690
	AIS2	I am confident in my decision-making regarding the use of AI caregiving robots		0.873			
	AIS3	I possess the necessary skills to effectively use AI caregiving robots		0.788			
	AIS4	I am confident in my understanding of the benefits and value that AI caregiving robots offer		-			
Attitude towards sustainability-oriented entrepreneurship	ATS1	For me, a career as a sustainable entrepreneur is attractive	Sharma, Bulsara, Bagdi, et al. (2023)	0.689	0.806	0.826	0.547
	ATS2	Rather than working for a company, I would rather be a sustainable entrepreneur		0.847			
	ATS3	I am positive about becoming a sustainable entrepreneur		0.806			
	ATS4	Being a sustainable entrepreneur, in my opinion, is quite desirable		0.590			
Perceived behavioral control	PBC1	It would be easy for me to start and run a sustainable enterprise	Sharma, Bulsara, Bagdi, et al. (2023)	0.772	0.842	0.837	0.562
	PBC2	I am confident in my ability to identify new business opportunities		0.718			
	PBC3	I think I have sufficient traits to start a sustainable firm		0.744			
	PBC4	I would have a good chance of succeeding if I tried to start a company		0.763			
Sustainability-oriented entrepreneurial intentions	SOI1	I wished to start a sustainability-oriented enterprise that assists in alleviating environmental issues during my study at the university	Yi (2020)	0.796	0.890	0.889	0.618
	SOI2	I had a preliminary idea for a sustainability-oriented enterprise to implement in the future during my studies at university.		0.859			
	SOI3	My professional goal was to become a sustainability-oriented entrepreneur during my studies at the university		0.631			
	SOI4	I was willing to do anything to become a sustainability-oriented entrepreneur during my studies at the university		0.816			
	SOI5	I would act as a professional manager and get involved in the management of a sustainability-oriented enterprise through promotion and preparation during my studies at the university.		0.809			
Subjective norms	SN1	My close family would approve of the decision to create a sustainable business	Truong et al. (2022)	0.853	0.876	0.880	0.709
	SN2	My friends would approve of the decision to create a sustainable business		0.863			
	SN3	My colleagues would approve of the decision to create a sustainable business		0.810			

Note: N = 217, α : Cronbach's alpha; CR = Composite reliability; AVE = Average variance extracted.

Table 2. Descriptive statistics and correlations

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9
Gender	1.539	0.500	-								
Age	2.069	0.471	0.038	-							
Fields	1.429	0.496	0.072	0.071	-						
SOI	3.063	0.952	-0.036	0.106	-0.024	0.786					
AIK	3.618	0.776	0.003	0.013	0.019	0.357**	0.687				
AIS	3.121	1.008	-0.078	0.148*	0.007	0.405**	0.363**	0.831			
ATS	3.501	0.745	0.023	0.062	-0.030	0.530**	0.469**	0.443**	0.740		
PBC	3.230	0.920	0.043	0.115	0.018	0.506**	0.407**	0.502**	0.568**	0.750	
SN	3.124	1.020	0.016	0.107	-0.030	0.363**	0.409**	0.377**	0.354**	0.538**	0.842

Note: N = 217. *p < 0.05, ** p < 0.01. The bolded scores along the diagonal represent the square root of the AVE.

Table 3. Hypothesis testing

Variables	Attitude towards sus. entrepreneurship				Perceived behavioural control				Sustainable entrepreneurial intentions			
	Model 1				Model 2				Model 3			
	β	SE	t	p-value	β	SE	t	p-value	β	SE	t	p-value
Constant	1.476***	0.320	4.608	<0.001	0.555	0.393	1.411	0.160	-0.142	0.312	-0.457	0.648
Age	0.019	0.092	0.211	0.833	0.096	0.113	0.848	0.397	0.098	0.112	0.876	0.382
Gender	0.074	0.086	0.861	0.390	0.133	0.106	1.262	0.208	-0.116	0.105	-1.104	0.271
Fields of study	-0.064	0.086	-0.744	0.458	0.004	0.106	0.039	0.969	-0.017	0.106	-0.165	0.869
AIK	0.341***	0.059	5.766	<0.001	0.306***	0.073	4.224	<0.001	0.053	0.080	0.656	0.513
AIS	0.234***	0.046	5.081	<0.001	0.371***	0.057	6.552	<0.001	0.082	0.063	1.298	0.196
SN									0.045	0.064	0.693	0.489
θ_1 : ATS	0.361***										3.849	<0.001
0.094												
θ_2 : PBC									0.338***	0.089	3.789	<0.001
θ_3 : ATS2									0.077	0.099	0.775	0.439
θ_4 : ATS x PBC									-0.092	0.109	-0.845	0.399
θ_5 : PBC2									0.162*	0.067	2.415	0.017
R2	0.310				0.318				0.393			
Adjusted R2	0.291				0.302				0.360			
F Change	18.971***				19.664***				12.041***			
Congruence line (ATS = PBC)												
$\tilde{\epsilon}_1$: Slope ($\theta_1 + \theta_2$)									0.700***	0.100	6.740	<0.001
$\tilde{\epsilon}_2$: Curvature ($\theta_3 + \theta_4 + \theta_5$)									0.150*	0.060	2.276	0.024
Incongruence line (ATS = -PBC)												
$\tilde{\epsilon}_3$: Slope ($\theta_1 - \theta_2$)									0.020	0.150	0.152	0.879
$\tilde{\epsilon}_4$: Curvature ($\theta_3 - \theta_4 + \theta_5$)									0.330	0.220	1.508	0.133

Note: N = 217, *p < 0.05. **p < 0.01, *** p < 0.001.

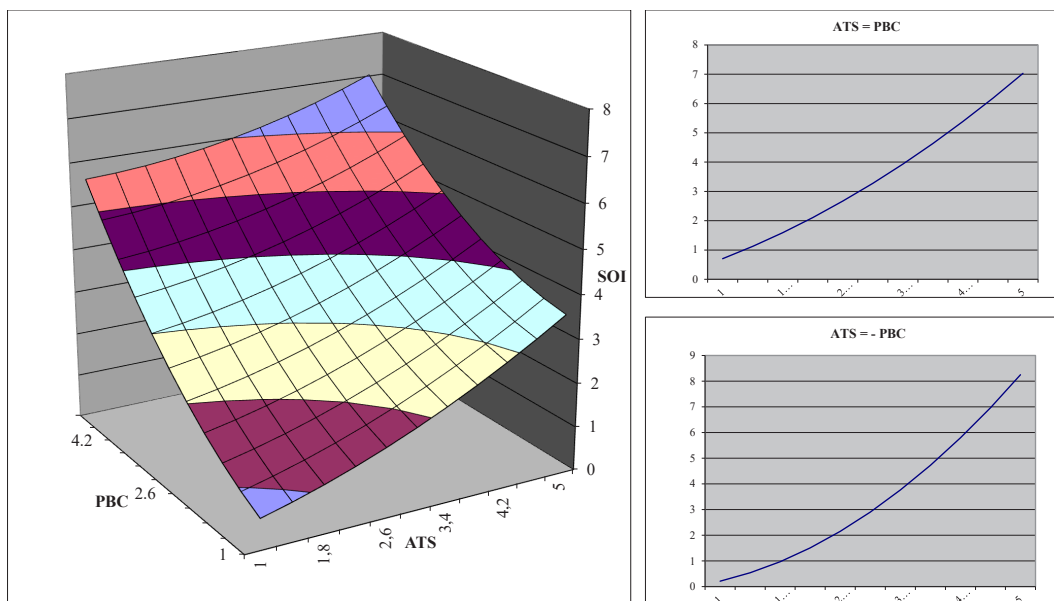


Figure 3. Response surface analysis of ATS and PBC

Table 4. Indirect effect analyses

Indirect paths				Effects	BootSE	Bootstrap 95% CIs		
						LLCI	ULCI	
AIK	→	ATS	→	SOI	0.189	0.058	0.081	0.308
AIK	→	PBC	→	SOI	0.142	0.048	0.056	0.247
AIS	→	ATS	→	SOI	0.137	0.042	0.060	0.225
AIS	→	PBC	→	SOI	0.120	0.043	0.042	0.211

Note: N = 217; LLCI: Lower level of confidence interval; ULCI: Upper level of confidence interval; SE: Standard errors.

Robustness test

To address concerns regarding the analytical approach and potential limitations of the polynomial regression and response surface analysis, we conducted additional robustness checks using structural equation modeling (SEM) with SmartPLS 4.0. This method enabled us to simultaneously assess multiple mediation, moderation, and interaction effects, providing a comprehensive validation of our original findings.

The SEM results, as shown in Table 5 and Figure 4, closely mirror those obtained from the main analyses. Both AIK and AIS maintained significant positive effects on ATS and PBC. In turn, ATS and PBC remained significant predictors of SOI, whereas the direct effects of AIK and AIS on SOI were not significant, again confirming full mediation through TPB pathways.

Importantly, we tested the interaction effects between AIK and AIS on all key outcomes, as recommended by the reviewer. Across all tested paths, the interaction terms (AIK×AIS and AIS×AIK) did not reach statistical significance (all $p > 0.05$), indicating that the synergy between AI knowledge and AI self-efficacy does not exert an additional effect on SOI beyond their individual contributions. These results further corroborate our initial conclusion that AIK and AIS primarily operate independently via attitudes and perceived control.

Additionally, the inclusion of SN in the model did not alter the pattern of results, as SN remained a non-significant predictor of SOI. Overall, the robustness analyses using SEM confirm the validity and stability of our main findings. The lack of significant interaction effects suggests that AI-related competencies individually, rather than synergistically, shape the cognitive antecedents of sustainability-oriented entrepreneurial intentions in our sample. This multi-method validation increases confidence in our results and addresses concerns about methodological limitations.

Table 5. Robustness test

Paths	β	S.D.	t-value	p-value	95% CIs	
					LL	UL
AIK → ATS	0.362 ***	0.065	5.565	0.000	0.230	0.487
AIK → PBC	0.272 ***	0.065	4.152	0.000	0.148	0.405
AIK → SOI	0.043	0.074	0.587	0.557	-0.101	0.186
AIS → ATS	0.308 ***	0.064	4.813	0.000	0.182	0.431
AIS → PBC	0.403 ***	0.075	5.389	0.000	0.251	0.544
AIS → SOI	0.109	0.072	1.508	0.132	-0.029	0.253
ATS → SOI	0.302 **	0.089	3.386	0.001	0.120	0.473
PBC → SOI	0.243 **	0.090	2.701	0.007	0.060	0.415
SN → SOI	0.070	0.085	0.814	0.416	-0.091	0.242
AIS*AIK → ATS	0.051	0.058	0.872	0.383	-0.067	0.163
AIS*AIK → PBC → SOI	0.001	0.018	0.033	0.973	-0.033	0.041
AIK → ATS → SOI	0.109 **	0.039	2.778	0.005	0.039	0.192
AIS → ATS → SOI	0.093 **	0.033	2.816	0.005	0.033	0.163
AIS → PBC → SOI	0.098 *	0.039	2.502	0.012	0.025	0.179
AIK → PBC → SOI	0.066 *	0.030	2.214	0.027	0.015	0.134
AIS*AIK → ATS → SOI	0.015	0.019	0.787	0.432	-0.020	0.058

Note: N = 217. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$; S.D.: Standard deviation; CIs: Confidence intervals; LL: Low limit (2.5%); UL: Upper limit (97.5%).

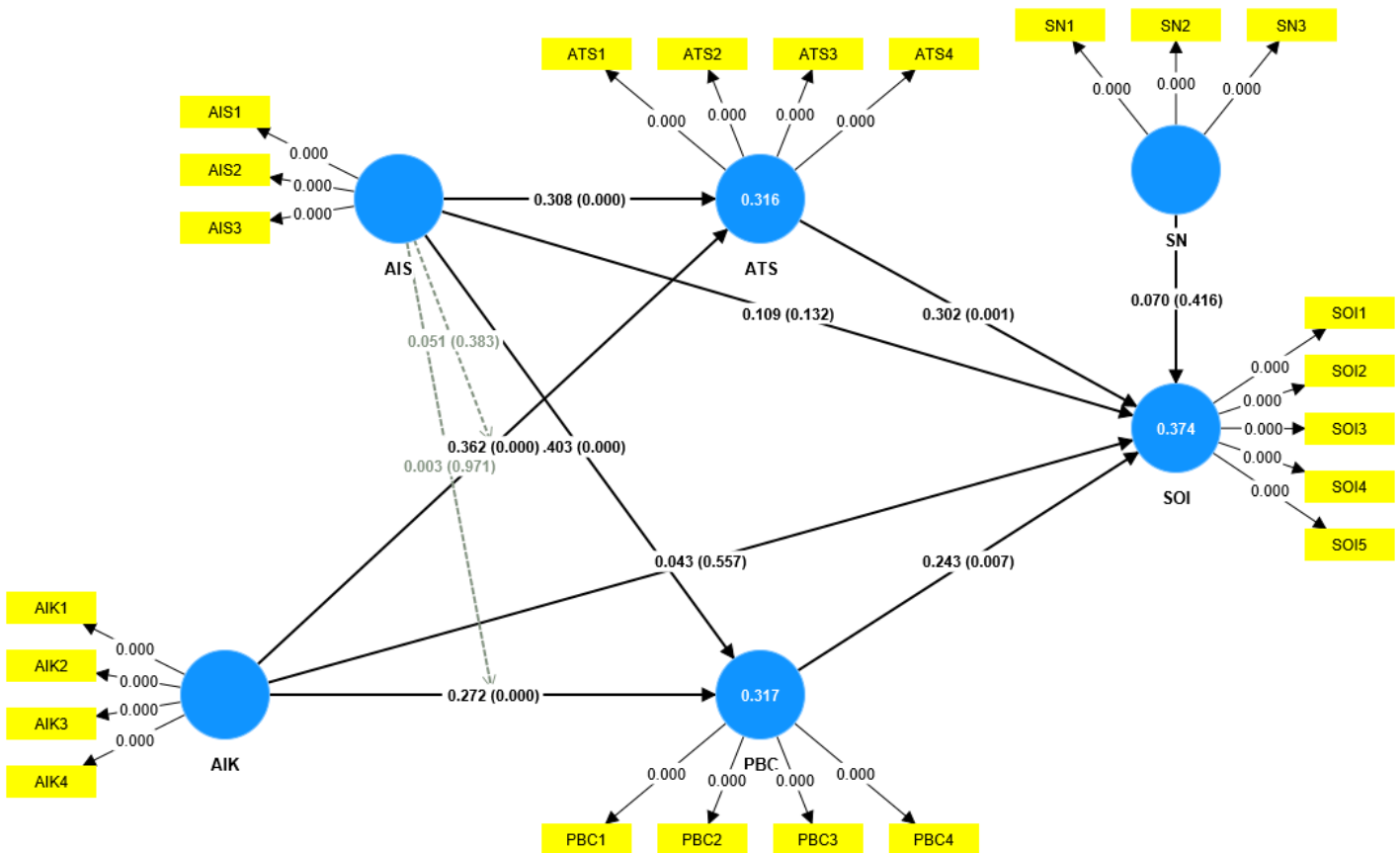


Figure 4. Robustness test

DISCUSSIONS

This study set out to investigate how AI-related competencies (knowledge and self-efficacy) shape sustainability-oriented entrepreneurial intentions through the cognitive pathways of attitude and perceived behavioral control, as grounded in the TPB. Overall, our findings provide strong support for the hypothesized model, with a few notable nuances.

First, consistent with TPB and prior entrepreneurship research, we found that both attitude towards SOE and perceived behavioral control had significant positive effects on sustainability-oriented entrepreneurial intentions. It means that students who held a more favorable attitude about engaging in sustainable entrepreneurship and those who felt a greater sense of control over launching a venture were more likely to express intentions to start a sustainability-oriented business. This aligns with numerous studies emphasizing attitude and self-efficacy as critical drivers of entrepreneurial intentions (Amani et al., 2024; Sharma, Bulsara, Bagdi, et al., 2023). Our results reaffirm that even in the specific domain of sustainability, where the venture's goals extend beyond profit, these personal motivational factors remain paramount. If an individual does not believe in the value of sustainable entrepreneurship or does not feel capable of performing it, they are unlikely to form an intention to pursue it. These findings align with those of Vuorio et al. (2017) and Tan et al. (2020), who also reported positive contributions of attitude and perceived feasibility to sustainable or social entrepreneurial intentions. We thereby extend their observations to a novel context involving AI considerations.

Turning to the interplay between attitude and perceived behavioral control, the response surface analysis provides important insights. We hypothesized that congruence between high attitude and high PBC would enhance intentions, while incongruence would reduce them. The findings partially supported these predictions. Intentions were highest when both attitude and PBC were strongly favorable, as indicated by the significant positive slope along the line of congruence (attitude = PBC). This suggests a synergistic effect: individuals who are both highly motivated towards sustainable entrepreneurship and confident in their ability to act are most committed to entrepreneurial action. This outcome also aligns with Shapero's model, which emphasizes the joint importance of desirability and feasibility (Krueger et al., 2000).

Furthermore, we found a significant positive curvature along the line of congruence, indicating a convex relationship. This suggests that the benefit of alignment becomes even more pronounced when both attitude and PBC are simultaneously high, providing additional support for the additive mechanism.

However, no significant punitive effect of incongruence was found. An imbalance between attitude and PBC did not significantly lower intentions compared to individual levels alone. The surface analysis showed that individuals with mismatched levels of attitude and PBC maintained moderate intention levels, suggesting an additive rather than multiplicative relationship. One strong factor appeared to partially compensate for the weaker one: high passion could sustain intentions despite low perceived control, and strong confidence could sustain intentions despite weaker sustainability commitment. This finding indicates that strengthening either attitude or PBC could independently foster sustainability-oriented entrepreneurial intentions. Although these results diverge from some theoretical expectations, they are consistent with empirical findings that found limited interaction effects between TPB components (Ahmed et al., 2025; Relente & Capistrano, 2024). In contrast to expectations based on the canonical TPB model, subjective norms did not exhibit a statistically significant effect on SOI. This finding suggests that perceived social approval from family, friends, and colleagues may not be a key determinant of students' intention to pursue sustainability-oriented entrepreneurship. This could reflect a broader trend observed in prior studies, where subjective norms were found to be weaker predictors of entrepreneurial intention compared to personal attitudes and perceived control (Heredia-Carroza et al., 2024; Sharma, Bulsara, Trivedi, et al., 2023). Another possible explanation lies in the growing autonomy of career decision-making among younger generations, who may prioritize internal motivations over external social expectations (Tran et al., 2023). Alternatively, in the specific Vietnamese university context studied, students may not yet perceive strong societal endorsement or peer pressure toward sustainable entrepreneurship (Truong et al., 2022).

A central contribution of this research is to illuminate the role of AI competencies in fostering sustainable entrepreneurial intentions. The data robustly supported our hypotheses regarding AI knowledge and AI self-efficacy, with some interesting patterns. We found that AI knowledge had a positive influence on both attitude towards SOE and perceived behavioral control. Students who possessed greater knowledge about AI tended to evaluate sustainable entrepreneurship more positively and felt more capable of starting such a venture. This result resonates with the argument that understanding technology can make sustainable business ideas seem more feasible and attractive (Bickley et al., 2025; Gupta et al., 2023). It appears that AI-literate individuals are more likely to see the potential of integrating AI solutions for sustainability challenges, which boosts their enthusiasm (attitude) for these ventures. Simultaneously, their familiarity with AI tools gives them confidence (PBC) that they can implement the technical side of a sustainable enterprise. These relationships mirror findings in general entrepreneurship education literature, where knowledge acquisition enhances both perceived desirability and feasibility of entrepreneurship (Fayolle & Gailly, 2015).

However, neither AI knowledge nor AI self-efficacy had a significant direct effect on SOE intentions when attitude and PBC were taken into account. This indicates that the influence of AI competencies on intentions is fully mediated by attitude and PBC, aligning with the TPB notion that such external factors work through the proximal determinants (Ajzen, 1991). In other words, simply knowing a lot about AI does not automatically translate into wanting to start a sustainable business – it translates into wanting and feeling able to do so, which then drives the intention. This full mediation is a significant theoretical confirmation, underscoring the value of the TPB framework in explaining how background factors, such as technological knowledge, influence entrepreneurial motivation. It also cautions that boosting AI knowledge alone may not increase entrepreneurial intentions unless it alters how people perceive the venture and their own capabilities.

With respect to AI self-efficacy, we observed similar patterns. Higher AI self-efficacy was associated with more positive attitudes towards SOE and higher PBC. This suggests that confidence in using AI engenders a mindset conducive to sustainable entrepreneurship. Those students who believed in their ability to work with AI were more optimistic about starting a venture that likely involves technology (improving their attitude) and felt fewer hurdles in doing so (elevating their perceived control). These findings are in line with broader entrepreneurship studies highlighting self-efficacy as a potent antecedent of attitudes and perceived feasibility (Newman et al., 2019). Our results extend this knowledge to the specific case of AI-related self-efficacy, showing that such domain-specific confidence can spill over into the entrepreneurial context. Again, the direct path from AI self-efficacy to intention was not significant, reinforcing that its effect on intentions is channeled via attitude and PBC. This full mediation was evidenced by the significant indirect effects: AI self-efficacy increased SOE intentions through its positive impact on attitude and on PBC. Essentially, an individual who feels adept with AI will likely think more positively about a sustainable venture and feel in control, which in turn makes them

more inclined to pursue that venture. This insight echoes prior research on self-efficacy in green entrepreneurship – for example, recent work by Al Issa et al. (2025) found that entrepreneurial self-efficacy (bolstered through experiential learning) significantly raised social entrepreneurial intentions by influencing individuals' confidence and aspirations.

Nonetheless, while these findings position AI-related competencies as important enablers, we caution that the adoption of AI in entrepreneurship is not without critical challenges. First, the transformative potential of AI for sustainability is accompanied by significant risks and contradictions. Many AI tools are embedded within capital- and resource-intensive infrastructures and may contribute to increased energy use and environmental burdens (Wang et al., 2025). This “digital sustainability paradox” suggests that while AI can advance sustainable outcomes, its widespread adoption could also exacerbate ecological footprints if not properly managed. Furthermore, the integration of AI into entrepreneurship can widen digital divides, as access to advanced AI technologies and training is unevenly distributed—potentially deepening inequalities among aspiring entrepreneurs, especially across regions or socio-economic groups (Vinuesa et al., 2020). Equity in access to AI tools and knowledge remains a pressing issue for educators and policymakers. Second, we acknowledge that our study primarily focuses on the enabling side of AI competencies, without directly investigating or controlling for the broader socio-technical and ethical risks associated with these competencies. Future work should critically examine both the positive and negative implications of digitalization for sustainable entrepreneurship, addressing the systemic and institutional context in which technological adoption unfolds. Finally, while we modeled and discussed subjective norms, further research should consider their indirect and contextual effects—especially in collectivist societies—where social and institutional support or resistance can shape entrepreneurial pathways.

CONCLUSIONS

Theoretical contributions

This research makes several important theoretical contributions. First, it extends the TPB into the novel intersection of AI and sustainability-oriented entrepreneurship. While TPB has been widely used in entrepreneurial intention studies, our study is among the first to incorporate AI-related personal factors into the TPB framework for sustainable entrepreneurship. By demonstrating that AI knowledge and AI self-efficacy have a significant influence on attitude and PBC, which in turn drive intentions, we provide evidence that the TPB can flexibly accommodate emerging determinants relevant to the digital age. This extension answers recent calls in the literature to integrate technological competencies into models of entrepreneurial intentions (Bui & Duong, 2024). We demonstrate that individuals' technological readiness (in terms of knowledge and confidence) is an important part of the cognitive equation for whether they decide to embark on a sustainable venture. In doing so, we also reinforce Ajzen's principle that background factors operate through proximal predictors: both AI knowledge and self-efficacy influence attitudes and control beliefs, rather than acting directly, thereby bolstering the theoretical premise of mediation in TPB. This contributes to the TPB literature by empirically confirming the mediated nature of external influences in a new context.

Second, our study contributes to the sustainable entrepreneurship theory by identifying concrete cognitive mechanisms through which the oft-discussed “technological enablers” affect sustainable entrepreneurial intentions. Prior research has acknowledged that technology (like digital platforms or green tech) can empower sustainable entrepreneurship (Lourenço et al., 2024), but there has been limited understanding of how this happens at the individual psychological level. Our findings suggest that simply having access to advanced technologies like AI is not enough – what matters is how these technologies are perceived and understood by the potential entrepreneur. We show that when individuals have internalized AI skills and confidence, they are more likely to view sustainable ventures as desirable and feasible, thereby increasing their intent to pursue them. This provides a more nuanced theoretical insight: the impact of technological advancements on sustainable entrepreneurship is mediated by human capital and cognitive perceptions. It bridges the gap between macro-level discussions of technology trends and micro-level analyses of entrepreneurial intention formation. This insight can be incorporated into sustainable entrepreneurship models, emphasizing personal technology readiness as part of the entrepreneurial “toolkit” that shapes venture creation decisions.

Third, our research makes a methodological and conceptual contribution by examining the interaction of attitude and perceived behavioral control using polynomial regression and response surface analysis. Entrepreneurship scholars have long debated whether the components of intention models simply add up or whether they have interactive effects (Schlaegel

& Koenig, 2014). We introduced and tested the concept of congruence versus incongruence between attitude and PBC in determining intention. While our hypothesis of a strong diminishment of intention under incongruence was not supported, the approach itself yielded rich information. We found evidence of a primarily additive relationship, implying that TPB's linear additive assumption held in our data – but we also confirmed that the “best case” scenario for intention is when both attitude and PBC are high (the ridge of the response surface). The lack of significant depression, despite a misaligned attitude/PBC, adds a new perspective: it suggests a certain robustness or compensatory effect in entrepreneurial motivation. This is a theoretical nuance that complements TPB: even if one cognitive driver is suboptimal, the other can buffer the effect to some degree. Future theoretical models of entrepreneurial intention could consider incorporating threshold or minimum conditions (e.g., perhaps one of the two must be above a certain level) rather than a strict interaction term. Our study thus contributes to the fine-tuning of intention theory in entrepreneurship, and it demonstrates the utility of advanced analytical techniques in unpacking these relationships beyond simple linear regression.

Finally, we enrich the literature on entrepreneurship in the digital era by combining insights from entrepreneurship, sustainability, and information systems. Our integrative approach shows that theories from one domain (like TPB from social psychology) can successfully interface with constructs from another domain (AI competencies from technology/education literature) to explain a complex phenomenon (sustainable entrepreneurship intention). The positive results lend support to an interdisciplinary theoretical outlook: understanding modern entrepreneurship requires considering technological factors as part of individuals' cognitive frameworks. In doing so, we provide a foundation for future research to explore other technology-related variables (such as actual usage of AI tools or attitudes specifically toward technology) within entrepreneurship theories. We also contribute to the emerging discourse on “sustainable digital entrepreneurship,” positioning our work at the convergence of digital transformation and sustainability in entrepreneurship. Theoretically, this helps build a narrative that sustainable entrepreneurs of the future will be those who can effectively harness digital innovations, and our study offers a tested model of how that convergence plays out at the intention stage.

Practical implications

Our findings carry important practical implications for educators, trainers, policymakers, and prospective entrepreneurs, especially in university and startup ecosystem settings.

Firstly, the significant role of attitude and perceived behavioral control in driving SOE intentions suggests that interventions aiming to foster sustainable entrepreneurship should focus on enhancing these cognitive factors. Educational programs in universities can help build positive attitudes towards sustainability-oriented businesses by showcasing success stories of impactful sustainable startups, incorporating sustainability challenges into entrepreneurship courses, and facilitating value-driven reflection among students. If students come to genuinely appreciate the societal and environmental value of sustainable ventures, their attitudes are likely to become more favorable. Simultaneously, programs should aim to increase students' perceived behavioral control. This can be achieved by equipping them with relevant skills (through workshops on business planning and sustainable innovation, for example), providing mentorship, and even conducting simulations of venture creation to allow them to practice entrepreneurial tasks. The more competent and in control students feel, the more likely they are to translate their interest into intention. Given that our results show intentions are maximized when both attitude and PBC are high, a balanced approach addressing both mindset and skillset is advisable. Given the additive effects identified in our response surface analysis, practitioners should seek a balanced approach that simultaneously builds both mindset and skillset, as the highest intentions were observed when both were high.

A second implication revolves around integrating AI and digital competencies into entrepreneurship development for sustainability. We found that AI knowledge and AI self-efficacy indirectly boosted intentions via attitude and PBC. This means that simply teaching about sustainability or business might not be enough; integrating technology training is key. Universities and incubators should consider adding AI-oriented modules in their entrepreneurship curriculum – for example, introducing students to AI tools that can be used in sustainable ventures (like data analytics for climate data, AI in recycling processes, or machine learning for social impact measurement). By doing so, students not only gain knowledge but can also practice with these tools, building their confidence (self-efficacy). Our research suggests that when aspiring entrepreneurs feel competent with AI, they will also feel more capable of launching a business that uses those tools, thereby indirectly encouraging entrepreneurial action. Importantly, this implies a synergy: promoting “tech for good” skill-building can serve the dual purpose of improving technical literacy and spurring sustainable entrepreneurship. For entrepreneurship support organizations, offering training sessions on AI for sustainability or hackathons that blend AI and environmental problem-solving could ignite interest and self-belief among participants, leading to more startup ideas

in this space. Importantly, access to such training should be broadened to avoid reinforcing digital divides, and educators should also address the ethical, environmental, and infrastructural challenges associated with AI adoption. By doing so, students not only gain knowledge but can also practice with these tools, building their confidence (self-efficacy).

Policymakers and innovation funding bodies can draw on our findings to design initiatives that encourage sustainability-oriented startups. One implication is to support the creation of interdisciplinary teams or programs that bring together students from computer science (with AI expertise) and students from environmental or business fields. Our results show that both knowledge and confidence in AI are assets – so if an individual entrepreneur lacks them, having a co-founder or team member with those strengths could compensate, boosting the team's overall attitude and perceived control. Policymakers could fund innovation labs or accelerators that explicitly pair tech-savvy youth with sustainability-focused youth to work on venture projects. Additionally, because attitude (i.e., personal commitment to sustainability) remains crucial, programs like innovation competitions or startup grants could put weight on sustainability impact, thereby attracting those who are passionate about these issues and reinforcing the societal importance (which bolsters positive attitude across the community of entrepreneurs).

Finally, our finding that misalignment between attitude and PBC did not drastically impede intentions suggests that practitioners can take a strength-based approach. If a prospective entrepreneur clearly has one strong suit (either high passion or high capability), mentors can work to leverage that strength while gradually addressing the weaker area. For instance, an idealistic student who lacks confidence might be encouraged to pursue their idea with the reassurance of resources and support networks (thus gradually improving their PBC). Conversely, a very confident student who has not yet embraced the sustainability mission might be exposed to compelling evidence of impact and market demand in sustainability (to elevate their attitude). In practice, this means that entrepreneurship support should be personalized: understanding whether a given individual needs more motivation or more skill empowerment, and tailoring support accordingly, can help maintain their intention to start a sustainable venture. In conclusion, our study provides actionable insights that integrating AI competency development with sustainability entrepreneurship programs will likely yield more robust intentions and, eventually, more startups that contribute to sustainable development.

Limitations and suggestions for future studies

Despite its contributions, this study has several limitations that suggest directions for future research. First, our focus on Vietnamese undergraduate students limits the generalizability of findings. Cognitive and motivational dynamics may differ in other age groups, life stages, and national contexts. We acknowledge that homogeneity in educational attainment, life stage, and the national context constrains external validity. Future research should replicate the study in diverse cultural and professional settings, and consider comparative or subgroup analyses, such as those between business and non-business students, to explore potential moderating effects.

Second, although we conducted additional robustness checks using structural equation modeling (SEM)—including nested model comparisons and interaction effects between AI knowledge and AI self-efficacy—the relatively small sample size may have limited statistical power. The lack of significant interaction effects may result from type II error rather than the absence of a true relationship. Future studies should employ larger, more heterogeneous samples to validate our findings and fully exploit the potential of advanced analytical techniques, such as SEM for simultaneous mediation, moderation, and interaction testing.

Third, our measurement of AI knowledge and AI self-efficacy, although statistically discriminant, may still be affected by conceptual overlap and measurement adaptation. In particular, the AI self-efficacy scale was adopted from Latikka et al. (2019), which was originally developed in the context of AI caregiving robots. Although we respected the original validated scale for methodological rigor, this creates a domain restriction: the items may not fully capture entrepreneurship-relevant AI competencies, such as AI-based decision support, data analytics, or venture planning. The inclusion of a dropped item (AIS4, loading = 0.402) further indicates residual domain misfit. Consequently, the findings regarding AI self-efficacy should be interpreted with caution, as they may not generalize to broader AI applications in entrepreneurship. Future research should either adapt the wording of items to reflect more generic AI usage or develop new instruments tailored specifically to entrepreneurial contexts, thereby improving construct validity and enhancing the applicability of findings across domains.

Fourth, while we included subjective norms in our revised conceptual model to enhance theoretical fidelity, our operationalization of this construct was limited. Future studies should develop more nuanced measures of social influence, network effects, and collective norms, particularly in collectivist contexts where social pressures may play a significant

role in shaping intentions. Further exploration of external, institutional, and policy-related factors—such as industry standards or government incentives—is also warranted.

Fifth, the theoretical framework of this study is primarily grounded in individual-level psychological constructs from the TPB, but it does not sufficiently capture the broader institutional, structural, and socio-technical barriers to sustainability-oriented entrepreneurship. We recommend that future research complement the TPB with perspectives from institutional theory, practice theory, or socio-technical transitions literature to investigate how policy, market structures, and collective action shape the relationship between intention and sustainable entrepreneurial behavior.

Moreover, the study employs a cross-sectional and intention-based design, capturing respondents' perceptions and intentions at a single point in time rather than actual entrepreneurial behaviors. This approach limits the ability to infer causal relationships and predict whether reported intentions will translate into actual entrepreneurial action. Future research should employ longitudinal designs to track changes in AI knowledge, self-efficacy, and entrepreneurial intentions over time, as well as to examine whether and how these intentions ultimately result in the founding and performance of sustainability-oriented ventures.

Finally, while our findings confirm the mediating role of attitude and perceived behavioral control in the relationship between AI-related competencies and sustainability-oriented entrepreneurial intentions, future research should further test the robustness of full versus partial mediation using additional model comparison techniques, such as Sobel tests. As technological landscapes evolve, future research could also extend this framework to investigate the entrepreneurial implications of other digital innovations, such as blockchain or the Internet of Things, and critically engage with both the enabling potential and the risks of digital technologies. This includes ethical, environmental, and social concerns, as well as equity of access, ensuring that technological competencies, such as AI self-efficacy, are understood not only as enablers but also as constructs shaped by contextual limitations.

References

- Aboobaker, N., D, R., & K.A, Z. (2023). Fostering entrepreneurial mindsets: The impact of learning motivation, personal innovativeness, technological self-efficacy, and human capital on entrepreneurial intention. *Journal of International Education in Business*, 16 (3), 312-333. <https://doi.org/10.1108/jieb-10-2022-0071>
- Abu Shriha, S., Al-Shboul, M. d. A., & Abaddi, S. (2024). The e-entrepreneurial intentions of Jordanian business students to start an online business in emerging economies: an application of planned behavior theory. *Management & Sustainability: An Arab Review* 4(2), 237-267. <https://doi.org/10.1108/msar-08-2023-0042>
- Adam, S., Mohd Fuzi, N., Ramdan, M. R., & Ismail, A. F. M. F. (2025). The effectiveness of digital entrepreneurship ecosystem toward enriching income generation: The moderating role of entrepreneurial intention. *SAGE Open*, 15(1), 1-16. <https://doi.org/10.1177/21582440241305361>
- Agu, A. G., Kalu, O. O., Esi-Ubani, C. O., & Agu, P. C. (2021). Drivers of sustainable entrepreneurial intentions among university students: an integrated model from a developing world context. *International Journal of Sustainability in Higher Education*, 22(3), 659-680. <https://doi.org/10.1108/ijsh-07-2020-0277>
- Ahmed, B. S., Wan Nawang, W. R., Saadallah, O., & Mursidi, A. (2025). Extending the theory of planned behavior in predicting entrepreneurial intention among university students: The role of perceived relational support. *The International Journal of Management Education*, 23(2), 101168. <https://doi.org/10.1016/j.ijme.2025.101168>
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Al-Romeedy, B. S., & El-Sisi, S. A.-W. (2024). Does AI have an effective role in applying sustainable entrepreneurship in the tourism industry? In D. Sharma, H. Abdullah, & P. Singh (Eds.), *Sustainable tourism* (Part A, pp. 3–22). Emerald Publishing. <https://doi.org/10.1108/978-1-83797-979-020241001>
- Al Issa, H.-E., Thai, M. T. T., & Saad, S. (2025). Empowering social entrepreneurial intentions through experiential learning and self-efficacy. *The International Journal of Management Education*, 23(2), 101154. <https://doi.org/10.1016/j.ijme.2025.101154>
- Alimehmeti, G., Ndoka, E., & Paletta, A. (2025). Cultivating green pioneers: examining the antecedents of sustainable entrepreneurial intent in higher education. *International Journal of Sustainability in Higher Education*. <https://doi.org/10.1108/ijsh-03-2024-0206>
- Amani, D., Ismail, I. J., Makona, A., Changalima, I. A., & Kazungu, I. (2024). Extending the mediation role of entrepreneurial self-efficacy on enhancing students' entrepreneurial intentions: A moderated mediation model. *The International Journal of Management Education*, 22(1), 1-12. <https://doi.org/10.1016/j.ijme.2023.100915>
- Anders, C., Hooley, I., & Kivlighan, D. M. (2023). The nature of a pandemic: Testing the relationship between access to nature, nature relatedness, wellbeing and belonging in nature using polynomial regression with response surface analysis. *Journal of Environmental Psychology*, 85, 101949. <https://doi.org/10.1016/j.jenvp.2022.101949>
- 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://doi.org/10.1037/0033-2909.103.3.411>
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.
- Bellver, D. O., Pérez-Campos, C., González-Serrano, M. H., & Martínez-Rico, G. (2022). Towards the development of future sustainable sports entrepreneurs: An asymmetric approach of the sports sciences sustainable entrepreneurial intentions. *Journal of Hospitality, Leisure, Sport & Tourism Education*, 31, 100403. <https://doi.org/10.1016/j.jhlste.2022.100403>

- Bewersdorff, A., Hornberger, M., Nerdel, C., & Schiff, D. S. (2025). AI advocates and cautious critics: How AI attitudes, AI interest, use of AI, and AI literacy build university students' AI self-efficacy. *Computers and Education: Artificial Intelligence*, 8, 100340. <https://doi.org/10.1016/j.caeai.2024.100340>
- Bickley, S. J., Macintyre, A., & Torgler, B. (2025). Artificial intelligence and big data in sustainable entrepreneurship. *Journal of Economic Surveys*, 39(1), 103–145. <https://doi.org/10.1111/joes.12611>
- Bonfanti, A., De Crescenzo, V., Simeoni, F., & Loza Adau, C. R. (2024). Convergences and divergences in sustainable entrepreneurship and social entrepreneurship research: A systematic review and research agenda. *Journal of Business Research*, 170, 114336. <https://doi.org/10.1016/j.jbusres.2023.114336>
- Brown, T. A. (2006). *Confirmatory factor analysis for applied research*. Guilford Press.
- Bui, H. N., & Duong, C. D. (2024). ChatGPT adoption in entrepreneurship and digital entrepreneurial intention: A moderated mediation model of technostress and digital entrepreneurial self-efficacy. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 19(2), 391–428. <https://doi.org/10.24136/eq.3074>
- Chin, W. W. (1998). The partial least squares approach for structural equation modeling. In G. A. Marcoulides (Ed.), *Modern methods for business research* (pp. 295–336). Lawrence Erlbaum Associates.
- Chiu, T. K. F., Ahmad, Z., & Çoban, M. (2024). Development and validation of teacher artificial intelligence (AI) competence self-efficacy (TAICS) scale. *Education and Information Technologies*, 30(5), 6667–6685. <https://doi.org/10.1007/s10639-024-13094-z>
- Duong, C. D. (2024). Exploring the role of cultural values on consumers' organic food consumption: Does blockchain-enabled traceability matter? *Oeconomia Copernicana*, 15(4), 1509–1546. <https://doi.org/10.24136/oc.3306>
- Duong, C. D. (2025). How AI-enabled drivers inspire sustainability-oriented entrepreneurial intentions: Unraveling the (in)congruent effects of perceived desirability and feasibility from the entrepreneurial event model perspective. *Sustainable Development*, 33 (4), 6228–6246. <https://doi.org/10.1002/sd.3461>
- Duong, C. D., Bui, H. N., Chu, T. V., Van Pham, T., & Do, N. D. (2024). ICT skills, entrepreneurial self-perceived creativity, and digital entrepreneurship: Insights from the stimulus-organism-response model. *Thinking Skills and Creativity*, 54, 101646 <https://doi.org/10.1016/j.tsc.2024.101646>
- Duong, C. D., & Nguyen, T. H. (2024). How ChatGPT adoption stimulates digital entrepreneurship: A stimulus-organism-response perspective. *The International Journal of Management Education*, 22(3), 101019. <https://doi.org/https://doi.org/10.1016/j.ijme.2024.101019>
- Fayolle, A., & Gailly, B. (2015). The impact of entrepreneurship education on entrepreneurial attitudes and intention: Hysteresis and persistence. *Journal of Small Business Management*, 53(1), 75–93. <https://doi.org/10.1111/jsbm.12065>
- Fazio, M. V., Freund, R., & Novella, R. (2024). Do entrepreneurial skills unlock opportunities for online freelancing? Experimental evidence from El Salvador. *Journal of Development Economics*, 172, 103363. <https://doi.org/10.1016/j.jdeveco.2024.103363>
- Füller, J., Hutter, K., Wahl, J., Bilgram, V., & Tekic, Z. (2022). How AI revolutionizes innovation management: Perceptions and implementation preferences of AI-based innovators. *Technological Forecasting and Social Change*, 178, 121598. <https://doi.org/10.1016/j.techfore.2022.121598>
- Füller, J., Hutter, K., Wahl, J., Bilgram, V., & Tekic, Z. (2022). How AI revolutionizes innovation management – Perceptions and implementation preferences of AI-based innovators. *Technological Forecasting and Social Change*, 178, 121598. <https://doi.org/10.1016/j.techfore.2022.121598>
- Giuggioli, G., & Pellegrini, M. M. (2022). Artificial intelligence as an enabler for entrepreneurs: a systematic literature review and an agenda for future research. *International Journal of Entrepreneurial Behavior & Research*, 29(4), 816–837. <https://doi.org/10.1108/ijeb-05-2021-0426>
- Guo, Q., Peng, Y., & Luo, K. (2025). The impact of artificial intelligence on energy–environmental performance: Empirical evidence from cities in China. *Energy Economics*, 141, 108136. <https://doi.org/10.1016/j.eneco.2024.108136>
- Gupta, B. B., Gaurav, A., Panigrahi, P. K., & Arya, V. (2023). Analysis of artificial intelligence-based technologies and approaches on sustainable entrepreneurship. *Technological Forecasting and Social Change*, 186, 1–9. <https://doi.org/10.1016/j.techfore.2022.122152>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). Evaluation of reflective measurement models. In J. F. Hair Jr., G. T. M. Hult, C. M. Ringle, M. Sarstedt, N. P. Danks, & S. Ray (Eds.), *Partial least squares structural equation modeling (PLS-SEM) using R: A workbook* (pp. 75–90). Springer. https://doi.org/10.1007/978-3-030-80519-7_4
- Hayes, A. F. (2018). *An Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach* (Third ed.). Guilford Press, New York.
- Heredia-Carroza, J., Chavarría-Ortiz, C., López-Estrada, S., & Zacharewicz, T. (2024). How to enhance the entrepreneurial intentions of the young population in rural areas: An approach from personal values and the socioeconomic environment. *European Research on Management and Business Economics*, 30(3), 100261. <https://doi.org/10.1016/j.iemeen.2024.100261>
- Hofstede, G. (2001). *Culture's Consequences. Comparing values, behaviors, institutions and organizations across nations* (2nd ed.). Thousand Oaks, CA: Sage.
- Hopp, C., Dey, P., Riniker, M., & Rüdiger, M. (2025). Financing sustainable entrepreneurship: Unpacking the role of campaign information and risk disclosure in reward-based crowdfunding. *Finance Research Letters*, 74, 106748. <https://doi.org/https://doi.org/10.1016/j.frl.2025.106748>
- Hsu, D. K., Burmeister-Lamp, K., Simmons, S. A., Foo, M.-D., Hong, M. C., & Pipes, J. D. (2019). “I know I can, but I don't fit”: Perceived fit, self-efficacy, and entrepreneurial intention. *Journal of Business Venturing*, 34(2), 311–326. <https://doi.org/10.1016/j.jbusvent.2018.08.004>
- Imjai, N., Nui-Suk, C., Usman, B., Somwethee, P., & Aujirapongpan, S. (2024). The influence of AI competency and design thinking skills on innovative entrepreneurial competency: The role of strategic intelligence amongst new age entrepreneurs in Thailand. *International Journal of Information Management Data Insights*, 4(2), 100301. <https://doi.org/https://doi.org/10.1016/j.jjime.2024.100301>
- Ip, C. Y. (2024). From green entrepreneurial intention to behaviour: The role of environmental knowledge, subjective norms, and external institutional support. *Sustainable Futures*, 8, 100331. <https://doi.org/10.1016/j.sfr.2024.100331>
- Kock, F., Berbekova, A., & Assaf, A. G. (2021). Understanding and managing the threat of common method bias: Detection, prevention and control. *Tourism Management*, 86, 104330. <https://doi.org/10.1016/j.tourman.2021.104330>
- Krueger, N. F., Reilly, M. D., & Carsrud, A. L. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing*, 15, 411–432.
- Kuckertz, A., & Wagner, M. (2010). The influence of sustainability orientation on entrepreneurial intentions — Investigating the role of business experience. *Journal of Business Venturing*, 25(5), 524–539. <https://doi.org/10.1016/j.jbusvent.2009.09.001>
- Kwilinski, A., Lyulyov, O., & Pimonenko, T. (2024). Green economic development and entrepreneurship transformation. *Entrepreneurial Business and Economics Review*, 12(4), 157–175. <https://doi.org/10.15678/eber.2024.120409>
- Latikka, R., Turja, T., & Oksanen, A. (2019). Self-efficacy and acceptance of robots. *Computers in Human Behavior*, 93, 157–163. <https://doi.org/10.1016/j.chb.2018.12.017>

- Lazarte-Aguirre, A. (2024). Pathways to sustainable entrepreneurship: Analysing drivers of sustainable entrepreneurial orientation. *Sustainable Technology and Entrepreneurship*, 3(3), 100081. <https://doi.org/10.1016/j.stae.2024.100081>
- Lortie, J., & Castogiovanni, G. (2015). The theory of planned behavior in entrepreneurship research: what we know and future directions. *International Entrepreneurship and Management Journal*, 11(4), 935-957. <https://doi.org/10.1007/s11365-015-0358-3>
- Lourenço, F., Lei, W. S., Couto, U., Lei, W. I., & Cheng, R. (2024). Driving sustainable entrepreneurship: Institutional and psychological influences at the Macao food festival. *Tourism Management Perspectives*, 53, 101298. <https://doi.org/10.1016/j.tmp.2024.101298>
- Neneh, B. N. (2020). Entrepreneurial passion and entrepreneurial intention: the role of social support and entrepreneurial self-efficacy. *Studies in Higher Education*, 47(3), 587-603. <https://doi.org/10.1080/03075079.2020.1770716>
- Newman, A., Obschonka, M., Schwarz, S., Cohen, M., & Nielsen, I. (2019). Entrepreneurial self-efficacy: A systematic review of the literature on its theoretical foundations, measurement, antecedents, and outcomes, and an agenda for future research. *Journal of Vocational Behavior*, 110, 403-419. <https://doi.org/10.1016/j.jvb.2018.05.012>
- Nguyen, N. M. (2023). The effect of FDI on domestic entrepreneurship: the case of greenfield investment and cross-border M&A activities. *Journal of Economics and Development*, 25(1), 62-78. <https://doi.org/10.1108/jed-11-2022-0228>
- Pan, M., Lai, C., & Guo, K. (2025). Effects of GenAI-empowered interactive support on university EFL students' self-regulated strategy use and engagement in reading. *The Internet and Higher Education*, 65, 100991. <https://doi.org/10.1016/j.iheduc.2024.100991>
- Relente, A. R. R., & Capistrano, E. P. S. (2024). Innovation self-efficacy, theory of planned behavior, and entrepreneurial intentions: The perspective of young Filipinos. *Asia Pacific Management Review*, 30 (3), 100350. <https://doi.org/10.1016/j.apmr.2024.100350>
- Renko, M., Shrader, R. C., & Simon, M. (2012). Perception of entrepreneurial opportunity: a general framework. *Management Decision*, 50(7), 1233-1251. <https://doi.org/10.1108/00251741211246987>
- Romero-Colmenares, L. M., & Reyes-Rodríguez, J. F. (2022). Sustainable entrepreneurial intentions: Exploration of a model based on the theory of planned behaviour among university students in north-east Colombia. *The International Journal of Management Education*, 20(2), 100627. <https://doi.org/10.1016/j.ijme.2022.100627>
- Roundy, P. T. (2022). Artificial intelligence and entrepreneurial ecosystems: Understanding the implications of algorithmic decision-making for startup communities. *Journal of Ethics in Entrepreneurship and Technology*, 2(1), 23-38. <https://doi.org/10.1108/JEET-07-2022-0011>
- Schlaegel, C., & Koenig, M. (2014). Determinants of Entrepreneurial Intent: A Meta-Analytic Test and Integration of Competing Models. *Entrepreneurship Theory and Practice*, 38(2), 291-332. <https://doi.org/10.1111/etap.12087>
- Shanock, L. R., Baran, B. E., Gentry, W. A., Pattison, S. C., & Heggstad, E. D. (2010). Polynomial regression with response surface analysis: A powerful approach for examining moderation and overcoming limitations of difference scores. *Journal of Business and Psychology*, 25(4), 543-554. <https://doi.org/10.1007/s10869-010-9183-4>
- Shapiro, A., & Sokol, L. (1982). The social dimensions of entrepreneurship. In C. Kent, D. Sexton, & K. V. Vesper (Eds.), *The encyclopedia of entrepreneurship* (pp. 72-90). Prentice Hall.
- Sharma, L., Bulsara, H. P., Bagdi, H., & Trivedi, M. (2023). Exploring sustainable entrepreneurial intentions through the lens of theory of planned behaviour: A PLS-SEM approach. *Journal of Advances in Management Research*, 21(1), 20-43. <https://doi.org/10.1108/jamr-01-2023-0006>
- Sharma, L., Bulsara, H. P., Trivedi, M., & Bagdi, H. (2023). An analysis of sustainability-driven entrepreneurial intentions among university students: the role of university support and SDG knowledge. *Journal of Applied Research in Higher Education*, 16(2), 281-301. <https://doi.org/10.1108/jarhe-11-2022-0359>
- Srivastava, M., Shivani, S., & Dutta, S. (2024a). An empirical contribution towards measuring sustainability-oriented entrepreneurial intentions: A study of Indian youth. *Environment, Development and Sustainability*, 26(3), 7319-7345. <https://doi.org/10.1007/s10668-023-03010-9>
- Srivastava, M., Shivani, S., & Dutta, S. (2024b). Sustainability-oriented entrepreneurial intentions: work values and the theory of planned behaviour. *Journal of Small Business and Enterprise Development*, 31 (2), 298-324. <https://doi.org/10.1108/jsbed-03-2023-0105>
- Tan, L. P., Pham, L. X., & Bui, T. T. (2020). Personality Traits and Social Entrepreneurial Intention: The Mediating Effect of Perceived Desirability and Perceived Feasibility. *The Journal of Entrepreneurship*, 30(1), 56-80. <https://doi.org/10.1177/0971355720974811>
- Tran, V. T., Nguyen, T. H., St-Jean, É., Duong, C. D., & Trinh, T. N. (2023). Social Entrepreneurial Intention among Youth in Vietnam: The Roles of Prior Experience and Perceived Educational Support. *Journal of Social Entrepreneurship*, 0(0), 1-29. <https://doi.org/10.1080/19420676.2023.2244985>
- Truong, H. T., Le, T. P., Pham, H. T. T., Do, D. A., & Pham, T. T. (2022). A mixed approach to understanding sustainable entrepreneurial intention. *The International Journal of Management Education*, 20(3), 1-14. <https://doi.org/10.1016/j.ijme.2022.100731>
- Ueda, D., Walston, S. L., Fujita, S., Fushimi, Y., Tsuboyama, T., Kamagata, K., Yamada, A., Yanagawa, M., Ito, R., Fujima, N., Kawamura, M., Nakaura, T., Matsui, Y., Tatsugami, F., Fujioka, T., Nozaki, T., Hirata, K., & Naganawa, S. (2024). Climate change and artificial intelligence in healthcare: Review and recommendations towards a sustainable future. *Diagnostic and Interventional Imaging*, 105(11), 453-459. <https://doi.org/https://doi.org/10.1016/j.diii.2024.06.002>
- van der Westhuizen, T., & Goyayi, M. J. (2019). The influence of technology on entrepreneurial self-efficacy development for online business start-up in developing nations. *The International Journal of Entrepreneurship and Innovation*, 21(3), 168-177. <https://doi.org/10.1177/1465750319889224>
- Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S. D., Tegmark, M., & Fuso Nerini, F. (2020). The role of artificial intelligence in achieving the sustainable development goals. *Nature Communications*, 11(1), 233. <https://doi.org/10.1038/s41467-019-14108-y>
- Vuorio, A. M., Puumalainen, K., & Fellnhofer, K. (2017). Drivers of entrepreneurial intentions in sustainable entrepreneurship. *International Journal of Entrepreneurial Behavior & Research*, 24(2), 359-381. <https://doi.org/10.1108/ijeb-03-2016-0097>
- Wang, Q., Li, Y., & Li, R. (2025). Integrating artificial intelligence in energy transition: A comprehensive review. *Energy Strategy Reviews*, 57, 101600. <https://doi.org/10.1016/j.esr.2024.101600>
- Wang, Z., Deng, Y., Zhou, S., & Wu, Z. (2023). Achieving sustainable development goal 9: A study of enterprise resource optimization based on artificial intelligence algorithms. *Resources Policy*, 80, 103212. <https://doi.org/10.1016/j.resourpol.2022.103212>
- Waris, I., Barkat, W., Ahmed, A., & Hameed, I. (2021). Fostering sustainable businesses: understanding sustainability-driven entrepreneurial intention among university students in Pakistan. *Social Responsibility Journal*, 18(8), 1409-1426. <https://doi.org/10.1108/srj-10-2020-0399>
- Webometrics. (2023). *Ranking Web of Vietnam Universities*. <https://www.webometrics.info/en/asia/vietnam>
- Yi, G. (2020). From green entrepreneurial intentions to green entrepreneurial behaviors: the role of university entrepreneurial support and external institutional support. *International Entrepreneurship and Management Journal*, 17(2), 963-979. <https://doi.org/10.1007/s11365-020-00649-y>

Zaremohzzabieh, Z., Ahrari, S., Krauss, S. E., Samah, A. A., Meng, L. K., & Ariffin, Z. (2019). Predicting social entrepreneurial intention: A meta-analytic path analysis based on the theory of planned behavior. *Journal of Business Research*, 96, 264-276. <https://doi.org/10.1016/j.jbusres.2018.11.030>

Zhao, H., Seibert, S. E., & Hills, G. E. (2005). The mediating role of self-efficacy in the development of entrepreneurial intentions. *Journal of Applied Psychology*, 90(6), 1265-1272. <https://doi.org/10.1037/0021-9010.90.6.1265>

Biographical notes

Son Tung Ha, Associate Professor and Dean of the Faculty of Business Administration at the National Economics University, focuses his research on entrepreneurship and sustainability-oriented behavior.

Thi Thanh Hoa Phan (Ph.D.), Researcher/Lecturer at the Faculty of Business Management, National Economics University, Vietnam. Her research interests include entrepreneurship and organizational behaviour.

Thi Viet Nga Ngo (Ph.D.), Researcher/Lecturer at the Faculty of Business Management, National Economics University, Vietnam. Her research interests include entrepreneurship and knowledge sharing.

Cong Doanh Duong (Ph.D.), Associate Professor at the Faculty of Business Management, Head of Lab for Business Analysis and Simulation, School of Business, National Economics University. His area of scientific interest includes entrepreneurship, corporate social responsibility, and sustainable development. His research on entrepreneurship has appeared in several journals, including the *Journal of Retailing and Consumer Services*, *Personality and Individual Differences*, *Asia Pacific Journal of Marketing and Logistics*, *Education + Training*, and *Management Decision*. He is an associate editor and a member of the editorial board of some journals, such as *The International Journal of Management Education* (Elsevier, SSCI/Q1, IF 5.2), *Entrepreneurial Business and Economics Review* (ESCI (ISI)/ Scopus Q1), *Oeconomia Copernicana* (SSCI IF = 8.5/Scopus Q1), and *International Entrepreneurial Review*.

Ngoc Thang Ha (Ph.D.), Researcher/Lecturer at the Faculty of Business Management, National Economics University, Vietnam. His research interests include entrepreneurship and online shopping.

Author contributions statement

Son Tung Ha: Conceptualization, Methodology, Investigation, Writing – Original Draft. **Thi Thanh Hoa Phan**: Conceptualization, Methodology, Formal Analysis, Writing – Review & Editing. **Thi Viet Nga Ngo**: Investigation, Writing – Review & Editing. **Cong Doanh Duong**: Conceptualization, Writing – Review & Editing, Data Collection, Writing – Original Draft. **Ngoc Thang Ha**: Investigation, Writing – Review & Editing.

Conflicts of interest

The authors declare no conflict of interest.

Citation (APA Style)

Ha, S.T., Phan, T.T.H., Ngo, T.V.N., Duong, C.D., & Ha, N.T. (2025). Integrating artificial intelligence competencies into the theory of planned behavior: Explaining sustainability-oriented entrepreneurial intentions. *Journal of Entrepreneurship, Management and Innovation*, 21(4), 30-53. <https://doi.org/10.7341/20252142>

ESG activities and their influence on commercial banks' profitability and financial stability

Irena Pyka¹ , Renata Karkowska² , Aleksandra Nocoń³ 

Abstract

PURPOSE: The ESG (Environmental, Social, and Corporate Governance) activities are a key element of the transformation of the financial system, particularly in the face of challenges arising from the 2007-2009 crisis and the COVID-19 pandemic. Consequently, the integration of environmental, social, and corporate governance aspects has been recognized as essential in shaping economic processes. This study contributes to the ongoing debate on ESG activities in the banking sector. The research aims to assess the impact of ESG implementation on the profitability and financial stability of commercial banks globally. The study examines whether ESG-related activities contribute to an increase in the market value of banks, reflecting higher profitability and improved financial stability. **METHODOLOGY:** The study encompasses financial and ESG data from 384 commercial banks across 62 countries worldwide, spanning the period from 2012 to 2021. The research sample is limited to banks for which ESG data is available in the Refinitiv Eikon database. A panel regression method is used to achieve the research objective. **RESULTS:** The results reveal a statistically significant relationship between the implementation of ESG activities and banks' financial performance. The research indicates a negative impact of ESG activities, particularly in the social and governance dimensions, on banks' profitability, measured by ROA and ROE. This negative relation may result from the substantial costs related to implementing ESG initiatives, regulatory pressures aimed at enhancing environmental protection, and the risks associated with financing green investments. Moreover, the uneven influence of the individual E, S, and G components may also contribute to the observed financial outcomes. Conversely, certain ESG activities, especially those related to the social dimension, are positively linked to banks' financial stability, as reflected by the Z-score index, suggesting increased institutional resilience to systemic risk. These findings suggest a growing disparity between the short-term financial performance and long-term stability of banks involved in ESG activities. **IMPLICATIONS:** The study highlights the importance of ESG in enhancing bank stability and supporting sustainable finance. It provides a theoretical contribution by linking ESG with banks' financial resilience and a practical contribution by promoting regulations and greater transparency in ESG-based business decision-making. Banks and policymakers can utilize the obtained findings to design strategic frameworks that integrate ESG factors into profitability measures, risk management processes, capital adequacy assessments, and long-term value creation. By incorporating ESG metrics into supervisory practices and disclosure requirements, financial institutions may enhance resilience against systemic shocks while fostering trust among stakeholders and aligning with global sustainability goals. **ORIGINALITY/VALUE:** This study makes a unique contribution to the literature by demonstrating a direct relationship between ESG practices and the profitability and stability of commercial banks. It extends previous research on the link between ESG activities and banks' operational activities, particularly financial security. **Keywords:** ESG (Environmental, Social, and Governance), ESG activities, sustainable finance, responsible banking, commercial banks, banking sector, bank profitability, financial performance, return on assets (ROA), return on equity (ROE), financial stability, systemic risk, Z-score, corporate governance, environmental risk, social responsibility, risk management, capital adequacy, global banking, panel regression, Refinitiv Eikon

1 Irena Pyka, Full Professor, Department of Banking and Financial Markets, Faculty of Finance, University of Economics in Katowice, ul. 1 Maja 50, Katowice, 40-287, Poland, e-mail: irena.pyka@ue.katowice.pl (ORCID: <https://orcid.org/0000-0001-5524-3550>).

2 Renata Karkowska, Ph.D., Hab., Associate Professor, Faculty of Management, University of Warsaw, ul. Szturmowa 1/3, Warsaw, 02-678, Poland, e-mail: rkarkowska@wz.uw.edu.pl (ORCID: <https://orcid.org/0000-0002-6335-2973>).

3 Aleksandra Nocoń, Ph.D., Assistant Professor, Department of Banking and Financial Markets, Faculty of Finance, University of Economics in Katowice, ul. 1 Maja 50, Katowice, 40-287, Poland, e-mail: aleksandra.nocon@ue.katowice.pl (ORCID: <https://orcid.org/0000-0003-3250-2382>).

INTRODUCTION

In December 2016, the European Commission appointed a group of experts on sustainable finance (High-Level Expert Group on Sustainable Finance, HLEG) to develop an overarching and detailed EU strategy for sustainable finance, including the identification of actions to direct capital flows towards sustainable investments and to ensure stability of the financial system in the face of environmental risks (European Commission, 2018). In 2018, the group published a report that presented a comprehensive view of European sustainable finance and indicated the imperatives for the future financial system. Firstly, the need to increase the involvement of finance in the long-term socio-economic development of the world economy was noticed. Secondly, it was emphasized that there is a need to improve financial stability by increasing awareness of ESG (Environmental, Social, and Corporate Governance) when making investment decisions. Following the intention contained in the documents: *United Nations Environment Programme* (UNEP) and *Principles for Responsible Investment* (PRI), ESG can be defined as follows: E (Environmental) - as environmental issues related to natural environment and natural systems; S (Social) - as social issues related to the rights of people and communities; and G (Corporate Governance) - as management issues related to corporate governance. The concept of ESG quickly became the subject of lively international discussion and numerous studies and scientific publications. Contemporary research areas regarding ESG activity mainly focus on: (1) the identification of the impact of environmental, social responsibility and corporate governance factors on a company's financial results and value, (2) ESG risk management, (3) the relation between ESG and sustainable development as well as corporate social responsibility (CSR) and (4) the importance of ESG strategy in the face of changing preferences and tastes of stakeholders.

Regulatory pressure and growing expectations of owners and stakeholders are leading to the transformation of business models. That's why non-financial ESG indicators are also becoming increasingly important in the banking sector. Banks play a strategic role in financing projects aimed at sustainable development, which makes taking ESG risks into account in investment and financing activities not only a necessity but also an important element of their long-term strategy. In the face of dynamic regulatory changes and growing social awareness, verifying banks' adaptability to the challenges of ESG activities allows us to better understand which factors support and inhibit their ability to achieve profitability and financial stability. The research also enables the preparation of recommendations in formulating principles and tasks for the effective allocation of bank capital in implementing ESG strategies in the banking sector. Therefore, the following research questions (RQs) were formulated:

RQ1: How do ESG-related activities undertaken by banks affect their performance?

RQ2: Does the growing banks' involvement in ESG activity positively affect their financial stability?

RQ3: To what extent do the individual ESG pillars differ in their influence on banks' profitability and financial stability?

The previous results of empirical research on the relation between ESG activity and the value of non-financial and financial companies are not unambiguous. Some researchers argue that ESG activity enhances companies' financial performance (Buallay, 2019; Cheng, Ioannou, & Serafeim, 2013). In particular, they indicate that economic entities that undertake sustainable development practices are characterized by higher profitability, higher market valuation, lower risk, and greater resistance to changes in the economic cycle. In turn, others suggest that investments in ESG activities may incur alternative costs related to inefficient capital allocation (Haans et al., 2016; Heli et al., 2008). In the case of banks with low profitability, identifying relations between ESG activities and profitability may help determine the stability of their income.

This article examines the impact of ESG-related activities and associated disclosure requirements on the performance and financial stability of banking institutions. Based on a sample of 384 commercial banks from 62 countries worldwide, covering the period from 2012 to 2021, the study confirms a relationship between ESG engagement and key indicators of bank stability and performance. The study's results reveal a consistent negative association between overall ESG performance, especially its social and governance dimensions, and banks' profitability, measured by ROA and ROE. This suggests that, in the short to medium term, ESG-related activities may impose additional costs and resource allocations that reduce immediate financial returns. Conversely, the environmental dimension does not significantly affect profitability, possibly due to the long-term nature of environmental investments. Regarding financial stability, greater ESG engagement, particularly in the social dimension, is linked to higher stability as reflected by the Z-score index, while environmental activities may have a negative impact.

Our study contributes to the existing literature by examining the relationship between ESG activity and selected aspects of performance and financial stability in the banking sector, a key component of the financial system. Investment in ESG assets has significant spillover effects, benefiting various sectors and entire economies. First, ESG investments promote sustainable business practices, leading companies to implement more environmentally and socially responsible solutions. Such actions not only improve the performance of individual companies but also strengthen financial stability and resilience. Many studies have indicated a positive correlation between pro-green investments and companies' ESG performance, particularly in terms of environmental and social aspects (Cao et al., 2023; Giese et al., 2019). Secondly, investments that focus on ESG promote innovation because companies, striving to meet ESG criteria, implement new technologies and processes. This innovativeness leads to the development of whole industries and increased efficiency, which benefits the entire economy. The undertaken research shows that ESG and innovation positively impact on the companies' value, however ESG actions not only increase their value but also act as a catalyst for innovation (Jung & Kim, 2022). Ultimately, the emphasis on corporate governance within the ESG framework contributes to greater transparency and stability among companies, which reduces the risk of financial irregularities and corruption, thereby strengthening investor confidence and supporting economic growth. Therefore, integrating ESG principles can initiate broad, positive changes that extend beyond the scope of sustainable investment (Atz et al., 2023).

Despite the growing number of studies on sustainability and the ESG concept, there is a lack of comprehensive and systematic analyses on identifying and explaining relations between ESG activities and banks' performance and the banking sector's financial stability level. Most existing studies focus either on broad aspects of corporate social responsibility or on separate research on the impact of ESG on individual elements of financial institutions' activities, without considering the multidimensional nature of these relations. Moreover, this research often overlooks the analysis of the role of ESG disclosure requirements and transparency as determinants of the market and supervisory institutions' responses, which limits a comprehensive understanding of the mechanisms by which ESG impacts banking sector stability. This study addresses the identified research gap in the literature by examining the impact of ESG practices in banking institutions and the related disclosure requirements on the stability of the banking sector. This study aims not only to assess the correlation between banks' ESG engagement and their financial performance, but also to examine how ESG practices can contribute to strengthening the resilience and stability of the banking sector in the context of growing environmental and social challenges.

The research on the impact of ESG on the profitability and stability of the banking sector may have significant theoretical and practical implications. From a theoretical perspective, it will contribute to filling the research gap by deepening knowledge of the role of non-financial factors in the functioning of financial institutions, which will enable a better understanding of the mechanisms by which ESG impacts the performance and financial stability of the banking system. The research may also provide empirical evidence to verify existing theories on sustainable development and systemic risk. In turn, practical implications include providing recommendations for managers, especially in areas that can improve financial stability and the reputation of credit institutions. The research results may also contribute to an increase in the effectiveness of ESG regulations, supporting the sustainable financing of green investments of economic entities. Furthermore, the analysis may increase transparency in the decision-making process regarding sustainable investments in business.

The article consists of the following parts: *Introduction* – which includes a presentation of the issues discussed in the article, the main objective of the study, and the research questions; *Literature review* – with a critical analysis of existing domestic and international literature. This section is divided into two parts. The first part refers to the origin and significance of the ESG concept. It encompasses the essence of the ESG concept, as well as the main trends and areas of ESG research prevalent in the literature. The second part presents the current literature on the impact of ESG activity on the performance and financial stability of banks; *Methodology* – where the data used in the empirical research and the adopted research method are presented; *Results and Discussion* – which includes the obtained results and a discussion in the context of the results of previous empirical studies, *Conclusion* – with the main research findings, limitations and directions of further research.

LITERATURE REVIEW

The origin and significance of the ESG concept

Environmental, Social, and Governance (ESG) is a concept that encompasses three criteria for assessing the sustainability performance of economic entities, and has become the subject of global discourse at the beginning of the 21st century (Serafeim, 2021). It refers to the implementation of environmental, social, and corporate governance (ESG) in economic activity, and changes how companies that follow these principles can be analyzed and evaluated (Amel-Zadeh & Serafeim, 2018). It is a set of criteria that investors consider in the investment decision-making process (Friede et al., 2015). ESG is also seen as a set of non-financial factors that can affect the risk and return on investment (Giese et al., 2019). Their integration into the company's strategy can lead to better risk management and increased stakeholder value (Fatemi et al., 2018). Although publications and scientific achievements in this area have been growing over the last two decades, many problems remain unexplored and worthy of attention. Combining E, S, and G into one term created an acronym whose meaning and function may vary depending on the context, evolve over time, and appeal to various stakeholders.

For the first time, the concept of 'ESG' appeared in the debate on sustainable development in the United Nations (UN) report: "Who Cares Wins", published in 2004 (IFC, 2004). It presented the contemporary context of the ESG concept and indicated how to integrate ESG factors with economic activity. Among the ESG concept's three basic components are environmental, social, and corporate governance, which have since become the main pillars of its implementation. The report emphasized that environmental, social, and governance factors can significantly impact companies' financial performance and should be taken into account in investment decisions. Companies that effectively manage ESG aspects can better identify risks and opportunities, which results in the stability of their performance. In turn, enterprises that do not incorporate ESG factors may be more vulnerable to reputational, regulatory, and operational losses. The "Who Cares Wins" report also referred mainly to the financial sector's role in promoting and implementing ESG principles. As key participants in the financial system, banks are identified as institutions that can influence sustainable development through their credit policies, investments, and risk management methods. Therefore, financial institutions should, on the one hand, promote ESG integration in their activities, but on the other hand, also encourage economic entities – their clients – to improve their results in this area (IFC, 2004).

The dynamic growth of interest in ESG issues was associated with the adoption of the Sustainable Development Goals (SDGs) in 2015, which outlined ways to achieve global sustainable development by 2030 (United Nations, 2015). These goals address global environmental challenges (including depletion of natural resources, climate change, global warming, and loss of biodiversity), social challenges (including the problems of hunger, poverty, inequality, and exclusion), as well as governance challenges (e.g., gender differences, corruption). Although these goals were defined at the macro level – states and governments, companies are considered the main entities obliged to implement them (Montiel et al., 2021; Van Zanten & Van Tulder, 2021). Thus, ESG factors have become important in the assessment and analysis of economic activity (MacNeil & Esser, 2022).

The relation between profitability, financial stability, and commitment to ESG activities can be explained based on economic theories. In this context, three main theoretical approaches can help clarify the mechanisms linking financial development to stability and long-term performance. One of them is the resource theory, which posits that financial development promotes economic growth through more efficient resource allocation (Levin, 1997). Financial institutions play a key role in reducing transaction and information costs, monitoring costs, facilitating the flow of capital and investment, and increasing productivity and innovation. In sustainable development, financing environmental and social projects can support long-term growth. However, an excessive focus on short-term profits can lead to environmental degradation and the deepening of social inequalities, ultimately undermining sustainable development goals in the long term.

In contrast, market theory presents the opposite relation, suggesting that economic growth drives financial development. As the real economy grows, demand for financial services increases, which leads to the expansion of capital markets and financial institutions (Ang & McKibbin, 2007). The development of the green economy sector, which increases the demand for financing green projects, such as renewable energy or carbon credit markets, can be a good example. However, this theory also highlights risks associated with excessive financial market development, such as speculation or investment bubbles, which can compromise the financial system's stability. Therefore, it is crucial for financial institutions and investors to take into account long-term sustainable development goals when promoting instruments, such as green bonds or impact investments.

Finally, Mitroff’s (1983) and Freeman’s (1984) stakeholder theory emphasize the importance of a wide range of entities that both influence and are influenced by a company’s functioning. According to this approach, enterprises do not operate in isolation from their environment, and their long-term success depends on their ability to consider the interests of various stakeholder groups – not only shareholders but also employees, customers, suppliers, local communities, and the natural environment.

Based on an in-depth literature review, we identified four leading trends and research areas related to ESG issues (Figure 1).

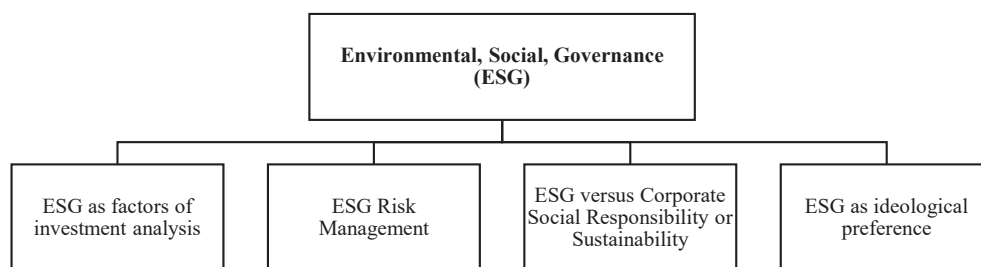


Figure 1. Main trends and areas of ESG research

The first area of research fully refers to the issues indicated in the previously mentioned report: “*Who cares win*”. They concern the essence of ESG and its impact on financial performance and long-term value of a company (Galbreath, 2013; Arvidsson & Dumay, 2022; De Giuli et al., 2023). In this approach, ESG is not only a synonym for ethical investing, but rather perceived as an integral part of the activity, investment strategy, which may affect effectiveness, efficiency, or stability of an economic entity. It is undoubtedly also a challenge, a contemporary process taking place in the companies’ environment, in addition to digitization and the use of advanced technologies (Łasak, 2023). This research direction also analyzes the issue of financing sustainable investments by the banking sector. Banking institutions play a crucial role in redirecting the flow of capital towards more sustainable investments. The implementation of sustainable development goals and activities resulting from the ESG concept is currently not only a possibility for banks, but has become an imperative for their activities. Research indicates that banking institutions in developed and developing countries have implemented and are gradually implementing the provisions included in the adopted ESG activities. Additionally, they are directing capital flows to green investments that meet the taxonomy criteria. Research in the banking sector also indicates that credit institutions offer financing for biodiversity and ecosystems, climate change, energy change, pollution, and waste management (Pyka & Nocoń, 2024).

The second research trend focuses on ESG analysis from a risk management perspective (De Giuli et al., 2023). Engagement in sustainable activities generates a new type of risk – the ESG risk, resulting from spectacular environmental, social, and corporate governance factors (PKO Bank Polski S.A., 2022). This is a relatively new type of risk, with a cross-sectional nature, that affects the identified traditional types of financial and non-financial risks to varying extents and through various transmission channels. Hence, it is indicated that ESG risk should be included in risk management systems. The increasing involvement of companies, including banking institutions, in the implementation of sustainable development goals increases their exposure to ESG risk (Marcinkowska, 2022; Chiaramonte et al., 2022; Liu et al., 2023; Zhang, 2023; Bolibok, 2024; Pyka & Nocoń, 2024). Research conducted for the banking sector indicates a growing awareness of the importance of ESG risk among banks, as reflected in practical activities related to bank risk management systems. Banks are increasingly aware of ESG risk and the need to incorporate it into their bank risk management processes, including the assessment of ESG risk exposure (Pyka & Nocoń, 2024).

The third research area focuses on the analysis of the ESG concept, which is often referred to as sustainable development, and is identified or conceptually combined with Corporate Social Responsibility (CSR) in many areas (Wood, 2015; Larcker et al., 2021; Gillan et al., 2021). ESG undoubtedly grew out of the sustainable development concept – a socio-economic doctrine of the second half of the 20th century, which originally assumed that the quality of life should correspond to a level allowed by the current state of civilization (Borkowski, 2001; Zakrzewska, 2019; Brundtland, 2004). ESG activities are therefore aimed at seeking solutions that, on the one hand, meet the needs of current generations, while on the other hand, do not hinder their implementation in the future (Borys & Czaja, 2009; Borys, 2012). In many

studies, ESG is also compared to CSR, defining it as a subcategory of CSR that measures a company's commitment to social responsibility (Hazan, 2021). In this approach, ESG is the modern equivalent of the previously well-known and implemented corporate social responsibility.

The fourth research trend posits that ESG represents the preferences or tastes of certain stakeholders (Serafeim, 2021). The growing importance of ESG can be attributed to the fact that economic entities face the challenge of adapting to the changing preferences of consumers and investors, who seek more sustainable products and services that reflect a shift away from the dogmas of the industrial era. It can also be considered as an effort to align business or investment activity with certain personal or collective values. Therefore, it expresses changing markets and societies (Kell, 2018). In this approach, ESG appears as a concept oriented to issues beyond purely financial aspects (Broadridge, 2021). For some, ESG is a marketing tool used by companies that often employ greenwashing, presenting themselves and their products or services as more ecological than they really are. Moreover, the literature review suggests that investors from countries with a clear liberal profile are willing to accept lower rates of return from investments consistent with ESG values, indicating ideological conditions for investment decisions. It is noted that the promotion of the ESG concept by international institutions is associated with a specific vision of the socio-economic order, based on values such as inclusiveness and climate protection, which can also be perceived as a manifestation of the "progressive agenda". Others (mainly conservative circles) identify ESG with an ideological preference/tool – called "woke capitalism", i.e. an attempt to impose specific social norms by corporations and asset managers (Sorkin et al., 2022; Rapoza, 2020; Polman, 2022; Blomqvist & Stradi, 2022). They also argue that current backlash against the use of ESG is a part of a larger conservative culture war against "woke" politics (Crews, 2023). Thus, ESG becomes not only a method of risk assessment but also a symbol of political and cultural division (Raghunandan & Rajgopal, 2022).

The impact of ESG on the performance and financial stability of banks

The growing importance of ESG has undoubtedly coincided with a renaissance in thinking about corporate goals, growing interest in implementing sustainable development assumptions and the so-called 'stakeholder capitalism', which has enriched the views and approaches to defining this concept (Pollman & Thompson, 2021; Sjøfjell & Bruner, 2020; Mayer, 2018; Edmans, 2020; Henderson, 2020; Serafeim, 2022; Sundheim & Starr, 2020; Bebchuk et al., 2023). In the UN Report in 2004, it was indicated that companies with better ratings or higher ESG assessments can increase shareholder value by better management of risk related to emerging ESG issues, anticipating regulatory changes or market trends, access to new markets and reducing costs, as well as improving brand and image (IFC, 2004). In the current trend of scientific research in ESG, one of the leading directions is to identify cause-and-effect relations between ESG activities and the financial results of economic entities (Friede et al., 2015; Saïdane & Abdallah, 2020). Initially, ESG was identified mainly with corporate social responsibility (CSR) when undertaking research in this area. The results of the first research works representing such an approach, which analyzed the impact of ESG activities on the financial performance of non-financial enterprises, were ambiguous (Naimy et al., 2021; Fatemi et al., 2018). On the one hand, the main reason for this was concerns about measurement and data limitations and, on the other hand, how they are reported (Li et al., 2017). However, El Ghouli et al. (2011) showed that adopting a sustainable policy has a positive impact on the cost of equity. A company that adopts social responsibility practices is characterized by lower risk and a higher market valuation. Albuquerque et al. (2012) noted that ESG is a strategic product that generates higher corporate profits. Moreover, sustainable activities reduce the systemic risk of a company and make its financial results less correlated with the economic cycle. In turn, Barth et al. (2015) proved that ESG activities and their reporting are positively related to a company's value, analyzing two channels through which this relation can arise – the capital market channel and the real effects channel. They investigated this relation from the perspective of the impact of sustainable activities on a company's liquidity, cost of capital, and expected future cash flows. Garcia et al. (2017) examined the relationship between a company's financial profile and its environmental, social responsibility, and corporate governance activities, based on companies in BRICS countries from 2010 to 2012. They noted that companies from the so-called sensitive industries — those exposed to social and environmental damage and subject to political and moral pressure — achieve better ESG results. Hassan et al. (2021) also indicated that corporate engagement in sustainable activities mitigates market risk. Chilukuri (2023) provided empirical evidence indicating that companies that strongly engage in ESG activities tend to demonstrate better financial performance and lower risk exposure. Yavuz et al. (2025), analyzing the impact of ESG on the financial performance of companies in Turkey from 2011 to 2020, also confirmed that activities implemented as part of an ESG strategy have an impact on corporate financial performance. Siwiec and Karkowska (2024), examining this impact among companies from the Central and Eastern European (CEE)

region from 2017 to 2021, showed a positive relationship between ESG disclosures and financial performance, as measured by the ROA indicator. Moreover, they noted that in the case of entities operating in the financial sector, this correlation is stronger than in companies operating in other industries.

However, Naimy et al. (2021), analyzing companies from the industrial sector in East Asia from 2011 to 2017, noticed that individual pillars E, S, and G have a different impact on financial results. They found a positive correlation between environmental and corporate governance activities, and a negative correlation between social responsibility and the financial results of companies. Moreover, they noticed that this impact also depends on the industry in which a company operates. In turn, Matuszewska-Pierzynka et al. (2023) found a statistically significant relationship between ESG results and dividend policy, using the example of non-financial companies included in the Global 500 in 2021. Błach et al. (2025), in line with this research trend, analyzed the impact of companies' involvement in sustainable development on their financial results in the context of various features of corporate governance (in particular board attributes and ownership structure) in Poland. They confirmed a significant positive relationship between ESG activities and financial results, measured by ROA and MV/BV ratios, indicating that a company's commitment to sustainable development improves its profitability and market value. They also observed a relation between gender diversity in corporate boards (the presence of women on the board of directors) and accounting performance.

The awareness of a need to integrate ESG aspects into financial strategies, processes, and instruments to generate value in the medium and long term is also growing in the banking industry. An increasing number of studies focus on analyzing the relationship between the implementation of ESG criteria and the performance and risks of banking institutions (Ahmed et al., 2018; Birindelli et al., 2018; Birindelli et al., 2019; Buallay, 2019; Miralles-Quirós et al., 2019a; Miralles-Quirós et al., 2019b; Shakil et al., 2019; Di Tommaso & Thornton, 2020; Paltrinieri et al., 2020). Azmi et al. (2021) studied the relationship between ESG and bank value in a research sample of 251 institutions from 44 emerging economies, spanning the period 2011-2017. They identified a non-linear relation between ESG activity and bank value. They noted that involvement in sustainable activities has a positive impact on the value of the analyzed institutions; however, it is noteworthy that economies of scale decrease with their increasing involvement in this area. In their opinion, the most important factors that have a positive impact on bank stability are environmental activities, including environmental transparency and emissions reduction. Similar studies were conducted by Chiaramonte et al. (2021), who analyzed the combined and separate impacts of environmental (E), social (S), and corporate governance (G) factors on bank stability. Based on a research sample of institutions operating in 21 European countries between 2005 and 2017, the study showed that the total commitment of institutions to sustainable activities reduces their fragility during periods of financial instability. The stabilizing effect is particularly visible in the case of banks with higher ESG ratings. At the same time, they supported regulatory actions aimed at implementing a requirement to disclose ESG information, as they proved that a longer reporting period yields greater benefits for a bank's stability. Finally, they noted that the links between ESG activities and the stability of a banking institution vary significantly depending on the bank's characteristics and the environment in which it operates. Buallay (2019), analyzing 235 banks from 2007 to 2016, found a significant positive impact of ESG on the financial performance of the analyzed institutions. However, she noted that in some areas, these results differ significantly. She indicated that:

- reporting information on the environment (E) has a positive impact on financial results (measured by ROE) and market results (measured by Tobin's Q);
- disclosing information on social responsibility (S) has a negative impact on all analyzed indicators, i.e. ROA, ROE and Tobin's Q;
- in turn, reporting information on corporate governance (G) has a negative impact on ROA and ROE.

However, while ESG activities in the banking sector are increasingly seen as essential tools for managing long-term risk and aligning capital allocation with sustainable development goals, banks, unlike manufacturing or energy companies, have limited direct environmental impact but exert massive indirect influence through their lending and investment portfolios. Compared to companies in other industries, such as tech firms, banks face stricter regulatory pressure to disclose their ESG performance, particularly under frameworks like the EU Taxonomy or the CSRD in Europe. Socially, banks are uniquely positioned to drive financial inclusion, especially by offering services to underserved or marginalized communities – a challenge that manifests differently than in industries like retail or telecommunications. In terms of governance, the complexity of financial instruments and fiduciary responsibilities creates heightened exposure to reputational and compliance risks, which often surpass governance demands faced by companies in less-regulated sectors (Wendt, 2015).

To summarize, sustainable development is becoming one of the key priorities in banks' strategies, resulting from the growing awareness of the importance of environmental, social, and corporate governance in the financial sector. Our analysis is based on Mitroff's (1983) and Freeman's (1984) stakeholder theory, which explains the impact of sustainable activities on financial performance by emphasizing the importance of ethical organization management and taking into account the interests of various stakeholder groups. Stakeholder theory suggests that organizations that consider the needs of a wide range of stakeholders – including customers, local communities, investors, and regulators – can achieve long-term benefits, such as financial and reputational stability. However, the costs of implementing ESG strategies can negatively affect financial performance in the short term, raising questions about the real impact of these activities on banks' profitability and stability.

Based on theoretical assumptions regarding the role of ESG in building banks' sustainable value, the following research hypotheses were formulated in the study:

H1: Implementation of ESG activities positively impacts commercial banks' profitability.

H2: Increasing banks' involvement in ESG-related activities positively impacts their financial stability, as reflected by a higher Z-score index.

METHODOLOGY

This analysis examines the impact of ESG strategies on the profitability and stability of commercial banks on an international scale. The study utilizes the most up-to-date banking data, incorporating ESG-related variables: Social, Governance, and Environment. These variables are defined according to the ESG scores methodology published by Refinitiv (Refinitiv, 2022). This source has been previously used in empirical research (Buallay, 2019; Caldeira dos Santos & Pereira, 2022; Galletta et al., 2022). Considering all three pillars, the ESG score provides a comprehensive assessment of a bank's ESG performance. The study initially considered a sample of 1,730 commercial banks between 2012 and 2021, based on data from the Refinitiv Eikon database. However, due to data availability issues, particularly the lack of ESG ratings reported by many banks, the final sample used in the analysis was reduced to 384 banks from 62 countries worldwide. Nevertheless, the analysis period encompassed by the study extends over a minimum of six years, ensuring sufficient temporal coverage to capture medium-term trends and mitigate the influence of short-term fluctuations. These data limitations also contribute to variation in the number of observations across the model estimations. Using a panel regression methodology, the study empirically documents the significance of ESG strategies for bank profitability and stability. The analysis focuses on three dimensions of ESG performance: environmental score (Environment), social score (Social), and governance score (Governance). The assessment of the Environmental pillar is based on three key aspects: 1) **Resource Use**, which reflects the bank's ability to reduce energy, water, and material consumption, as well as to find complementary and more eco-friendly solutions; 2) **Emissions Reduction**, which measures the company's effectiveness and commitment to reducing environmental emissions; 3) **Innovations**, which reflect the bank's ability to lower ecological costs through new technologies or eco-friendly projects. The **Social** pillar ranking considers four categories: 1) **Workforce Score**, which measures the bank's effectiveness in ensuring a healthy and safe workplace, maintaining job satisfaction, and providing equal opportunities for its employees; 2) **Human Rights**, which refer to the company's compliance with fundamental human rights conventions; 3) **Community Score**, which indicates the bank's commitment to business ethics and public health; 4) **Product Responsibility**, which reflects the bank's ability to offer high-quality services. Finally, the assessment of the **Governance** pillar combines the bank's effectiveness in applying best corporate governance practices, ensuring equal treatment of shareholders, and integrating social responsibility strategies into its ongoing operations.

Although the Refinitiv Eikon database provides extensive ESG-related data for a large number of commercial banks, the dataset is not free from limitations. In particular, potential biases may arise from missing or unevenly reported ESG scores across banks, countries, and years. To address this, the analysis includes only banks with the largest possible number of observations having complete ESG and financial data for the examined period. This approach ensures consistency and comparability across observations.

Table 1 presents the distribution of the number of banks across the countries participating in this study. The sample distribution exhibits significant geographical diversity, enabling a comprehensive analysis of the impact of ESG strategies across diverse economic and social contexts. The highest number of banks originates from countries, such as the United States (67) and Japan (25), highlighting the dominance of large economies and developed financial markets in defining ESG

activities within their banking sectors, while banks from developing countries, such as India (19) and the Philippines (18), are also significant. This heterogeneity in the research sample mitigates potential biases arising from over-concentration in specific regions, thereby improving the generalizability and validity of the GMM estimations.

Table 1. Geographical distribution and number of banks in the research sample

Country	# Banks	Percent	Country	# Banks	Percent
Argentina	3	0.8	Mauritius	2	0.5
Austria	3	0.8	Morocco	2	0.5
Bangladesh	2	0.5	Netherlands	1	0.3
Belgium	1	0.3	New Zealand	1	0.3
Brazil	5	1.3	Nigeria	7	1.8
Canada	9	2.3	Norway	15	3.9
Chile	4	1.0	Oman	4	1.0
China	13	3.4	Pakistan	1	0.3
Colombia	3	0.8	Papua New Guinea	1	0.3
Czech Republic	1	0.3	Peru	1	0.3
Denmark	3	0.8	Philippines	18	4.7
Egypt	5	1.3	Poland	9	2.3
Finland	1	0.3	Portugal	1	0.3
France	3	0.8	Puerto Rico	1	0.3
Germany	3	0.8	Qatar	5	1.3
Ghana	3	0.8	Russia	3	0.8
Greece	4	1.0	Rwanda	1	0.3
Hong Kong	3	0.8	Saudi Arabia	1	0.3
Hungary	2	0.5	Singapore	3	0.8
India	19	4.9	South Africa	5	1.3
Indonesia	14	3.6	Spain	5	1.3
Ireland	4	1.0	Sweden	3	0.8
Israel	4	1.0	Switzerland	5	1.3
Italy	7	1.8	Taiwan	9	2.3
Japan	25	6.5	Thailand	6	1.6
Jordan	1	0.3	Turkey	6	1.6
Kenya	8	2.1	Ukraine	1	0.3
Korea	6	1.6	United Arab Emirates	9	2.3
Kuwait	4	1.0	United Kingdom	8	2.1
Lebanon	3	0.8	United States	67	17.4
Malaysia	11	2.9	Vietnam	6	1.6
			Total banks:	384	100.0
			Total countries:	62	

Source: Own elaboration based on Refinitiv Eikon data.

Figure 2 presents the average annual scores for the Social, Governance, and Environmental dimensions of banks over the period from 2012 to 2021. The Social score exhibits a clear upward trend, increasing steadily from around 43 in 2012 to approximately 60 in 2021. This suggests a growing emphasis by banks on social responsibility aspects, such as community engagement, employee relations, and customer welfare, over the analyzed decade. The Governance score begins at a higher baseline of approximately 52 in 2012 and maintains a relatively stable trajectory, with a slight increase, peaking around 58 in 2019 and then slightly declining thereafter. This indicates consistent attention to governance practices, including board effectiveness, transparency, and shareholder rights, which appear well-established and sustained throughout the period. In contrast, the Environmental score demonstrates more variability and generally lower values

compared to Social and Governance scores. Starting near 47 in 2012, it declines around 2017-2018 to about 37, followed by a partial recovery reaching roughly 48 in 2021. This pattern may reflect fluctuating priorities or challenges related to environmental sustainability efforts within the banking sector, possibly due to evolving regulatory pressure or differing strategic objectives over time.

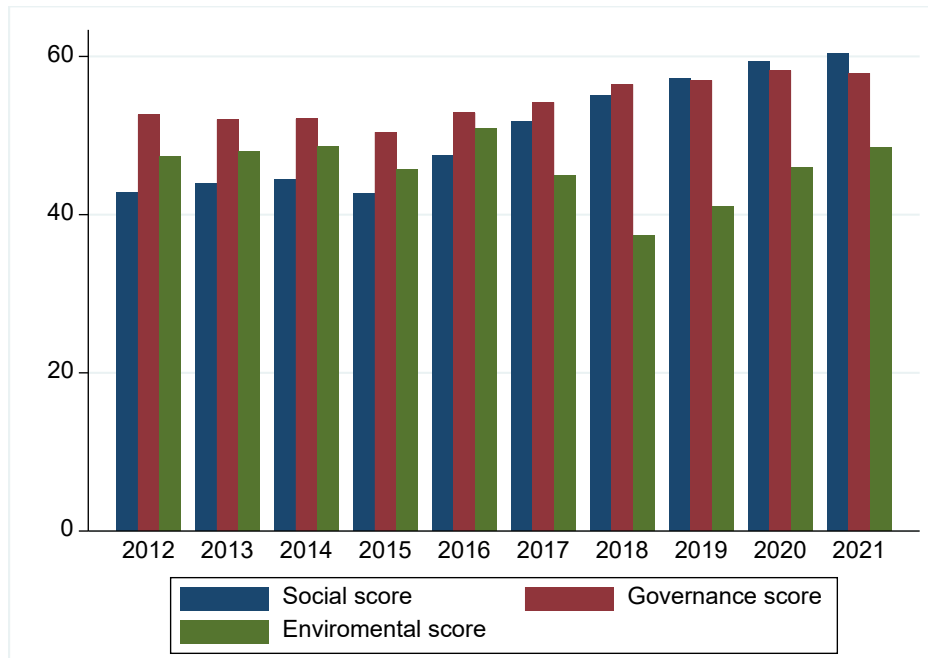


Figure 2. The average annual ESG rating of banks' activities corresponding to the social, corporate governance and environmental pillars in a given year across the full sample. The data is based on aggregated ESG indicators available in the Refinitiv Eikon database.

Source: Own elaboration based on Refinitiv Eikon data.

To verify the impact of ESG activities on bank performance and stability, we employed three key financial indicators: Return on Assets (ROA), Return on Equity (ROE), and the Z-score. ROA and ROE are widely recognized in the literature as standard measures of bank profitability, reflecting the institution's ability to generate earnings from its assets and equity base, respectively. ROA is calculated as net income divided by total assets, indicating how efficiently a bank uses its assets to generate profit. ROE, in turn, is calculated as net income divided by shareholders' equity, measuring the return generated on the capital provided by shareholders. These indicators provide a clear and comparable view of how efficiently a bank transforms its resources into financial returns. On the other hand, financial stability is assessed using the Z-score, a well-established proxy for insolvency risk in banking studies. The Z-score combines profitability, leverage, and return volatility into a single metric, capturing a bank's capacity to absorb financial shocks without becoming insolvent. A higher Z-score indicates greater stability and a lower probability of default. While these indicators may appear self-evident to those familiar with the field, their selection was based on both their frequent use in empirical studies on ESG and financial performance (e.g., Buallay, 2019) and their relevance to the research objectives. ROA and ROE capture short-term performance outcomes, while the Z-score adds a longer-term dimension by incorporating risk and volatility.

The Z-score is calculated by applying the formula:

$$Z - score_{n,t} = \frac{CAR_{n,t} + ROA_{n,t}}{\sigma ROA_n} \quad (1)$$

where:

$Z - score_{n,t}$ – the Z-score was calculated for each bank n over time t . Specifically, CAR represents the bank's capital adequacy ratio. At the same time, ROA and σROA denote the estimated expected value and standard deviation of each bank's return on assets over the full period, respectively (Lepetit & Strobel, 2013). The Z-score reflects the number of standard

deviations by which ROA would need to decline from its expected value before the bank's capital is depleted, signaling risk of insolvency. In simple terms, it acts like a financial "shock absorber," the higher the Z-score, the greater the bank's stability, indicating a lower probability of insolvency. Just as a well-cushioned car suspension can handle bumps on the road more smoothly, a high Z-score suggests that a bank can better withstand financial shocks.

Control and macroeconomic variables are incorporated into the model to ensure a more accurate estimation of the relationship between ESG performance and bank outcomes, accounting for factors that influence profitability and stability. The debt-to-assets ratio reflects a bank's leverage and overall financial risk. Higher leverage can increase vulnerability to shocks and reduce stability. The loan-to-assets ratio captures the extent of credit exposure, which directly affects income generation but also introduces credit risk, depending on loan quality. These financial ratios are standard controls in banking literature, as they are key determinants of performance and resilience. To account for country-specific economic conditions, the model also includes GDP growth, which influences banks' operating environments, affecting loan demand, investment activity, and risk exposure. By controlling for these factors, the model aims to isolate the unique contribution of ESG-related practices to financial outcomes.

A two-step GMM estimator (Blundell & Bond, 1998) was used to test the research questions. It is particularly useful for analyzing dynamic panels with a short study period and many observations. Its advantage lies in accounting for the dynamic nature of banks' decisions, such as operational strategies affecting income. Additionally, the method effectively addresses potential endogeneity issues using internal instruments, enhancing the robustness and credibility of the estimated relationships between ESG activities and financial outcomes. The model also uses lagged explanatory variables as instruments, which helps reduce the problem of endogeneity. The two-step GMM estimator is more efficient than one-step estimators as it mitigates biases arising from heteroskedasticity and autocorrelation in the residuals (Roodman, 2009). However, the GMM estimator also has certain limitations. One of its limitations is its sensitivity to the quality of the selected instruments; an excessive number of instruments can weaken diagnostic tests, such as Hansen's test, making it more challenging to verify the correctness of the model specification. Additionally, caution is required when interpreting the results, as the model accounts only for linear relationships between variables and may overlook nonlinear effects, which could also be relevant in ESG-related decisions and a bank's financial stability.

The general form of the model is expressed by the equation (2):

$$Y_{n,i,t} = \beta_0 + \beta_1 Y_{n,i,t} + \beta_2 ESG_{n,i,t} + \beta_3 Bank_Control_{n,i,t} + \beta_4 GDPgrowth_{i,t} + \varepsilon_{i,t} \quad (2)$$

where:

Y represents the bank stability indicators [ROA, ROE, Z-score] as dependent variables, where ROA denotes the return on assets for each n bank from i country in t year, ROE represents the return on equity, and Z-score serves as an indicator of bank insolvency risk. The model incorporates the ESG variable vector, $ESG = [esg_score, social, governance, enviro]$, which corresponds to the bank's sustainable policy in the following dimensions: overall ESG approach, social responsibility, corporate governance, and environmental impact. Additionally, control variables characterizing the bank were included, defined as $Bank_Control = [debt/ta, loan/ta]$, where $debt/ta$ represents the bank's debt-to-assets ratio, and $loan/ta$ reflects the share of loans in the bank's total assets. The variable $GDPgrowth$, included in the model as a macroeconomic control, captures the annual change in a country's GDP, reflecting the pace of its economic expansion or contraction. Finally, the error term ε . Table 2 presents a detailed overview of the variables used in the empirical analysis, including their definitions, calculation methods, classification, and the expected direction of their impact on bank profitability and financial stability.

Table 2. Description of variables used in the empirical analysis

Variable	Description / Calculation	Type	Expected Effect
ROA	Return on Assets = Net Income / Total Assets	Dependent variable	Measures bank profitability
ROE	Return on Equity = Net Income / Equity	Dependent variable	Measures bank profitability
Z-score	$(ROA + Equity/Assets) / \text{Standard deviation of ROA}$	Dependent variable	Indicates bank stability (higher value = lower insolvency risk)
ESG_Score	Overall ESG score provided by Refinitiv Eikon	Main independent variable	Captures total ESG engagement; expected positive or mixed effect

Variable	Description / Calculation	Type	Expected Effect
Social	ESG sub-score: social responsibility (workforce, human rights, community, product responsibility)	Independent variable	Expected positive impact on stability and stakeholder trust
Governance	ESG sub-score: governance quality (transparency, board structure, shareholder rights)	Independent variable	Expected positive impact on both profitability and stability
Environmental	ESG sub-score: environmental practices (emissions reduction, resource use, innovation)	Independent variable	Potential short-term negative effect on profitability due to high costs
Debt/TA	Debt-to-Assets Ratio = Total Debt / Total Assets	Control variable	Higher leverage may negatively affect stability
Loan/TA	Loan-to-Assets Ratio = Total Loans / Total Assets	Control variable	Reflects credit risk exposure; may impact performance depending on loan quality
GDPgrowth	Country's annual growth of GDP	Macro variable	Year-over-year change in the total economic output of a country, indicating the pace of its economic expansion or contraction

Diagnostic tests were conducted to assess key model assumptions. Hansen's test (Hansen, 1982) was used to evaluate the validity of the instrument set and the presence of over-identifying restrictions. The Arellano-Bond tests (1991) for first-order (AR(1)) and second-order (AR(2)) serial correlation in the residuals were applied to detect autocorrelation patterns. Specifically, these tests examined whether the model's error terms exhibited serial correlation at lag 1 and lag 2. The null hypothesis in the Arellano-Bond tests assumes no autocorrelation; therefore, failure to reject the null hypothesis indicates that residuals are not serially correlated, supporting the model's specification.

Descriptive statistics of the variables used in the model are presented in Table 3. The ESG score statistic shows a mean value of 50.14 and a standard deviation of 20.95, indicating that, on average, the analyzed banks met the ESG requirements. The highest compliance is observed in the area of corporate governance (54.49), followed by sustainable social activities (50.89), while the lowest adherence is related to environmental efforts (45.72). On the other hand, during the analyzed period, the average value of the ROA indicator was 1, ROE stood at 11, and the Z-score was at the level of 51.17. The Z-score, which measures the financial stability of banks by combining profitability, capitalization, and volatility indicators, shows substantial variability, with a standard deviation of 47.44 and a range extending from -62.42 to 572.10. A higher Z-score value indicates greater financial stability and lower risk of insolvency. Conversely, negative Z-score values suggest that some banks experienced financial distress or were close to insolvency during the period under study. The positive skewness (3.93) further indicates that while most banks maintain moderate to high financial stability, a few outliers with very high Z-score values heavily influence the distribution. This variability underscores the heterogeneous financial health status among the sampled banks throughout the analyzed timeframe.

Table 3. Descriptive statistics for the research sample

	Obs	Mean	Median	Std.Dev.	Min	Max	Skew
esg_score	2870	50.14	49.99	20.95	1.57	94.78	-0.07
social	2870	50.89	51.00	24.44	0.63	97.62	-0.12
governance	2870	54.49	56.34	22.34	0.47	99.38	-0.24
envir	2870	45.72	47.27	30.00	0.00	97.47	0.06
roa	3840	0.01	0.01	0.01	-0.12	0.23	3.59
roe	3840	0.11	0.10	0.12	-5.74	0.91	-24.62
z-score	3840	51.17	39.24	47.44	-62.42	572.10	3.93
debt/ta	2820	0.11	0.06	0.20	0.00	11.12	25.55
loan/ta	3840	0.62	0.64	0.16	-0.03	2.00	-0.44
GDPgrowth	3840	2.80	2.90	4.09	-25.91	25.18	-1.00

Notes: Descriptive statistics were performed on a sample of 384 banks worldwide over the period 2012–2021.

Source: Own study based on Refinitiv Eikon data.

To gain deeper insight into the relationships among the variables, a correlation analysis was performed, and the results are summarized in Table 4. The analysis reveals that ROA exhibits a weak but statistically significant negative correlation with the overall ESG score (-0.09), as well as with the social (-0.06) and environmental (-0.17) dimensions. Similarly, ROE shows very weak negative correlations with ESG (-0.03), social (-0.03), and environmental (-0.01) factors. Financial stability, as measured by the Z-score, demonstrates a weak positive correlation with the overall ESG score (0.15)

and the social dimension (0.19), while the environmental dimension is weakly negatively correlated with the Z-score (-0.20). Control variables such as loan-to-asset ratio correlate weakly and positively with ROA (0.11) and Z-score (0.09), whereas debt-to-asset ratio correlates weakly and negatively with Z-score (-0.21) and ROA (-0.04).

Table 4. Correlation matrix

	roa	roe	z-score	esg_score	social	governance	envir	loan_ta	debt_ta	GDPgrowth
roa	1.00									
roe	0.64***	1.00								
z-score	0.01	0.01	1.00							
esg_score	-0.09***	-0.03*	0.15***	1.00						
social	-0.06**	-0.03*	0.19***	0.93***	1.00					
governance	-0.04	0.04*	-0.02	0.73***	0.45***	1.00				
envir	-0.17***	-0.01*	-0.20***	0.78***	0.73***	0.38***	1.00			
loan_ta	0.11***	0.01	0.09***	0.03	0.08***	-0.04	-0.02	1.00		
debt_ta	-0.04*	0.02	-0.21***	0.10***	0.09***	0.06**	0.09***	0.06*	1.00	
GDPgrowth	0.11***	0.17***	0.02*	-0.03	-0.01	-0.02	-0.01	0.06**	0.05	1.00

Note: P-values * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Own study based on Refinitiv Eikon data.

RESULTS AND DISCUSSION

The analysis was conducted based on a prior empirical study of the banking sector across 44 emerging market countries from 2011 to 2017 (Azmi et al., 2021) and a sample of 20 banks in Pakistan from 2008 to 2017 (Ramzan et al., 2021). The subsequent Tables 5–7 present the average results of the panel regression estimation, examining the impact of ESG activities on the profitability and stability of commercial banks (specifically, Table 5 for the ROA variable, Table 6 for ROE, and Table 7 for Z-score). The estimation was conducted based on the formulated research hypotheses: H1, assuming a positive impact of ESG activities on bank profitability, and H2, assuming a positive effect of increasing ESG engagement on the financial stability of banks. To examine these relationships, each table separately verifies the impact of ESG activities measured by the overall index (Model 1) as well as its components: social (Model 2), governance (Model 3), and environmental (Model 4). This division enables a detailed analysis of the ESG aspects that are most crucial for banks' profitability and financial stability.

The estimation results (Tables 5 and 6) indicate that overall ESG performance, as well as its social dimension, is negatively and significantly associated with both ROA and ROE, suggesting a consistent adverse relationship between ESG engagement and banks' profitability. In addition, the governance dimension shows a negative and significant effect on ROA, while its impact on ROE is statistically insignificant. The environmental dimension does not exhibit a significant influence on either profitability measure. These findings do not support Hypothesis H1, which posits that the implementation of ESG activities positively impacts commercial banks' profitability. On the contrary, the results suggest that, in the short to medium term, ESG-related initiatives, particularly those within the social and governance domains, may involve financial outlays or resource reallocations that reduce banks' immediate profitability, as reflected in both asset- and equity-based returns. Several factors may explain this negative relationship. First, implementing ESG activities often entails additional operational costs, such as investments in green technologies, regulatory compliance, and social engagement. These expenditures may reduce bank profits in the short term. Second, banks prioritising ESG may adopt more conservative lending practices, limiting financing to high-carbon industries, which could also affect their revenue. It is important to note that these results are specific to the analyzed period and may not necessarily reflect long-term trends. Over a longer horizon, increased environmental and social responsibility could enhance banks' reputations, attract investors, and mitigate regulatory risks, potentially leading to higher profitability.

Similar results were obtained by Cornett et al. (2016), who indicated that increased commitment to sustainable development may pose a short-term burden on bank profitability. Likewise, Goss and Roberts (2011) observed that banks with high ESG activities incur higher operational costs, which negatively affect their financial performance. The findings also show that environmental activities do not drive bank performance (-0.001). This result can be explained by the potentially higher costs of implementing ESG initiatives, which may weigh on banks' current financial performance. These costs may

stem from the need to invest in more sustainable initiatives or to adapt operations to regulatory requirements, which in the short term leads to lower profitability indicators. Furthermore, the negative relationship concerning environmental activities may be linked to their long-term nature. The benefits of such initiatives are often not visible in the short run, as confirmed by Scholtens (2008). The author emphasized that investments in environmentally friendly actions generate value only over a longer horizon when both initial costs and regulatory effects begin to amortize. Therefore, in light of the obtained results, the proposed hypothesis H1, stating that the implementation of ESG activities positively affects the profitability of commercial banks, cannot be positively verified. The analysis demonstrated that the relationship between ESG activities and profitability is negative, implying that increased engagement in environmental, social, and corporate governance aspects may be associated with lower profitability indicators in the analyzed banks.

Table 5. Estimation results of models verifying the impact of ESG on the ROA ratio of the full sample of commercial banks in the 10 years of 2012–2021

	(1) esc_all	(2) social	(3) gover	(4) envir
L(-1) roa	0.698*** (0.062)	0.724*** (0.060)	0.698*** (0.063)	0.660*** (0.070)
esg_score	-0.011* (0.001)			
social		-0.001* (0.001)		
governance			-0.001* (0.001)	
envir				-0.000 (0.000)
loan_ta	0.103*** (0.005)	0.068*** (0.004)	0.018 (0.006)	0.059*** (0.003)
debt_ta	-0.004** (0.007)	-0.006* (0.007)	-0.003** (0.006)	-0.003** (0.006)
GDPgrowth	0.000*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Observations	1146	1146	1146	1146
Number of groups	191	191	191	191
Number of instruments	17	17	17	17
Hansen statistic	32.61	33.18	35.08	31.61
p value of Hansen statistic	0.112	0.100	0.1673	0.137
AR(1)	-2.293	-2.287	-2.243	-2.065
p-value	0.0218	0.0222	0.0249	0.0389
AR(2)	1.372	1.347	1.361	1.546
p-value	0.170	0.178	0.173	0.122

Note: The model is presented using equation (2). The models were estimated using the GMM estimator. The standard error is provided in parentheses. The p-value indicates significance at the respective level * $p < 0,1$, ** $p < 0,05$, *** $p < 0,01$. AR(1) and AR(2) AR(1) and AR(2) represent the empirical values of the Arellano-Bond test for first- and second-order autocorrelation, respectively, for the null hypothesis H0: There is no first-order (second-order) autocorrelation is present. Regarding the variation in the number of observations across the models, this is due to missing data in specific ESG subcomponents, which slightly reduced the sample and the number of groups. Nevertheless, the analysis period encompassed by the study extends over a minimum of six years, ensuring sufficient temporal coverage to capture medium-term trends and mitigate the influence of short-term fluctuations.

Source: Own study based on Refinitiv Eikon data.

The applied control variables, namely *loan_ta* (the share of loans in total assets) and *debt_ta* (the share of debt in total assets), also deserve attention due to their significance in shaping bank profitability. The *loan_ta* coefficient is positive and statistically significant, indicating that increasing the share of loans in a bank's assets leads to higher profitability. This result suggests that lending activities positively impact bank profitability, which aligns with expectations, given that loans represent one of the primary sources of banks' interest income. In contrast, the *debt_ta* variable has a negative coefficient for ROA, meaning that a higher share of debt in a bank's assets leads to a decline in profitability, and is not significant for ROE. This finding implies that an elevated level of debt may burden banks with higher financing costs, negatively affecting their profitability. Both results highlight the importance of effective asset and liability management in banks to enhance their financial performance. The results for the macroeconomic control variable indicate that GDP growth is positively

and significantly related to both ROA and ROE, implying that favorable economic conditions enhance banks' profitability regardless of their ESG engagement. This reinforces the notion that broader economic cycles play a substantial role in shaping banks' financial performance.

The results presented in Table 7 provide partial support for Hypothesis H2, which posits that increasing banks' involvement in ESG-related activities positively impacts their financial stability, as measured by the Z-score index. Specifically, the overall ESG score and the social dimension exhibit a positive and statistically significant relationship with the Z-score, indicating that greater ESG engagement in these areas is associated with higher financial stability. The coefficient of 0.286 for the overall ESG score suggests that a one-unit increase is associated with a statistically significant (10 level) rise of about 0.286 in the Z-score, reflecting improved financial stability in banks. These findings align with the research of Scholtens (2009), which demonstrated that financial institutions' social engagement enhances their reputation, customer trust, and loyalty, ultimately strengthening financial performance stability. However, the governance dimension shows a negative but statistically insignificant effect, while the environmental dimension has a statistically significant negative impact on the Z-score. Research conducted by Hong and Kacperczyk (2009) also indicated that implementing pro-environmental strategies in the financial sector may face investment and regulatory barriers, affecting their effectiveness in the short term. These mixed findings suggest that while social aspects of ESG may enhance banks' resilience, certain components, particularly environmental and governance factors, might be linked to reduced financial stability in the short to medium term. This observation is supported by the study of Boda and Karaś (2023), who analyzed 64 banks from 20 European countries between 2010 and 2021 and identified a nonlinear relationship between the ESG score and selected financial stability indicators. Their analysis demonstrated that the integration of ESG factors into banking operations can contribute to improved financial stability. Similar conclusions emerge from the study by Bax et al. (2021), who examined the relationship between ESG ratings and corporate risk, finding that ESG factors can influence corporate risk, which is essential for financial institutions.

One possible explanation for this pattern is that social initiatives, such as community engagement or employee welfare, may strengthen banks' reputations and stakeholder trust, thereby contributing to greater stability. Conversely, environmental activities might require substantial upfront investments or expose banks to transition risks related to shifting regulatory frameworks and market dynamics, which could temporarily undermine financial stability. The negative, albeit insignificant, effect of governance could reflect costs or disruptions associated with internal restructuring or compliance efforts. These nuances highlight that the impact of ESG on financial stability is multifaceted and depends on the specific dimension considered.

Additionally, macroeconomic conditions, as captured by GDP growth, make a positive and significant contribution to financial stability, reinforcing the importance of a favorable economic environment for bank soundness. The loan-to-asset ratio positively relates to the Z-score, indicating that higher lending activity may be associated with better stability. In contrast, a higher debt-to-asset ratio is linked to lower stability, highlighting the risks associated with leverage.

The potential implications of the study's findings underscore the need for a well-planned and structured approach to implementing ESG initiatives in banks. The positive impact of social initiatives on financial stability suggests that financial institutions should prioritize investments in projects that support local community development, promote inclusivity, and improve the living conditions of customers and employees. These actions can enhance bank stability and strengthen its reputation and long-term relationships with stakeholders.

In contrast, the negative impact of environmental initiatives on stability underscores the need for careful management of costs associated with climate protection. Banks may explore innovative financial solutions, such as green bonds, to mitigate the short-term financial burden of environmental investments. The findings also suggest that regulatory policies supporting ecological transformations in the banking sector should consider their impact on long-term financial stability to enable a more sustainable implementation of ESG activities.

Table 6. Estimation results of models verifying the impact of ESG on the ROE ratio of the full sample of commercial banks in the 10 years of 2012–2021

	(1)	(2)	(3)	(4)
	esc_all	social	gover	envir
L(-1) roe	0.506*** (0.076)	0.505*** (0.072)	0.560*** (0.071)	0.540*** (0.073)
esg_score	-0.013* (0.007)			
social		-0.013** (0.006)		
governance			0.001 (0.008)	
envir				-0.001 (0.003)
loan_ta	0.113** (0.045)	0.114*** (0.037)	0.027 (0.048)	0.041* (0.022)
debt_ta	0.079 (0.060)	0.073 (0.062)	0.054 (0.053)	0.055 (0.059)
GDPgrowth	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)
Observations	1198	1198	1198	1198
Number of groups	198	198	198	198
Number of instruments	21	21	21	21
Hansen statistic	28	26.71	30.02	32.82
p value of Hansen statistic	0.260	0.318	0.184	0.108
AR(1)	-1.677	-1.678	-1.665	-1.515
p-value	0.0936	0.0933	0.0959	0.013
AR(2)	1.011	0.962	0.985	1.080
p-value	0.312	0.336	0.325	0.280

Note: The model is presented using equation (2). The models were estimated using the GMM estimator. The standard error is provided in parentheses. The p-value indicates significance at the respective level * p<0,1, ** p<0,05, *** p<0,01. AR(1) and AR(2) AR(1) and AR(2) represent the empirical values of the Arellano-Bond test for first- and second-order autocorrelation, respectively, for the null hypothesis H0: There is no first-order (second-order) autocorrelation is present. Regarding the variation in the number of observations across the models, this is due to missing data in specific ESG subcomponents, which slightly reduced the sample and the number of groups. Nevertheless, the analysis period encompassed by the study extends over a minimum of six years, ensuring sufficient temporal coverage to capture medium-term trends and mitigate the influence of short-term fluctuations. **Source:** Own study based on Refinitiv Eikon data.

Table 7. Estimation results of models verifying the impact of ESG on the Z-score ratio of the full sample of commercial banks in the 10 years of 2012–2021

	(1)	(2)	(3)	(4)
	esc_all	social	gover	envir
L(-1) z-score	0.686*** (0.102)	0.681*** (0.105)	0.652*** (0.100)	0.623*** (0.089)
esg_score	0.286* (0.745)			
social		0.011* (0.624)		
governance			-0.612 (0.912)	
envir				-0.703**

	(1) esc_all	(2) social	(3) gover	(4) envir
loan_ta	24.919*** (7.854)	23.758*** (7.591)	28.743*** (9.385)	21.960*** (7.785)
debt_ta	-37.460** (16.036)	-38.733** (16.210)	-39.224** (16.801)	-33.448** (15.466)
GDPgrowth	0.165*** (0.034)	0.171*** (0.034)	0.152*** (0.036)	0.195*** (0.038)
Observations	1134	1134	1134	1134
Number of groups	189	189	189	189
Number of instruments	17	17	17	17
Hansen statistic	29.99	30.47	29.39	28.67
p value of Hansen statistic	0.185	0.170	0.206	0.233
AR(1)	-4.376	-4.387	-4.284	-3.831
p-value	1.21e-05	1.15e-05	1.84e-05	0.000
AR(2)	0.631	0.677	0.523	-0.116
p-value	0.528	0.498	0.601	0.908

Note: The model is presented using equation (2). The models were estimated using the GMM estimator. The standard error is provided in parentheses. The p-value indicates significance at the respective level * p<0,1, ** p<0,05, *** p<0,01. AR(1) and AR(2) AR(1) and AR(2) represent the empirical values of the Arellano-Bond test for first- and second-order autocorrelation, respectively, for the null hypothesis H0: There is no first-order (second-order) autocorrelation is present. Regarding the variation in the number of observations across the models, this is due to missing data in specific ESG subcomponents, which slightly reduced the sample and the number of groups. Nevertheless, the analysis period encompassed by the study extends over a minimum of six years, ensuring sufficient temporal coverage to capture medium-term trends and mitigate the influence of short-term fluctuations. **Source:** Own study based on Refinitiv Eikon data.

CONCLUSION

Our research primarily focused on assessing the effects of implementing ESG activities in the banking sector. Therefore, the scope of the study was narrowed to the operational activities of banks, where the fundamental outcome of financial capital allocation remains a continuous increase in profitability. However, due to various factors, notably the 2007–2009 financial crisis and the COVID-19 pandemic, business strategies in credit institutions differ significantly from those of non-financial enterprises. These strategies require banks to secure the risks from their asset portfolios with bank capital to enhance financial stability. The absence of such security exposes banks to the risk of losing financial liquidity, which may lead to insolvency and bankruptcy. Nonetheless, the primary reason for developing bank risk management systems is to ensure the solvency of bank deposits. Banks play a crucial role in accumulating savings in every country. Disruptions in the mechanism of bank capital allocation, for this reason, threaten not only the financial security of credit institutions but also the stability of global financial systems.

The effects of the global financial crisis 2007–2009 expanded the scope of regulatory discipline in banking operations at both the microprudential and macroprudential levels. In contrast, the COVID-19 pandemic led to a global economic downturn, a depreciation of national currencies, and the implementation of anti-inflationary monetary policies. Under these circumstances, the pace of implementation of ESG activity increased significantly. In European Union member states that were particularly affected by the energy crisis, ESG activities came to be recognized as a source of technological and technical innovation, ultimately contributing to a new level of economic growth for EU countries and their role in the global economy. In a short period, the intensification of ESG activity implementation stimulated discussions on the practical aspects of sustainable development, particularly concerning its realisation conditions, sources, and costs. Banks proactively engaged in the process of green financing for the economy by integrating ESG strategies into their banking business management processes. The high ESG risk associated with credit institutions in the process of green funding for economic entities has been incorporated into their management systems, following the view that implementing better governance structures in the banking sector should reduce business risk and contribute to increasing shareholder

value (Bătae et al., 2020). Therefore, this study aims to examine the significance of ESG practices in financial institutions concerning commercial banks' profitability and financial stability on a global scale.

Using a dataset from the Refinitiv Eikon database, which covers 384 commercial banks from 62 countries between 2012 and 2021, and applying panel regression methodology, the empirical relevance of ESG activities for bank profitability and financial stability has been documented. The analysis focused on three dimensions of ESG performance: environmental (E), social (S), and governance (G) scores. The estimation of the collected research data indicates that ESG activities have a low but statistically significant impact on bank profitability, measured by ROA and ROE indicators. This negative relationship suggests that higher engagement in ESG-related practices is associated with a reduction in short-term bank performance. The results primarily reflect aggregated ESG scores and their social, environmental, and governance pillars, without direct examination of specific ESG initiatives or projects. The study also revealed that engagement in ESG activities, particularly within the social dimension, is positively associated with financial stability and the growth of the capital base of the analyzed banks. Meanwhile, the environmental pillar showed a negative relationship with both profitability and stability metrics, though the underlying causes of this effect cannot be conclusively determined from the aggregated data alone. From a policy perspective, these findings indicate that while ESG integration may involve trade-offs in the short term, further research using more granular ESG subcomponent data is necessary to clarify the specific mechanisms through which different types of ESG activities influence bank performance. Previous studies, such as Aevoae et al. (2022), also emphasize the complexity of ESG integration and its potential impacts on banks' systemic risk, highlighting the importance of continued multidimensional investigation.

Interesting conclusions also emerge from the analysis of the impact of banks' ESG activities on their financial stability. The study found a positive association between engagement in the social and governance dimensions and higher Z-score values, indicating greater financial stability. These results underscore the potential role of responsible social practices and governance structures in enhancing trust and supporting the long-term financial resilience of banking institutions. However, it is important to note that the aggregated nature of the ESG data limits the ability to pinpoint which specific activities drive these outcomes. Moreover, the effectiveness of ESG initiatives likely depends on their implementation details, as well as prevailing regulatory and market environments. Banks that strategically integrate ESG considerations into their operations may improve their stability and potentially strengthen their competitive position over time. Conversely, a negative relationship was observed for the environmental dimension, suggesting that, on aggregate, greater environmental engagement is associated with lower financial stability in the short term. This finding suggests potential challenges associated with environmental efforts, but further investigation with more granular data is required to better understand the underlying factors.

The study did not provide clear guidelines on which ESG actions are the most effective for commercial banks. However, it showed that intensifying the implementation of ESG activities in banks does not bring measurable short-term benefits. Nevertheless, implementing ESG actions may generate secondary benefits, such as improving the quality of life in society or increasing the attractiveness of foreign direct investments. The results of the study are, therefore, original. Firstly, because they differentiate the evaluation system for implementing ESG activities in banks. Secondly, they assess the impact of ESG actions on two groups of parameters that are most crucial for banking business operations. Thirdly, they explore a relatively under-researched area, paving the way for further studies and discussions. Since geopolitical factors, including the varying approval of ESG implementation in economic entities, are reshaping its existing vision, similar studies require further in-depth analysis. Assessing the impact of ESG activities on banks' profitability and financial stability is just one of the key research areas. In green finance, studies identifying the effects of ESG strategy implementation in enterprises are equally important. Banks seem to respond differently when financing small and large green investment projects. Examining the impact of ESG on the banking sector also requires an assessment of systemic risk. Credit institutions are subject to macroprudential regulations that mitigate this risk with bank capital. This situation may alter banks' approach to green financing as systemic risk increases. Ultimately, however, ESG research demands a thorough theoretical debate. The global economy continues to grow, regardless of post-crisis concepts aimed at slowing it down. Meanwhile, sustainable development represents a new dimension of life in wealthy economies. Numerous critical issues remain unanswered within this research field. ESG activities were expected to address many of them. However, they have now been suspended in a state of political limbo, which will result in high financial and opportunity costs for both financial and non-financial businesses in the context of financing green investments.

However, this study has limitations, which should be acknowledged and may guide future research. First, the use of aggregated ESG scores from the Refinitiv Eikon database limits the ability to assess the quality or depth of individual ESG

initiatives reported by banks. These scores are based on disclosed information, which may vary in consistency, completeness, and actual implementation across institutions and countries. Second, the study focuses solely on commercial banks, excluding other financial institutions whose ESG engagement and financial dynamics may differ. Third, while the panel regression method allows for robust estimation, it does not fully capture potential endogeneity or reverse causality between ESG activities and financial performance. Finally, the research relies on quantitative measures and does not incorporate qualitative insights that might help explain why certain ESG activities may not translate into profitability gains.

Addressing these limitations in future studies, such as incorporating case-based analysis, alternative data sources, or differentiating between ESG activities with short-term and long-term effects, could provide a more nuanced understanding of the link between ESG engagement and bank performance.

Acknowledgment

The study is a part of Renata Karkowska's research internship at the University of Economics in Katowice.

References

- Aevoae, G. M., Andrieş, A. M., Ongena, S., & Sprincean, N. (2023). ESG and systemic risk. *Applied Economics*, 55(27), 3085–3109. <https://doi.org/10.1080/00036846.2022.2108752>
- Ahmed, S. U., Ahmed, S. P., & Hasan, I. (2018). Why banks should consider ESG risk factors in bank lending. *Banks and Bank Systems*, 13(3), 71–80. [https://doi.org/10.21511/bbs.13\(3\).2018.07](https://doi.org/10.21511/bbs.13(3).2018.07)
- Amel-Zadeh, A., & Serafeim, G. (2018). Why and how investors use ESG information: Evidence from a global survey. *Financial Analysts Journal*, 74(3), 87–103. <https://doi.org/10.2469/faj.v74.n3.2>
- Ang, J. B., & McKibbin, W. J. (2007). Financial liberalization, financial sector development and growth: Evidence from Malaysia. *Journal of Development Economics*, 84(1), 215–233. <https://doi.org/10.1016/j.jdeveco.2006.11.006>
- Arvidsson, S., & Dumay, J. (2022). Corporate ESG reporting quantity, quality and performance: Where to now for environmental policy and practice? *Business Strategy and the Environment*, 31(3), 1091–1110. <https://doi.org/10.1002/bse.2947>
- Atz, U., Van Holt, T., Liu, Z. Z., & Bruno, C. C. (2023). Does sustainability generate better financial performance? Review, meta-analysis, and propositions. *Journal of Sustainable Finance & Investment*, 13(1), 802–825. <https://doi.org/10.1080/20430795.2022.2106934>
- Azmi, W., Hassan, M. K., Houston, R., & Karim, M. S. (2021). ESG activities and banking performance: International evidence from emerging economies. *Journal of International Financial Markets, Institutions and Money*, 70, 101277. <https://doi.org/10.1016/j.intfin.2020.101277>
- Barth, M. E., Cahan, S. F., Chen, L., & Venter, E. R. (2017). The economic consequences associated with integrated report quality: Early evidence from a mandatory setting. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2699409>
- Bătae, O. M., Dragomir, V. D., & Feleagă, L. (2020). Environmental, social, governance (ESG), and financial performance of European banks. *Journal of Accounting and Management Information Systems*, 19(3), 442–462. <https://doi.org/10.24818/jamis.2020.03003>
- Bebchuk, L. A., Kastiel, K., & Tallarita, R. (2023). Stakeholder capitalism in the time of COVID. *Yale Journal on Regulation*, 40(1), 60–126. <https://doi.org/10.2139/ssrn.4026803>
- Birindelli, G., Iannuzzi, A. P., & Savioli, M. (2019). The impact of women leaders on environmental performance: Evidence on gender diversity in banks. *Corporate Social Responsibility and Environmental Management*, 26(6), 1485–1499. <https://doi.org/10.1002/csr.1762>
- Birindelli, G., Dell'Atti, S., Iannuzzi, A. P., & Savioli, M. (2018). Composition and activity of the board of directors: Impact on ESG performance in the banking system. *Sustainability*, 10(12), 4699. <https://doi.org/10.3390/su10124699>
- Błach, J., Bukalska, E., Kaźmierska-Jóźwiak, B., & Radman Pęsa, A. (2025). Sustainability performance, corporate governance, and financial performance: Evidence from Poland and Central European listed companies. *Journal of Entrepreneurship, Management and Innovation*, 21(1), 58–80. <https://doi.org/10.7341/20252114>
- Blomqvist, A., & Stradi, F. (2024). Responsible investments: An analysis of preference—The influence of local political views on the return on ESG portfolios. *The European Journal of Finance*, 30(7), 696–725. <https://doi.org/10.1080/1351847X.2022.2137423>
- Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87(1), 115–143. [https://doi.org/10.1016/S0304-4076\(98\)00009-8](https://doi.org/10.1016/S0304-4076(98)00009-8)
- Boda, M., & Karaś, M. (2023). The impact of ESG indicators on financial stability in European banks: A nonlinear approach. *Bezpieczny Bank*. Advance online publication. <https://doi.org/10.26354/bb.6.2.91.2023>
- Bolibok, P. M. (2024). Does firm size matter for ESG risk? Cross-sectional evidence from the banking industry. *Sustainability*, 16(2), 752. <https://doi.org/10.3390/su16020752>
- Borkowski, R. (2001). *Cywilizacja, technika, ekologia: Wybrane problemy rozwoju cywilizacyjnego u progu XXI wieku*. Uczelniane Wydawnictwa Naukowo-Dydaktyczne.
- Borys, T., & Czaja, S. (2009). *Badania nad zrównoważonym rozwojem w polskich ośrodkach naukowych*. W D. Kiełczewski (Red.), *Od koncepcji ekorozwoju do ekonomii zrównoważonego rozwoju* (s. 51–58). Wydawnictwo Wyższej Szkoły Ekonomicznej w Białymstoku.
- Borys, T. (2012). *Trwały i zrównoważony rozwój*. W W. Gasparski (Red.), *Biznes, etyka, odpowiedzialność* (s. 477–479). Wydawnictwo Profesjonalne PWN.
- Broadridge. (2021, May 5). From the retail trading frenzy to growing ESG trends: What will be in proxy season? *PR Newswire*. <https://www.prnewswire.com/news-releases/from-the-retail-trading-frenzy-to-growing-esg-trends-what-will-be-in-proxy-season-2021-301281582.html>
- Brundtland, G. H. (1987). *Our common future: Report of the World Commission on Environment and Development*. Oxford University Press. <https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf>
- Buallay, A. (2019). Is sustainability reporting (ESG) associated with performance? Evidence from the European banking sector. *Management of Environmental Quality: An International Journal*, 30(1), 98–115. <https://doi.org/10.1108/MEQ-12-2017-0149>

- Caldeira dos Santos, M., & Pereira, F. H. (2022). ESG performance scoring method to support responsible investments in port operations. *Case Studies on Transport Policy*, 10(1), 664–673. <https://doi.org/10.1016/j.cstp.2022.01.027>
- Cao, M., Duan, K., & Ibrahim, H. (2023). Green investments and their impact on ESG ratings: Evidence from China. *Economics Letters*, 232, 111365. <https://doi.org/10.1016/j.econlet.2023.111365>
- Cheng, B., Ioannou, I., & Serafeim, G. (2014). Corporate social responsibility and access to finance. *Strategic Management Journal*, 35(1), 1–23. <https://doi.org/10.1002/smj.2131>
- Chiaromonte, L., Dreassi, A., Girardone, C., & Piserà, S. (2022). Do ESG strategies enhance bank stability during financial turmoil? Evidence from Europe. *The European Journal of Finance*, 28(12), 1173–1211. <https://doi.org/10.1080/1351847X.2021.2007890>
- Chilukuri, N. S. (2023). ESG and sustainable finance: A critical review of the influence of ESG scores on firm performance. *ResearchGate*. <https://doi.org/10.13140/RG.2.2.10447.46244>
- Cornett, M. M., Erhemjants, O., & Tehranian, H. (2016). Greed or good deeds? An examination of the relation between corporate social responsibility and the financial performance of U.S. commercial banks. *Journal of Banking & Finance*, 70, 137–159. <https://doi.org/10.1016/j.jbankfin.2016.04.024>
- Crews, C. (2023). The far right culture war on ESG. *Religions*, 14(10), 1257. <https://doi.org/10.3390/rel14101257>
- De Giuli, M. E., Grechi, D., & Tanda, A. (2023). What do we know about ESG and risk? A systematic and bibliometric review. *Corporate Social Responsibility and Environmental Management*, 30(6), 2575–2587. <https://doi.org/10.1002/csr.2624>
- Di Tommaso, C., & Thornton, J. (2020). Do ESG scores affect bank risk-taking and value? Evidence from European banks. *Corporate Social Responsibility and Environmental Management*, 27(5), 2286–2298. <https://doi.org/10.1002/csr.1964>
- Edmans, A. (2020). *Grow the pie: Creating profit for investors and value for society*. Cambridge University Press.
- El Ghoul, S., Guedhami, O., Kwok, C. C. Y., & Mishra, D. R. (2011). Does corporate social responsibility affect the cost of capital? *Journal of Banking & Finance*, 35(9), 2388–2406. <https://doi.org/10.1016/j.jbankfin.2011.02.007>
- European Commission. (2018). *Final report 2018 by the High-Level Expert Group on Sustainable Finance: Financing a sustainable European economy*. https://finance.ec.europa.eu/system/files/2018-01/180131-sustainable-finance-final-report_en.pdf
- Fatemi, A., Glaum, M., & Kaiser, S. (2018). ESG performance and firm value: The moderating role of disclosure. *Global Finance Journal*, 38, 45–64. <https://doi.org/10.1016/j.gfj.2017.03.001>
- Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Pitman.
- Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: Aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment*, 5(4), 210–233. <https://doi.org/10.1080/20430795.2015.1118917>
- Galbreath, J. (2013). ESG in focus: The Australian evidence. *Journal of Business Ethics*, 118(3), 529–541. <https://doi.org/10.1007/s10551-012-1607-9>
- Galletta, S., Mazzù, S., & Naciti, V. (2022). A bibliometric analysis of ESG performance in the banking industry: From the current status to future directions. *Research in International Business and Finance*, 62, 101684. <https://doi.org/10.1016/j.ribaf.2022.101684>
- Garcia, A. S., Mendes-Da-Silva, W., & Orsato, R. (2017). Sensitive industries produce better ESG performance: Evidence from emerging markets. *Journal of Cleaner Production*, 150, 135–147. <https://doi.org/10.1016/j.jclepro.2017.02.180>
- Giese, G., Lee, L.-E., Melas, D., Nagy, Z., & Nishikawa, L. (2019). Foundations of ESG investing: How ESG affects equity valuation, risk, and performance. *The Journal of Portfolio Management*, 45(5), 69–83. <https://doi.org/10.3905/jpm.2019.45.5.069>
- Gillan, S. L., Koch, A., & Starks, L. T. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, 66, 101889. <https://doi.org/10.1016/j.jcorpfin.2021.101889>
- Goss, A., & Roberts, G. S. (2011). The impact of corporate social responsibility on the cost of bank loans. *Journal of Banking & Finance*, 35(7), 1794–1810. <https://doi.org/10.1016/j.jbankfin.2010.12.002>
- Haans, R. F. J., Pieters, C., & He, Z.-L. (2016). Thinking about U: Theorizing and testing U- and inverted U-shaped relationships in strategy research. *Strategic Management Journal*, 37(7), 1177–1195. <https://doi.org/10.1002/smj.2399>
- Hassan, M. K., Chiaromonte, L., Dreassi, A., Paltrinieri, A., & Piserà, S. (2021). The crossroads of ESG and religious screening on firm risk. *Research in International Business and Finance*, 58, 101500. <https://doi.org/10.1016/j.ribaf.2021.101500>
- Hazen, T. L. (2021). Social issues in the spotlight: The increasing need to improve publicly held companies' CSR and ESG disclosures. *University of Pennsylvania Journal of Business Law*, 23, 740–746.
- Heli, W., Jaepil, C., & Jiatao, L. (2008). Too little or too much? Untangling the relationship between corporate philanthropy and firm financial performance. *Organization Science*, 19(1), 143–159. <https://doi.org/10.1287/orsc.1070.0271>
- Henderson, R. (2020). *Reimagining capitalism in a world on fire*. PublicAffairs.
- Hong, H., & Kacperczyk, M. (2009). The price of sin: The effects of social norms on markets. *Journal of Financial Economics*, 93(1), 15–36. <https://doi.org/10.1016/j.jfineco.2008.09.001>
- International Finance Corporation. (2004). *Who cares wins: Connecting financial markets to a changing world*. World Bank Group. https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_report_whocareswins_wci_1319579355342
- Jung, M., & Kim, Y.-L. (2022). The interaction effect of ESG and innovation on firm value. *Korean Journal of Financial Studies*, 51(4), 471–498. <https://doi.org/10.26845/KJFS.2022.08.51.4.471>
- Kell, G. (2018, July 11). The remarkable rise of ESG. *Forbes*. <https://www.forbes.com/sites/georgkell/2018/07/11/the-remarkable-rise-of-esg/>
- Larcker, D. F., Tayan, B., & Watts, E. M. (2021, November 4). *Seven myths of ESG* (Stanford Closer Look Series). Stanford Graduate School of Business. <https://www.gsb.stanford.edu/faculty-research/publications/seven-myths-esg>
- Łasak, P. (2023). Contemporary determinants of business performance: From the editor. *Journal of Entrepreneurship, Management and Innovation*, 19(4), 6–11. <https://doi.org/10.7341/20231940>
- Lepetit, L., & Strobel, F. (2013). Bank insolvency risk and time-varying Z-score measures. *Journal of International Financial Markets, Institutions and Money*, 25, 73–87. <https://doi.org/10.1016/j.intfin.2013.01.004>
- Levine, R. (1997). Financial development and economic growth: Views and agenda. *Journal of Economic Literature*, 35(2), 688–726.
- Li, Y., Gong, M., Zhang, X.-Y., & Koh, L. (2018). The impact of environmental, social, and governance disclosure on firm value: The role of CEO power. *The British Accounting Review*, 50(1), 60–75. <https://doi.org/10.1016/j.bar.2017.09.007>
- Liu, S., Jin, J., & Nainar, K. (2023). Does ESG performance reduce banks' nonperforming loans? *Finance Research Letters*, 55, 104619. <https://doi.org/10.1016/j.frl.2023.104619>

- MacNeil, I., & Esser, I.-M. (2022). From a financial to an entity model of ESG. *European Business Organization Law Review*, 23(1), 9–45. <https://doi.org/10.1007/s40804-021-00234-y>
- Marcinkowska, M. (2022). Próby włączenia ryzyka ESG do unijnych regulacji ostrożnościowych dla banków. *Bezpieczny Bank*, 3(88), 37–58.
- Matuszewska-Pierzynka, A., Mrzygłód, U., & Pieloch-Babiarz, A. (2023). ESG performance and dividend stability of the world's largest enterprises. *Journal of Entrepreneurship, Management and Innovation*, 19(4), 184–217. <https://doi.org/10.7341/20231946>
- Mayer, C. (2018). *Prosperity: Better business makes the greater good*. Oxford University Press.
- Miralles-Quirós, M. M., Miralles-Quirós, J. L., & Redondo Hernández, J. (2019a). ESG performance and shareholder value creation in the banking industry: International differences. *Sustainability*, 11(5), 1404. <https://doi.org/10.3390/su11051404>
- Miralles-Quirós, M. M., Miralles-Quirós, J. L., & Redondo Hernández, J. (2019b). The impact of environmental, social, and governance performance on stock prices: Evidence from the banking industry. *Corporate Social Responsibility and Environmental Management*, 26(6), 1446–1456. <https://doi.org/10.1002/csr.1759>
- Mitroff, I. I. (1983). *Stakeholders of the organizational mind*. Jossey-Bass.
- Montiel, I., Cuervo-Cazurra, A., Park, J., Antolín-López, R., & Husted, B. W. (2021). Implementing the United Nations' Sustainable Development Goals in international business. *Journal of International Business Studies*, 52(5), 999–1030. <https://doi.org/10.1057/s41267-021-00445-y>
- Naimy, V., El Khoury, R., & Iskandar, S. (2021). ESG versus corporate financial performance: Evidence from East Asian firms in the industrials sector. *Estudios de Economía Aplicada*, 39(3), Article e4457. <https://doi.org/10.25115/eea.v39i3.4457>
- Paltrinieri, A., Dreassi, A., Migliavacca, M., & Piserà, S. (2020). Islamic finance development and banking ESG scores: Evidence from a cross-country analysis. *Research in International Business and Finance*, 51, 101100. <https://doi.org/10.1016/j.ribaf.2019.101100>
- PKO Bank Polski S.A. (2022). Ryzyka ESG. <https://www.pkobp.pl/relacje-inwestorskie/esg-w-grupie-pko-banku-polskiego/ryzyka-esg/>
- Pollman, E., & Thompson, R. B. (Eds.). (2021). *Research handbook on corporate purpose and personhood*. Edward Elgar.
- Polman, P. (2022, January 24). Critics of “woke” capitalism are wrong. *Financial Times*. <https://www.ft.com/content/34cf61c7-345d-4277-bf18-c1dbdd8a91fc>
- Pyka, I., & Nocoń, A. (2024). Exposure to the ESG risk of the Polish banking sector. *Economics and Environment*, 88(1), Article 701. <https://doi.org/10.34659/eis.2024.88.1.701>
- Raghunandan, A., & Rajgopal, S. (2022). Do ESG funds make stakeholder-friendly investments? *Review of Accounting Studies*. Advance online publication. <https://ssrn.com/abstract=3826357>
- Ramzan, M., Amin, M., & Abbas, M. (2021). How does corporate social responsibility affect financial performance, financial stability, and financial inclusion in the banking sector? Evidence from Pakistan. *Research in International Business and Finance*, 55, 101314. <https://doi.org/10.1016/j.ribaf.2020.101314>
- Rapoza, K. (2020, April 5). How the “woke” capitalists can save America. *Forbes*. <https://www.forbes.com/sites/kenrapoza/2020/04/05/how-the-woke-capitalists-can-save-america/>
- Refinitiv. (2022). *Environmental, social and governance (ESG) scores from Refinitiv*.
- Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal*, 9(1), 86–136. <https://doi.org/10.1177/1536867X0900900106>
- Saidane, D., & Abdallah, S. B. (2020). Sustainability and financial stability: Evidence from European banks. *Economics Bulletin*, 40(2), 1769–1780.
- Scholtens, B. (2009). Corporate social responsibility in the international banking industry. *Journal of Business Ethics*, 86(2), 159–175. <https://doi.org/10.1007/s10551-008-9841-x>
- Serafeim, G. (2021). ESG: Hyperboles and reality. *Harvard Business School Research Paper* (No. 22-031). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3966695
- Serafeim, G. (2022). *Purpose + profit: How business can lift up the world*. Harvard Business Review Press.
- Shakil, M. H., Mahmood, N., Tasnia, M., & Munim, Z. H. (2019). Do environmental, social and governance performance affect the financial performance of banks? A cross-country study of emerging market banks. *Management of Environmental Quality: An International Journal*, 30(6), 1331–1344. <https://doi.org/10.1108/MEQ-08-2018-0155>
- Sjåfjell, B., & Bruner, C. M. (Eds.). (2020). *The Cambridge handbook of corporate law, corporate governance and sustainability*. Cambridge University Press.
- Sorkin, A. R., Karaian, J., Kessler, S., Gandel, S., de la Merced, M. J., Hirsch, L., & Livni, E. (2022, January 18). Larry Fink defends stakeholder capitalism. *The New York Times*. <https://www.nytimes.com/2022/01/18/business/dealbook/fink-blackrock-woke.html>
- United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. <https://sdgs.un.org/2030agenda>
- Van Zanten, J. A., & van Tulder, R. (2021). Improving companies' impacts on sustainable development: A nexus approach to the SDGs. *Business Strategy and the Environment*, 30(8), 3703–3720. <https://doi.org/10.1002/bse.2835>
- Wajahat, A., Hassan, M. K., Houston, R., & Karim, M. S. (2021). ESG activities and banking performance: International evidence from emerging economies. *Journal of International Financial Markets, Institutions and Money*, 70, 101277. <https://doi.org/10.1016/j.intfin.2020.101277>
- Wendt, K. (Ed.). (2015). *Responsible investment banking: Risk management frameworks, sustainable financial innovation and soft law standards*. Springer. <https://doi.org/10.1007/978-3-662-45390-0>
- Wood, D. (2015). What do we mean by the S in ESG? Society as a stakeholder in responsible investment. In T. Hebb, J. P. Hawley, A. G. F. Hoepner, A. L. Neher, & D. Wood (Eds.), *The Routledge handbook of responsible investment* (pp. 553–565). Routledge.
- Yavuz, M. S., Tatli, H. S., Bozkurt, G., & Öngel, G. (2025). Does ESG performance have an impact on financial performance? Evidence from Turkey. *Journal of Entrepreneurship, Management and Innovation*, 21(1), 24–42. <https://doi.org/10.7341/20252112>
- Zakrzewska, B. (2019). Zrównoważony rozwój a jakość życia. *Organizacja i Zarządzanie*, 20(4), 38–41. <https://doi.org/10.24136/atest.2019.113>
- Zhang, D. (2023). Does green finance really inhibit extreme hypocritical ESG risk? A greenwashing perspective exploration. *Energy Economics*, 121, 106688. <https://doi.org/10.1016/j.eneco.2023.106688>

Biographical notes

Irena Pyka is a Full Professor at the University of Economics in Katowice in the Department of Banking and Financial Markets. Her research interests focus on the problems of the functioning of the financial sector, particularly the banking system. Her publications cover a wide range of financial issues, including the unconventional monetary policy instruments

of central banks, their effects on the banking sector and financial markets, central banks' responsibility for financial stability, and the impact of the new regulatory framework on the financing of the economy through bank credit. Currently, she conducts scientific research related to the green financing of economic entities.

Renata Karkowska, Ph.D., is an Associate Professor at the University of Warsaw, Faculty of Management. Her research activities encompass areas such as capital markets, banking, systemic risk, and portfolio management. She is the author of about 100 scientific publications, including papers, chapters, and monographs. Currently, she is a lecturer in bachelor's, master's, and Ph.D. courses. For many years, she has served as a CFA mentor at the University of Warsaw and as a member of the editorial and reviewer boards. She worked with practitioners and experts in the capital market and banking sector.

Aleksandra Nocoń, Ph.D., is an Assistant Professor at the University of Economics in Katowice, Faculty of Finance, Department of Banking and Financial Markets. Her scientific interests and research concentrate mainly on central banking and monetary policy, as well as commercial banking and financial markets. She is very active in her scientific activity, publishing in both Polish and foreign monographs and high-quality scientific journals. She is an author of over 110 scientific publications and monographs. She participated in many international conferences and scientific activities. Her activity has been awarded the Medal of the National Education Commission, the Bronze Medal for Long Service, the Scholarship of the Minister of Science and Higher Education for Outstanding Young Scientists, the InterStar award of the University of Economics in Katowice for her contribution to the University's internationalization of the university, numerous awards of the Rector of the University of Economics in Katowice and Rector's scientific grants.

Authorship contribution statement

Irena Pyka: Conceptualization, Supervision. **Renata Karkowska**: Conceptualization, Data Curation, Formal Analysis, Methodology, Software, Writing – Original Draft Preparation. **Aleksandra Nocoń**: Conceptualization, Literature Review, Writing – Original Draft Preparation, Editing.

Conflicts of interest

The authors declare no conflict of interest.

Citation (APA Style)

Pyka, I., Karkowska, R., Nocoń, A. (2025). ESG activities and their influence on commercial banks' profitability and financial stability. *Journal of Entrepreneurship, Management and Innovation*, 21(4), 54-75. <https://doi.org/10.7341/20252143>

Scientific mapping of environmental, social, and governance (ESG) research from the perspective of stakeholders: A content analysis study

Joanna Błach¹ , Iwona Gorzeń-Mitka² , Małgorzata Lipowicz³ 

Abstract

PURPOSE: The purpose of this study is to illustrate the thematic evolution and intellectual structure of environmental, social, and governance (ESG) research from the perspective of stakeholders through the scientific mapping of 262 articles published over the past five years. **METHODOLOGY:** The study employs various techniques, implemented through SciMat software, including bibliometric analysis, scientific mapping, and content analysis of research documents from Scopus. It aims to examine the intellectual structure of ESG research within the context of a stakeholder perspective and traces its evolution over time. **FINDINGS:** The study reveals specific themes related to stakeholders' perspectives on ESG issues, such as green innovation, disclosure of sustainability goals, and reputational risk. This highlights areas where ESG performance largely depends on stakeholder engagement. Moreover, findings underscore the bidirectional relationship between ESG performance and stakeholders. On one hand, strong ESG performance can enhance value creation for stakeholders. On the other hand, corporate duties, legal regulations, as well as stakeholders' expectations may motivate companies to integrate ESG factors into their business strategies. **IMPLICATIONS:** This study may contribute to the scholarly discourse on ESG research from the stakeholder perspective by mapping its progress, identifying critical gaps, and providing insights that can guide future research. For managers and policymakers, it highlights the multifaceted and interconnected dimensions of ESG, emphasizing its relevance in fostering sustainable development and responsible corporate decision-making. It also underlines the importance of the link between stakeholder engagement and corporate ESG performance, as well as the relevance of ESG reporting. **ORIGINALITY AND VALUE:** This research is the first to map ESG literature (using SciMAT) specifically from a stakeholder perspective. It extends prior work by reorganizing ESG research thematically around stakeholder-relevant concerns and by capturing their evolution during a period of intensified global attention to sustainability. This stakeholder-centric approach offers new insights into the dynamics of ESG discourse and opens valuable directions for future research.

Keywords: environmental, social, and governance (ESG), stakeholder perspective, stakeholder engagement, sustainability reporting, ESG disclosure, corporate social responsibility (CSR), bibliometric analysis, scientific mapping, content analysis, intellectual structure, green innovation, reputational risk, value creation, sustainable development, corporate governance, business strategy, ESG performance, regulatory compliance, ESG evolution, co-word analysis, scientific mapping, sustainability disclosure

1 Joanna Błach, Associate Professor, University of Economics in Katowice, Faculty of Finance, 1 Maja 50, 40-287 Katowice, Poland, e-mail: joanna.blach@uekat.pl (ORCID: <https://orcid.org/0000-0002-6546-2172>).

2 Iwona Gorzeń-Mitka, Assistant Professor, University of Economics in Katowice, Faculty of Finance, 1 Maja 50, 40-287 Katowice, Poland, e-mail: iwona.gorzen-mitka@uekat.pl (ORCID: <https://orcid.org/0000-0002-2844-0054>).

3 Małgorzata Lipowicz, Assistant Professor, University of Economics in Katowice, Faculty of Finance, 1 Maja 50, 40-287 Katowice, Poland, e-mail: malgorzata.lipowicz@uekat.pl (ORCID: <https://orcid.org/0000-0001-8981-7401>).

Received 9 April 2025; Revised 28 July 2025; Accepted 11 September 2025.

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INTRODUCTION

In recent years, environmental, social, and governance (ESG) issues have garnered unprecedented attention across a broad spectrum of academic disciplines and industry sectors (Cai et al., 2024; Khurshid & Islam, 2025). This rising interest is driven by the increasing recognition that traditional financial metrics alone are insufficient to fully capture the complexities of corporate performance and its long-term implications. Stakeholders, including investors, regulators, consumers, employees, and communities, are demanding that organizations adopt more responsible and sustainable business practices (Hazaea et al., 2025). The call for corporate accountability has moved beyond compliance and a niche concern to a central tenet of business strategy, emphasizing the integration of ESG principles to create sustainable value (Helfaya et al., 2023).

The widespread interest in ESG performance reflects a deeper understanding of the interconnectedness between corporate behavior, economic outcomes, societal well-being, and environmental sustainability. As organizations navigate this dynamic landscape, they are increasingly expected to measure, disclose, and improve their ESG activities. This transition is not only a response to stakeholders' pressures and regulatory development but also an acknowledgment of the role ESG plays in generating value, enhancing corporate resilience, innovation, and competitive advantage. Indeed, the growing prominence of the ESG concept in the corporate world has catalyzed a rapid expansion of academic work, exploring the complex relationships between corporate practices, stakeholders' engagement, and the broader socio-ecological environment (Bassetti et al., 2020; Chouaibi et al., 2021; Doś & Pattarin, 2024; Tamasiga et al., 2024).

The complexity of the ESG concept as a research domain is reflected in its heterogeneous literature, encompassing diverse conceptualizations, frameworks, and empirical methodologies (Husted & Sousa-Filho, 2019). Scholars have approached ESG from multiple vantage points, ranging from corporate ethical duties and legal compliance to its impact on financial performance and investment strategies, as well as its role in shaping corporate reputation, risk management, innovation, and stakeholders' trust. In particular, the discussion on the link between ESG and financial performance is still open, as various research provides different results, which is explained by the country-level factors, industry characteristics, governance structures, or by the heterogeneity in ESG performance measurement and reporting (Lassala et al., 2021; Rahi et al., 2023).

Among these perspectives, a growing body of research has emphasized the stakeholder dimension, investigating how both internal and external actors influence and are influenced by ESG-related decisions and outcomes (Chouaibi et al., 2021; Mori et al., 2013). This stakeholder-centric approach highlights the interconnectedness of corporate actions and the expectations of various constituencies, underscoring the need for companies to align their ESG strategies with the interests of their stakeholders.

As the field of ESG research continues to expand, the need for systematic and structured analyses becomes increasingly apparent. Such analyses can synthesize prevailing themes, identify emerging patterns, and provide guidance for future research directions (Bakar et al., 2019). While the body of literature on ESG issues has proliferated significantly over the past five years, relatively few studies have attempted to systematically map its intellectual structure within the context of stakeholder perspectives (Gao et al., 2021; Marzuki et al., 2023). Addressing this gap, the present study employs a combination of bibliometric techniques and content analysis to provide a scientific mapping of ESG research from a stakeholder perspective (Ellili, 2022; Marzuki et al., 2023).

This study aims to uncover key thematic clusters, influential scholarly contributions, and intellectual trajectories that have shaped the discourse on ESG. By doing so, it seeks to bridge the gap between the rapidly evolving literature and the practical needs of organizations striving to integrate ESG considerations into their decision-making processes. The rationale for adopting a stakeholder lens is grounded in the recognition that corporate sustainability is not solely driven by intrinsic corporate values, ethical duties, or regulatory compliance. Instead, it is profoundly shaped by the interactions and expectations of diverse stakeholders' groups, whose interests often intersect and evolve over time (Joshi & Dash, 2023; Saini, 2023).

Focusing on the stakeholder perspective enables a deeper understanding of the relational dynamics that underpin corporate ESG practices. This lens illuminates how organizations navigate complex stakeholder relationships, balance competing demands, and prioritize ESG initiatives that align with stakeholders' interests. It also sheds light on how these interactions influence corporate behavior, decision-making, and performance over time (Christianna, 2023; Joshi & Dash, 2023; Saini, 2023). By mapping the intellectual structure of ESG research, this study contributes to a more nuanced understanding of the field, providing valuable insights for academics, practitioners, and policymakers alike. In this

context, the paper falls into the stream of literature on ESG corporate actions and its integration with the stakeholder theories: the original stakeholder theory developed by Freeman (Freeman, 1984), the resource dependence theory (Pfeffer & Salancik, 1978), the stakeholder salience theory (Mitchell et al., 1997), the paradox theory (Pinto, 2019) and the dynamic stakeholder ecosystems (Windsor, 2010).

The present study aims to advance the ESG discourse by systematically examining its development from a stakeholder perspective. This approach not only enhances our understanding of how organizations engage with their stakeholders (often with conflicting demands) but also highlights the broader implications of ESG practices for sustainable value creation, societal well-being, and environmental stewardship.

The primary objective of this paper is to conduct a comprehensive analysis of the existing body of knowledge in the research field of Environmental, Social, and Governance (ESG) performance, with a specific focus on understanding it from the perspective of various stakeholders. By examining the evolution and current state of the ESG research landscape, this study aims to provide a comprehensive understanding of the field's theoretical and practical foundations, as well as to identify emerging trends and critical issues that are shaping its trajectory. In line with this objective, the study addresses the following key research questions (RQs):

RQ1: What is the current status of ESG research from the perspective of stakeholders?

RQ2: What are the key concepts (keywords) that define the field of ESG research from the perspective of stakeholders?

RQ3: What emerging trends and issues is the field of ESG research evolving toward from the perspective of stakeholders?

RQ4: What are the most relevant issues and turning points in the evolution of ESG research from the perspective of stakeholders?

By addressing these questions, the paper aims to contribute to the scholarly discourse on ESG research from the stakeholder perspective, mapping its progress, identifying critical gaps, and providing insights that can guide future research and practice. Through its stakeholder-focused perspective, the study highlights the multifaceted and interconnected dimensions of ESG, emphasizing its relevance in fostering sustainable development and responsible corporate decision-making.

The rest of this paper is structured as follows. The next section presents the theoretical framework of the study. Section three describes the applied methodology and functionality of SciMAT software. Section four presents the results of a scientific mapping, section five includes a discussion, and the final section concludes the study.

THEORETICAL BACKGROUND

ESG performance and its significance for corporate success

Although ESG-related issues have been extensively discussed over recent decades in both business practice and academia, many topics still require further investigation. Firstly, as supported by an extensive body of research, ESG performance plays a critical role in corporate performance (Awaysheh et al., 2020; Henriques et al., 2022; Vishwanathan et al., 2019; Wang, 2024). However, the nature of the relationship between ESG performance and firm performance remains a subject of ongoing debate (Lassala et al., 2021; Rahi et al., 2023). In this study, we align with the predominant research stream that posits a positive link between ESG and firm performance, as explained by theories such as the Social Impact Hypothesis and the Reputation-building Hypothesis. These are supported by many empirical studies, including the meta-analysis by Friede et al. (2015). Firms that adopt corporate social responsibility (CSR) policies — a foundational element of ESG — consistently demonstrate superior financial outcomes compared to their counterparts. Studies reveal that firms focusing on ESG achieve better short-term financial results, as illustrated by profitability ratios: ROE and ROA, as well as long-term performance as measured by market ratios: Tobin's Q or Market-to-Book value (M/BV) (Błach et al., 2025; Henriques et al., 2022; Yavuz et al., 2025). The mechanisms driving this positive relationship include operational efficiencies, risk mitigation, innovation, enhanced stakeholder relationships, and improved access to resources (Guan et al., 2023; Wang et al., 2024). Studies showing a negative relationship between ESG and firm performance are relatively rare. When such negative impacts are identified, they are often attributed to the substitution hypothesis and the short-term costs incurred by ESG actions, which may only yield benefits in the long run (Lassala et al., 2021).

The positive association between strong ESG and financial performance stems from several factors. ESG initiatives enhance brand reputation, foster customer loyalty and employee engagement, differentiate products and services, leading to higher sales revenues. ESG practices also signal effective management and a commitment to social and environmental responsibility, which attract investors who incorporate ESG criteria into their investment decisions, thereby elevating firm valuation and stakeholder trust (Awaysheh et al., 2020; Vishwanathan et al., 2019). Furthermore, ESG strategies contribute to increased operating effectiveness, improved risk management, innovation and better access to capital, collectively enhancing corporate performance and sustainable growth (Wang et al., 2024).

Secondly, the ESG performance is multifaceted, encompassing diverse environmental, social, and governance activities. On the environmental (E) front, initiatives include energy efficiency, waste management, and the circular economy, as well as emissions reduction, biodiversity protection, and the adoption of renewable energy (Guan et al., 2023). The social dimension (S) encompasses employee welfare and health, diversity, equity, and inclusion, community engagement, product responsibility, customer well-being, labor practices, and human rights (Naheed et al., 2021; Nguyena et al., 2020; Uyar et al., 2020). Governance-related efforts (G) focus on board composition and independence, executive compensation, shareholder rights and stakeholder engagement, risk management, ethical business practices, compliance, decision-making transparency, and reporting (Gharbi & Jarboui, 2023; Rashid et al., 2020; Zhang, 2022).

The emphasis on specific ESG dimensions varies by industry and region. For instance, environmental and social priorities are prominent in tourism and hospitality, while governance aspects are pivotal in finance (Gangi et al., 2019; Nguyena et al., 2020). Additionally, a country's regulatory environment and ownership structures influence ESG priorities (Akben-Selçuk, 2019; Gharbi & Jarboui, 2023; Zhang, 2022). Miralles-Quirós et al. (2019) found that ESG performance has a positive impact on firm market value; however, investors may value it differently depending on the ESG pillar and the type of industry. For example, environmental performance is positively linked to the market value of firms from the non-environmental sensitive industries, while social and governance practices are positively assessed in these sensitive industries. Moreover, the study by Giese et al. (2021) demonstrated that the duration of the financial impact of specific ESG pillars varies: E and S factors tend to have long-term financial effects, while G actions are more critical in the short-term perspective.

Finally, researchers assess ESG performance using various metrics. ESG scores from providers such as Thomson Reuters, Bloomberg, and MSCI are widely used to comprehensively evaluate companies across environmental, social, and governance domains (Partalidou et al., 2020). However, they use various methodologies for these indices, which limits the comparability of results. Disclosure of CSR initiatives and financial investments in ESG activities serve as alternative measures (Naheed et al., 2021; Rashid et al., 2020). Some studies employ specific indicators, such as energy consumption and employee diversity, to capture distinct ESG dimensions (Jiang et al., 2018; Nikolaou et al., 2019). Other researchers construct tailored, aggregated ESG indexes, focusing on selected aspects of ESG performance relevant to the analyzed firms (Błach et al., 2025; Dočekalová & Kocmanová, 2016; Matuszewska-Pierzynka et al., 2023; Partalidou et al., 2020). Traditional performance metrics are also modified to illustrate ESG performance. Adopted metrics include: the Sustainable Balanced Scorecard (SBSC) (Figge et al., 2002; Kaplan & McMillan, 2021), the modified DuPont model (Shan et al., 2024), or the Economic Value Added (EVA) model expanded to incorporate ESG factors enhancing the value creation process (Sanga & Situmorang, 2024). The main framework for sustainability reporting is provided by the GRI (Global Reporting Initiative), which helps companies present their ESG performance in a transparent and comparable manner. Other disclosure guidelines are provided by the Sustainability Accounting Standards Board (SASB) or ISO 26000. Depending on the country and firm characteristics, ESG reporting may be voluntary or mandatory, utilizing various reporting standards and guidelines (e.g., the CSRD Directive in the European Union). ESG disclosure increases a firm's transparency and may build trust capital, but it also requires professional expertise and generates costs. Another concern stems from the risk of greenwashing (Ruiz-Blanco et al., 2022), where exaggerated, superficial, or selective ESG efforts reported by a company may damage the reputation and trust of the management team. These factors underscore the complexity and heterogeneity in ESG research and disclosure practices, which can yield mixed results across studies and sectors.

The literature highlights the strategic importance of ESG practices in enhancing corporate performance. ESG initiatives not only bolster competitiveness and financial success but also address broader social and environmental objectives, making them integral to contemporary business strategy.

Stakeholder theory and stakeholder relevance to corporations

The stakeholder theory developed by R.E. Freeman in 1984 has been a cornerstone of economic and management literature, underscoring the importance of incorporating the perspectives and needs of various stakeholders into corporate decision-making processes (Freeman, 1984). Unlike traditional shareholder-centric models, which prioritize maximizing shareholder value, the stakeholder theory advocates for a broader approach that takes into account the interests of all stakeholders impacted by organizational actions (Babiak & Kihl, 2018; Signori & Fassin, 2023; Sonjaya, 2024).

However, various explanations exist for the necessity of effective stakeholder management (Donaldson & Preston, 1995; Freeman et al., 2010; Lazzarini, 2025). The normative stakeholder theory focuses on the moral and ethical obligations of a company towards its stakeholders and is linked to philosophical concepts. The interests of all stakeholders are of intrinsic value and should be respected by a company, because it is its fundamental duty, regardless of its economic or financial consequences (Donaldson & Preston, 1995; Freeman, 1984). In contrast, the instrumental stakeholder theory (Jones, 1995) views stakeholder management as a means to achieve corporate objectives, including financial ones. Stakeholder engagement is a crucial tool, as it benefits a company by helping to achieve long-term goals, improving its reputation, and enhancing financial performance (Lazzarini, 2025; Porter & Kramer, 2006). Another approach is offered by the empirical (descriptive) stakeholder theory, which aims to understand how companies actually organize their relationships with multiple stakeholders, how they consider stakeholders' needs and expectations in their decision-making process, and how they regard the power and importance of these stakeholders for the company (Mitchell et al., 1997). Finally, the integrative stakeholder theory attempts to combine the normative, descriptive, and instrumental perspectives by recognizing the ethical imperatives and simultaneously appreciating the strategic importance of stakeholders in achieving objectives and driving business success (Klara, 2024).

Stakeholders, as defined by Freeman, include „any group or individual who can affect or is affected by the achievement of the organization's objectives” (Sonjaya, 2024). Stakeholders are also defined as various groups whose support is crucial for an organization's survival and development (Donaldson & Preston, 1995). Stakeholders are diverse and can be categorized into two main groups: internal and external. Internal stakeholders include employees, managers, and board members who are directly involved in the organization's operations. External stakeholders, on the other hand, comprise customers, suppliers, investors, governments, and the broader community, all of whom interact with the organization outside its formal structure (Cheshmberah, 2020; Derakhshan et al., 2019; Macassa et al., 2021). These stakeholders create a dynamic and complex ecosystem that shifts over time (due to various factors: learning, values, competition, sustainable development, creative disruption, value creation, etc.) (Windsor, 2011) and requires constant monitoring and adaptation to changing needs and expectations. The stakeholder ecosystem, as well as the company itself, respond also to institutional shifts, due to changes in legal regulations, social norms, values, and pressures. As explained by the resource dependence theory (Pfeffer & Salancik, 1978), stakeholders provide companies with the required resources (tangible or intangible), which are critical for survival and success, in exchange for benefits (both financial and non-financial). To secure access to these resources, a firm must effectively manage its relationships with stakeholders. A study by Wagner Mainardes et al. (2012) found that relevance, mutual influence and participation are key variables in explaining the organization and stakeholder relationship. Additionally, the stakeholder salience theory (Mitchell et al., 1997) explains the attributes of stakeholders, such as power, legitimacy, proximity, and urgency, which result in varying priorities for different groups of stakeholders. Consequently, a company must implement holistic and dynamic strategies that balance multiple objectives to manage stakeholder relationships effectively and create value.

Each group of stakeholders has distinct expectations that influence their interactions with the organization. Employees typically expect fair compensation, job security, opportunities for professional growth, and a safe working environment. Their satisfaction often translates into higher productivity and organizational loyalty (Macassa et al., 2021). Customers prioritize the delivery of high-quality goods and services at competitive prices. Customer satisfaction drives brand loyalty and market competitiveness (Alabdullah, 2023), resulting in increased sales growth. Suppliers value reliability in payments, transparency in dealings, and long-term contractual relationships that offer mutual benefits (Ghezal, 2024). Maintaining good relationships with suppliers is crucial to the company's ability to sustain its operations, maintain financial liquidity, and deliver high-quality products and services. Investors are primarily focused on the rate of return and level of risk associated with the capital they provide to businesses; however, it is observed that their role is evolving in the context of sustainable development (Ruiz et al., 2021). Communities and governments expect organizations to act as responsible corporate citizens, contributing to societal well-being through sustainable practices, philanthropy, and adherence to regulatory standards (Babiak & Kihl, 2018).

This stakeholder polyphony, reflected in the varied and sometimes conflicting interests of stakeholders, creates challenges for organizations. Shareholders, for instance, may prioritize short-term financial returns and dividend payments, which can conflict with the long-term interests of employees, who may value job stability, or communities, which might emphasize sustainability and environmental responsibility (Harrison et al., 2019; Signori & Fassin, 2023; Sonjaya, 2024). Similarly, customers' demands for cost efficiency could clash with employees' expectations for higher wages or suppliers' needs for fair pricing. Moreover, Carney et al. (2011) highlighted the importance of intra-stakeholder conflict, which is often neglected but may have a crucial impact on corporate performance.

These conflicts, if not effectively managed, can disrupt organizational harmony and performance. The paradox theory indicates that these tensions and contradictions, as inherent elements of the organizational system, should be managed dynamically to enhance resilience, innovation, and sustainable performance. It suggests treating such conflicts as a source of strategic advantage rather than a problem that should be eliminated (Pinto, 2019). Research has highlighted the importance of proactive conflict resolution strategies to mitigate the negative effects of these competing interests (Bahadorestani et al., 2020; Cheshmberah, 2020; Derakhshan et al., 2019). To address these challenges, organizations must adopt a strategic approach to stakeholder engagement. Continuous dialogue with stakeholders is crucial for understanding their concerns and aligning organizational objectives with stakeholder expectations. Key strategies for managing stakeholder relationships include: fostering trust and reducing misunderstandings by open and honest communication (Babiak & Kihl, 2018; Estaswara, 2020); adopting ethical practices to ensure fairness and integrity in the decision-making, balancing the competing needs of different stakeholder groups (Aguinis et al., 2019; Alabdullah, 2023); embedding CSR initiatives into business practices to address societal and environmental concerns while creating shared value for stakeholders (Ghezal, 2024).

When organizations effectively manage stakeholder relationships, they achieve multiple benefits. These include enhanced accountability, improved trust, strengthened relationships, and access to crucial resources, which collectively contribute to long-term organizational success. Moreover, research indicates that aligning stakeholder interests with organizational goals enhances performance and sustainability over time.

However, there are complexities in these interactions. Studies have shown that stakeholders may not always respond positively to ethical organizational behavior. For example, gaps may exist between stakeholders' declared ethical intentions and their actual actions, creating challenges for organizations aiming to implement and communicate ethical practices effectively.

The stakeholder theories provide a vital framework for understanding the dynamics of stakeholder relationships and their relevance to corporate success. Managing these relationships requires a nuanced approach that considers the unique expectations and potential conflicts among various stakeholder groups. By fostering transparent communication, making ethical decisions, and integrating CSR into their core strategies, organizations can navigate these complexities to create value for all stakeholders. Ultimately, balancing the interests of stakeholders is not merely an ethical imperative but a strategic necessity for achieving sustainable growth and long-term success (Harrison et al., 2019; Signori & Fassin, 2023; Sonjaya, 2024).

ESG performance and stakeholder perception

A growing body of evidence suggests that companies with strong environmental, social, and governance (ESG) performance are better positioned to engage with stakeholders and address their diverse and changing needs and concerns (Dasinapa, 2024; Kulova & Nikolova-Alexieva, 2023). This capability stems from the integration of ESG principles into corporate decision-making, which encourages transparency, inclusivity, sustainability, and accountability. By actively involving stakeholders — such as investors, customers, suppliers, employees, and community members — in decision-making processes and seeking their input, companies can access valuable insights that support the development of more responsible and sustainable business practices (Dasinapa, 2024; Kulova & Nikolova-Alexieva, 2023; Tan, 2024). By engaging stakeholders in the ESG integration process, a company can better identify material ESG issues, address conflicting interests and needs, and ultimately align corporate actions with stakeholders' expectations. Stakeholders' engagement requires active collaboration during the entire process of ESG integration, with the major elements: precise identification and mapping of key stakeholders, defining objectives and priorities, formulating ESG strategy, taking specific ESG actions, interactive bidirectional communication about ESG actions together with feedback analysis and strategy modification, unified and standardized ESG reporting and performance measurement. Stakeholders' engagement in the ESG integration process results in a shift in business orientation, from short-term profit maximization to a long-term value creation objective.

The successful integration of ESG processes may be enhanced by an integrative approach, where ethical values and responsibilities form the foundation for strategic stakeholder management, aiming at genuine business transformation.

This participatory approach not only strengthens trust and collaboration between companies and their stakeholders but also enhances the alignment of corporate objectives with societal expectations. Zumente Bistrova (2021) analyzed how ESG performance may improve the value-creation process. They found that both financial and non-financial factors related to ESG performance are important for long-term value, including reputation, stakeholder trust and employee satisfaction. However, as suggested by Calabrese et al. (2012), the final evaluation of corporate sustainable initiatives depends on stakeholder perception, which is a key factor in the ESG assessment process. This perception may be influenced by ESG communication and reporting, as well as by stakeholder relationship management.

The increasing prioritization of ESG considerations by stakeholders highlights their growing awareness of the long-term value generated by responsible corporate behavior. For instance, investors are more likely to support companies that demonstrate a commitment to sustainability, recognizing that such companies are better equipped to manage risks and capitalize on emerging opportunities in an evolving global market (Kim & Li, 2021; Shakil et al., 2019; Shen, 2024). This approach is illustrated by the increasing value of assets classified as SRI (sustainable and responsible investments). Similarly, customers increasingly favor brands that align with their values, particularly in terms of environmental stewardship and social responsibility.

Despite the evident advantages, the relationship between ESG performance and stakeholder perceptions is complex and multifaceted. Some studies suggest that the benefits of strong ESG performance, such as improved corporate reputation and stakeholder trust, may take considerable time to translate into measurable financial gains (Tang, 2020). Moreover, the impact of ESG initiatives is influenced by various contextual factors, including the legal and institutional environment, industry characteristics, corporate governance structures, and the specific ESG metrics being evaluated (Clementino & Perkins, 2021; Miralles-Quirós et al., 2019). For example, in industries with high environmental risks, stakeholders may prioritize environmental performance more heavily than social or governance criteria, whereas in other sectors, social dimensions such as diversity and labor practices may carry greater weight. Similarly, variations in institutional frameworks across regions can affect how stakeholders perceive and value corporate ESG efforts. Various groups of stakeholders may value the outcomes of specific ESG actions differently. For example, local communities may pay more attention to environmental aspects, while employees may be more focused on social factors, and ultimately, investors may require higher-quality governance structures, transparency, and corporate reporting.

Furthermore, some researchers have noted that ESG performance alone cannot fully explain variations in stakeholder perceptions and corporate outcomes. Factors such as a company's communication strategies, historical performance, and alignment with stakeholder values can significantly influence how ESG initiatives are received and evaluated (Tang et al., 2020). This underscores the need for companies not only to implement strong ESG practices but also to effectively communicate their efforts and maintain consistent engagement with their stakeholders.

While stakeholder-related aspects of ESG have been addressed in numerous conceptual and empirical studies — as demonstrated above — existing research remains fragmented and limited to specific contexts or stakeholder groups. Despite the growing relevance of stakeholder issues in ESG scholarship, a systematic mapping of the literature from this perspective has not been conducted. In response to this gap, the present study examines how stakeholder-related issues are represented and interconnected within ESG research. Using SciMAT as a bibliometric mapping tool, the study traces the thematic evolution and intellectual structure of this body of work over the past five years. By mapping ESG literature around stakeholder-relevant concerns, it offers a novel analytical perspective. This stakeholder-centric approach offers a more comprehensive view of ESG discourse and provides a structured foundation for advancing future research in the field.

METHODOLOGY

Research design

This study employs a multidimensional approach to examine ESG research from the perspective of stakeholders, utilizing a concept mapping framework – a recognized method for visualizing conceptual structures and relationships. Various tools and methods are utilized in the analysis. Initially, abstracts and citations were sourced from major databases of peer-reviewed scientific publications, with Scopus being the primary focus due to its extensive indexing of journals in management, economics, and finance, surpassing databases like Web of Science. Although this study is based exclusively

on Scopus-indexed publications, this choice is methodologically justified and consistent with the exploratory nature of the research. Scopus is widely recognized as one of the most comprehensive abstract and citation databases, particularly suitable for interdisciplinary fields such as ESG research. According to Mongeon and Paul-Hus (2016), Scopus provides approximately 66% broader journal coverage compared to Web of Science (WoS), and includes nearly 99% of the journals indexed in WoS. Moreover, Archambault et al. (2009) demonstrated that bibliometric indicators such as publication volume and citation counts are highly correlated between WoS and Scopus. This suggests that structural and thematic bibliometric results are largely robust to the choice of database. Since the objective of this study is not to evaluate citation impact but to map thematic and intellectual structures within ESG literature, Scopus provides a sufficient and appropriate basis for the analysis.

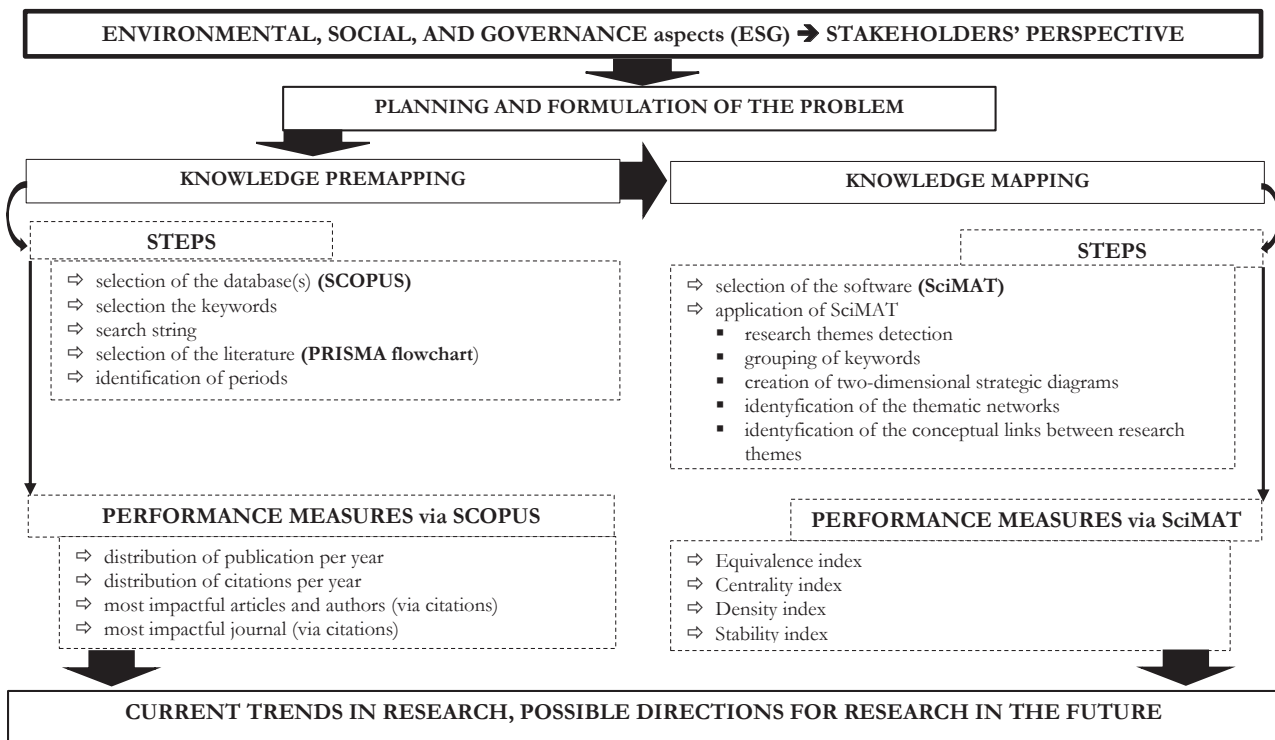


Figure 1. ESG research from the perspective of stakeholders – research map

Figure 1 presents a conceptual map of bibliometric analysis of ESG research from a stakeholders' perspective. To capture recent trends and ensure the relevance of the findings, this study limited its bibliometric analysis to articles published within the past five years (2020–2024). This time frame was deliberately chosen due to several converging developments that have significantly reshaped the environmental, social, and governance (ESG) research landscape. First, the period marks a turning point in global ESG regulation and disclosure practices – in particular, the introduction and enforcement of frameworks such as the EU Sustainable Finance Disclosure Regulation (SFDR) in 2019, and the Corporate Sustainability Reporting Directive (CSRD) in 2021 (Busch & Friede, 2018; European Commission, 2025). Second, the COVID-19 pandemic (2020–2021) triggered a major re-evaluation of corporate responsibility. It brought ESG issues — particularly those related to social sustainability and stakeholder welfare — to the forefront of public and academic discourse, highlighting the need for firms to respond effectively to stakeholder expectations in times of crisis (Adigwe 2025; Amel-Zadeh & Serafeim, 2018). Third, bibliometric studies confirm a steep rise in ESG-related scholarly publications during this period. This reflects a maturing field, as evidenced by Khurshid and Islam (2025), and Wan et al. (2023). Lastly, selecting a recent five-year window ensures that the analysis captures the most current dynamics, making the insights more relevant and actionable for both researchers and practitioners in a rapidly evolving ESG landscape (George et al., 2021).

The search targeted relevant articles by screening keywords in the following steps. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2020) were applied in conducting the search, which centered on terms like „ESG” OR „environmental, social, and governance „AND „stakeholder*””. The data collected

was then analyzed using SciMAT (v1.1.04), a specialized scientific mapping software. Although several tools are available for bibliometric mapping, the SciMAT software was selected due to its specific suitability for the analytical objectives of this study, namely, to explore not only the intellectual structure but also the thematic evolution of ESG research from a stakeholder perspective over time. SciMAT is less commonly used than other bibliometric mapping tools such as VOSviewer, CiteSpace, and Bibliometrix (Gorzeń-Mitka & Wiczorek-Kosmala, 2023; Tomaszewski, 2023), but it proves particularly advantageous for tracking research development over time. SciMAT stands out for its open-access availability and offers unique database preprocessing capabilities, including deduplication, time slicing, stop words, and data editing (Moral-Muñoz et al., 2020). SciMAT is specifically designed for science mapping analysis with a longitudinal dimension, offering a unique combination of features that are critical to our research goals. As detailed by Moral-Muñoz et al. (2020), SciMAT offers a fully integrated workflow that spans from data preprocessing to mapping and visualization, ensuring consistency and transparency. More importantly, SciMAT enables the construction of strategic diagrams based on two key dimensions — centrality and density — which allows for the identification of motor themes, emerging topics, and underdeveloped areas (Cobo et al., 2011). These capabilities are especially relevant for a dynamic and multidimensional research field such as ESG, where stakeholder views evolve and interact over time. By contrast, while VOSviewer excels in generating co-authorship and co-citation networks, it lacks integrated tools for analyzing thematic evolution. Similarly, Bibliometrix — though flexible — requires additional coding and does not offer a strategic mapping function or temporal theme tracking in the same structured way. Moreover, SciMAT has been effectively applied in a number of studies (e.g., Cai et al., 2024; Cobo et al., 2012; Burbano et al., 2024), validating its robustness in handling research topics that require both structural and temporal bibliometric analysis.

Notably, this study emphasizes knowledge mapping as a distinct approach from traditional systematic literature reviews. The applied scientific mapping techniques include co-citation analysis, co-expression analysis, and the study of collaborative networks, enabling a detailed representation of the scientific landscape (Cobo et al., 2011; Gonzales-Aguilar, 2023). These visual mappings reveal complex relationships and trends in the field, helping identify key areas and future research paths (Cobo et al., 2012; Martins et al., 2022).

Data collection

Figure 2, featuring a PRISMA flow diagram, depicts the steps taken to construct a knowledge base on ESG research from the stakeholders' perspective.

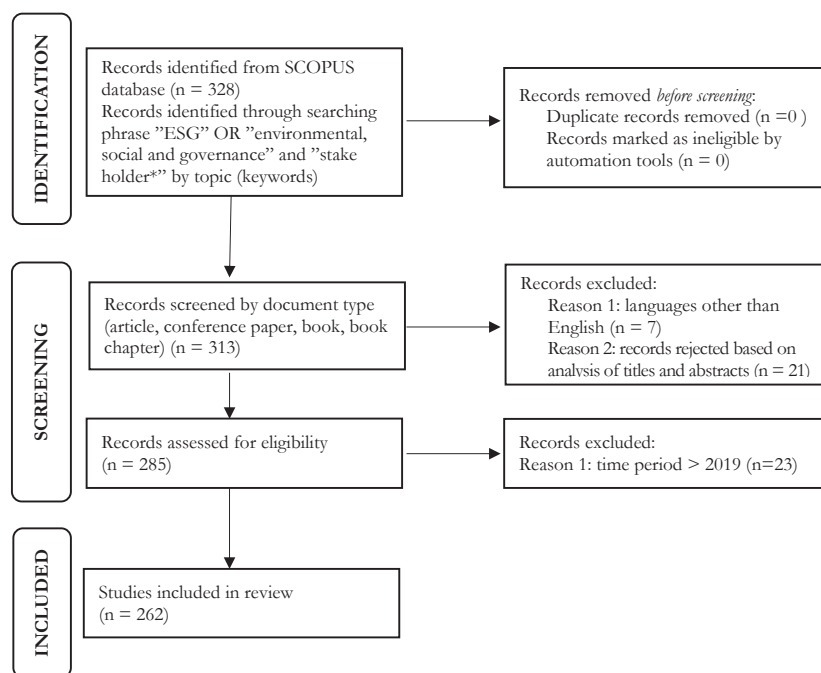


Figure 2. ESG research from the perspective of stakeholders – PRISMA flowchart

An initial search, conducted in October 2024, yielded 328 documents. Selection criteria, as outlined in Figure 2, guided the inclusion of documents for further review. Ultimately, after a detailed screening process, data from 262 scientific papers was analyzed to map knowledge on ESG and stakeholders. We searched the Scopus database using the following search query: (KEY (ESG) OR KEY („environmental, social and governance”) AND KEY (stakeholder*)) AND PUBYEAR > 2019 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE, „ar”) OR LIMIT-TO (DOCTYPE, „ch”) OR LIMIT-TO (DOCTYPE, „cp”) OR LIMIT-TO (DOCTYPE, „bk”)) AND (LIMIT-TO (LANGUAGE, „English”)) AND (LIMIT-TO (PUBSTAGE, „final”)).

Knowledge pre-mapping methodology

In the pre-mapping phase, the prepared dataset was subjected to a temporal and citation analysis with the application of tools available in the SCOPUS database. This helps to assess the research productivity and citability over time (number of publications and citations in a specific period) and to identify the most important authors and articles.

Knowledge mapping methodology

In the principal mapping phase, the acquired dataset was analyzed using the dedicated scientific mapping software SciMAT (v1.1.04), which is an open-source software tool developed to perform science mapping analysis within a longitudinal framework (Cobo et al. 2011, 2012, 2018; Moral-Muñoz et al. 2020). The use of specialized software to explore and map large datasets is becoming increasingly common among researchers in all fields of science. They are used to analyze the state of research in a field, identify and track directions for its evaluation, and search for knowledge gaps and potential directions for new research. The motivation for this choice was the data processing capabilities and functionality of SciMAT. In particular, it is worth emphasizing that SciMAT is the only software of its kind currently available for evolutionary research. Furthermore, it contains the widest range of functions in terms of pre-processing options (available methods for deduplication process, time cutting, stop words and data editing) (Moral-Muñoz et al., 2020). The software enables the analysis of a given research area, as well as the detection and visualization of its conceptual subdomains (specific themes or general thematic areas), and the representation of the thematic evolution of the analyzed research area (Cobo et al., 2018). A detailed description of the functionality of the different SciMAT modules and algorithms can be found in Cobo et al. (2012). Although SciMAT provides robust tools for bibliometric analysis and scientific mapping (Cobo et al., 2012), it is important to recognize the limitations of its methodology. The tool is highly sensitive to keyword variability. The quality of co-word analysis depends heavily on the consistency, specificity, and semantic clarity of the keywords used throughout the dataset. To address this, a manual normalization process was employed to unify synonyms, harmonize variant spellings and abbreviations, and remove redundant or overly generic terms. This aligns with the recommended data refinement practices for bibliometric research (Donthu et al., 2021). In this study, the co-word occurrence threshold was deliberately set to zero to ensure the inclusion of all potential conceptual linkages, including those based on single co-occurrences. This decision aimed to capture weak but potentially meaningful or emerging thematic connections, which are particularly relevant in a complex, evolving, and multidisciplinary research field such as ESG from the stakeholder perspective. While prior studies suggest applying minimum thresholds (e.g., ≥ 3 or ≥ 5) to reduce noise (Callon et al., 1991), setting the threshold to zero was justified by the exploratory nature of this study, its limited time span (five years), dataset size (262 articles), and the aim of identifying niche or peripheral themes that may not yet be well established. The increased risk of including spurious associations was mitigated by rigorous data cleaning and keyword normalization, in line with best practices for bibliometric analysis (Donthu et al., 2021). Despite SciMAT's built-in deduplication features, there is still a risk of data duplication due to inconsistencies in author names, article titles, or journal metadata. A manual review and cleaning process was therefore conducted prior to analysis to address these issues and ensure the reliability of the dataset (Öztürk et al., 2024). The approach, following Cobo et al. (2018), consists of four steps (Figure 1) and employs various measures (Table 1).

Table 1. Mapping measures

Steps	Measures	Formula	Interpretation
1	Centrality measure	$c = 10 * \Sigma e_{uv}$ <p>Where: c – centrality u – an item belonging to the cluster v – an item belonging to other clusters</p>	c – assesses the external coherence of the network by measuring the degree to which the network interacts with other networks In its raw form, c has no fixed upper limit because it grows with the number and strength of connections (Σe_{uv}) after normalization, c is scaled between 0 and 1: • 0 – the cluster is completely isolated from other clusters (no inter-cluster connections) • 1 – maximum interaction, meaning all connections of the cluster lead to nodes in other clusters
2	Density measure	$d = 100 \frac{\Sigma e_{ij}}{n}$ <p>Where: d – density i, j – items belonging to the cluster n – the number of items in the theme</p>	d – assesses the internal coherence of the network by measuring its internal strength It ranges from 0 to 100: • higher values, greater coherence or stronger interconnectedness within the network • 0 – there are no connections between items in the cluster, a lack of internal coherence • 100 – a fully connected network, every item is directly linked to every other item (maximum internal strength)
3	Equivalence index	$E_{ij} = \frac{C_{ij}^2}{C_i * C_j}$ <p>Where: E_{ij} – the equivalence index i, j, ... – keywords C_i – the number of occurrences of the keyword i C_j – the number of occurrences of the keyword j C_{ij} – the number of co-occurrences of the keywords i and j</p>	E – identifies the similarity between keywords It ranges from 0 to 1: • 0 – no co-occurrence (no similarity) between the two keywords • 1 – perfect similarity, whenever one keyword occurs, the other always does as well
4	Stability index	$S_{ij} = \frac{n_{t_1 t_2}}{n_{t_1} + n_{t_2} - n_{t_1 t_2}}$ <p>Where: S_{ij} – the stability index t₁, t₂, ... – periods n_{t1} – the number of keywords related to period t₁ n_{t2} – the number of keywords related to period t₂ n_{t1t2} – the number of keywords shared by periods t₁ and t₂</p>	S – assesses the degree of stability between two consecutive periods It ranges from 0 to 1: • the closer to 1, the more consistent and stable the thematic elements are over time • 0 – complete instability, where there are no shared keywords between the two periods, a lack of continuity in thematic or conceptual focus • 1 – complete stability, all keywords from t ₁ are retained in t ₂ and vice versa, full thematic consistency across the periods

Source: Own elaboration based on Callon et.al (1991); Cobo et al. (2011).

The strategy diagram visualizes the thematic clusters generated by SciMAT's bibliometric analysis. Our interpretive framework is grounded in the works of Cobo et al. (2011, 2012). According to these sources, the strategic diagram used in SciMAT classifies themes based on two key dimensions: centrality (the degree of interaction with other themes) and density (the internal development of the theme). This results in the identification of four quadrants, each corresponding to a specific type of thematic role in the structure of the field: (1) motor themes (upper-right quadrant) exhibit high centrality and high density. These are both conceptually developed and structurally important themes, which drive the intellectual development of the field; (2) highly developed but isolated themes (upper-left quadrant) have strong internal cohesion (high density) but weak external ties (low centrality), indicating specialization or marginal relevance to the broader field; (3) emerging or declining themes (lower-left quadrant) are weak in both dimensions and are interpreted as either nascent research directions or areas losing relevance; (4) basic and transversal themes (lower-right quadrant), are characterized by high centrality but low density; these themes connect to multiple other themes but are not yet internally developed. Each sphere represents a theme, which is a keyword (main topic or concept) derived from the bibliographic data. Larger spheres indicate themes with higher citability (in our case) in the dataset. Larger (more important and significant) balls (themes) are generally more central; smaller (indicating niche or emerging topics) balls (themes) are more diffused and reflect their nascent status.

RESULTS

Pre-mapping phase

The initial phase of the study involved conducting a bibliometric performance analysis. Metadata were pre-processed using the Scopus platform's bibliometric tools, allowing for an assessment of annual publication and citation trends (as shown in Figure 3). Figure 3 displays the yearly count of published articles, with a dashed line indicating citation counts. Research on ESG topics from the perspective of stakeholders first appeared in 2009, after which the number of publications steadily increased. Over the last five years, there has been a significant rise in both publication and citation numbers on this subject.

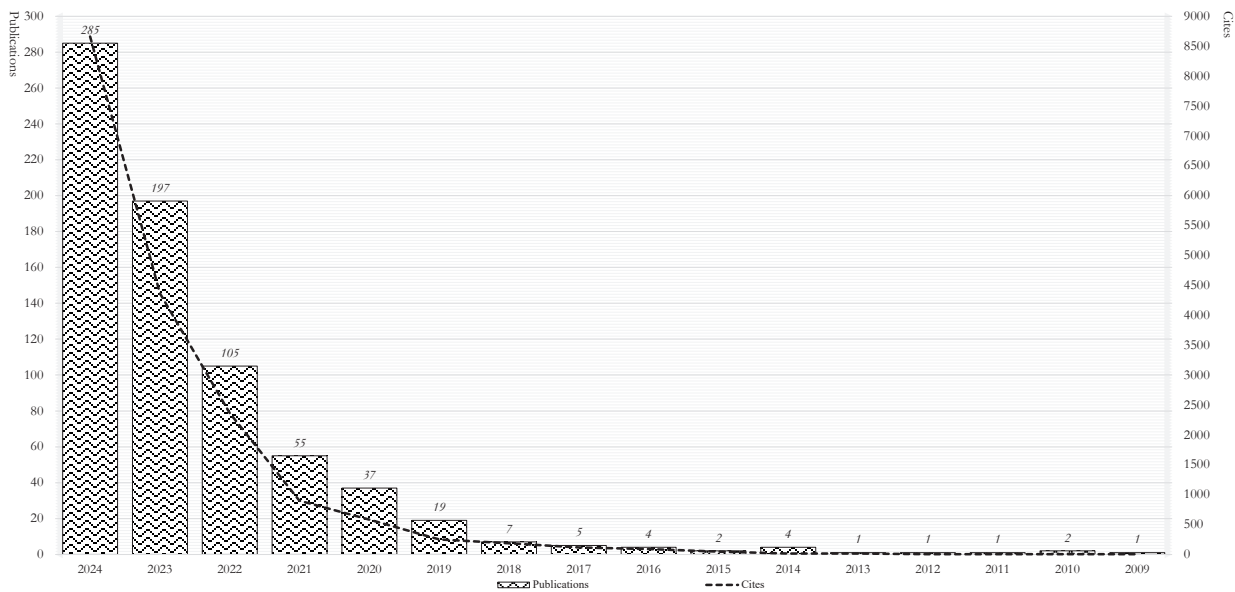


Figure 3. ESG research from stakeholders' perspective – distribution of publications and citations per year (2009-2024 (October))

Source: Own elaboration via Scopus.

It should be noted, that over the past five years, the number of publications in this field has grown by more than seven times (from 19 in 2019 to 285 in 2024). Simultaneously, the number of citations has grown by over eight times during this period. In the next step, the leading papers in the study area were identified based on their citability (Table 2). The article that is most frequently cited both overall (total citations, TC) and by number of citations per year (total citations per year, TCY) is the paper by Cheng et al. (2014). In their study, the authors demonstrated that CSR engagement improves a firm's access to finance by building trust with external stakeholders. Companies with a strong CSR reputation tend to experience lower capital constraints as they are perceived as less risky and more transparent. This ultimately benefits shareholders, lenders, and broader stakeholders by enhancing financial stability and providing more reliable access to financing.

The second most frequently cited paper was that of Broadstock et al. (2021). In this paper, the authors indicated that firms with high ESG performance exhibited greater resilience during the COVID-19 financial crisis, thereby demonstrating that strong ESG practices can serve as a buffer during economic shocks. This finding supports the view that ESG investments foster trust and long-term stability, which is particularly beneficial for stakeholders during crises. These findings are corroborated by other papers included in Table 2, namely: Velte (2017) and Xie et al. (2019). In contrast, the findings presented by Tang and Zhang (2020) suggest that green bond issuance benefits not only shareholders through immediate positive financial returns, but also broader stakeholders by aligning corporate strategies with ESG values.

In a subsequent study, Garcia et al. (2017) demonstrate that stakeholder pressure is a critical driver of ESG performance, particularly in sensitive industries within emerging markets. By understanding and addressing stakeholders' concerns, these companies are often more proactive in managing ESG risks, leading to better overall performance in these areas. The importance of geographical diversification in stakeholders' approaches to ESG is also highlighted by Duque-Grisales and

Aguilera-Caracuel (2021) or Lokuwaduge and Heenetigala (2017). The study by Yu et al. (2020) underscores the need for caution when interpreting ESG disclosures, as greenwashing can distort reality and impact investment and consumption decisions. Stakeholders, therefore, benefit from a critical approach, seeking multiple sources of information to verify corporate ESG performance. Additionally, they play a crucial role in advocating for improved regulatory standards that promote transparency and integrity in ESG reporting, ultimately leading to a more sustainable and trustworthy corporate environment.

Table 2. ESG research from stakeholders' perspective – most impactful articles and authors

Rank	Title of the Paper	Author	Journal	Year	Tc	Tcy
1	Corporate social responsibility and access to finance	Cheng, B., Ioannou, I., & Serafeim, G.	SMJ	2014	1977	197.7
2	The role of ESG performance during times of financial crisis: Evidence from COVID-19 in China	Broadstock, D. C., Chan, K., Cheng, L. T. W., & Wang, X.	FRL	2021	679	135.8
3	Do environmental, social, and governance activities improve corporate financial performance?	Xie, J., Nozawa, W., Yagi, M., Fujii, H., & Managi, S.	BSE	2019	499	83.2
4	Do shareholders benefit from green bonds?	Tang, D. Y., & Zhang, Y.	JCF	2020	457	91.4
5	Sensitive industries produce better ESG performance: Evidence from emerging markets	Garcia, A. S., Mendes-Da-Silva, W., & Orsato, R. J.	JCP	2017	433	54.1
6	Environmental, social and governance (ESG) scores and financial performance of multilatinas: Moderating effects of geographic international diversification and financial slack	Duque-Grisales, E., & Aguilera-Caracuel, J.	JBE	2021	422	105.5
7	Does ESG performance have an impact on financial performance? Evidence from Germany	Velte, P.	JGR	2017	376	47.0
8	Mandatory CSR and sustainability reporting: Economic analysis and literature review	Christensen, H. B., Hail, L., & Leuz, C.	RAS	2021	372	93.0
9	Greenwashing in environmental, social and governance disclosures	Yu, E. P. Y., Luu, B. V., & Chen, C. H.	RIBF	2020	356	89.0
10	Integrating environmental, social and governance (ESG) disclosure for a sustainable development: An Australian study	Lokuwaduge, C. S. D. S., & Heenetigala, K.	BSE	2017	324	40.5

Note: TC = Total citations; Tcy= Total citations per year; FRL=Finance Research Letters; JCF=Journal of Corporate Finance; SMJ=Strategic Management Journal; BSE=Business Strategy and the Environment; JCP=Journal of Cleaner Production; JBE=Journal of Business Ethics; RAS=Review of Accounting Studies; JGR= Journal of Global Responsibility; RIBF=Research in International Business and Finance.

Source: Own elaboration via Scopus.

Across these studies, a consistent finding is that strong ESG practices have a positive influence on corporate financial performance, particularly by enhancing trust with a diverse range of stakeholders. These observations are consistent with the Reputation-building and the Social-impact hypothesis. ESG practices mitigate risks, especially during crises, improve access to finance, and ensure accountability and transparency, aligning with the stakeholders' perspective that emphasizes broad social responsibility and long-term stability over short-term profits. This analysis leads to the conclusion that stakeholders' role can be viewed either as a driving force behind ESG initiatives or as beneficiaries of strong ESG performance, due to their active engagement in the ESG integration process, which underlines the instrumental role of stakeholders within ESG frameworks.

The next step of analysis involves the assessment of the productivity of the journals. As shown in Figure 4, the top ten journals accounted for almost 34% of all publications in the extracted database. “*Sustainability*” is the leading journal for ESG works from a stakeholders' perspective (10.89% of publications in the identified database). The second most productive journal is “*The Journal of Cleaner Production*” (5.6% of publications in the identified database). This suggests a relatively high concentration of publications on ESG-stakeholders research.

The next step of research involved assessing productivity by subject area. As shown in Figure 5, the top three areas accounting for 44.8% of all publications in the extracted database are business, management and accounting, environmental sciences, and social sciences. Other identified areas suggest the diversity of applied theoretical frameworks and methodological approaches to the studies in this field.

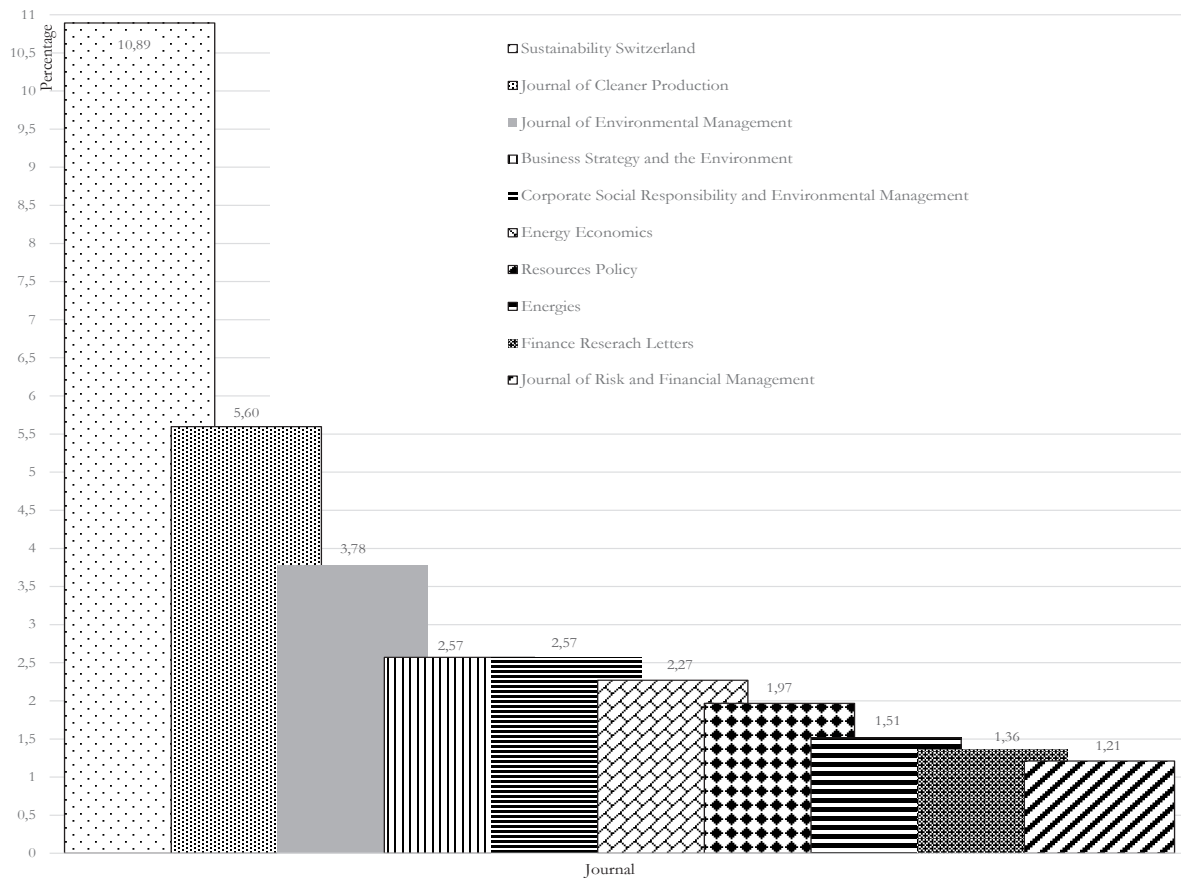


Figure 4. ESG research from stakeholders' perspective – most impactful journals

Source: Own elaboration via Scopus.

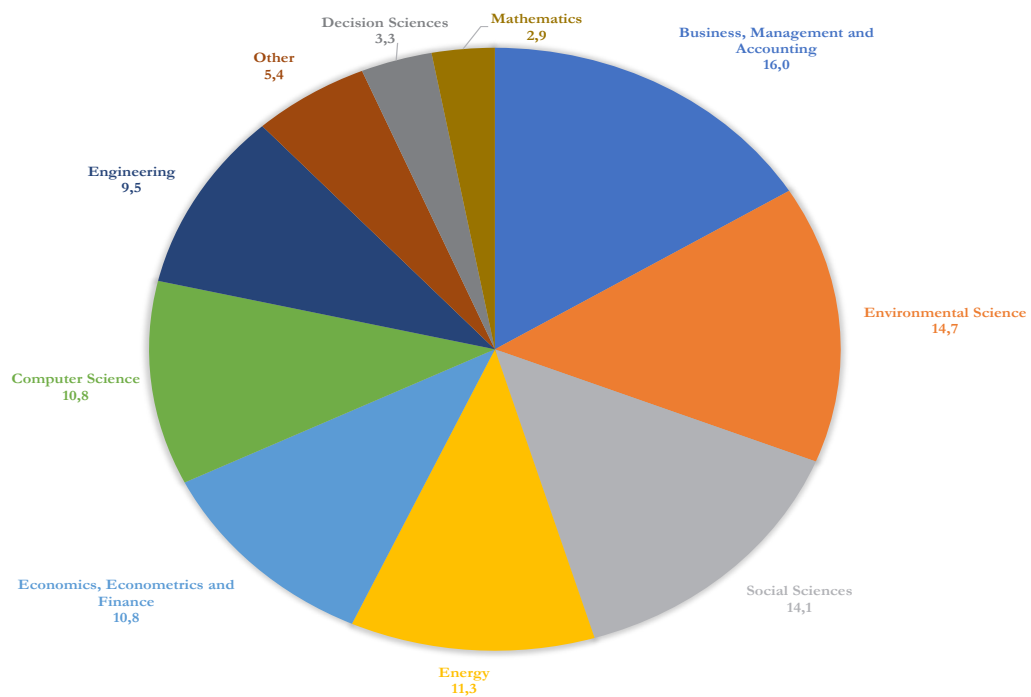


Figure 5. ESG research from stakeholders' perspective – main subject areas

Source: Own elaboration via Scopus.

To summarize the results of the pre-mapping phase of knowledge on ESG research from the perspective of stakeholders, it can be noted that: 1) there has been a significant increase in both the number of publications and citations, especially over the last five years, with a sevenfold increase in publications and an eightfold increase in citations; 2) the most influential papers demonstrate that strong ESG practices enhance financial performance, particularly by fostering trust and transparency among stakeholders, reducing risks in crisis situations, and improving financial stability and access to capital. This is consistent with the Reputation-building and the Social-impact hypothesis; 3) an analysis of journal productivity indicates that research in this field has primarily been published in journals such as *Sustainability* and the *Journal of Cleaner Production*, indicating a high concentration of publications; 4) an analysis of subject areas reveals that research in this field aligns with the disciplines of business, management and accounting, environmental sciences, and social sciences, illustrating the multidisciplinary scope of ESG research.

ESG research from stakeholders’ perspective – knowledge mapping

The knowledge mapping analysis is focused on the period 2020-2024 as the most productive (as shown in the pre-mapping phase) in terms of publications addressing ESG issues from a stakeholders’ perspective. The results are visualized in the form of strategy diagrams, thematic networks, as well as overlay and evolutionary maps.

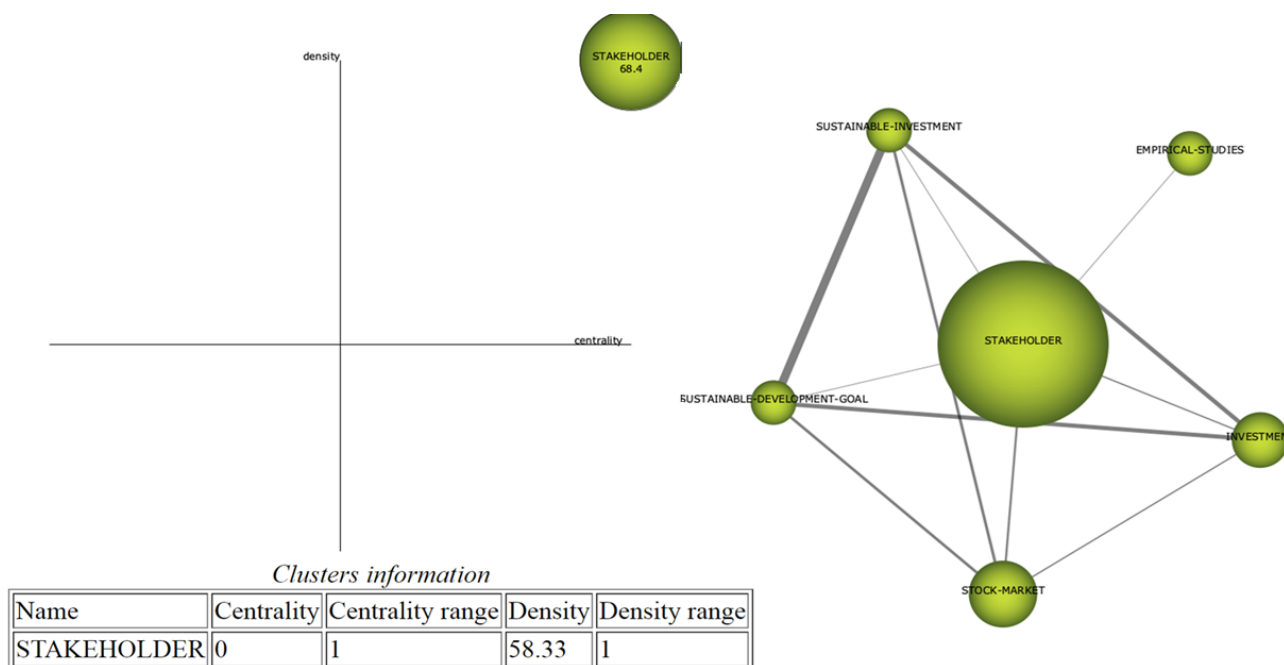


Figure 6. ESG research from stakeholders’ perspective – strategic chart (left) and thematic network (right) – 2020

Source: Own elaboration via SciMAT.

The knowledge mapping analysis reveals a leading theme in 2020: ‘Stakeholder’. Studies published in this year (Figure 6) collectively highlight that ESG practices — ranging from board diversity (Qureshi et al., 2020) and ESG disclosure to CSR reporting (Esser et al., 2018), as well as sustainable investment (Cunha et al., 2020) — have positive impacts across various groups of stakeholders. Investors see potential for reduced risk and higher returns, especially in ESG-aligned firms (Chiu et al., 2020; Zaccone & Pedrini, 2020). Corporate managers are encouraged to integrate ESG factors into business strategies to attract responsible investment and bolster firm value. Lastly, enhanced stakeholders’ engagement through transparent reporting and inclusive governance strengthens stakeholders’ trust and can lead to sustained reputational and financial benefits.

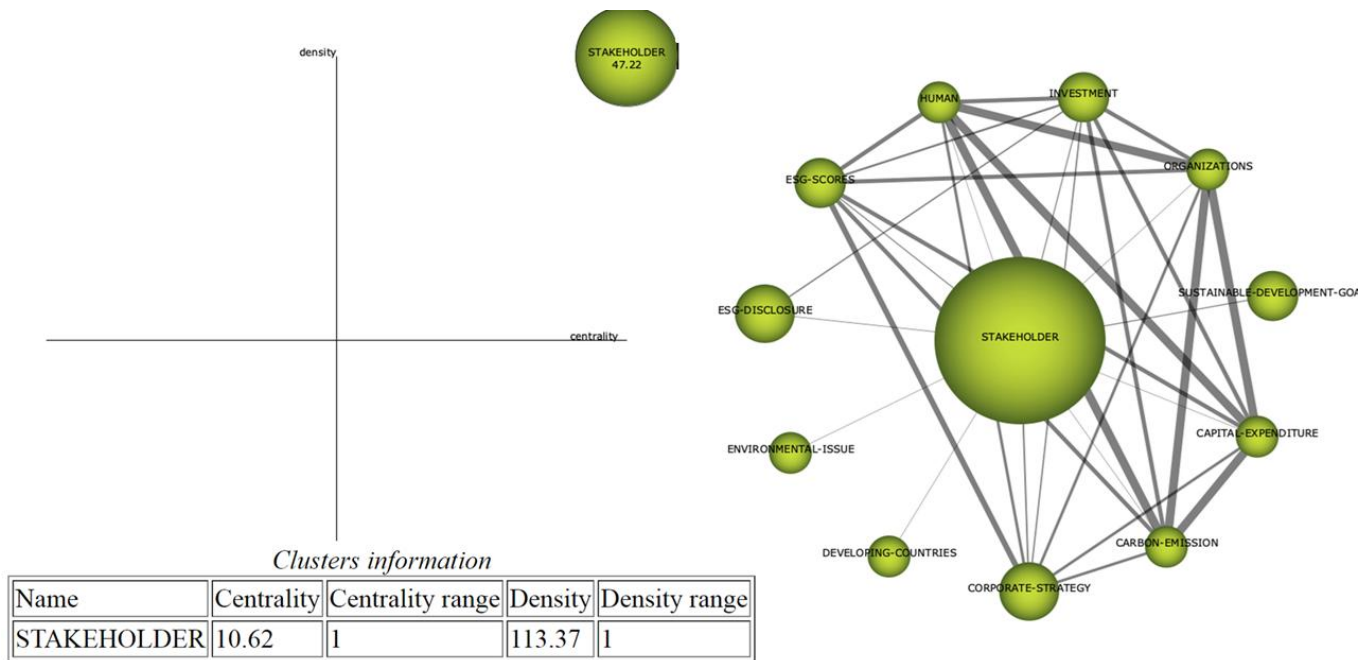


Figure 7. ESG research from stakeholders’ perspective – strategic chart (left) and thematic network (right) – 2021
Source: Own elaboration via SciMAT.

The leading research published in 2021 (Figure 7) provides a refinement of the findings on stakeholders’ perceptions of ESG from the previous period. They confirmed that various aspects of ESG, relating to governance structure, diversity of board composition, industry specifics, or forward-looking approaches, are important. They point out that these factors are critical to meeting the diverse, sometimes conflicting demands of stakeholders, managing risk and supporting a sustainable business landscape. For example, the study by Karim et al. (2021) highlights the impact of investment and corporate governance on carbon disclosure. In the context of stakeholders, particularly investors and regulators, the importance of corporate transparency in environmental impact reporting is highlighted. Improved carbon disclosure serves to enhance accountability, helping stakeholders assess a company’s commitment to the environment and mitigate associated risks. In contrast, Atif & Ali’s (2021) findings link robust ESG disclosure to lower default risk, which is important for investors, creditors, and financial analysts. They provide evidence that companies with comprehensive ESG reporting practices are likely to have lower financial risks, which is consistent with stakeholders’ demands for sustainable and resilient investment options. This reinforces the value of ESG disclosure as a risk management tool. This period is also characterized by a growing stakeholder focus on diversity and inclusion, as evidenced by research by De Masi et al. (2021), which suggests that the presence of women on boards has a positive impact on ESG disclosure.

Further development of research on stakeholders and ESG performance was observed in 2022 (Figure 8). Researchers consider ESG issues, examining specifically their impact on corporate behavior, stakeholders’ expectations, financial performance, and market dynamics across geographies and sectors. Ruiz-Blanco et al. (2022) analyze the phenomenon of greenwashing dynamics, showing that companies with higher levels of public scrutiny are more prone to greenwashing as they attempt to maintain the appearance of environmental responsibility without making significant changes. Thus, they postulate the requirement for transparent and authentic ESG commitments. In contrast, a study by Tang (2022) examining the role of ESG in corporate innovation suggests that ESG initiatives help companies access capital more easily, thereby supporting innovation aligned with sustainable goals. For stakeholders, this provides assurance that companies are not only meeting compliance standards but also driving progressive change in the area of sustainability.

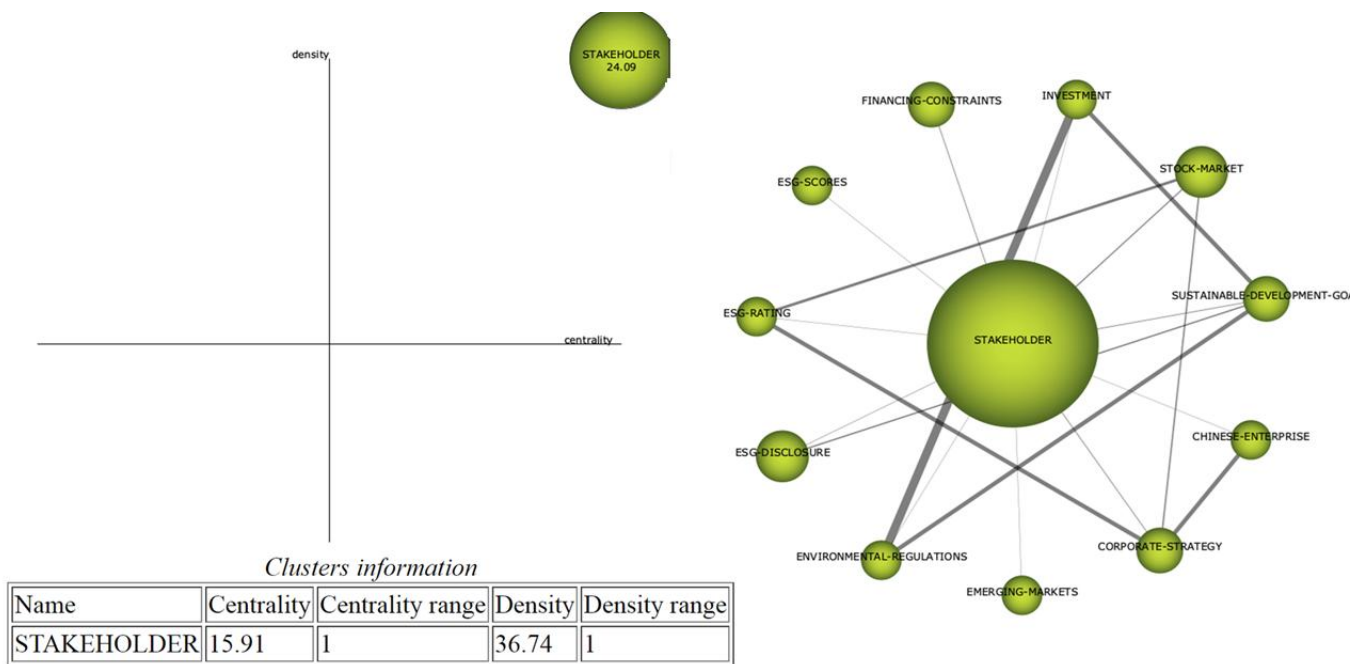


Figure 8. ESG research from stakeholders' perspective – strategic chart (left) and thematic network (right) – 2022
Source: Own elaboration via SciMAT.

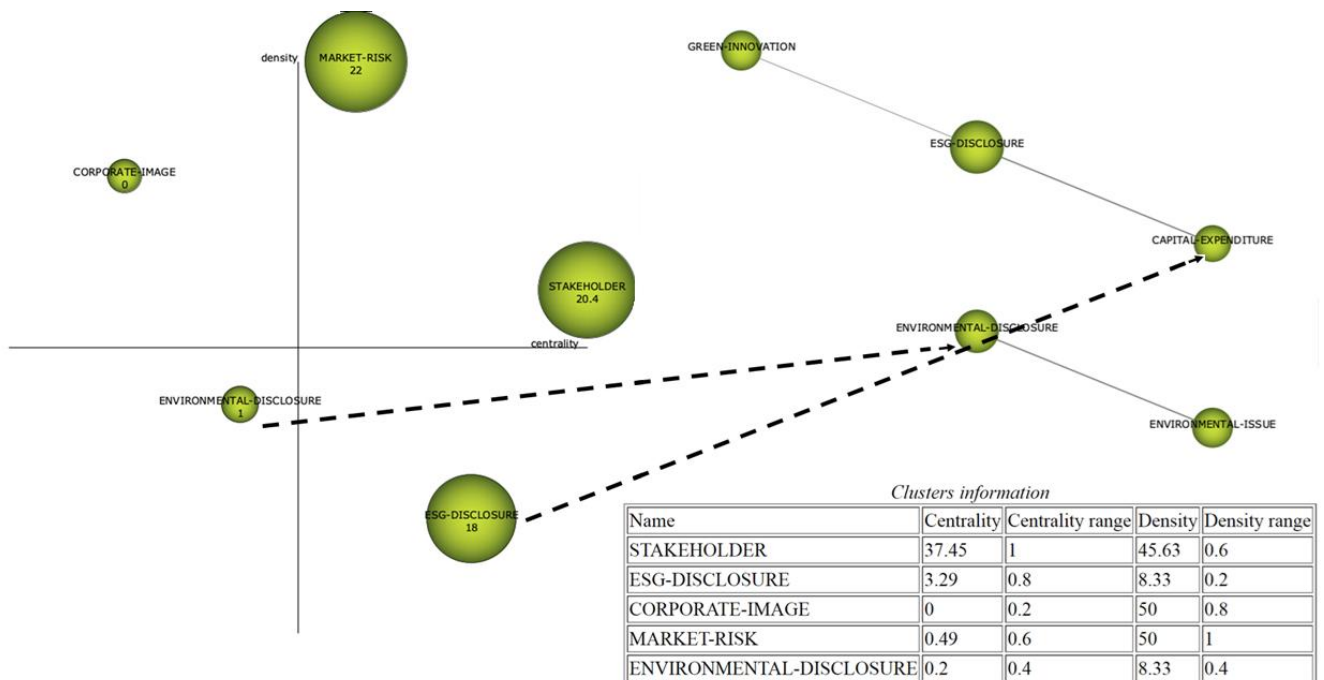


Figure 9. ESG research from stakeholders' perspective – strategic chart (left) and thematic network (right) – 2023 quadrants 3 and 4
Source: Own elaboration via SciMAT.

The 2023 research (Figure 9) highlights the need for robust, transparent and regulated ESG reporting that meets stakeholders' expectations for corporate responsibility and sustainability. Among others, a study by Khanchel et al. (2023) examined the relationship between sustainability practices (especially ESG disclosure) and firm performance, with a particular focus on green innovation. They found that companies that actively disclose ESG initiatives and invest in green innovation tend to perceive a positive impact on firm performance. Stakeholders, including investors, regulators,

NGOs (Wichianrak et al., 2023), and consumers, are increasingly critical of superficial or voluntary ESG disclosure and favour companies that devote resources to measurable, impactful ESG initiatives. To maintain stakeholders' trust and meet growing demands for accountability, companies should prioritize transparency in ESG reporting and align their capital investments with sustainable goals.

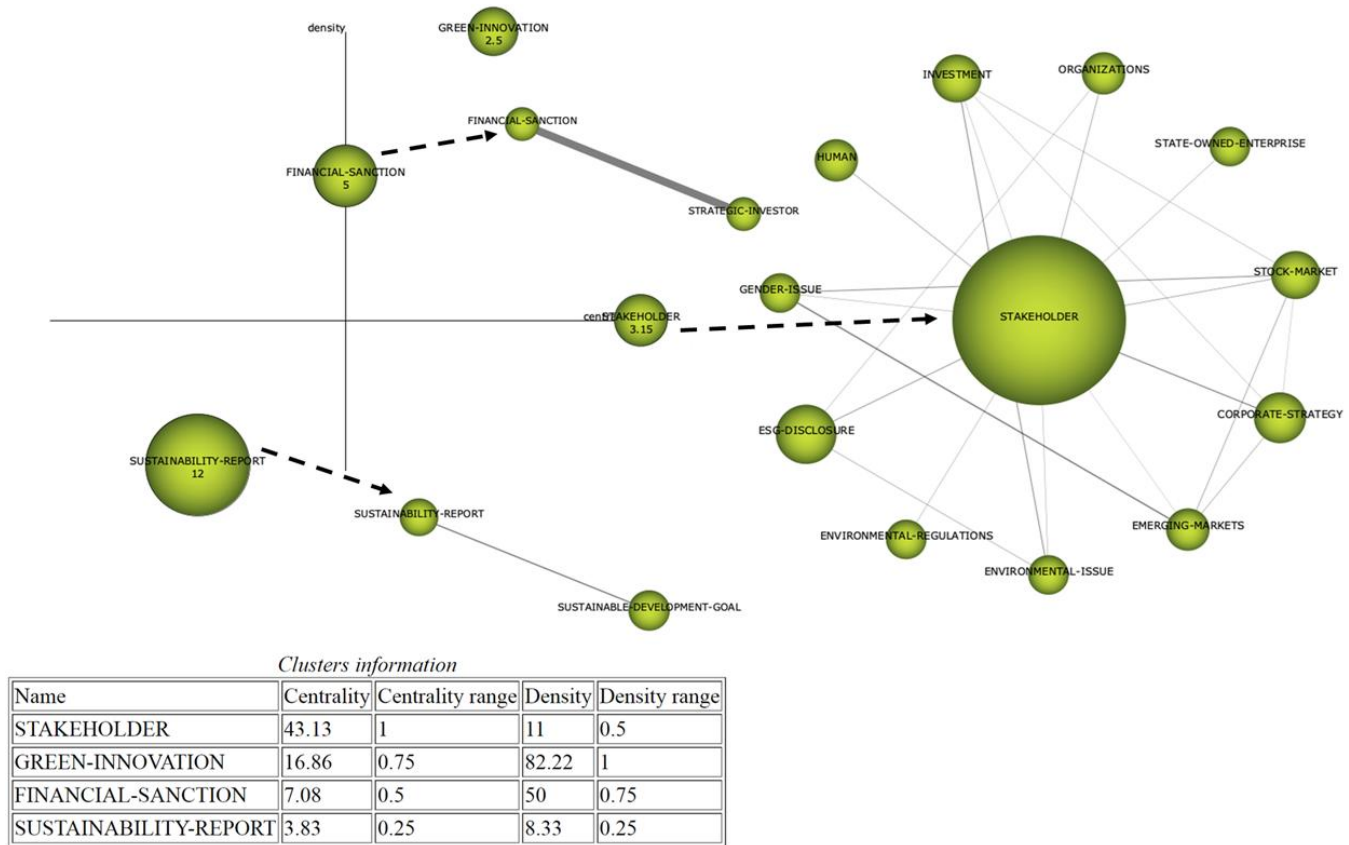


Figure 10. ESG research from stakeholders' perspective – strategic chart (left) and thematic network (right) – 2024
Source: Own elaboration via SciMAT.

Figure 10 illustrates that, in 2024, research in this field focused on sustainable reporting. From a stakeholder's perspective, the study by Bose et al. (2024) highlights the importance of transparent SDG (Sustainable Development Goals) disclosure as a key element in ESG frameworks. Clear SDG reporting helps stakeholders understand a company's commitment to sustainable practices, fostering trust and accountability. Figure 10 also reveals that some research topics, such as green innovations, have continued from previous years, indicating the persistent connection between innovation and ESG performance.

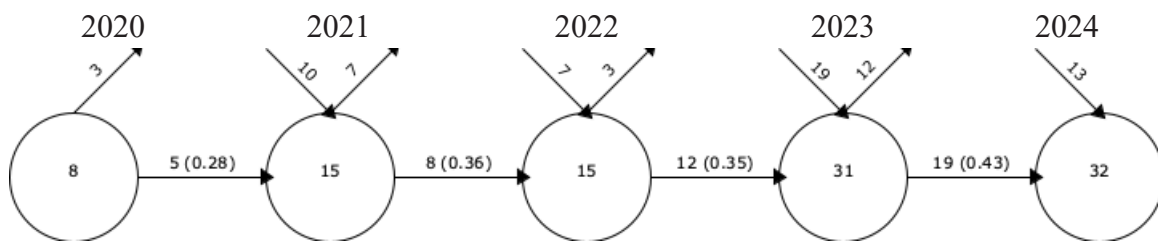


Figure 11. ESG research from stakeholders' perspective – overlapping map
Source: Own elaboration via SciMAT.

The next step of the analysis involved interpreting the overlay graph (Figure 11), which visualizes the thematic evolution of ESG research from the stakeholder perspective. The graph displays the number of keywords in each period (represented by the circles), the inflow and outflow of keywords across periods (indicated by the arrows), and the stability index, which measures the degree of thematic continuity between time intervals. A stability index close to 1 typically reflects a high level of conceptual maturity and coherence, while lower values indicate fragmentation and instability.

In this study, the stability index was calculated to be 0.43, indicating relatively low thematic continuity over time. This is further supported by the sharp increase in the number of keywords — from 8 in 2020 to 32 in 2024 — which signals not only growing academic interest but also ongoing conceptual diversification. According to Cobo et al. (2012), a stability index below 0.5 indicates thematic fragmentation or conceptual redefinition, suggesting that the field is still in an emerging and exploratory phase. It can therefore be concluded that this low stability index reflects the dynamic and evolving nature of ESG research from the stakeholder perspective. The diversity of stakeholder roles and their specific needs, sectoral ESG challenges, and a rapidly changing regulatory environment contribute to a field that is still defining its theoretical direction. This ongoing development of core concepts underscores the active effort within the academic community to clarify and consolidate the positioning of stakeholders within ESG frameworks. In this light, the observed thematic instability is consistent with the characteristics of an emerging research domain and underscores the need for further theoretical refinement, conceptual integration, and cross-sectoral analysis in future ESG studies.

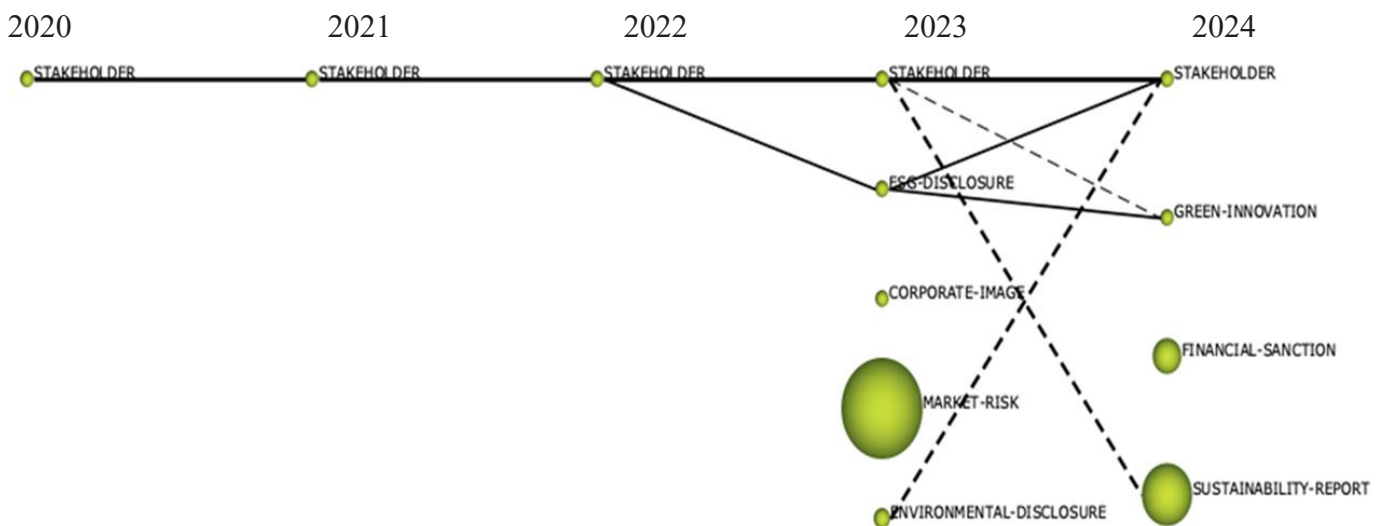


Figure 12. ESG research from stakeholders' perspective – evolution map

Source: Own elaboration via SciMAT.

The concluding step of this analysis involves consolidating the identified research trends (previously discussed in depth) into an evolutionary map (see Figure 12). This approach enables the tracking of connections between various areas across the analyzed period, along with their evolution over time.

DISCUSSION

The knowledge mapping analysis helps identify thematic clusters, revealing research themes and their evolution over the past five years (Table 3), illustrating the current status of ESG research from the perspective of stakeholders (RQ1). Stakeholder theory emerged as the dominant framework (the leading theme 'Stakeholder' appeared consistently in each year of analysis), emphasizing the importance of balancing different stakeholders' interests to achieve sustainable value creation. This persistence may indicate a thematic stagnation, but a detailed analysis of the growing number of subthemes related to 'Stakeholder' theme every year illustrates the evolving nature of this area and underscores its conceptual resilience. Previous studies have also highlighted the importance of stakeholders and their perspectives on ESG issues (e.g., Alsayegh et al., 2020; Daugaard & Ding, 2022).

Other leading themes emerged in 2023 (Market risk) and 2024 (Green innovation), indicating a recent expansion of the thematic network and broadening of the research focus. These new leading themes show two distinct perspectives in ESG and stakeholder-related research, indicating various interests. ‘Market risk’ underscores the importance of the instability of market parameters that may impact both a firm’s performance and its relationship with stakeholders (this may be linked to the observed increase in market prices, interest rates, and inflation in recent years). Thus, this may suggest a growing role for market factors in stakeholder engagement within the ESG integration process. On the other hand, ‘Green innovation’ theme underlines the importance of innovative processes in companies related to environmental issues, sustainable development, green projects, and renewable energy sources. Green innovation theme is identified as a driver for sustainable business transformation. This aligns with the findings of Khanchel et al. (2023), who investigated the role of green innovation in enhancing firm performance. However, the present study places greater emphasis on green innovation as part of a comprehensive corporate strategy, rather than merely as a performance-enhancing tool. These topics are linked to legal regulations and the availability of sources of funds offered for such projects (e.g., the Sustainable Finance framework in the European Union, the development of green bond markets, or sustainable-linked project loans).

Table 3. Main research themes and their evolution (2020-2024)

Period	Motor (leading) themes	Specialized/ peripheral themes	Emerging/ marginal themes	Transversal/ general themes
2020 2021 2022	STAKEHOLDER	X	X	X
2023	STAKEHOLDER MARKET RISK	CORPORATE IMAGE	ENVIRONMENTAL DISCLOSURE	ESG DISCLOSURE
2024	STAKEHOLDER GREEN INNOVATION	FINANCIAL SANCTION	SUSTAINABILITY REPORT	X

Source: Own elaboration via Scopus.

Over the analyzed period, only two specialized themes were identified: ‘Corporate image’ in 2023 and ‘Financial sanction’ in 2024. Furthermore, there is a clear link between the ‘Corporate image’ theme and corporate reporting studies, represented by themes such as ‘Environmental disclosure’, ‘ESG disclosure’, and ‘Sustainability report’, as these were identified as either emerging or general topics during the same years. Given that corporate reporting practices aiming at reducing asymmetric information directly affect corporate reputation and image, the emergence of such themes in recent years underlines the growing importance of corporate transparency for stakeholders. ESG reporting represents an important field of research, both for academia and for business practice. Researchers investigate the drivers and consequences of effective ESG reporting, including its quality and content, as well as differences among countries and industries. Based on these analyses, they postulate the required modifications and standardization that can be used by policymakers and managers. It is expected that such discussions will continue in the following years, as many issues still need to be addressed.

Table 4. Main research domains and related keywords (2020-2024)

Main research domains	Key words
SUSTAINABILITY	sustainable investment, sustainable development goal, ESG scores, ESG disclosure, ESG rating, sustainability report
ENVIRONMENTAL ASPECTS	environmental issue, carbon emissions, environmental regulations, green innovations, environmental disclosure
FINANCE & INVESTMENT	stock-market, investment, capital expenditure, financing constraints, financial sanctions, strategic investor, market risk
MANAGEMENT	stakeholder, corporate strategy, organizations, human, green innovations, corporate image, gender issue
CORPORATE REPORTING	ESG disclosure, sustainability report, environmental disclosure

Source: Own elaboration via Scopus.

The detailed analysis of thematic clusters enables the identification of five main research domains and related keywords (RQ2), which can serve as a lexicon for further literature review studies (Table 4). The first two research domains are related

to sustainable development and environmental-issues. Finance & Investment domain groups topics related to financial markets and investment processes. The management domain integrates topics related to business strategy, organization, and innovation. Finally, the reporting domain identifies topics related to various forms and types of corporate reports. These five groups of keywords illustrate different research perspectives on studies that combine ESG and stakeholder theory, suggesting various theoretical frameworks, research objectives, and methodologies, as well as central topics and research questions.

The findings suggest that ESG research is shifting towards addressing challenges such as greenwashing, the role of ESG in driving business innovation, and the need for standardized ESG reporting frameworks (RQ3). Thematic trends also indicate an increasing focus on aligning ESG initiatives with the Sustainable Development Goals (SDGs), reflecting a more holistic approach to sustainability. These themes represent a departure from earlier studies, which have predominantly focused on the financial and stakeholder implications of ESG performance. For instance, Kim & Li (2021) explored ESG from the perspective of corporate profitability and stakeholder perceptions, without directly addressing the risks of greenwashing or the call for unified reporting standards. Similarly, Cai et al. (2025) examined inconsistencies in ESG reporting, focusing on data-related challenges rather than greenwashing or ethical considerations. The findings also underscore the role of ESG in driving business innovation, a theme that has been relatively underexplored in prior research. Martins et al. (2022) analyzed social innovation but did not directly connect it to ESG practices. Similarly, Cai et al. (2025) investigated the impact of ESG on corporate resilience during market volatility, focusing more on financial outcomes than on innovative practices driven by ESG strategies. This highlights a gap in the literature that the current findings address by positioning ESG as a catalyst for innovation.

Key turning points include the emphasis on transparent ESG disclosure as a risk management tool, the integration of board diversity into governance practices, and the role of ESG in mitigating financial risks during crises (RQ4). The research also highlights the importance of aligning ESG initiatives with measurable outcomes to enhance stakeholders' trust and accountability. For instance, while Cai et al. (2024) explored conflicts among stakeholder interests in sustainable business practices, their focus did not address the use of ESG disclosures as a risk management tool or the integration of diversity into governance practices. Similarly, Karim et al. (2021) introduced a novel measure of corporate carbon emission disclosure, but their focus was on its relationship with capital expenditures and corporate governance, rather than its risk management implications. Additionally, while the findings highlight the strategic role of ESG in managing financial risks during crises, prior studies, such as Cai et al. (2025), which addressed inconsistencies in ESG reporting, and examined ESG contribution to corporate resilience, did not emphasize crisis-specific financial risk mitigation. This distinction underscores the forward-looking nature of the findings, positioning ESG as both a governance and risk management framework that extends beyond traditional performance metrics.

CONCLUSION

The primary motivation for this study was the need to address a critical knowledge gap in the rapidly evolving field of environmental, social and governance (ESG) research linked to stakeholder theory. While ESG issues have attracted considerable academic and practical interest, a systematic analysis of their intellectual structure within the stakeholders' theoretical framework has been lacking. By focusing on the role of stakeholders, this study contributes to the understanding of the complex interactions between corporate actions and stakeholders' expectations, which may be conflicting and shifting over time. This research not only enhances the theoretical foundation of ESG studies, but also highlights their practical implications for promoting sustainable and responsible business practices by engaging multiple stakeholders.

The identified research gap stems from the fragmented and heterogeneous nature of the ESG literature, with limited emphasis on stakeholders-driven perspectives. This study fills this gap by employing bibliometric and content analysis techniques, using SciMAT software, to map the intellectual structure and thematic development of ESG research. The stakeholder perspective is particularly important in ESG discourse because it highlights the interconnectedness of corporate responsibilities to all stakeholders, ESG activities, stakeholders' expectations, and broader socio-environmental outcomes. Filling this gap was necessary to provide clarity on the dynamic and relational aspects of ESG practices that are central to aligning corporate strategies with the interests of stakeholders, societal values, and the regulatory landscape.

The pre-mapping of ESG research from a stakeholder perspective shows a significant increase in publications and citations over the past five years, indicating the evolving nature of this domain. This is closely related to the implementation of new legal regulations, such as ESG reporting requirements. Leading research indicates that strong ESG practices have

a positive impact on financial performance by fostering stakeholders' trust and transparency, mitigating risk during crises, and promoting financial stability and easier access to capital. These results support the reputation-building hypothesis and align with the resource dependence theory. It also suggests the dominant instrumental approach to stakeholder engagement into the ESG process. An analysis of journal productivity reveals that most research in this area is concentrated in a few key journals and is closely linked to fields such as business, management, accounting, environmental science, and social sciences. This indicates the heterogeneity of methodological approaches and theoretical frameworks in modern research linking ESG issues to stakeholder theory.

An analysis of the essential mapping of ESG research from a stakeholders' perspective reveals an evolving landscape from 2020 to 2024, with clear thematic shifts evident in each year. The 2020 research highlights the positive impact of ESG practices on various stakeholder groups, emphasizing board diversity, transparent ESG disclosure, and financial benefits for investors and corporate managers. The 2021 research refines these findings, highlighting the importance of corporate governance, board diversity and transparent disclosure in meeting stakeholders' expectations, mitigating risk, and building corporate resilience. In 2022, the research deepened to address issues such as greenwashing and the role of ESG in corporate innovation, underscoring the need for authentic and influential ESG commitments to maintain credibility and attract capital. In 2023, research focuses on the growing demand for rigorous and regulated ESG reporting. Stakeholders, including investors, NGOs, and consumers, favor companies that invest in green innovation and align their ESG initiatives with key environmental and social objectives. The 2024 study emphasizes the importance of transparent reporting on the Sustainable Development Goals as a crucial component of the ESG framework, thereby enhancing trust and accountability among stakeholders. These thematic shifts illustrate a global tendency to move from voluntary to mandatory corporate ESG disclosures. Regulatory developments enhance more robust ESG integration, influencing the sustainability-linked actions and their impact on firm performance and its stakeholders.

Our findings underscore the bidirectional relationship between ESG performance and stakeholders. On one hand, strong ESG performance can enhance value creation for stakeholders by attracting investments, implementing innovation, mitigating risk, and fostering resilience during crises. On the other hand, corporate responsibilities and legal regulations, together with stakeholders' expectations, may motivate companies to integrate ESG factors into their business strategies. This is particularly important in light of the growing interest of ESG-focused investors (Meng et al., 2023). However, inconsistencies in ESG reporting highlight areas for further scrutiny and standardization, which should be addressed by the policy-makers. Such standardization may reduce methodological fragmentation, enabling comparisons across firms and sectors. This push for global standardization should be balanced with the need for context-specific ESG frameworks. Another issue that should be addressed is the superficial or symbolic adoption of ESG observed in many companies, instead of a genuine sustainability transformation. Greenwashing or the co-optation of ESG can dilute or distort the transformative potential of ESG, creating confusion and consequently reducing stakeholder trust. However, this risk can be mitigated by authentic, mature, and accountable ESG strategies that aim for ambitious objectives, moving beyond regulatory compliance, image-building, or maintaining legitimacy. These mature ESG strategies should strive to balance the protection of the rights and values of various stakeholder groups with the objective of enhancing stakeholder engagement to achieve genuine sustainable growth and create value. This approach is suggested by the integrative stakeholder theory.

The limitations of the study stem from the methodological assumptions. It exclusively used only the Scopus database, and while this is a leading resource for business and management research, some relevant scientific works may have been missed. Altering the keywords or search criteria could have also changed the content of the dataset. Finally, the SciMAT software, with its various similarity measures and clustering algorithms, could have produced different visualization and performance results. Applying different parameters could lead to different results. This limits the generalizability of the findings to other datasets and tools, highlighting avenues for refining future research methodologies.

While the study confirms the positive impact of ESG practices, challenges such as regional differences, data inconsistencies, greenwashing, and regulatory fragmentation present conflicting implications. Future studies should explore harmonized reporting standards that strike a balance between global comparability and regional specificity. Research should delve deeper into the intersection of ESG practices with technological advancements, such as artificial intelligence and blockchain, to enhance transparency, monitoring, and accountability of strategic ESG. Another avenue for future research may be to examine the specific drivers of long-term value creation for stakeholders, as well as to identify which ESG factors are most material to specific groups of stakeholders. Future studies may also explore the problem of different outcomes of ESG actions for different groups of stakeholders and the strategies a company may use

to address such conflicting situations. These observations reflect the complexity and multidimensional nature of the ESG process and engagement of multiple stakeholders.

Acknowledgments

Funded by the Ministry of Science under the “Regional Initiative of Excellence.”

References

- Adigwe, P. D. (2025). Post-pandemic corporate governance in emerging markets: An accounting and ESG perspective. *International Journal of Accounting, Management and Economic Review*, 1(2), 39-50. <https://doi.org/10.57233/ijamer.v1i2.04>
- Aguinis, H., & Glavas, A. (2019). On corporate social responsibility, sensemaking, and the search for meaningfulness through work. *Journal of Management*, 45(3), 1057-1086. <https://doi.org/10.1177/0149206317691575>
- Alabdullah, T. T. Y. (2023). How do sustainability assurance, internal control, audit failures influence auditing practices. *Journal of Management, Accounting, General Finance and International Economic Issues*, 2(3), 671-688
- Alsayegh, M. F., Rahman, R. A., & Homayoun, S. (2020). Corporate economic, environmental, and social sustainability performance transformation through ESG disclosure. *Sustainability*, 12(9), 3910. <https://doi.org/10.3390/su12093910>
- Amel-Zadeh, A., & Serafeim, G. (2018). Why and how investors use ESG information: Evidence from a global survey. *Financial Analysts Journal*, 74(3), 87-103. <https://doi.org/10.2469/faj.v74.n3.2>
- Archambault, É., Campbell, D., Gingras, Y., & Larivière, V. (2009). Comparing bibliometric statistics obtained from the Web of Science and Scopus. *Journal of the American Society for Information Science and Technology*, 60(7), 1320-1326. <https://doi.org/10.1002/asi.21062>
- Atif, M., & Ali, S. (2021). Environmental, social and governance disclosure and default risk. *Business Strategy and the Environment*, 30(8), 3937-3959. <https://doi.org/10.1002/bse.2850>
- Awaysseh, A., Heron, R. A., Perry, T., & Wilson, J. I. (2020). On the relation between corporate social responsibility and financial performance. *Strategic Management Journal*, 41(5), 965-987. <https://doi.org/10.1002/smj.3122>
- Babiak, K., & Kihl, L. A. (2018). A Case Study of Stakeholder Dialogue in Professional Sport: An Example of CSR Engagement. *Business and Society Review*, 123(1), 119-149. <https://doi.org/10.1111/basr.12137>
- Bahadorestani, A., Naderpajouh, N., & Sadiq, R. (2020). Planning for sustainable stakeholder engagement based on the assessment of conflicting interests in projects. *Journal of Cleaner Production*, 242, 118402. <https://doi.org/10.1016/j.jclepro.2019.118402>
- Bakar, A. B. S. A., Ghazali, N. A. B. M., & Ahmad, M. B. (2019). Sustainability Reporting and Board Diversity in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 9(2), 91-99. <http://dx.doi.org/10.6007/IJARBS/v9-i2/5663>
- Bassetti, T., Blasi, S., & Sedita, S. R. (2020). The management of sustainable development: A longitudinal analysis of the effects of environmental performance on economic performance. *Business Strategy and the Environment*, 30(1), 21-37. <https://doi.org/10.1002/bse.2607>
- Błach, J., Bukalska, E., Kaźmierska-Jóźwiak, B., & Radman Pesa, A. (2025). Sustainability performance, corporate governance, and financial performance: Evidence from Poland and Central European listed companies. *Journal of Entrepreneurship, Management and Innovation*, 21(1), 58-80. <https://doi.org/10.7341/20252114>
- Bose, S., Khan, H. Z., & Bakshi, S. (2024). Determinants and consequences of sustainable development goals disclosure: International evidence. *Journal of Cleaner Production*, 434, 140021. <https://doi.org/10.1016/j.jclepro.2023.140021>
- Broadstock, D. C., Chan, K., Cheng, L. T. W., & Wang, X. (2021). The role of ESG performance during times of financial crisis: Evidence from COVID-19 in China. *Finance Research Letters*, 38, 101716. <https://doi.org/10.1016/j.frl.2020.101716>
- Burbano, V. C., Delmas, M. A., & Cobo, M. J. (2024). The past and future of corporate sustainability research. *Organization & Environment*, 37(2), 133-158. <https://doi.org/10.1177/10860266231213105>
- Busch, T., & Friede, G. (2018). The robustness of the corporate social and financial performance relation: A second-order meta-analysis. *Corporate Social Responsibility and Environmental Management*, 25(4), 583-608. <https://doi.org/10.1002/csr.1480>
- Cai, C., Hazaea, S. A., Hael, M., Al-Matari, E. M., Alhebri, A., & Alfadhli, A. M. H. (2024). Mapping the landscape of the literature on environmental, social, governance disclosure and firm value: A bibliometric analysis and systematic review. *Sustainability*, 16(10), 4239. <https://doi.org/10.3390/su16104239>
- Calabrese, A., Costa, R., Menichini, T., & Rosati, F. (2012). Measuring the CSR company-stakeholder fit. *World Academy of Science, Engineering and Technology*, 71, 1860-1866. <https://doi.org/10.5281/zenodo.1334504>
- Carney, M., Gedajlovic, E., & Sur, S. (2011). Corporate governance and stakeholder conflict. *Journal of Management and Governance*, 15, 483-507. <https://doi.org/10.1007/s10997-010-9135-4>
- Cheng, B., Ioannou, I., & Serafeim, G. (2014). Corporate social responsibility and access to finance. *Strategic Management Journal*, 35(1), 1-23. <https://doi.org/10.1002/smj.2131>
- Cheshmberah, M. (2020). Projects portfolio determination based on key stakeholders' expectations and requirements: Evidence from public university projects. *Journal of Project Management*, 5(2), 139-150. <http://dx.doi.org/10.5267/j.jpm.2019.10.001>
- Cheungsirakulvit, T., & Pranee, S. (2023). Integrative ESG strategies, transformative leadership and stakeholder engagement in Thailand's corporate landscape [Paper presentation]. In *Proceedings of the 2023 International Conference on Creativity, Management, Education, Technology and Sciences* (pp. 376-381).
- Chiu, A. A., Chen, L. N., & Hu, J. C. (2020). A study of the relationship between corporate social responsibility report and the stock market. *Sustainability*, 12(21), 9200. <https://doi.org/10.3390/su12219200>
- Chouaibi, S., Rossi, M., Siggia, D., & Chouaibi, J. (2021). Exploring the moderating role of social and ethical practices in the relationship between environmental disclosure and financial performance: Evidence from ESG companies. *Sustainability*, 14(1), 209. <https://doi.org/10.3390/su14010209>
- Clementino, E., & Perkins, R. (2021). How do companies respond to environmental, social and governance (ESG) ratings? Evidence from Italy. *Journal of Business Ethics*, 171(2), 379-397. <https://doi.org/10.1007/s10551-020-04441-4>

- Cobo, M. J., López-Herrera, A. G., Liu, X., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology*, 62(7), 1382-1402. <https://doi.org/10.1002/asi.21525>
- Cobo, M. J., López-Herrera, A. G., Liu, X., & Herrera, F. (2012). SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology*, 63(8), 1609-1630. <https://doi.org/10.1002/asi.22688>
- Cunha, F. A. F. D. S., de Oliveira, E. M., Orsato, R. J., Klotzle, M. C., Cyrino Oliveira, F. L., & Caiado, R. G. G. (2020). Can sustainable investments outperform traditional benchmarks? Evidence from global stock markets. *Business Strategy and the Environment*, 29(2), 682-697. <https://doi.org/10.1002/bse.2397>
- Dasinapa, M. B. (2024). The integration of sustainability and ESG accounting into corporate reporting practices. *Advances in Applied Accounting Research*, 2(1), 13-25. <https://doi.org/10.60079/aaar.v2i1.167>
- Daugaard, D., & Ding, A. (2022). Global drivers for ESG performance: The body of knowledge. *Sustainability*, 14(4), 2322. <https://doi.org/10.3390/su14042322>
- De Masi, S., Słomka-Gołębiowska, A., Becagli, C., & Paci, A. (2021). Toward sustainable corporate behavior: The effect of the critical mass of female directors on environmental, social, and governance disclosure. *Business Strategy and the Environment*, 30(4), 1865-1878. <https://doi.org/10.1002/bse.2721>
- Derakhshan, R., Mancini, M., & Turner, J. R. (2019). Community's evaluation of organizational legitimacy: Formation and reconsideration. *International Journal of Project Management*, 37(1), 73-86. <https://doi.org/10.1016/j.ijproman.2018.10.004>
- Dočekalová, M. P., & Kocmanová, A. (2016). Composite indicator for measuring corporate sustainability. *Ecological Indicators*, 61, 612-623. <https://doi.org/10.1016/j.ecolind.2015.10.012>
- Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. *Academy of Management Review*, 20(1), 65-91. <https://doi.org/10.5465/amr.1995.9503271992>
- Doś, A., & Pattarin, F. (2024). Is sustainability a cost, an obligation, or an opportunity? Evidence on sustainable entrepreneurship orientation from Poland. *Entrepreneurial Business and Economics Review*, 12(1), 17-33. <https://doi.org/10.15678/EBER.2023.120102>
- Ellili, N. O. D. (2022). Bibliometric analysis and systematic review of environmental, social, and governance disclosure papers: current topics and recommendations for future research. *Environmental Research Communications*, 4(9), 092001. <https://doi.org/10.1088/2515-7620/ac8b67>
- Esser, I. M., MacNeil, I., & Chalaczkiewicz-Ladna, K. (2018). Proposed revisions to the UK Corporate Governance Code: a step forward in recognising a company's responsibilities towards wider stakeholders? *Company Lawyer*, 39(8), 254-256.
- Estaswara, H. (2020). Defining communication problems in stakeholder relations based on stakeholder theory. *Jurnal Aspikom*, 5(1), 87-101. <http://dx.doi.org/10.24329/aspikom.v5i1.540>
- European Commission. (2025). *Corporate sustainability reporting*. https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en
- Figge, F., Hahn, T., Schaltegger, S., & Wagner, M. (2002). The sustainability balanced scorecard: Linking sustainability management to business strategy. *Business Strategy and the Environment*, 11(5), 269-284.
- Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*. Pitman.
- Freeman, R. E., Harrison, J. S., Wicks, A. C., Parmar, B. L., & de Colle, S. (2010). *Stakeholder theory: The state of the art*. Cambridge University Press.
- Friede G., Busch T., & Bassen A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment*, 5(4), 210-233. <https://doi.org/10.1080/20430795.2015.1118917>
- Gangi, F., Mustilli, M., & Varrone, N. (2019). The impact of corporate social responsibility (CSR) knowledge on corporate financial performance: evidence from the European banking industry. *Journal of Knowledge Management*, 23(1), 110-134. <http://dx.doi.org/10.1108/JKM-04-2018-0267>
- Gao, S., Meng, F., Gu, Z., Liu, Z., & Farrukh, M. (2021). Mapping and clustering analysis on environmental, social and governance field a bibliometric analysis using Scopus. *Sustainability*, 13(13), 7304. <https://doi.org/10.3390/su13137304>
- Garcia, A. S., Mendes-Da-Silva, W., & Orsato, R. J. (2017). Sensitive industries produce better ESG performance: Evidence from emerging markets. *Journal of Cleaner Production*, 150, 135-147. <https://doi.org/10.1016/j.jclepro.2017.02.180>
- Gharbi, M., & Jarboui, A. (2023). The moderating effect of dividend policy on the relationship between corporate social responsibility and financial performance: evidence from French context. *International Journal of Economics and Business Administration*, 11(2), 97-114. <http://dx.doi.org/10.35808/ijeba/811>
- Ghezal, R. (2024). Determinants of engagement with and of stakeholders in CSR decision-making: a stakeholder perspective. *European Business Review*, 36(5), 771-790. <https://doi.org/10.1108/EBR-03-2023-0085>
- Giese, G., Nagy, Z., & Lee, L. E. (2021). Deconstructing ESG Ratings Performance: Risk and Return for E, S, And G by Time Horizon, Sector and Weighting. *Journal of Portfolio Management*, 47(3), 94-111.
- Gonzales-Aguilar, A., Colmenero-Ruiz, M., Paletta, F., & Verlaet, L. (2023). Loet leydesdorff: bibliometric analysis and mapping of his scientific production. *Profesional de la Información*, 32(7). <https://doi.org/10.3145/epi.2023.dic.09>
- Goźeń-Mitka, I., & Wiczorek-Kosmala, M. (2023). Mapping the energy sector from a risk management research perspective: A bibliometric and scientific approach. *Energies*, 16(4), 2024. <https://doi.org/10.3390/en16042024>
- Harrison, J. S., Barney, J. B., Freeman, R. E., & Phillips, R. A. (Eds.). (2019). *The Cambridge handbook of stakeholder theory*. Cambridge University Press. <https://doi.org/10.1017/9781108123495>
- Hazaea, S. A., Cai, C., Khatib, S. F., & Hael, M. (2025). The moderating role of audit quality in the relationship between ESG practices and the cost of capital: Evidence from the United Kingdom. *Borsa Istanbul Review*, 25(5), 1085-1099. <https://doi.org/10.1016/j.bir.2025.06.007>
- Helfaya, A., Morris, R., & Aboud, A. (2023). Investigating the factors that determine the ESG disclosure practices in Europe. *Sustainability*, 15(6), 5508. <https://doi.org/10.3390/su15065508>
- Henriques, R., Gaio, C., & Costa, M. (2022). Sustainability reporting quality and stakeholder engagement assessment: The case of the paper sector at the Iberian level. *Sustainability*, 14(21), 14404. <https://doi.org/10.3390/su142114404>
- Husted, B. W., & Sousa-Filho, J. M. (2019). Board structure and environmental, social, and governance disclosure in Latin America. *Journal of Business Research*, 102, 220-227. <https://doi.org/10.1016/j.jbusres.2018.01.017>
- Jiang, Q., Liu, Z., Liu, W., Li, T., Cong, W., Zhang, H., & Shi, J. (2018). A principal component analysis based three-dimensional sustainability assessment model to evaluate corporate sustainable performance. *Journal of Cleaner Production*, 187, 625-637. <https://doi.org/10.1016/j.jclepro.2018.03.255>

- Jones, T. M. (1995). Instrumental stakeholder theory: A synthesis of ethics and economics. *Academy of Management Review*, 20(2), 404-437. <https://doi.org/10.5465/amr.1995.9507312924>
- Joshi, G., & Dash, R. (2023). A bibliometric analysis of climate investing. *International Journal of Energy Economics and Policy*, 13(3), 396-407. <https://doi.org/10.32479/ijee.14279>
- Kaplan, R. S., & McMillan, D. (2021). Reimagining the balanced scorecard for the ESG era. *Harvard Business Review*, 3.
- Karim, A. E., Albitar, K., & Elmarzouky, M. (2021). A novel measure of corporate carbon emission disclosure, the effect of capital expenditures and corporate governance. *Journal of Environmental Management*, 290, 112581. <https://doi.org/10.1016/j.jenvman.2021.112581>
- Khanchel, I., Lassoued, N., & Baccar, I. (2023). Sustainability and firm performance: the role of environmental, social and governance disclosure and green innovation. *Management Decision*, 61(9), 2720-2739. <https://doi.org/10.1108/MD-09-2021-1252>
- Khurshid, R., & Islam, A. U. (2025). ESG literature mapping: Insights from bibliometric analysis. *International Journal of Disclosure and Governance*, 22(2), 476-503. <https://doi.org/10.1057/s41310-024-00244-5>
- Kim, S., & Li, Z. (2021). Understanding the Impact of ESG Practices in Corporate Finance. *Sustainability*, 13(7), 3746. <http://dx.doi.org/10.3390/su13073746>
- Kalra, P. (2024). Corporate social responsibility and stakeholder theory: An integrated review. *Journal of Management & Entrepreneurship*, 10. <http://dx.doi.org/10.13140/RG.2.2.32886.82243>
- Koblianska, I., Fujin, W., & Shutong, D. (2024). Elaboration of successful ESG policy: Learning from European companies. *Ekonomika rozvytku system*, 6(1), 24-30. <http://dx.doi.org/10.32782/2707-8019/2024-1-3>
- Kulova, I., & Nikolova-Alexieva, V. (2023). ESG strategy: pivotal in cultivating stakeholder trust and ensuring customer loyalty. *E3S Web of Conferences*, 462, 03035. EDP Sciences. <http://dx.doi.org/10.1051/e3sconf/202346203035>
- Lassala, C., Orero-Blat, M., & Ribeiro-Navarrete, S. (2021). The financial performance of listed companies in pursuit of the Sustainable Development Goals (SDG). *Ekonomika Istraživanja*, 34(1), 427-449. <https://doi.org/10.1080/1331677x.2021.1877167>
- Lazzarini, S. G. (2025). The strategic imperative: Do we need normative considerations in strategic theories of stakeholder engagement? *Strategy Science*. <https://doi.org/10.1287/stsc.2024.0254>
- Li, Y., Gong, M., Zhang, X. Y., & Koh, L. (2018). The impact of environmental, social, and governance disclosure on firm value: The role of CEO power. *The British Accounting Review*, 50(1), 60-75. <https://doi.org/10.1016/j.bar.2017.09.007>
- Linnenluecke, M. K. (2022). Environmental, social and governance (ESG) performance in the context of multinational business research. *Multinational Business Review*, 30(1), 1-16. <http://dx.doi.org/10.1108/MBR-11-2021-0148>
- Lokuwaduge, C. S. D. S., & Heenetigala, K. (2017). Integrating environmental, social and governance (ESG) disclosure for a sustainable development: An Australian study. *Business Strategy and the Environment*, 26(4), 438-450. <https://doi.org/10.1002/bse.1927>
- Macassa, G., McGrath, C., Tomaselli, G., & Buttigieg, S. C. (2021). Corporate social responsibility and internal stakeholders' health and well-being in Europe: a systematic descriptive review. *Health Promotion International*, 36(3), 866-883. <https://doi.org/10.1093/heapro/daaa071>
- Marie, M., Qi, B., Gerged, A., & Nobanee, H. (2024). Exploring Environmental, Social and Governance research in the wake of COVID-19: A bibliometric analysis of current trends and recommendations for future research. *Corporate Social Responsibility and Environmental Management*, 31(6), 6131-6149. <https://doi.org/10.1002/csr.2909>
- Markopoulos, E., & Ramonda, M. B. (2022). An ESG-SDGs alignment and execution model based on the Ocean Strategies transition in emerging markets. *Creativity, Innovation and Entrepreneurship*, 31(31), 93-103. <https://doi.org/10.54941/ahfe1001511>
- Martins, T., Braga, A., Ferreira, M. R., & Braga, V. (2022). Diving into Social Innovation: a Bibliometric Analysis. *Administrative Sciences*, 12(2), 56. <https://doi.org/10.3390/admsci12020056>
- Marzuki, A., Nor, F. M., Ramli, N. A., Basah, M. Y. A., & Aziz, M. R. A. (2023). The Influence of ESG, SRI, Ethical, and Impact Investing Activities on Portfolio and Financial Performance -Bibliometric Analysis/Mapping and Clustering Analysis. *Journal of Risk and Financial Management*, 16(7), 321. <https://doi.org/10.3390/jrfm16070321>
- Matuszewska-Pierzynka, A., Mrzygłód, U., & Pieloch-Babiarz, A. (2023). ESG performance and dividend stability of the world's largest enterprises. *Journal of Entrepreneurship, Management and Innovation*, 19(4), 184-217. <https://doi.org/10.7341/20231946>
- Meng, T., Yahya, M.H.D.H., Ashhari, Z.M., & Yu, D. (2023). ESG performance, investor attention, and company reputation: Threshold model analysis based on panel data from listed companies in China. *Heliyon*, 9(e20974). <https://doi.org/10.1016/j.heliyon.2023.e20974>
- Miralles-Quirós, M. M., Miralles-Quirós, J. L., & Redondo-Hernández, J. (2019). The impact of environmental, social, and governance performance on stock prices: Evidence from the banking industry. *Corporate Social Responsibility and Environmental Management*, 26(6), 1446-1456. <https://doi.org/10.1002/csr.1759>
- Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. *Academy of Management Review*, 22(4), 853. <https://doi.org/10.2307/259247>
- Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics*, 106(1), 213-228. <https://doi.org/10.1007/s11192-015-1765-5>
- Moral-Muñoz, J. A., Herrera-Viedma, E., Santisteban-Espejo, A., & Cobo, M. J. (2020). Software tools for conducting bibliometric analysis in science: An up-to-date review. *Profesional de la Información*, 29(1), e290103. <http://dx.doi.org/10.3145/epi.2020.ene.03>
- Mori, R., Best, P. J., & Cotter, J. (2013). Sustainability reporting and assurance: A historical analysis on a worldwide phenomenon. *Journal of Business Ethics*, 120(1), 1-11. <https://doi.org/10.1007/s10551-013-1637-y>
- Page, M. J., McKenzie, J., Bossuyt, P., Boutron, I., Hoffmann, T., Mulrow, C., & Moher, D. (2020, September 14). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *OSF Preprints*. <https://doi.org/10.31222/osf.io/v7gm2>
- Partalidou, X., Zafeiriou, E., Giannarakis, G., & Sariannidis, N. (2020). The effect of corporate social responsibility performance on financial performance: the case of food industry. *Benchmarking: An International Journal*, 27(10), 2701-2720. <https://doi.org/10.1108/BIJ-11-2019-0501>
- Pfeffer, J., & Salancik, G.R. (1978). *The external control of organizations: A resource dependence perspective*. New York: Harper and Row.
- Pinto, J. (2019). Key to effective organizational performance management lies at the intersection of paradox theory and stakeholder theory. *International Journal of Management Reviews*, 21(2), 185-208. <https://doi.org/10.1111/ijmr.12199>
- Porter, M. E., & Kramer, M. R. (2006). Strategy and Society: The link between competitive advantage and corporate social responsibility. *Harvard Business Review*, 84(12), 78-92.
- Qureshi, M. A., Kirkerud, S., Theresa, K., & Ahsan, T. (2020). The impact of sustainability (ESG) disclosure and board diversity on firm value: The moderating role of industry sensitivity. *Business Strategy and the Environment*, 29(3), 1199-1214. <https://doi.org/10.1002/bse.2427>

- Rahi, A. F., Johansson, J., Blomkvist, M., & Hartwig, F. (2023). Corporate sustainability and financial performance: A hybrid literature review. *Corporate Social Responsibility and Environmental Management*, 31(2), 801–815. <https://doi.org/10.1002/csr.2600>
- Rasheed, A., Fayyaz, S., Shahzad, I., & Ali, K. (2020). Does profitability of a corporation depend on its corporate social responsibility? *Journal of Educational Paradigms*, 2(1), 87–91. <https://doi.org/10.47609/020102020>
- Ruiz, S., Romero, S., & Fernandez-Feijoo, B. (2021). Stakeholder engagement is evolving: Do investors play a main role? *Business Strategy and the Environment*, 30(2), 1105–1120. <https://doi.org/10.1002/bse.2674>
- Ruiz-Blanco, S., Romero, S., & Fernandez-Feijoo, B. (2022). Green, blue or black, but washing—What company characteristics determine greenwashing? *Environment, Development and Sustainability*, 24(3), 4024–4045. <https://doi.org/10.1007/s10668-021-01602-x>
- Sanga M. H., & Situmorang R. (2024). The future of valuation: Combining ESG impact with EVA methodology for corporate's value. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.4932437>
- Senadheera, S., Gregory, R., Rinklebe, J., Farrukh, M., Rhee, J., & Ok, Y. (2022). The development of research on environmental, social, and governance (ESG): A bibliometric analysis. *Sustainable Environment*, 8(1). <https://doi.org/10.1080/27658511.2022.2125869>
- Shakil, M. H., Mahmood, N., Tasnia, M., & Munim, Z. H. (2019). Do environmental, social and governance performance affect the financial performance of banks? A cross-country study of emerging market banks. *Management of Environmental Quality: An International Journal*, 30(6), 1331–1344. <https://doi.org/10.1108/MEQ-08-2018-0155>
- Shan, X., Song, Y., & Song, P. (2024). How ESG performance impacts corporate financial performance: a DuPont analysis approach. *International Journal of Climate Change Strategies and Management*. <https://doi.org/10.1108/ijccsm-07-2024-0125>
- Shen, R. (2024). A study of the impact of ESG on total factor productivity in a dual-carbon context - Based on the moderating role of CEOs' overseas experience. *Sustainability*, 16(13), 5676. <http://dx.doi.org/10.3390/su16135676>
- Signori, S., & Fassin, Y. (2023). Family members' salience in family business: An identity-based stakeholder approach. *Journal of Business Ethics*, 183(1), 191–211. <https://doi.org/10.1007/s10551-021-04998-8>
- Sonjaya, Y. (2024). The influence of corporate culture on audit practices and ethics. *Golden Ratio of Auditing Research*, 4(2), 107–124. <http://dx.doi.org/10.52970/grar.v4i2.394>
- Tamasiga, P., Onyeaka, H., Bakwena, M., & Ouassou, E. (2024). Beyond compliance: evaluating the role of environmental, social and governance disclosures in enhancing firm value and performance. *SN Business & Economics*, 4(10), 118. <https://doi.org/10.1007/s43546-024-00714-6>
- Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance*, 61, 101427. <https://doi.org/10.1016/j.jcorpfin.2018.12.001>
- Tomaszewski, R. (2023). Visibility, impact, and applications of bibliometric software tools through citation analysis. *Scientometrics*, 128(7), 4007–4028. <https://doi.org/10.1007/s11192-023-04725-2>
- Velte, P. (2017). Does ESG performance have an impact on financial performance? Evidence from Germany. *Journal of Global Responsibility*, 8(2), 169–178. <https://doi.org/10.1108/JGR-11-2016-0029>
- Wagner Mainardes, E., Alves, H., & Raposo, M. (2012). A model for stakeholder classification and stakeholder relationships. *Management Decision*, 50(10), 1861–1879. <https://doi.org/10.1108/00251741211279648>
- Wan, G., Dawod, A. Y., Chanaim, S., & Ramasamy, S. S. (2023). Hotspots and trends of environmental, social and governance (ESG) research: a bibliometric analysis. *Data Science and Management*, 6(2), 65–75. <https://doi.org/10.1016/j.dsm.2023.03.001>
- Wang, H., Li, S., Gong, Y., & Wang, Y. (2024). The impact of corporate social responsibility on green innovation: A test based on meta-analysis. *Chinese Management Studies*. <https://doi.org/10.1108/CMS-04-2024-0258>
- Wichianrak, J., Khan, T., Teh, D., & Dellaportas, S. (2023). Critical perspectives of NGOs on voluntary corporate environmental reporting: Thai public listed companies. *Sustainability*, 15(7), 6195. <https://doi.org/10.3390/su15076195>
- Windsor, D. (2010). The role of dynamics in stakeholder thinking. *Journal of Business Ethics*, 96 (Suppl 1), 79–87. <https://doi.org/10.1007/s10551-011-0937-3>
- Xie, J., Nozawa, W., Yagi, M., Fujii, H., & Managi, S. (2019). Do environmental, social, and governance activities improve corporate financial performance? *Business Strategy and the Environment*, 28(2), 286–300. <https://doi.org/10.1002/bse.2224>
- Yavuz, M.S., Tatli, H.S., Bozkurt, G., & Öngel, G. (2025). Does ESG performance have an impact on financial performance? Evidence from Turkey. *Journal of Entrepreneurship, Management and Innovation*, 21(1), 24–42. <https://doi.org/10.7341/20252112>
- Yu, E. P. Y., Luu, B. V., & Chen, C. H. (2020). Greenwashing in environmental, social and governance disclosures. *Research in International Business and Finance*, 52, 101192. <https://doi.org/10.1016/j.ribaf.2020.101192>
- Zacccone, M. C., & Pedrini, M. (2020). ESG factor integration into private Equity. *Sustainability*, 12(14), 5725. <http://dx.doi.org/10.3390/su12145725>
- Zhang, X., Li, H., & Zhao, Y. (2022). ESG and firm's default risk. *Finance Research Letters*, 47, 102713. <https://doi.org/10.1016/j.frl.2022.102713>
- Zumente I., & Bistрова J. (2021). ESG importance for long-term shareholder value creation: literature vs. practice. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(2), 127. <https://doi.org/10.3390/joitmc7020127>

Biographical notes

Joanna Błach (Ph.D., Hab.) is an Associate Professor at the Department of Corporate Finance and Insurance at the Faculty of Finance, University of Economics in Katowice, Poland. Her research interests include corporate financial strategy, financial innovations, and corporate governance. She gives lectures on corporate finance, financial analysis, sustainable finance and financial economics. She is a member of the Polish Economic Association, British Accounting and Finance Association and European Finance Association.

Iwona Gorzeń-Mitka, Ph.D., is an Assistant Professor, Department of Corporate Finance and Insurance, Faculty of Finance, University of Economics in Katowice (Poland). Her research interests include risk in corporate decision-making, enterprise risk management (application of ERM to ESG risks), risk management standards and methodologies, risk in organisational culture. She is the author (co-author) of 3 books and more than 120 scientific papers. She is deputy

editor-in-chief of the journal “Problems of Management in 21st Century”. She is a member of scientific and professional associations, e.g. AOM, IRM Institute of Risk Management, Polish Economic Society, ERRN European Risk Research Network, The Global Association of Risk Professionals.

Małgorzata Lipowicz, Ph.D., is an Assistant Professor, Department of Corporate Finance and Insurance, Faculty of Finance, University of Economics in Katowice (Poland). Her research interests include corporate finance, raising capital by enterprises, sustainable finance, corporate governance and green bonds and blue bonds. She is the author of more than 10 scientific publications. She is a member of scientific and professional associations, e.g. Polish Economic Society, Data Management Association (DAMA). Her teaching experience includes finance-related courses for bachelor and master students.

Author contributions statement

Joanna Błach: Conceptualization, Investigation, Methodology, Supervision, Writing – Original Draft, Writing – Review & Editing. **Iwona Gorzeń-Mitka:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Supervision, Visualization, Writing – Original Draft, Writing – Review & Editing. **Małgorzata Lipowicz:** Data Curation, Investigation, Methodology, Resources, Software, Validation, Writing – Original Draft, Writing – Review & Editing.

Conflicts of interest

The authors declare no conflict of interest.

Citation (APA Style)

Błach, J., Gorzeń-Mitka, I., & Lipowicz, M. (2025). Scientific mapping of environmental, social, and governance (ESG) research from the perspective of stakeholders: A content analysis study. *Journal of Entrepreneurship, Management and Innovation*, 21(4), 76-102. <https://doi.org/10.7341/20252144>

DOI: <https://doi.org/10.7341/20252145>
JEL Codes: L23, M11

Toward Industry 5.0: Mapping technologies, competencies, and research opportunities

Camila Fabrício Poltronieri¹ , Luciana Rosa Leite² 
Yasmin Silva Martins Xavier³ , José Pedro Teixeira Domingues⁴ 
José Carlos de Toledo⁵ , Otávio José de Oliveira⁶ 

Abstract

PURPOSE: The goal of this study is to map the current state of academic knowledge on Industry 5.0 by identifying key technologies, required competencies, and emerging thematic areas through a systematic literature review. Based on this analysis, the study proposes a conceptual framework that synthesizes these findings to support future research and enhance understanding of this evolving industrial paradigm—particularly by identifying critical capabilities for implementing human-centric, sustainable, and resilient strategies aligned with the Sustainable Development Goals (SDGs). **METHODOLOGY:** A systematic literature review was conducted by querying the Scopus and Web of Science databases. This comprised eight steps designed to comprehensively understand existing literature on I5.0. In total, 470 papers were assessed, 112 of which qualified for subsequent data extraction and analysis. **FINDINGS:** The study organizes existing literature into five key thematic domains that structure current academic knowledge and guide future research on Industry 5.0: (1) Technologies and Digital Development; (2) Education, Skills, and Knowledge, alongside People, Ethics, Health, and Safety; (3) Society, Laws, and Government; (4) Benefits, Challenges, and General Factors, in conjunction with Organizational Strategy and Management; and (5) Sustainability. These domains offer a comprehensive perspective on the core components and interdependencies that characterize the Industry 5.0 paradigm. The findings also indicate that future research should prioritize empirical studies that examine how human-centricity, resilience, and sustainability are being operationalized within real-world industrial contexts. **IMPLICATIONS:** This study highlights specific gaps for future research, particularly the need to explore how human-centricity, sustainability, and resilience are integrated in practice. For organizations, the findings provide clarity on key technologies, competencies, and strategic priorities, helping guide transitions aligned with the SDGs. **ORIGINALITY:** While grounded in a systematic literature review, this study offers originality by structuring dispersed academic knowledge into five thematic domains that reflect the evolving nature of Industry 5.0. The resulting framework does not claim to be a new theoretical model but adds value by connecting concepts, technologies, competencies, and implementation challenges in a coherent and actionable structure. This contribution helps scholars frame future research and offers organizations a clearer path to navigating the Industry 5.0 landscape.

¹ Camila Fabrício Poltronieri, Ph.D., Professor, Department of Chemical and Production Engineering, Lorena School of Engineering (EEL), University of São Paulo (USP), Estrada Municipal do Campinho, s/n, Lorena, 12602-810, São Paulo, Brazil, e-mail: camilafp@usp.br (ORCID: <https://orcid.org/0000-0001-5829-2462>). Corresponding author.

² Luciana Rosa Leite, Ph.D., Professor, Department of Production and Systems Engineering, State University of Santa Catarina (UDESC), Rua Paulo Malschitzki, 200, 89219-710, Joinville, Santa Catarina, Brazil, e-mail: luciana.leite@udesc.br (ORCID: <https://orcid.org/0000-0002-7240-9070>).

³ Yasmin Silva Martins Xavier, Ph.D., Professor, Production Department, Faculty of Engineering and Sciences, São Paulo State University (UNESP), Av. Dr. Ariberto Pereira da Cunha, 333, 12516-410, Guaratinguetá, São Paulo, Brazil, e-mail: yasmin.xavier@unesp.br (ORCID: <https://orcid.org/0000-0002-7582-7876>).

⁴ José Pedro Teixeira Domingues, Ph.D., Principal Researcher, ALGORITMI Research Centre/LASI, University of Minho, R. da Universidade, 4710-057, Braga, Portugal, e-mail: pdomingues@dps.uminho.pt (ORCID: <https://orcid.org/0000-0003-1406-4905>).

⁵ José Carlos de Toledo, Ph.D., Full Professor, Department of Production Engineering, Federal University of São Carlos (UFSCar), Rodovia Washington Luís, km 235, 13565-905, São Carlos, São Paulo, Brazil, e-mail: toledo@dep.ufscar.br (ORCID: <https://orcid.org/0000-0002-7625-0984>).

⁶ Otávio José de Oliveira, Ph.D., Full Professor, Production Department, Faculty of Engineering and Sciences, São Paulo State University (UNESP), Av. Dr. Ariberto Pereira da Cunha, 333, 12516-410, Guaratinguetá, São Paulo, Brazil, e-mail: otavio.oliveira@unesp.br (ORCID: <https://orcid.org/0000-0002-5192-3644>).

Received 4 April 2025; Revised 15 June 2025; 10 August 2025; Accepted 11 September 2025.

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Keywords: Industry 5.0, I5.0, 5th industrial revolution, human-centric manufacturing, sustainable industrial systems, resilient production, digital technologies, competencies and skills, sustainable development goals (SDGs), organizational strategy, socio-technical systems

INTRODUCTION

Industry 5.0 (I5.0) refers to the use of technology not only to drive economic growth and job creation but also to support sustainability and place a strong emphasis on worker well-being (Breque et al., 2021). In line with this vision, the World Economic Forum introduced a new multidimensional framework in 2024 to evaluate national progress beyond GDP. This framework is built on four pillars: Innovation, Inclusion, Sustainability, and Resilience (WEF, 2024). The topic is gaining increasing attention in both academic and industrial circles (Madsen & Berg, 2021; Ghobakhloo et al., 2023). Indeed, several authors, including Xu et al. (2021), Cillo et al. (2022), and Madsen and Slåtten (2023), argue that the COVID-19 pandemic underscored the fragility of global supply chains and highlighted the need to rethink business models and work practices. The aim is to build industries that are better equipped for the future: more resilient, human-centric, and sustainable.

Most Industry 5.0 (I5.0) technologies have evolved from the advancements made during Industry 4.0 (I4.0), which primarily focused on digital transformation and the use of AI-driven technologies to enhance production flexibility and efficiency (Atif, 2023). While I4.0 emphasized process optimization, it often overlooked the human costs associated with these improvements. In this context, Nahavandi (2019) notes that I4.0 may encounter challenges and resistance, particularly due to concerns over job displacement and environmental impact. Joseph Schumpeter's theory of technological change helps explain how paradigms such as Industry 4.0 and Industry 5.0 emerge through innovation and "creative destruction," replacing old technologies and redefining production, work, and consumption models.

Although many Industry 4.0 (I4.0) technologies can also be applied within Industry 5.0 (I5.0), their implementation must now prioritize essential social needs, values, and responsibilities as core objectives. Several studies (Xu et al., 2021; Saniuk et al., 2022; Grabowska et al., 2022; Narkehede et al., 2024) suggest the emergence of a new techno-social revolution, in which technology serves as an enabler and social needs become the primary focus. This shift represents a fusion of two paradigms: the technology-driven approach of I4.0 and the value-driven perspective of I5.0 (Xu et al., 2021).

Nahavandi (2019) argues that I5.0 may offer a solution to the limitations of I4.0 by fostering a collaboration between humans and machines, allowing for greater use of human creativity and intellect to enhance both process efficiency and sustainability through the integration of intelligent systems into workflows. Similarly, Daoud et al. (2025) contend that I5.0 has the potential to drive innovation aligned with the Sustainable Development Goals (SDGs), promoting a more sustainable and human-centered model of development.

One key distinction between Industry 4.0 (I4.0) and Industry 5.0 (I5.0) lies in their core focus: while I4.0 emphasizes digitization and customization, I5.0 shifts toward personalization (Javaid & Haleem, 2020). The advancements made under I4.0 provide a foundation for the I5.0 framework, which is built on three main pillars: human-centricity, sustainability, and resilience (Nahavandi, 2019; Jafari et al., 2022; Ghobakhloo et al., 2022; Atif, 2023). The human-centric approach prioritizes individuals' interests, needs, and expectations, placing them at the heart of the production process. Rather than asking what can be done with new technologies, the guiding question becomes: what can these technologies do for humans? Furthermore, an exclusive focus on profit has proven to be unsustainable. It is now crucial—and increasingly urgent—to integrate social and environmental concerns in order to maximize not only efficiency and profit, but also long-term prosperity for all stakeholders, including shareholders, employees, customers, and society as a whole. This perspective also resonates with the Society 5.0 (Fukuyama, 2018), which emphasizes a human-centered technological evolution aimed at addressing societal challenges and enhancing overall well-being. In terms of resilience, Industry 5.0 emphasizes building greater robustness in industrial production, aiming to prevent disruptions and enable faster recovery from crises—specifically, events that could lead to process underperformance (Fonda & Meneghetti, 2022; Lu et al., 2022a; Atif, 2023; Madsen & Slåtten, 2023).

The European Commission has taken proactive steps to promote this vision through initiatives such as the Industry 5.0 Community of Practice (CoP 5.0), which supports the implementation of the New European Innovation Agenda (NEIA). This community brings together stakeholders to exchange ideas and advance innovation efforts aligned with I5.0 principles (European Commission, 2023a). However, Madsen and Berg (2021) and Ben Youssef and Mejri (2023) highlight the ongoing need for clearer and more consistent definitions of I5.0. To date, much of the existing literature offers only a broad overview, focusing on publication trends and identifying key documents, authors, sources, and countries—without delving deeply into the conceptual and practical dimensions of Industry 5.0.

Given the significance of the issues at stake—for academia, the business sector, and society at large—this paper aims to address the following research question (RQ):

RQ: What are the key issues that must be addressed in future research on Industry 5.0?

The main goal of this study is to map the current state of academic knowledge on Industry 5.0 by identifying key technologies, required competencies, and emerging thematic areas through a systematic literature review. Therefore, we propose a framework that organizes the core concepts and thematic trends found in the I5.0 literature, while also highlighting the central challenges that may shape future research directions.

To support this goal, a Systematic Literature Review (SLR) was conducted based on the methodology proposed by Tranfield et al. (2003). This structured approach allows researchers to “locate existing studies, select and evaluate contributions, analyze and synthesize data, and report the evidence in such a way which allows reasonably clear conclusions to be reached about what is already known” on a particular subject (Denyer & Tranfield, 2009, p. 671).

This article is organized into five sections. The first introduces and contextualizes the research problem, followed by a statement of the study’s purpose. The second provides the theoretical background necessary to understand the central topic of Industry 5.0 (I5.0). The third outlines the entire Systematic Literature Review (SLR) process and highlights the study’s main contributions and originality. The fourth section presents the key definitions, tools, skills, and capabilities associated with I5.0 identified in the literature, which are then analyzed within a theoretical framework and used to propose a research agenda. Finally, the fifth section summarizes the main findings and discusses the study’s limitations and opportunities for future research.

LITERATURE REVIEW

It is important to raise certain questions and clarify key concepts related to Industry 4.0 (I4.0), Industry 5.0 (I5.0), the Fifth Industrial Revolution, and Society 5.0, as these terms are often sources of confusion and are sometimes used interchangeably or even merged. Pessôa and Becker (2020) draw a distinction between I4.0 and the Fourth Industrial Revolution, noting that I4.0 is specifically focused on the industrial environment, while the Fourth Industrial Revolution extends the I4.0 concept beyond the factory floor to encompass broader societal impacts. The authors also emphasize that the term “Industry 4.0” was introduced and formally defined at the Hannover Fair in 2011, whereas the Fourth Industrial Revolution—like its predecessors—does not have a fixed starting point and is typically viewed as a gradual and evolving process.

Breque et al. (2021) explain that the concept of Industry 5.0 (I5.0) originated from a 2020 meeting that brought together European research institutions, technology organizations, and funding agencies. This meeting resulted in a European Commission document titled “Industry 5.0: Towards a sustainable, human-centric and resilient European industry.” However, the exact timing of when the concept first emerged is still debated. Breque et al. (2021) also note that the idea of Society 5.0 was introduced earlier, in 2016, by an industrial federation in Japan. Furthermore, the way people secure their livelihoods is closely tied to how they shape society, with the numbering of societies (such as Society 5.0) following a different timeline than that of Industry 5.0. The first two societies correspond to pre-industrial eras. Society 3.0 roughly overlaps with the first, second, and part of the third industrial revolutions. Society 4.0 represents a highly digitized stage that spans the third industrial revolution up to the present day. According to this model, the upcoming Society 5.0 aims to balance solutions to environmental and social challenges alongside economic growth.

Although the European Commission has played a significant role in advancing Industry 5.0, research on the topic is clearly spreading well beyond Europe. Martins et al. (2022) identify India, Italy, and the USA as the three leading countries in conducting and publishing research on I5.0. Similarly, Slavic (2023) points to China, India, and Italy as the most productive countries in terms of publication volume. Rejeb et al. (2025) also highlight China, India, and Italy as the top contributors to the literature. While Italy consistently appears as a key player in all three studies, the other leading countries are outside Europe. This demonstrates that, from a scientific standpoint, knowledge about Industry 5.0 is increasingly expanding across regions worldwide.

Kraaijenbrink (2022) argues that the core of Industry 5.0 (I5.0) marks a shift in focus from economic value to social value. Integrating social and environmental concerns into industry is not entirely new—it echoes concepts like Corporate Social Responsibility, ESG, and the Triple Bottom Line. Ghobakhloo et al. (2023b) also emphasize that many sustainable manufacturing practices discussed are not unique to I5.0. In fact, Piccarozzi et al. (2023) note that Industry 4.0 (I4.0)

offers technologies that can advance sustainability but require a systemic perspective combined with innovative business models. Kraaijenbrink (2022) points out that while many ideas within I5.0 have been explored before, the proposal to prioritize the planet and people over profits and growth as the defining goals of industry is unprecedented. This represents a fundamental rethinking of the industry's core objectives. This paradigm shift also aligns with broader policy efforts, such as those supported by the European Structural and Investment Funds (ESIF), which seek to foster economic, social, and territorial cohesion through inclusive and sustainable growth initiatives (Veiga, 2025).

Along these lines, Nahavandi (2019) suggests that, unlike Industry 4.0 (I4.0), which focuses on improving process efficiency through automation often without considering the human cost, Industry 5.0 (I5.0) aims to use automation to enhance the work experience for employees. Its goal is to bring people back into the workplace and improve process efficiency by supporting collaboration. In fact, while Industry 5.0 emphasizes human-centricity, ethics, and societal well-being, the ethical foundations of its implementation remain insufficiently developed. There is a notable gap between the aspirational discourse on ethical industrial transformation and the concrete mechanisms by which ethical principles are operationalized in practice.

Moreover, Potoczek (2021) points out that the digitalization driven primarily by Industry 4.0 has been influenced not only by technological innovation but also by customer demands and various social, environmental, political, and health factors that have contributed to the rise of Industry 5.0. According to Vacchi, Siligardi, and Settembre-Blundo (2024), the shift from Industry 4.0 to Industry 5.0 represents a paradigm change—from automation and data collection to smart manufacturing and human-centered automation. Nahavandi (2019) argues that I5.0 offers a solution by integrating humans and machines, harnessing human creativity and intellectual capacity to boost process efficiency through the combination of workflows and intelligent systems.

According to Pathak et al. (2019), the core principles of Industry 5.0 (I5.0) include mass customization (tailoring products or services to individual needs), cultural collaboration (breaking down borders between countries and regions to foster new ideas that improve products), customer centricity (placing customer aspirations at the center), cyber-physical systems (developing intelligent systems that help meet customer needs), and green computing (emphasizing the use of renewable energy sources). Bettiol et al. (2023) further explain that knowledge creation and innovation rely not only on technology but also on the relationships a company builds both within and beyond its organizational boundaries. Therefore, since I5.0 emphasizes human-centricity, prioritizing the quality of relationships inside and between organizations is crucial for effective knowledge and innovation management.

METHODOLOGY

This article presents a systematic literature review (SLR), which is defined as a method for searching and analyzing scientific articles in a specific area of interest to ensure greater rigor and more reliable results (Denyer & Tranfield, 2009). Following the approach outlined by Tranfield et al. (2003), the SLR was carried out in eight steps, organized into three phases: planning, conducting, and reporting (see Figure 1).

By examining the current research landscape on Industry 5.0 (I5.0) and reviewing the existing literature (step 1), the main gap identified was the lack of in-depth investigation into this emerging topic. Therefore, this systematic literature review (SLR) aims to establish a foundation for identifying and organizing key concepts and themes related to I5.0, and proposes a framework to guide future research efforts.

To explore this literature, four review questions were formulated, derived from the overall research question:

RQ1: What are the definitions and foundational concepts surrounding Industry 5.0?

RQ2: What are the most relevant technologies and tools for implementing Industry 5.0?

RQ3: What skills and capabilities are required for implementing Industry 5.0?

RQ4: What gaps and research opportunities exist within Industry 5.0?

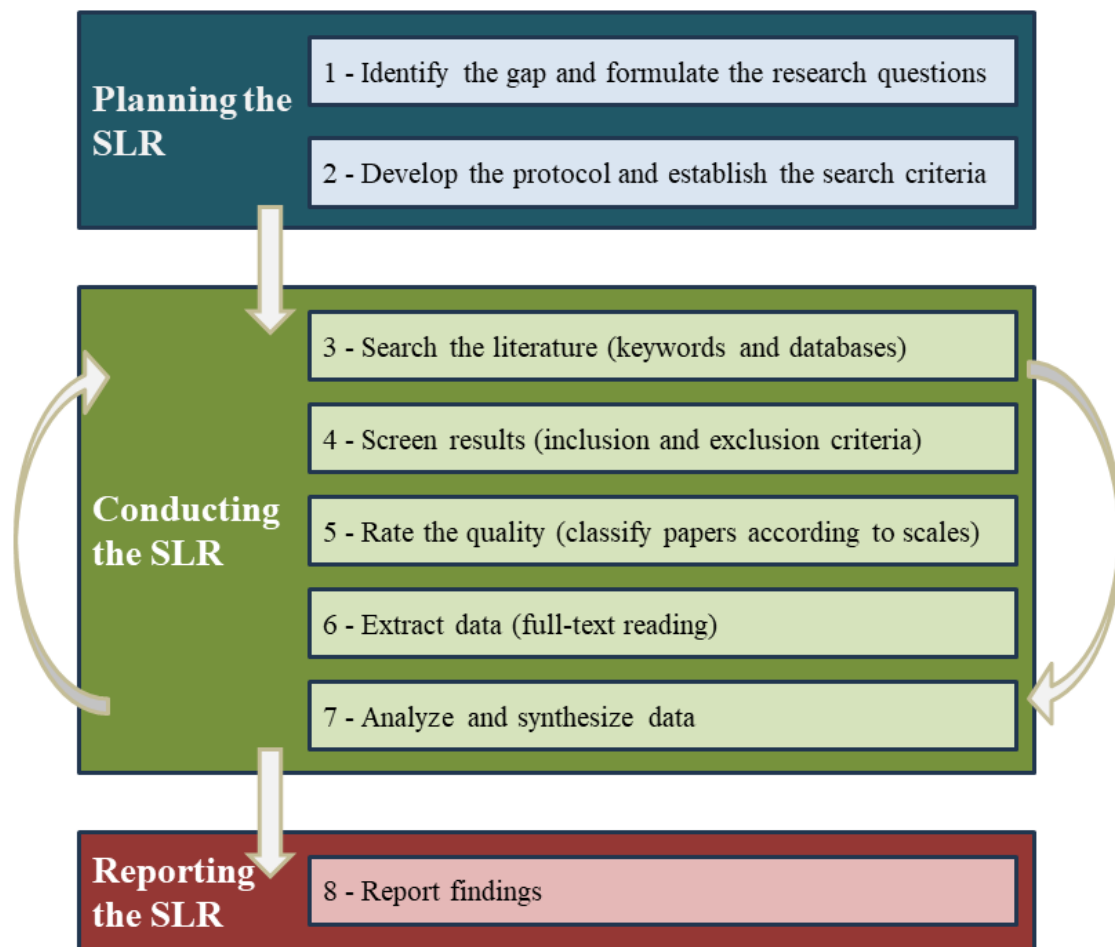


Figure 1. SLR process.

Source: Adapted from Tranfield et al. (2003).

The following criteria were established to develop the research protocol (step 2). Scopus and Web of Science were chosen as the primary databases due to their extensive coverage and accessibility of relevant articles. Initially, the authors considered other databases, such as ScienceDirect, EBSCO, and PubMed. However, most of the relevant articles were already identified through searches in Scopus and Web of Science. Since both are well-established and comprehensive databases (Mongeon & Paul-Hus, 2016; Li et al., 2016), the search was focused on these two. In research areas that are relatively new or specialized, broader database coverage is especially important for capturing a wider range of relevant studies (Balstad & Berg, 2020; Zupic & Cater, 2014).

After testing various terms, “Industry 5.0” was selected as the search string for the title, keywords, and abstract fields, as the goal of this review is to gather broad and up-to-date information on this emerging topic (step 3). The authors decided not to include specific keywords directly related to I5.0, since existing systematic literature reviews already cover those aspects. For example, Alves et al. (2023) focused on the human-centricity of I5.0, Ghobakhloo et al. (2023) discussed I5.0 in relation to sustainability, and Borchardt et al. (2022) examined resilience from the perspective of education and training.

No time frame was applied to capture the earliest appearance of this topic in academic literature. After the initial search results, duplicate papers were removed. Two inclusion criteria were then applied in the first screening: language—excluding any articles not written in English, Spanish, or Portuguese—and accessibility—excluding articles lacking access information such as a DOI (step 4). These criteria were set to ensure that the selected articles are in languages familiar to the researchers and are readily accessible, thereby supporting the replicability of the study.

The results presented here were obtained by following the research protocol outlined in Figure 1 and detailed in Figure 2. The initial database search was conducted in December 2021, yielding 105 papers that were analyzed and

categorized according to the established criteria (step 5). The search was then updated twice: first in August 2022, covering papers published between December 2021 and August 2022, which added 169 new articles; and again in May 2023, covering August 2022 to May 2023, which added 196 more articles. Out of a total of 1,419 documents identified, 470 were screened, and 112 were selected for data extraction.

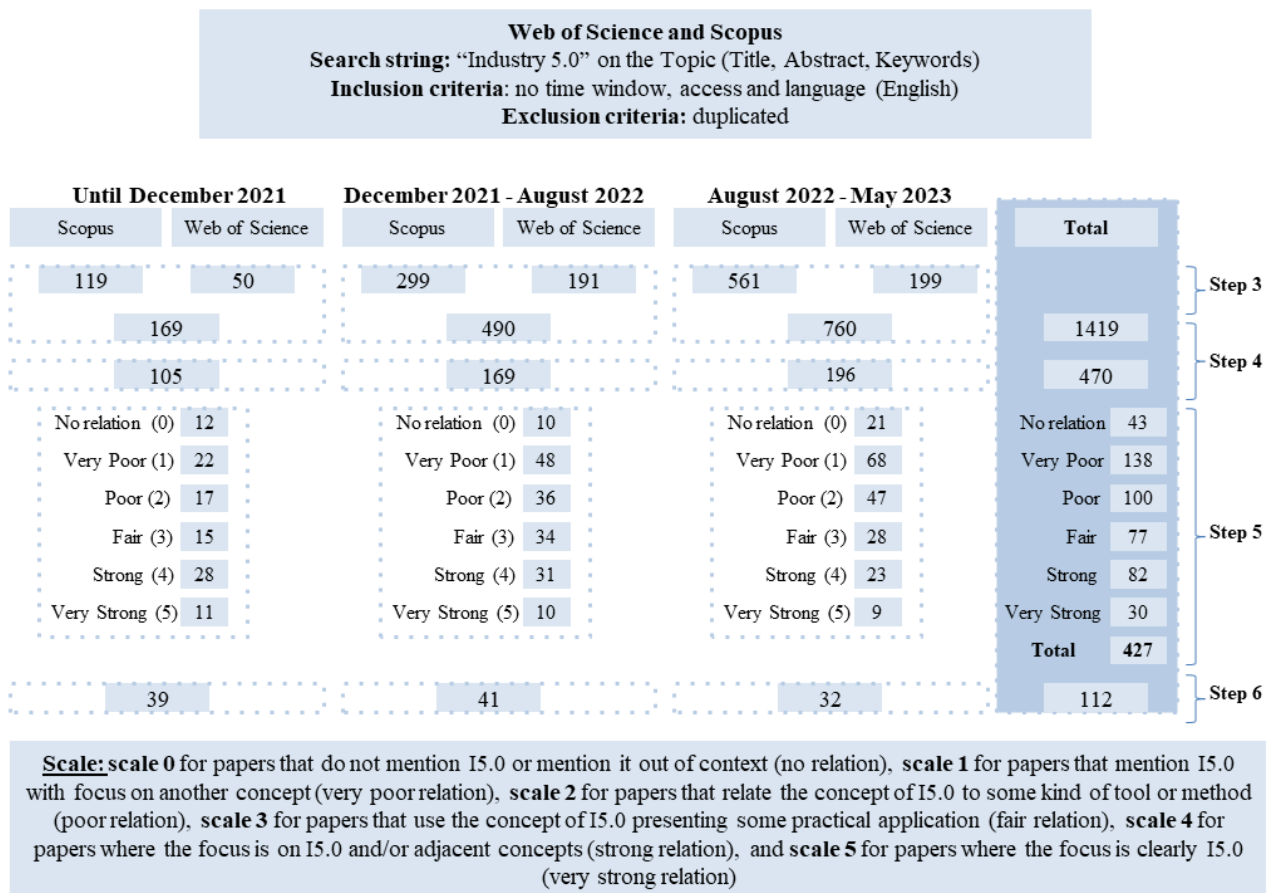


Figure 2. Overview of the SLR

Before analysis, the papers were classified according to their relevance to Industry 5.0 (I5.0) using the scale proposed by Martins et al. (2022) (step 5). Only those rated as “strong” or “very strong” were included for data extraction and analysis, as they were considered most relevant to addressing the review questions (steps 6 and 7). The results of the systematic literature review (SLR) are presented in the results and discussion section (step 8).

Out of the 470 papers assessed during the quality rating process (step 5), 82 were rated as strong (4) and 30 as very strong (5) in their relation to I5.0, and were thus selected for full-text data extraction (see Figure 2). The SLR team consisted of four researchers working in pairs to conduct the classification rounds, with each pair reviewing the other’s work to ensure consistency and quality.

The 82 papers rated as strong (4) and the 30 rated as very strong (5)—a total of 112 documents—were selected for data extraction through full-text reading. Their content formed the basis for reporting the results. Figure 3 illustrates the publication trends over the years: out of 427 selected papers (excluding those rated 0, meaning no relation to I5.0), 222 were published in 2022 and 88 in 2023 (up to May), representing over 70 percent of the total.

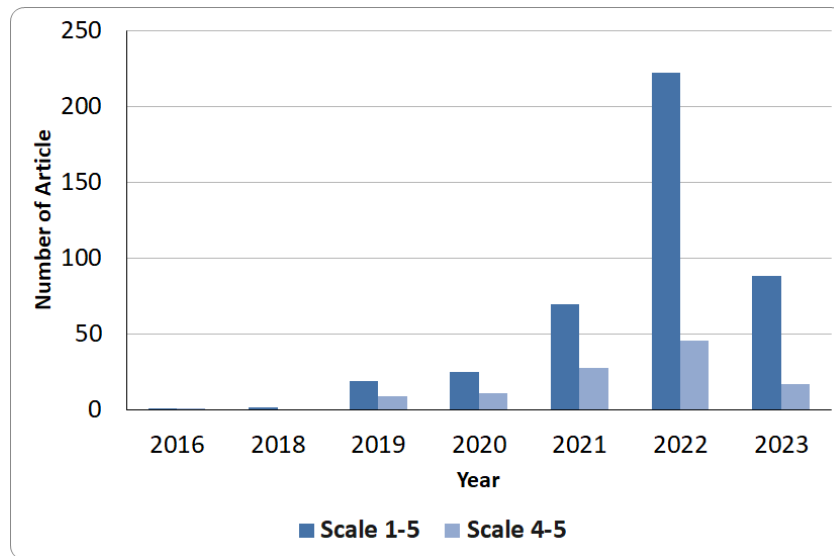


Figure 3. Number of publications by year

Finally, Figure 4 provides a summary of the research steps. The data extraction process involved a thorough reading of each of the 112 selected articles, followed by systematic recording of information using spreadsheet software. Basic bibliographic details were collected, including authorship, publication source, research method, and keywords. Additionally, the following elements were manually coded: the definition of Industry 5.0 used, references to Society 5.0, cited technologies and applications, the main contributions of each study, as well as identified research gaps and emerging trends.

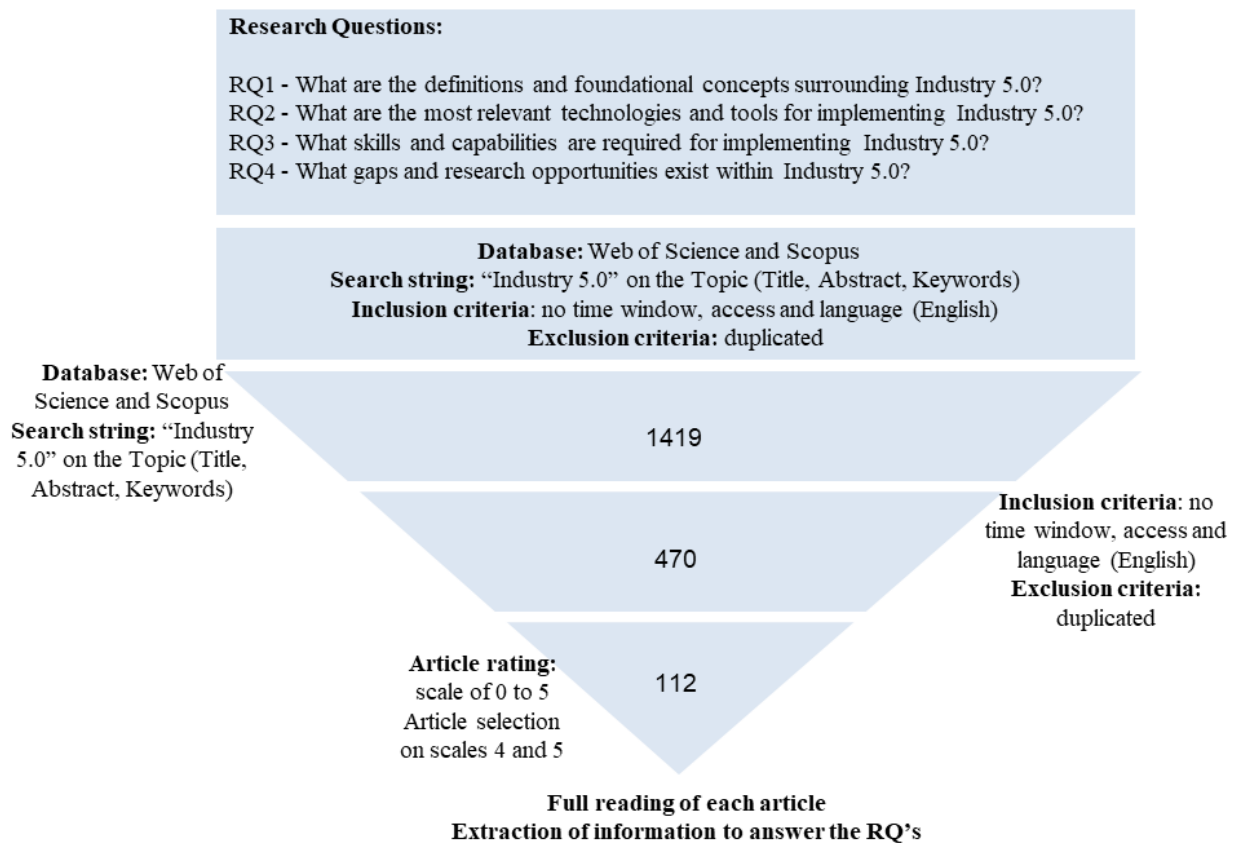


Figure 4. Research stages

While this approach (Figure 4) helped maintain clarity in the scope of the review, it may not have captured studies that address related ideas using alternative terminology—such as “fifth industrial revolution,” “human-centric manufacturing,” or “Society 5.0”. Additionally, the review was limited to two databases (Scopus and Web of Science), publications in English, Spanish, or Portuguese, and access was restricted to institutional affiliations in Brazil and Portugal.

RESULTS AND DISCUSSION

The findings (step 8 of the SLR process) are presented in the following sections, organized around this article’s four research questions. The analysis includes articles selected across the three data collection stages (Figure 2) and covers publications up to May 2023. Notably, among the 112 articles identified, the three countries with the highest number of publications are India (17), Italy (11), and the USA (7). This finding aligns with those from other studies, such as Martins et al. (2022), Slavic (2023), and Rejeb et al. (2025). Beyond these leading countries, the research also incorporates publications from a diverse range of regions worldwide. The top 12 countries by number of publications are: Ireland (5), the United Kingdom (5), Russia (5), Greece (4), Germany (3), China (3), Indonesia (3), Norway (3), and Poland (3).

The research methods identified during data extraction are summarized in Table 1, with the studies grouped as follows: The “reviews” category includes various literature review methods classified differently by authors, such as bibliometric analysis (BA), literature review (LR), constructive research methodology (CRM), integrative literature review (ILR), and systematic literature review (SLR). The “theoretical” group comprises papers that are neither reviews nor applied studies but offer discussions or descriptive approaches—sometimes labeled as theoretical studies—or editorial articles. The “qualitative” group includes case studies, action research, grounded theory, and interviews. The “quantitative” group encompasses studies that utilize statistical, modeling, or experimental analyses, as well as decision-making methods such as the Analytic Hierarchy Process (AHP), simulations, and surveys. Finally, the “mixed” group refers to articles combining qualitative or review methods with quantitative approaches, often considered applied studies related to I5.0. While some papers in the mixed methods group address applications related to digital technologies in I5.0, none report actual cases of I5.0 implementation. This highlights the need for more empirical research on this emerging topic.

Table 1. Distribution of publications by research methods

Research method	Total publications (n)
Theoretical	49
Reviews	30
Mixed	12
Quantitative	12
Qualitative	9
Total	112

Given the novelty of the concept, the authors anticipated that many papers from the SLR would be theoretical or focus on various types of literature reviews. This was taken into account during data analysis and synthesis (step 7) to identify the objectives of each review paper and to compare their goals with those of this study. Among the 30 review papers identified, 9 used bibliometric analysis, 12 were literature reviews, 1 applied constructive research methodology, 1 conducted an integrative literature review, and 7 performed systematic literature reviews.

Theoretical data were examined using content analysis, focusing on the keywords and research questions addressed in each review, which helped clarify the aims of each study. This approach revealed which aspects of each article were relevant to the present study. Notably, most authors (16 out of 30) conducted reviews on topics related to, but not directly focused on, Industry 5.0, often linking it to related concepts such as Society 5.0 and Employment 5.0, as summarized in Table 2.

Table 2. Review papers from SLR with no focus on Industry 5.0

Subjects only related to Industry 5.0	Review papers
Circular economy	Atif (2023)
Construction industry	Marinelli (2023)
Industry 4.0	Grabowska et al. (2022), Roblek et al. (2021), Mourtiz et al. (2022a), Kolade and Owoseni (2022), Dhirani et al. (2023), Marinelli (2022), Madhavan et al. (2022)
Innovation management	Aslam et al. (2020)
Lean manufacturing	Mladineo et al. (2021)
Maritime industry	Shahbakhsh et al. (2021)
Supply chain and smart logistics	Frederico (2021), Jafari et al. (2022)
Technological competitiveness	Alvarez-Aros and Bernal-Torres (2021)
Trauma and orthopaedics	Iyengar et al. (2022)

The remaining 14 articles are more focused on I5.0 itself and, consequently, show more similarities to this SLR as described in Table 3 and discussed as follows. Same database: Agarwal and Chauhan (2022), Borchardt et al. (2022), and Pizon and Gola (2023) also conducted their searches using the Scopus and Web of Science databases. However, their reviews were more targeted in scope, focusing respectively on: e-commerce and cobots; Industry 5.0 in the context of business and management operations; and human-machine interaction. Same keyword: Akundi et al. (2022) and Madsen and Berg (2021) chose to use “Industry 5.0” as their sole search term. Despite this similarity, their research methods and selected databases differ from those used in this SLR. Additionally, Akundi et al. (2022) limit their discussion to five major themes related to Industry 5.0 found in the literature, while Madsen and Berg (2021) explore the main differences between Industries 4.0 and 5.0, with a focus on bibliometric data. Same research method: Alves et al. (2023), Borchardt et al. (2022), Ghobakhloo et al. (2023), Hein-Pensel et al. (2023), and Tavares et al. (2022) also conducted systematic literature reviews (SLRs). However, as shown in Table 3, their approaches were more narrowly focused on specific aspects related to Industry 5.0, rather than the concept as a whole.

Table 3. Description of review papers from this SLR

Author (year)	Method	Search criteria	Main goals and discussions
Agarwal and Chauhan (2022)	Literature Review	Database: Scopus and Web of Science Keywords: „E-commerce industry” + „cobots” (and related terms)	This study focuses on the essential employability skills needed to work with cobots in the e-commerce industry, emphasizing that effective collaboration between cobots and humans relies on three key drivers: Human Resources acting as change agents, employees’ skills, and organizational support.
Akundi et al. (2022)	Literature Review	Database: IEEE, Science Direct and MDPI Keywords: „Industry 5.0”	The authors analyze the current state of Industry 5.0 and identify five major themes: supply chain, enterprise innovation, smart and sustainable manufacturing, transformation driven by Industry 4.0 technologies, and human-machine coexistence.
Alves et al. (2023)	Systematic Literature Review	Database: Science Direct, Scopus, and Web of Science Keywords: “Industry 5.0” + “Human-centricity”	Given the novelty of Industry 5.0, the authors center their discussion on its human-centric nature after presenting bibliometric data, raising the question: “If Industry 5.0 is human-oriented, will Industry 6.0 focus on environmental concerns?”
Ben Youssef and Mejri (2023)	Bibliometric Analysis	Database: Scopus Keywords: “Industry 5.0” + terms of I4.0 technologies + “smart sustainability”	The authors provide a general bibliometric analysis on Industry 5.0, highlighting that while the results cover a broad spectrum, there is still a need for more literature on the topic.
Borchardt et al. (2022)	Systematic Literature Review	Database: Scopus and Web of Science Keywords: “Industry 5.0” + filter of subject area “business and management operations”	The primary goal of the study is to analyze and understand Industry 5.0 from the perspective of business and operations management, identifying four main themes: technological applications, human resources and workers, education, and business and operations management.

Author (year)	Method	Search criteria	Main goals and discussions
Espina- Romero et al. (2023)	Bibliometric Analysis	Database: Scopus Keywords: „Industry 5.0” + „human-centered Industry 4.0”	The study aims to assess the current state of Industry 5.0 through bibliometrics, discussing the most influential industries and key topics for future research, such as sustainability, cobots, bioeconomy, smart cities, and sentiment analysis.
Ghobakhloo et al. (2023)	Systematic Literature Review	Database: Scopus, Web of Science, and Google Scholar Keywords: „Industry 5.0” + „Society 5.0”	This paper explains how Industry 5.0 transformation supports sustainable development. After reviewing previous research and outlining its main characteristics, the authors propose a roadmap of 11 critical enablers for sustainable industrial growth and recommend extending this work in future studies.
Hein-Pensel et al. (2023)	Systematic Literature Review	Database: SpringerLink, ScienceDirect, and ResearchGate Keywords: terms related to manufacturing, Industry 4.0, human-centricity, and maturity models	This study investigates whether existing maturity models for Industry 4.0 are suitable for evaluating digital transformation processes in the context of Industry 5.0, particularly emphasizing the human-centered perspective in small and medium-sized enterprises (SMEs).
Humayun (2021)	Literature Review	No search criteria were provided in the paper	Another author discusses general aspects of Industry 5.0, including concepts, applications, enabling technologies, opportunities, and challenges within the Fifth Industrial Revolution.
Madsen and Berg (2021)	Bibliometric Analysis	Database: Scopus Keyword: “Industry 5.0”	Through exploratory bibliometric analysis, authors compare Industry 4.0 and 5.0, examining publication trends in citations, countries, authors, and sources, while suggesting future research should include more in-depth review studies.
Pizon and Gola (2023)	Literature Review	Database: Scopus and Web of Science Keywords: terms related to human-machine + Industry 5.0	The authors explore the human-machine relationship within Industry 5.0, asking: “How is the perspective on human-machine relationships changing, and what developmental path accompanies these changes?”
Proia et al. (2022)	Literature Review	Database: IEEE Keyword: “cobots” (and related terms)	This study focuses on critical aspects of human-robot collaboration (HRC), identifying safety, ergonomics, and efficiency as the main priorities, alongside control techniques used in collaborative robotics.
Raja Santhi and Muthuswamy (2023)	Literature Review	Database: Google Scholar, Scopus, and Web of Science Keywords: combinations of “Industry 4.0” + “Industry 5.0” + various technologies	The authors identify and describe enabling technologies of Industry 4.0, their application across manufacturing functions, and discuss Industry 5.0’s sustainability aspects, suggesting it might be called “Industry 4.0S.”
Tavares et al. (2022)	Systematic Literature Review	Database: Scopus and Google Scholar Keywords: “Industry 4.0” + “Industry 5.0” + “Society 5.0” + “Education 5.0”	The authors highlight the paradigm of a new era they term “Era 5.0,” encompassing Society, Education, and Industry 5.0. They present discussions on each topic and on Industry 4.0, pointing out the most promising applications to develop a more humanistic and sustainable society.

None of the reviewed articles adopts the same methodological procedures and research criteria as those used in the present study. While some papers share a similar structure, the authors emphasize the following limitations and suggestions for future research: the need for more in-depth review studies that extend beyond bibliometric analysis and cover different timeframes, particularly using both Scopus and Web of Science databases, given the rapid emergence of the I5.0 topic (Madsen & Berg, 2021); and the necessity of expanding the literature on the definition and conceptual framing of Industry 5.0 (Ben Youssef & Mejri, 2023; Ghobakhloo et al., 2023).

To achieve the main goal of this study, which is to map the current state of academic knowledge on Industry 5.0 by identifying key technologies, required competencies, and emerging thematic areas through a systematic literature review, this SLR is guided by the four research questions outlined in the previous section. Addressing these questions is essential not only to understand the current state of the literature but also to consolidate existing knowledge and provide clear, precise definitions of Industry 5.0. In doing so, the study aims to identify and highlight real gaps in the field, which are subsequently incorporated into a proposed research agenda.

RQ1 – What are the definitions and foundational concepts surrounding Industry 5.0?

Although Industry 5.0 has gained increasing attention in academic and industrial discourse, the concept remains poorly defined. The absence of a unified and operationalized definition contributes to theoretical fragmentation and impedes the consolidation of a coherent research agenda. This ambiguity hinders the clear differentiation of Industry 5.0 from its predecessor, Industry 4.0, and impedes the development of robust frameworks for analysis and implementation.

According to Demir et al. (2019), the industrial revolutions were driven by the aim of separating “human work” from “machine work.” The term refers to technological advancements that have transformed society (Taj & Jhanjhi, 2022). Since 1784, it is evident that technological innovations have disrupted traditional production models, subsequently influencing societal development. Industry 1.0 harnessed the power of water and steam to perform mechanical work. Industry 2.0 introduced electricity as the key enabler of new production methods. The emergence of information technology in production processes led to the era of Industry 3.0, characterized by the automation of systems. Industry 4.0 (I4.0) emphasizes productivity enhancement through cutting-edge technologies, including the Internet of Things (IoT), robotics, artificial intelligence (AI), big data, and cloud computing (Javaid & Haleem, 2020; Mourtzis et al., 2022a).

According to Madsen and Slåtten (2023), unlike the well-documented onset of Industry 4.0 (I4.0), it is challenging to determine when Industry 5.0 (I5.0) began precisely. These authors suggest that the concept was first introduced by Michael Rada in 2015 via social media platforms. Since then, discussions surrounding I5.0 have grown steadily in both academic literature and on social media. In contrast, Breque et al. (2021) argue that I5.0 originated from a 2020 meeting involving European research institutions, technology organizations, and funding agencies.

Some of the earliest academic publications to reference I5.0 include works by Sachsenmeier (2016), Özdemir and Hekim (2018), Nahavandi (2019), and Alvarez-Aros and Bernal-Torres (2021). These studies began to address the challenges and societal impacts of I4.0 technologies, marking a shift toward the human-centric perspective now associated with I5.0. These early contributions can be considered seminal, as they highlight the need for a paradigm shift in the direction of industrial development. Figure 5 shows how frequently these foundational papers are cited across the 112 articles analyzed in this study, along with their key contributions to the conceptualization of Industry 5.0.

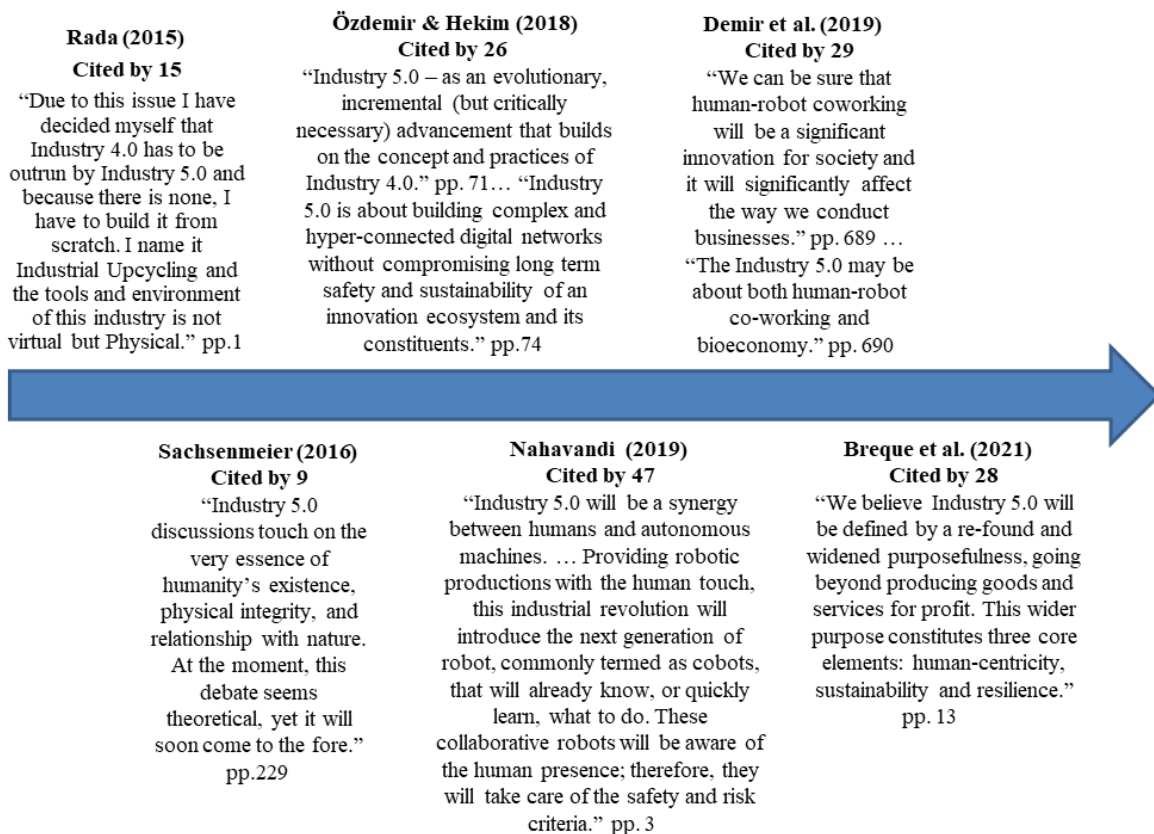


Figure 5. Industry 5.0 concepts identified in the analyzed articles

Although it is difficult to pinpoint the exact starting point of Industry 5.0 (I5.0), the concept has quickly gained traction among academic researchers, as illustrated in Figure 3. Despite the growing dissemination of ideas summarized in Table 1, Ghobakhloo et al. (2023a) argue that I5.0 remains an emerging and underdeveloped concept, with no consensus yet established around its definition. For example, echoing the perspectives of Rada (2015) and Sachsenmeier (2016), Østergaard (2020) describes I5.0 as the return of the “human touch” to the factory floor. In comparing Industry 4.0 and 5.0, Johansson (2017) explains that while I4.0 is primarily focused on interconnecting devices, I5.0 emphasizes collaboration between humans and machines in industrial environments. Similarly, Bednar and Welch (2020) note that I4.0 aimed to accelerate technological performance, whereas I5.0 emphasizes the need for synergy between technological and social systems to enable the mass customization of goods and services. Thus, rather than replacing human workers, I5.0 is centered on optimizing human–robot collaboration—leveraging each other’s strengths and compensating for their respective limitations (Welfare et al., 2019).

Several of the analyzed papers emphasize collaboration between humans and machines. For example, Nahavandi (2019), Javaid and Haleem (2020), Madsen and Berg (2021), Kumar et al. (2021), Shahbakhsh et al. (2022), Javaid et al. (2020), and Chin (2020) highlight the importance of human–machine synergy through the use of autonomous systems, collaborative robots, and other digital technologies. These technologies are applied to reduce waste, lower final manufacturing costs, and enable the production of more personalized products and services. As a result, it is expected that intelligent robots and systems will play a significant role in shaping the future of supply chains (Frederico, 2021).

Although Pathak et al. (2019) suggest that the primary goal of Industry 5.0 (I5.0) is to represent an evolutionary and incremental advancement of Industry 4.0 (I4.0), Xu et al. (2021) and Mourtzis et al. (2022a) emphasize that I5.0 should not be seen as a chronological continuation of I4.0. The European Commission (EC) instead proposes a paradigm shift, aiming to transform industry into a resilient engine of prosperity—one that respects planetary boundaries while placing the well-being of industrial workers at its core (Breque et al., 2021). As Xu et al. (2021) note, the COVID-19 pandemic highlighted the limitations of purely evolutionary approaches and underscored the need for a new industrial paradigm centered on resilience, human-centricity, and sustainability.

Breque et al. (2021) also highlight a growing synergy in Industry 5.0 (I5.0) between key technological drivers and societal development, organized into six main categories: human–machine interaction, bio-inspired technologies and smart materials, digital twins and simulation, big data analytics, artificial intelligence, and energy efficiency. While many of these technologies were already central to Industry 4.0 (I4.0), I5.0 emphasizes the importance of the human–machine interface in their application. In this regard, I5.0 does not introduce entirely new technologies or breakthroughs. Instead, this new industrial paradigm encourages companies to redefine their roles—not only as engines of job creation and economic growth, but also as contributors to broader environmental and social values (Lattanzio et al., 2022).

Pramanik et al. (2020) and Mladineo et al. (2021) describe Industry 5.0 (I5.0) as a natural evolution of Industry 4.0 (I4.0), emphasizing the European Commission’s concept, which frames I5.0 as the fusion of human creativity with the speed, productivity, and precision of robots. Similarly, other scholars—including Gürdür Broo et al. (2022), Akundi et al. (2022), Romero and Stahre (2021), Taj and Jhanjhi (2022), Bitsch (2022), and Mourtzis et al. (2022a)—present a shared understanding of I5.0 built on three core pillars: human-centricity, resilience, and sustainability. However, there is still a lack of consensus across the literature regarding these defining characteristics.

Figure 6 shows that most of the analyzed articles highlight human-machine interaction as the defining feature of Industry 5.0, with 41 articles emphasizing this aspect. This relationship—often referred to as “cobots”—suggests that collaborative robots working alongside humans can generate more creative solutions and enable customer-centric or personalized products (Doyle & Kopacek, 2021). The themes of human-centered design and sustainability also appear frequently, featured in 40 and 33 articles, respectively. Although resilience appears less often, the concept introduced by Breque et al. (2021) aligns well with the understanding of I5.0 found in the analyzed literature. Specifically, these results support Pramanik et al. (2020), who describe I5.0 as centered on human-machine collaboration with a focus on customized manufacturing. However, these authors view I5.0 not as a completely new paradigm but rather as an evolution of I4.0.

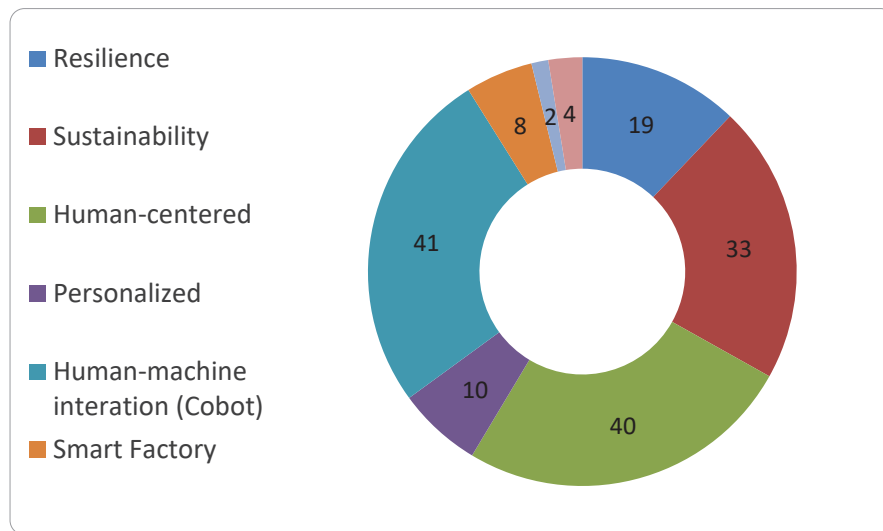


Figure 6. Elements of I5.0 cited in the analyzed articles (number of citations)

Babkin et al. (2022), Lattanzio et al. (2022), and Borchardt et al. (2022) emphasize that Industry 5.0 is not a new industrial revolution but rather an evolutionary extension of Industry 4.0 technologies, aimed at enhancing collaboration between humans and robots (Pizon & Gola, 2023; Alves et al., 2023). Industry 5.0 sets a forward-looking agenda that builds on the unique features of Industry 4.0 by placing sustainability at the heart of digital industrial transformation. Despite ongoing discussions, this concept must move beyond academic circles and be applied in practice. Industries must adopt a human-centric approach, prioritize sustainability, and foster resilience to become the driving force behind a new society (Xu et al., 2021). In short, while buzzwords like ‘Industry 6.0’ or ‘Industry 7.0’ might inspire academic papers or funding proposals, if they fail to translate into concrete business actions or technological solutions, they risk remaining mere theoretical ideas with little real impact on industrial progress or societal development.

RQ2 – What are the most relevant technologies and tools for implementing Industry 5.0?

Many authors note that while digital technologies from Industry 4.0 remain important in Industry 5.0, certain technologies will require greater focus (Xu et al., 2021). This is especially true for those related to sustainability, which is widely discussed today in contexts such as Environmental, Social, and Corporate Governance (ESG), as well as technologies aimed at energy efficiency, storage, renewable energy, and bio-inspired solutions. Demir et al. (2019) similarly highlight renewable resources, sustainable agricultural production, and bionics as key Industry 5.0 technologies.

From the SLR papers discussing technologies and tools in the context of Industry 5.0, two main groups emerge: those that identify Industry 4.0 technologies as the foundation for Industry 5.0, and those that emphasize novel tools and technologies more specifically aligned with the core pillars of Industry 5.0. Technologies linked to human-centricity tend to focus on collaborative robots and human-machine interaction, while those related to sustainability typically address production and operational contexts tied to resilience. These sustainability-related technologies are also closely connected to human factors such as training and education.

Table 4 summarizes the aforementioned tools, grouped by technology category, along with the authors who identified them as being relevant to Industry 5.0.

Table 4. Technologies and tools discussed by the SLR papers

Technologies and tools related		References that mention or suggest them
Human- centricity	Cobots/Collaborative Robots, Individualized human-machine interaction, Worker-friendly ergonomic design	Aceta et al. (2022), Agarwal and Chauhan (2022), Al Mubarak (2022), Alves et al. (2023), Bednar and Welch (2020), Cimini et al. (2022), Demir et al. (2019), Doyle-Kent and Kopacek (2021), Duggal et al. (2021), Emma-Ikata and Doyle-Kent (2022), Frederico (2021), Gervasi et al. (2023), Haleem and Javaid (2019), Javaid and Haleem (2020), Javaid et al. (2020), John et al. (2020), Kemendi et al. (2022), Kukreja and Kumar (2020), Kumar Singh and Sobti (2022), Lu et al. (2022b), Lykov and Razumowsky (2023), Madsen and Slåtten (2023), Marinelli (2022), Nahavandi (2019), Pathak et al. (2019), Pizon and Gola (2023), Prassida and Asfari (2021), Raja Santhi and Muthuswamy (2023), Taj and Jhanjhi (2022), Xu et al. (2021)
Sustainability	Bioengineering, Bio-inspired technologies, Smart Materials, Renewable Resources, Sustainable Agricultural Production, Bionics, Advanced Materials, Nanotechnology, Sustainable Manufacturing, Smart grids	Demir et al. (2019), Duggal et al. (2021), Ghobakhloo et al. (2023a), Habash (2022), Möller et al. (2022), Xu et al. (2021)
Resilience	Biological transformation, Virtual training, Worker Assistance Systems	Cimini et al. (2022), Nahavandi (2019), Rauch (2020)
Industry 4.0	Big data, Smart sensors, Internet of Things (IoT), Internet of Everything (IoE), Artificial Intelligence (IA) and emerging artificial intelligence, Blockchain, Multi-agent systems and technologies, Digital Ecosystem, Digital twins, Smart manufacturing/Smart factory, Smart cities, Complex adaptive systems, 3D printing, 4D printing, 5D printing, 3D scanning, Holography, Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), Extended Reality (XR), Cyber-Physical Systems (CPS), Information and Communication Technology (ICT), machine learning, 6G communications	Adel (2022), Al Mubarak (2022), Alvarez-Aros and Bernal-Torres (2021), Alves et al. (2023), Atif (2023), Boschetti et al. (2023), Bitsch (2022), Demir and Cicibaş (2019), Emma-Ikata and Doyle-Kent (2022), Frederico (2021), Garcia Rivera et al. (2022), Ghobakhloo et al. (2023b), Humayun (2021), Javaid and Haleem (2020), Javaid et al. (2020), John et al. (2020), Johri et al. (2021), Kemendi et al. (2022), Khaimovich et al. (2020), Khan et al. (2022), Kolade and Owoseni (2022), Kukreja and Kumar (2020), Kumar Singh and Sobti (2022), Lykov and Razumowsky (2023), Maddikunta et al. (2021), Marinelli (2022), Martynov et al. (2019), Mladineo et al. (2021), Möller et al. (2022), Mourtzis et al. (2022a), Pathak et al. (2019), Raja Santhi and Muthuswamy (2023), Romero and Stahre (2021), Rožanec et al. (2022), Sharma et al. (2022), Taj and Jhanjhi (2022)

In fact, the intensification of advanced technologies applied at I5.0—such as artificial intelligence, robotics, and smart systems—raises concerns about overreliance on digital infrastructures and the potential for labor displacement. While Industry 5.0 promotes human-machine collaboration, the growing automation of industrial processes may lead to job loss, increased skills gaps, and a widening digital divide, particularly in regions with limited technological capacity or workforce training.

RQ3 – What skills and capabilities are required to implement Industry 5.0?

From an organizational perspective, the authors identified studies within the SLR that discuss practices companies adopt to enable the implementation of Industry 5.0. For example, Mladineo et al. (2021) suggest that implementing lean manufacturing can support I5.0, especially for small and medium-sized enterprises. They highlight key success factors in lean manufacturing that align with I5.0 principles, such as respect for people, education, communication, leadership, customer value, personal experience, empowerment, continuous improvement, waste elimination, organization, lead time reduction, and systems thinking.

Choi et al. (2022) describe Industry 5.0 as “human-centered” rather than “system-centered.” In this context, Mondal and Samaddar (2023) highlight that effective collaboration between humans and smart systems demands new skills, competencies, knowledge, and abilities. Raja Santhi and Muthuswamy (2023) explain that collaborative robots, or cobots, are flexible robots designed to enable the 3Cs: coexistence, cooperation, and collaboration. Their main purpose is “to mainly carry out routine tasks and work hand-in-hand with humans” (Emma-Ikata & Doyle-Kent, 2022, p. 420). However, the skills and competencies required to program and automate cobots remain a limiting factor. Other authors

addressing skills related to cobots include Proia et al. (2022), Welfare et al. (2019), and Nahavandi (2019). Supporting this discussion, Agarwal and Chauhan (2022) emphasize the importance of assessing the employability skills needed to work effectively with cobots.

All aforementioned points converge on the worker’s perspective. Al Mubarak (2022) focuses on the emerging skills gaps in Industry 5.0, stressing the need for digital literacy, leadership, problem-solving, and self-management skills. Likewise, Suciu et al. (2023) explore the skillsets necessary for a truly sustainable, resilient, and inclusive Industry 5.0, emphasizing both technical and non-technical competencies. These include proficiency with technological tools, analytical and innovative thinking, programming, creativity, originality, initiative, emotional intelligence, leadership, and the ability to tackle complex problems.

In a study focusing on India, Kukreja and Kumar (2020) emphasize that adopting innovative management practices, investing in human capital, and improving workers’ qualifications are key factors for implementing Industry 5.0. They highlight the education sector as playing a crucial role in developing the skills needed for these new industrial revolutions. Similarly, Emma-Ikata and Doyle-Kent (2022) stress the importance of educating “future modern workers,” arguing that 15.0 and its related tools, technologies, and approaches should be integrated into students’ curricula so they gain the skills required to work with these innovations. Gürdür Broo et al. (2022) propose that to prepare engineers for Industry 5.0, education must follow four strategies: lifelong learning and transdisciplinary education; modules on sustainability, resilience, and human-centered design; practical courses on data fluency and management; and hands-on experience with human-machine interaction. Additionally, Tavares et al. (2022, p. 17) underscore that educators and educational institutions, as foundational pillars for improving human capital and driving societal progress, hold significant responsibility in this process of change and transformation.

A new concept has emerged from this literature review, capturing the competencies needed for successful Industry 5.0 implementation: Operator 5.0. Mourtzis et al. (2022b) highlight the key skills and attributes associated with this role, including strong communication abilities, proficiency in working with artificial intelligence and IT systems across different interfaces and platforms, and a willingness to embrace continuous change. Other important competencies include creative problem-solving, the ability to work safely and effectively—both physically and mentally—with emerging technologies, and strong intercultural and interdisciplinary collaboration skills. Additionally, the Operator 5.0 must be aware of cybersecurity, privacy, and data protection concerns, be able to manage increasing complexity and multitasking demands, and combine cognitive, physical, sensory, and interactive capabilities. Meanwhile, Romero and Stahre (2021) discuss Operator 5.0, focusing on intelligent and resilient systems, and emphasize anticipation skills and resilience as key characteristics, enabling adaptation to unexpected changes and recovery from new situations.

Table 5 provides an overview of the key skills and capabilities required for Industry 5.0, along with the related aspects discussed earlier and their respective references.

Table 5. Main skills and capabilities required for Industry 5.0

Worker’s main skills and capabilities		Related aspects and respective references
Non-technical	Leadership, problem-solving, self-management, creativity, originality, initiative, emotional intelligence, communication, open-mindedness towards constant change, anticipation ability and resilience to adapt and recover from new situations, inter-cultural and disciplinary skills, attributes such as cognitive, physical, sensorial, and interaction capabilities, ability to handle increasing complexity of many requirements and simultaneous tasks	Organizational practices (Mladineo et al., 2021; Kukreja & Kumar, 2020) Education/qualification (Emma-Ikata & Doyle-Kent, 2022; Gürdür Broo et al., 2022; Al Mubarak, 2022; Suciu et al., 2023) Operator 5.0 (Mourtzis et al. 2022b; Romero & Stahre, 2021)
Technical	Programming and automating cobots, analytical and innovative thinking, knowledge to work with artificial intelligence and information technology systems through different interfaces and platforms, digital and technological devices, cybersecurity, privacy, and data mindfulness	Cobots/training (Mondal & Samaddar, 2023; Welfare et al., 2019; Nahavandi, 2019; Proia et al., 2022) Education/qualification (Emma-Ikata & Doyle-Kent, 2022; Gürdür Broo et al., 2022; Al Mubarak, 2022; Suciu et al., 2023) Operator 5.0 (Mourtzis et al. 2022b; Romero & Stahre, 2021)

In sum, Industry 5.0 represents a sociotechnical transformation that extends beyond technological innovation to include human and societal dimensions. It aspires to integrate human-centricity, sustainability, and resilience into industrial systems. However, balancing these goals with productivity and efficiency presents significant practical and conceptual challenges. The integration of ethical considerations, worker well-being, and social responsibility into industrial design remains insufficiently addressed in both scholarly and practical discussions.

RQ4 – What gaps and research opportunities exist within Industry 5.0?

Based on the analysis, the authors propose a future research agenda outlined in Table 6. They suggest that most of these questions should be addressed through practical research rather than theoretical studies alone. This conclusion is supported by the data in Table 1, which shows that practical studies (quantitative, qualitative, and mixed methods) account for less than 30% of the existing literature. Table 6 organizes eight thematic areas identified as most relevant based on the authors' judgment and the findings from the Systematic Literature Review. The first column lists these thematic areas, the second presents research questions developed through a synthesis of relevant literature and the authors' insights, and the last column credits the authors who inspired each thematic area and the corresponding research questions. For example, Sharma et al. (2022) and Frederico (2021) highlight the need for studies exploring the benefits and challenges of Industry 5.0. Sharma et al. (2022) examined barriers to implementing Industry 5.0 in the pharmaceutical sector and recommended conducting similar analyses in other industries. Frederico (2021) proposed research on the benefits and challenges involved in transitioning to Supply Chain 5.0. Building on their work, several research questions were formulated to explore previously unexplored aspects, including the benefits and challenges across different sectors, as well as the potential influence of an organization's size and age.

Crucially, future research should focus on education, skills, and knowledge in the context of Industry 5.0. Doyle-Kent and Kopacek (2021), Borchardt et al. (2022), and Taj and Jhanjhi (2022) emphasize the need to evaluate how educational systems are adapting to these changes. Lattanzio et al. (2022) emphasize the importance of examining the profile of the next generation of workers and their implications for education. Kolade and Owoseni (2022) call for research on interventions aimed at addressing inequalities caused by disruptive digital transformation. Additionally, Demir et al. (2019), Nahavandi (2019), Al Mubarak (2022), Borchardt et al. (2022), Mondal and Samaddar (2023), and Suciú et al. (2023) suggest investigating new skills, capabilities, and competencies, along with methods for their development. Future studies should also investigate how different generations will adapt to these changes and which skills may be more or less accessible to them.

Organizational strategy and management also require further attention. Future research could explore strategies and their impact on Industry 5.0 (Frederico, 2021); the implications of I5.0 for business outcomes and operations management (Borchardt et al., 2022); studies focused specifically on small and medium-sized enterprises (Madhavan et al., 2022); and the effects of organizational culture (Suciú et al., 2023). Several authors, including Duggal et al. (2021), Durmaz and Kitapçı (2021), Borchardt et al. (2022), and Ben Youssef and Mejri (2023), emphasize the need for research on new business models tailored to the demands of Industry 5.0. Borchardt et al. (2022) emphasize the importance of focusing on innovative business models. Overall, management and organizational strategy play a crucial role in guiding change. Future studies should delve deeper into aspects such as culture, leadership, innovation management, and lean manufacturing.

Another crucial area for research is the role of laws and government. Demir et al. (2019), Dhirani et al. (2023), and Atif (2023) emphasize the need to study legal, regulatory, and policy constraints. Ghobakhloo et al. (2022) emphasize the importance of examining how public-private partnerships can influence the development of policies, initiatives, and regulatory frameworks to support Industry 5.0. It is essential to investigate the impact of these changes on legal matters and how governments and legal systems are adapting to such rapid and significant transformations. In this sense, research in this direction must incorporate concepts from stakeholder theory and institutional theory, taking into account the holistic perspective of I5.0.

It is also important to study the impact on people and related ethical issues. Several authors recommend research on human-robot interaction (Demir et al., 2019; Cimini et al., 2022; Emma-Ikata & Doyle-Kent, 2022; Espina-Romero et al., 2023; Gervasi et al., 2023; Ghobakhloo et al., 2023a; Pizon & Gola, 2023), as well as evaluations of the technologies that support this interaction to promote human-centeredness (Ghobakhloo et al., 2023a) and investigations into people's main fears and insecurities (Nahavandi, 2019). There is a clear need for more research on the psychological impact, social implications, and effects on organizational climates (Demir et al., 2019). Doyle-Kent and Kopacek (2021) argue that research should explore how Industry 5.0 can contribute to creating higher-value, more comfortable, and safer jobs.

Studies on ethics are also crucial (Nahavandi, 2019; Welfare et al., 2019; Long, 2020; Borchardt et al., 2022; Alves et al., 2023; Ben Youssef & Mejri, 2023), along with investigations into the health impacts of I5.0 (Rožanec et al., 2022; Taj & Jhanjhi, 2022) and its effect on workers’ quality of life (Longo, 2020). Research on health and safety issues is equally important (Welfare et al., 2019; Longo, 2020; Lattanzio et al., 2022; Alves et al., 2023; Marinelli, 2023). Overall, it is crucial to understand how organizations maintain a human-centric approach to their decision-making processes.

The topic of technologies and digital development has already attracted significant interest from researchers who have proposed studies on various aspects, including the role of technologies in Industry 5.0 (Humayun, 2021; Ghobakhloo et al., 2022; Taj & Jhanjhi, 2022); Industry 4.0 technologies that can support Industry 5.0 (Frederico, 2021); the impacts of digital development on the transition from Industry 4.0 to 5.0 (Babkin et al., 2022); resilience and antifragility implications (Ghobakhloo et al., 2023a); and cybersecurity concerns (Ghobakhloo et al., 2022; Kemendi et al., 2022; Atif, 2023; Ben Youssef & Mejri, 2023). Research focusing on new technologies and digital development across different countries, as well as the primary technologies adopted by organizations according to sector and size, is essential, including cybersecurity.

Some authors also suggest exploring societal issues in the era of Industry 5.0 (Frederico, 2021; Borchardt et al., 2022; Mourtzis et al., 2022a; Taj & Jhanjhi, 2022; Tavares et al., 2022), smart cities (Espina-Romero et al., 2023), and bioeconomics (Borchardt et al., 2022; Espina-Romero et al., 2023). Studies examining the transition across different continents and countries, considering their economic contexts, are equally essential.

Sustainability has also attracted significant attention and is considered a central focus of Industry 5.0. Some authors emphasize the need for studies that demonstrate how Industry 5.0 contributes to achieving climate goals and promoting the circular economy (Frederico, 2021; Borchardt et al., 2022). Others emphasize the importance of research on Industry 5.0 in relation to the Sustainable Development Goals (SDGs) (Borchardt et al., 2022; Tavares et al., 2022); social dimensions (Atif, 2023; Espina-Romero et al., 2023; Ghobakhloo et al., 2023a; Raja Santhi & Muthuswamy, 2023); environmental factors (Espina-Romero et al., 2023; Ghobakhloo et al., 2023a); corporate governance (Ghobakhloo et al., 2022); sustainable business models (Borchardt et al., 2022); and greener production processes (Ben Youssef & Mejri, 2023). Consequently, it is crucial to conduct research that evaluates the practical contributions of Industry 5.0 to sustainability.

Most articles have focused on theoretical studies, leaving the question of how actually to implement Industry 5.0 unanswered. Initiatives like the European Commission’s (2023a) call for participation in the Industry 5.0 Community of Practice (CoP 5.0) play a crucial role, providing strong incentives to put Industry 5.0 into practice. At the same time, case studies, action research, surveys, and interviews with employees in organizations that have adopted Industry 5.0 are vital. Future research must address the three key aspects most authors emphasize: human-centricity, resilience, and sustainability. Echoing the European Commission’s intentions, new business models will need to emerge to enable the successful adoption of Industry 5.0.

Table 6. Proposed agenda for future research

Area	Research question	Authors
Benefits, challenges and general factors	What benefits are organizations experiencing from implementing Industry 5.0? How do sector and company size influence these benefits?	Sharma et al. (2022); Frederico (2021)
	Does a company’s age affect its adoption of Industry 5.0? What role do startups play in this transition?	
	What are the main barriers organizations face when transitioning to Industry 5.0, and how have they overcome them?	
	How is Industry 5.0 being implemented across different departments within organizations and between organizations? For example: Quality 5.0, Logistics 5.0, Supply Chain 5.0, Project Management 5.0, Purchasing 5.0, Sales 5.0, Production Planning and Control 5.0, People Management 5.0, etc.	
	How has Industry 5.0 impacted various sectors, such as healthcare, transportation, tourism, and construction?	
Education, skills and knowledge	How are educational institutions responding and adapting to the changes brought by Industry 5.0?	Demir et al. (2019); Nahavandi (2019); Doyle-Kent and Kopacek (2021); Al Mubarak (2022); Borchardt et al. (2022); Borchardt et al. (2022); Kolade and Owoseni (2022); Lattanzio et al. (2022); Taj and Jhanjhi (2022); Mondal and Samaddar (2023); Suci et al. (2023)
	What are the key hard and soft skills people need to develop to adapt to Industry 5.0, and how are they acquiring them?	
	What challenges do different generations (Baby Boomers, Generation X, Millennials (Y), Generation Z, Alpha) face in adapting to Industry 5.0?	

Area	Research question	Authors
Organizational strategy and management	<p>What strategies have companies successfully transitioning to Industry 5.0 employed?</p> <p>How do leadership styles and organizational culture influence the transition to Industry 5.0?</p> <p>Are certain leadership types or cultures more conducive to this shift?</p> <p>Are organizations migrating to Industry 5.0 seeing better financial and non-financial results?</p> <p>How significant is Industry 5.0's impact on organizational performance?</p> <p>What new business models have emerged with Industry 5.0, and how will it affect existing models?</p> <p>Are companies with Lean practices finding it easier to implement Industry 5.0?</p> <p>How can knowledge and innovation management support the transition to Industry 5.0?</p>	Duggal et al. (2021); Durmaz and Kitapçı (2021); Frederico (2021); Borchardt et al. (2022); Madhavan et al. (2022); Suciú et al. (2023); Ben Youssef and Mejri (2023)
Law and government	<p>How has Industry 5.0 influenced legal and regulatory issues, especially concerning AI and collaborative robots (cobots)?</p> <p>How might delays in legislation affect people's lives amid the rise of Industry 5.0?</p> <p>In what ways can public-private partnerships facilitate the transition to Industry 5.0?</p>	Demir et al. (2019); Ghobakhloo et al. (2022); Dhirani et al. (2023); Atif (2023)
People, ethics, health and safety	<p>How have labor relations evolved with the adoption of Industry 5.0? What effects do new technologies have on workers' physical and mental health, as well as social interactions?</p> <p>Within organizations, who decides which technologies to adopt, and how are decisions made considering their impact on workers' well-being?</p> <p>How secure are the new technologies being introduced? What roles do organizations, research institutions, and governments play in assessing security?</p> <p>How are organizations and governments addressing ethical issues related to new technologies?</p> <p>Are organizations genuinely placing humans at the center of decision-making? How is this being achieved?</p>	Demir et al. (2019); Nahavandi (2019); Welfare et al. (2019); Longo (2020); Doyle-Kent and Kopacek (2021); Borchardt et al. (2022); Cimini et al. (2022); Emma-Ikata and Doyle-Kent (2022); Lattanzio et al. (2022); Rožanec et al. (2022); Taj and Jhanjhi (2022); Alves et al. (2023); Ben Youssef and Mejri (2023); Espina-Romero et al. (2023); Gervasi et al. (2023); Ghobakhloo et al. (2023a); Marinelli (2023); Pizon and Gola (2023)
Technologies and digital development	<p>How has the development and adoption of new technologies and digital advancements varied across countries and regions? What impact will this have on financially disadvantaged countries?</p> <p>What are the leading technologies currently used by organizations, and how do these vary by sector, company size, and location?</p>	Frederico (2021); Humayun (2021); Babkin et al. (2022); Kemendi et al. (2022); Ghobakhloo et al. (2022); Taj and Jhanjhi (2022); Atif (2023); Ben Youssef and Mejri (2023); Ghobakhloo et al. (2023a)
Society	<p>What are the main societal impacts of Industry 5.0?</p> <p>How will the transition to Industry 5.0 unfold, considering the economic conditions of different countries and regions?</p> <p>How can organizations and governments support this transition, ensuring people remain central not only within organizations but also across society?</p> <p>How can society and the labor market be prepared for the changes brought by Industry 5.0? What steps have already been taken?</p>	Frederico (2021); Borchardt et al. (2022); Mourtzis et al. (2022b); Taj and Jhanjhi (2022); Tavares et al. (2022); Espina-Romero et al. (2023)
Sustainability	<p>What social and environmental impacts are resulting from the adoption of Industry 5.0? Is Industry 5.0 contributing effectively to sustainable development?</p> <p>How has Industry 5.0 supported the achievement of the Sustainable Development Goals (SDGs), considering different societal sectors?</p> <p>What impact has Industry 5.0 had on organizations recognized for their ESG performance?</p> <p>How has Industry 5.0 contributed to advancing the circular economy?</p>	Frederico (2021); Borchardt et al. (2022); Ghobakhloo et al. (2022); Tavares et al. (2022); Atif (2023); Ben Youssef and Mejri (2023); Espina-Romero et al. (2023); Ghobakhloo et al. (2023a); Raja Santhi and Muthuswamy (2023)

Framework proposal

To achieve the objectives of this study, a framework was developed based on the findings of the systematic literature review (Figure 7). This framework aims to support companies in their transition to Industry 5.0 by highlighting essential technologies and the required competencies, thereby aiding the effective pursuit of the Sustainable Development Goals. From an academic perspective, it identifies key concepts, thematic areas, and future research directions to promote a deeper understanding and further exploration of this emerging paradigm. Introducing Industry 5.0 requires a clear understanding of its core elements and an evaluation of how these elements interact in practice. Additionally, it is crucial to have skilled personnel who can effectively use the wide range of technologies and tools available. Beyond this, a human-centered approach calls for a new style of management. Regarding technologies and tools (detailed in section 4.2), these include both Industry 4.0 innovations focused on automation, additive manufacturing, and smart factories, as well as those specifically linked to Industry 5.0. These technologies have been grouped following the classifications used by the European Commission and other key studies.

The analyses give rise to potential future areas of research. Future studies should focus on how Industry 5.0 changes are being implemented in practice. Conducting surveys, case studies, and action research would be especially valuable.

The research themes were grouped according to the areas outlined in Table 6. Notably, the themes of “Education, skills, and knowledge” and “People, ethics, health, and safety” share significant overlap, as any progress toward Industry 5.0 directly impacts these areas. Research centered on these topics, in turn, supports advancements across other domains. Here, it is interesting to note that human participation becomes limited to supervisory or adaptive functions, rather than being meaningfully integrated into design and decision-making processes. This may marginalize the social, emotional, and ethical aspects of labor, undermining the very values that Industry 5.0 purports to prioritize.

“Technologies and digital development” represent a crucial aspect of Industry 5.0, and ethical considerations must always be taken into account when evaluating existing or emerging technologies. For instance, questions regarding data privacy, algorithmic bias, workplace surveillance, and the unequal distribution of technological benefits. Since sustainability is a central focus of Industry 5.0, it is essential to understand how technologies can support this goal, how knowledge is generated and shared, and how widely recognized concepts like the Sustainable Development Goals (SDGs), Environmental, Social, and Governance (ESG) criteria, and the circular economy are being addressed within the Industry 5.0 context.

Other groups focus on the areas of “Benefits, challenges, and general factors” and “Organizational strategy and management.” Research in these areas should not only explore the benefits and challenges of Industry 5.0 but also examine how organizations are managing these changes and what strategies they are employing. Finally, the groups “Society” and “Laws and government” remind us that all the changes discussed in the other areas will directly impact society. Therefore, legislation and government policies must keep pace to ensure decisions align with ethical standards, environmental protection, and the well-being of people. In fact, considering the results from this SRL, the integration of ethical concerns into design processes and strategic decision-making is often superficial, lacking frameworks that ensure accountability, inclusivity, and transparency.

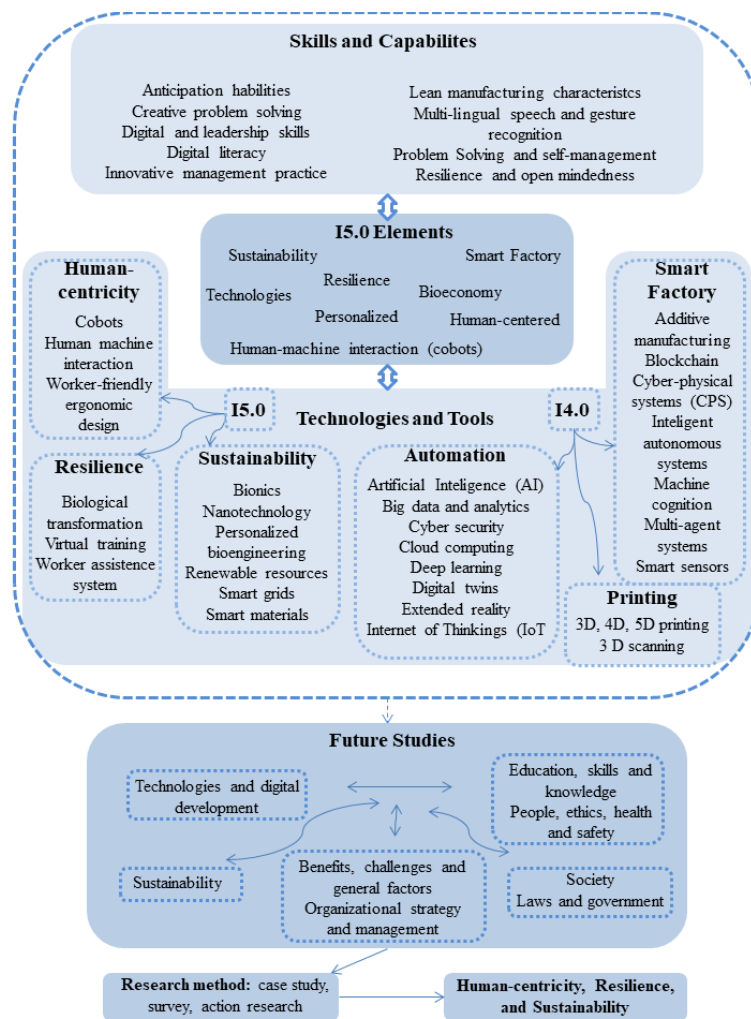


Figure 7. Theoretical framework for Industry 5.0

From a business perspective, the framework provides strategic insights into how organizations can align technological innovation with human-centered values, ethical considerations, and sustainability goals. By outlining the competencies required for implementing Industry 5.0, companies can identify skill gaps, guide workforce development, and foster leadership models that promote collaboration between humans and intelligent systems. Moreover, integrating emerging technologies—such as human-robot collaboration tools, AI-driven decision support, and smart manufacturing systems—requires not only technical adoption but also organizational change. This involves rethinking business models, redefining performance metrics, and nurturing a culture that embraces continuous learning, resilience, and social responsibility.

The proposed framework aligns with the Sustainable Development Goals (SDGs) by guiding organizations in their transition to Industry 5.0 in a human-centered, technologically advanced, and sustainable manner. It supports SDG 8 (Decent Work and Economic Growth) by promoting people-focused work environments; SDG 9 (Industry, Innovation, and Infrastructure) by encouraging the responsible adoption of advanced technologies; and SDG 12 (Responsible Consumption and Production) by fostering more circular and efficient production practices. Additionally, by addressing skills development, education, and workplace well-being, the framework also contributes to SDGs 3, 4, 5, and 13, emphasizing the strategic role businesses play in advancing global sustainability goals.

CONCLUSION

With growing academic and institutional interest in Industry 5.0, this study aims to address the following research question: What are the key issues that future research on Industry 5.0 should focus on? This article provides a comprehensive review of the recent and emerging literature on I5.0. The number of publications on this topic rose significantly—from 25 in 2020 to 70 in 2021, and then to 222 in 2022 (Figure 3)—highlighting its increasing relevance. The European Commission has played a major role in advancing Industry 5.0, alongside growing academic interest, by launching initiatives such as the Industry 5.0 Award (European Commission, 2023b) to recognize EU-funded projects that promote a more human-centered, resilient, and sustainable industry. According to Ghobakhloo et al. (2023b), I5.0 is expected to spread rapidly beyond Europe, just as I4.0 did. The authors note that significant contributions to Industry 4.0 came from both emerging and developed economies outside Europe—including Brazil, China, the USA, and Australia—and a similar trend is anticipated for Industry 5.0.

This article presents the main current definitions of Industry 5.0. However, the concept still requires a clearer definition in the literature, as there is no consensus on its key elements or when exactly I5.0 emerged—most articles mention the term only superficially. Another important topic discussed in the literature concerns the technologies used in Industry 5.0: many authors note that numerous Industry 5.0 technologies originated from Industry 4.0. Still, some researchers question the need for new, specific technologies for this era, especially those focused on sustainability. Additionally, many emphasize the importance of developing and enhancing the competencies and skills required for I5.0—particularly individuals who are psychologically, physically, and intellectually prepared to operate within its three core pillars: human-centricity, sustainability, and resilience. Finally, this article proposes a framework based on the insights gathered from the systematic literature review, highlighting key factors for the transition to I5.0 and directions for future research.

Moreover, while the article rightly highlights the need for new skills and competencies, the literature still lacks detailed guidance on the educational and organizational strategies needed to develop these capacities in practice. Therefore, although this study helps organize and frame the current state of research, it also underscores the conceptual, technological, and practical uncertainties that must be addressed to advance both academic understanding and the industrial implementation of Industry 5.0.

Based on the findings, future research on Industry 5.0 should focus on several key gaps to help establish it as both a solid theoretical framework and a practical guide for industrial transformation. First, it is crucial to develop a clear and consistent definition of Industry 5.0 that clearly distinguishes its principles and scope from earlier industrial paradigms. Second, research should identify and validate technological enablers that truly align with the core values of human-centricity, sustainability, and resilience. Third, since human skills are central to this new industrial era, future studies need to explore educational strategies and organizational models that support the development of these competencies. Additionally, there is a pressing need to create metrics and indicators to measure the performance and impact of Industry 5.0 initiatives. Further research should also investigate how Industry 5.0 integrates with broader sustainability agendas and ESG frameworks across different regions and industrial sectors. Finally, the ethical, social, and legal aspects—especially those related to the evolving role of humans within increasingly automated systems—require a deeper interdisciplinary

exploration. Addressing these challenges will be crucial to realizing the promise of Industry 5.0 and deriving tangible, measurable benefits for both industry and society.

In conclusion, this study contributes to Industry 5.0 research by clarifying its core principles, distinguishing it from related concepts, and proposing an integrative framework that links definitions, technologies, competencies, and research gaps, while also outlining a research agenda. Methodologically, it employs a structured and systematic literature review process, supported by relevance scales that guided the selection of articles. From a practical perspective, it offers a starting point for organizations transitioning toward more sustainable, resilient, and human-centric industrial models, in alignment with the Sustainable Development Goals.

Practical and theoretical implications

The proposed framework contributes to the ongoing discussion around Industry 5.0 by going beyond simply organizing existing literature. It synthesizes findings from the systematic literature review into an integrated structure that links conceptual definitions, enabling technologies, and necessary competencies with the identified research gaps and practical challenges. This comprehensive approach makes the framework valuable both as an academic resource, facilitating further theoretical research, and as a strategic guide for organizations navigating the shift toward a more human-centered, sustainable, and resilient industrial model. In this way, it provides a forward-looking roadmap to tackle unresolved issues and align academic work with industrial practice as Industry 5.0 continues to evolve.

From an academic standpoint, this work highlights several directions for future research, emphasizing the need to deepen understanding of the interfaces and integration among key elements of Industry 5.0, such as the connections between process technologies and people, as well as the interaction between these technologies, people, and sustainability. Additionally, it stresses the importance of field research to gain clearer insights into what companies are actually implementing in practice and the challenges they encounter in adopting Industry 5.0.

From an organizational perspective, the article provides an overview to help clarify the nature of Industry 5.0. It aims to address common misunderstandings between Industry 5.0, Industry 4.0, the Fifth Industrial Revolution, and Society 5.0. The literature reveals a lack of consensus on the definition of Industry 5.0, with some authors using the terms interchangeably with Industry 4.0 or Society 5.0. While Industry 5.0 builds upon Industry 4.0, sometimes referred to as Industry 4.0+, 4.5, or 4.0S, it places distinct emphasis on human-centricity, sustainability, and resilience. Unlike Industry 4.0, which focuses mainly on automation and efficiency, Industry 5.0 prioritizes integrating human and environmental values into industrial systems. Society 5.0, in contrast, represents a broader societal vision that goes beyond the industrial context. The key difference lies in Industry 5.0's goal to transform industry through values-driven innovation, leveraging both existing and emerging technologies to promote social and environmental well-being. Additionally, the article outlines the main technologies currently in use and the skills and capabilities required from workers, providing organizations with the knowledge needed to begin their transition into this new era.

In conclusion, the proposed framework advances the Sustainable Development Goals (SDGs) by providing a clear, structured approach for organizations transitioning to Industry 5.0. It supports SDG 8 (Decent Work and Economic Growth) by promoting human-centered, resilient work environments; SDG 9 (Industry, Innovation, and Infrastructure) through the responsible integration of technology; and SDG 12 (Responsible Consumption and Production) by encouraging more efficient and sustainable production methods. Additionally, by addressing education, skills development, workplace well-being, and ethical considerations, the framework also contributes to SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 5 (Gender Equality), and SDG 13 (Climate Action). This highlights the strategic role Industry 5.0 plays in promoting inclusive, innovative, and sustainable development.

Future studies

Future research could benefit from expanding the search strategy to include variations from the term "Industry 5.0", thereby encompassing a broader range of perspectives on the topic. Additionally, as a suggestion for future work, this article proposes a research agenda (framework) based on the literature review and the authors' personal experiences. At this stage, we have not established hierarchical relationships or causal assumptions between the analyzed elements. Our intention was to map and connect the key concepts, technologies, and competencies associated with Industry 5.0. The resulting framework reflects this approach and has the potential to guide future theoretical or empirical research, which may build upon it to explore deeper relationships or propose more specific models. For instance, the Industry 5.0

approach presupposes the human-centered use of advanced technologies, with the expectation that its implementation may foster job satisfaction, engagement, and social well-being. However, validating such cause-and-effect relationships requires further research focused on defining and consolidating measurement items and scales for this construct, enabling its assessment through quantitative methods in specific empirical contexts. Furthermore, future research should focus on the practical applications of Industry 5.0, utilizing methods such as case studies, surveys, action research, and expert and academic interviews. Additionally, research should focus on real-world cases that allow for the analysis of human-centricity, resilience, and sustainability within practical settings, exploring the interactions and cause-and-effect relationships among these three pillars of Industry 5.0 and their potential impacts on desired outcomes.

Acknowledgment

This work was supported by FCT – Fundação para a Ciência e Tecnologia within the R&D Unit Project Scope UID/00319/Centro ALGORITMI (ALGORITMI/UM); by the Foundation for Research and Innovation Support of the State of Santa Catarina (FAPESC) under grant number 2023TR000495; by the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) under grant number 2023/16971-7; by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) under grant number 314918/2023-0; and by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) under grant number 001.

References

- Aceta, C., Fernández, I., & Soroa, A. (2022). KIDE4I: A generic semantics-based task-oriented dialogue system for human-machine interaction in Industry 5.0. *Applied Sciences*, 12(3), 1192. <https://doi.org/10.3390/app12031192>
- Adel, A. (2022). Future of Industry 5.0 in society: Human-centric solutions, challenges, and prospective research areas. *Journal of Cloud Computing (Heidelberg)*, 11(40). <https://doi.org/10.1186/s13677-022-00314-5>
- Agarwal, N., & Chauhan, C. (2022). Amplifying employability skills to create co-working space for human and cobots in the e-commerce industry. *Procedia Computer Science*, 214, 1040–1048. <https://doi.org/10.1016/j.procs.2022.11.275>
- Akundi, A., Euressti, D., Luna, S., Ankobiah, W., Lopes, A., & Edinbarough, I. (2022). State of Industry 5.0—Analysis and identification of current research trends. *Applied System Innovation*, 5(1), 27. <https://doi.org/10.3390/asi5010027>
- Al Mubarak, M. (2023). Sustainably developing in a digital world: Harnessing artificial intelligence to meet the imperatives of work-based learning in Industry 5.0. *Development and Learning in Organizations*, 37(3), 18–20. <https://doi.org/10.1108/DLO-04-2022-0063>
- Alvarez-Aros, E. L., & Bernal-Torres, C. A. (2021). Technological competitiveness and emerging technologies in Industry 4.0 and Industry 5.0. *Anais da Academia Brasileira de Ciências*, 93(1), e20191290. <https://doi.org/10.1590/0001-3765202120191290>
- Alves, J., Lima, T. M., & Gaspar, P. D. (2023). Is Industry 5.0 a human-centred approach? A systematic review. *Processes*, 11(1), 193. <https://doi.org/10.3390/pr11010193>
- Aslam, F., Aimin, W., Li, M., & Ur Rehman, K. (2020). Innovation in the era of IoT and Industry 5.0: Absolute Innovation Management (AIM) framework. *Information*, 11(2), 124. <https://doi.org/10.3390/info11020124>
- Atif, S. (2023). Analysing the alignment between circular economy and Industry 4.0 nexus with Industry 5.0 era: An integrative systematic literature review. *Sustainable Development*, 1–21. <https://doi.org/10.1002/sd.2542>
- Babkin, A., Shkarupeta, E., Kabasheva, I., Rudaleva, I., & Vicentiy, A. (2022). A framework for digital development of industrial systems in the strategic drift to Industry 5.0. *International Journal of Technology*, 13(7), 1373–1382. <https://doi.org/10.14716/ijtech.v13i7.6193>
- Balstad, M. T., & Berg, T. (2020). A long-term bibliometric analysis of journals influencing management accounting and control research. *Journal of Management Control*, 30, 357–380. <https://doi.org/10.1007/s00187-019-00287-8>
- Bednar, P. M., & Welch, C. (2020). Socio-technical perspectives on smart working: Creating meaningful and sustainable systems. *Information Systems Frontiers*, 22, 281–298. <https://doi.org/10.1007/s10796-019-09921-1>
- Ben Youssef, A., & Mejri, I. (2023). Linking digital technologies to sustainability through Industry 5.0: A bibliometric analysis. *Sustainability*, 15(9), 7465. <https://doi.org/10.3390/su15097465>
- Bitsch, G. (2022). Conceptions of man in human-centric cyber-physical production systems. *Procedia CIRP*, 107, 1439–1443. <https://doi.org/10.1016/j.procir.2022.05.171>
- Borchardt, M., Pereira, G. M., Milan, G. S., Scavarda, A. R., Nogueira, E. O., & Poltosi, L. C. (2022). Industry 5.0 beyond technology: An analysis through the lens of business and operations management literature. *Organizacija*, 55. <https://doi.org/10.2478/orga-2022-0020>
- Boschetti, G., Faccio, M., & Granata, I. (2022). Human-centered design for productivity and safety in collaborative robots cells: A new methodological approach. *Electronics*, 12(1), 167. <https://doi.org/10.3390/electronics12010167>
- Breque, M., De Nul, L., & Petridis, A. (2021). Industry 5.0 – Towards a sustainable, human-centric and resilient European industry. *European Commission, Directorate-General for Research and Innovation - Publications Office of the European Union*. <https://doi.org/10.2777/308407>
- Chin, S. T. S. (2020). Influence of emotional intelligence on the workforce for Industry 5.0. *Journal of Human Resources Management Research*, 2021. <https://doi.org/10.5171/2021.882278>
- Choi, T.-M., Kumar, S., Yue, X., & Chan, H.-L. (2022). Disruptive technologies and operations management in the Industry 4.0 era and beyond. *Production and Operations Management*, 31, 9–31. <https://doi.org/10.1111/poms.13622>
- Cillo, V., Gregori, G. L., Daniele, L. M., Caputo, F., & Bitbol-Saba, N. (2022). Rethinking companies' culture through knowledge management lens during Industry 5.0 transition. *Journal of Knowledge Management*, 26(10), 2485–2498. <https://doi.org/10.1108/JKM-09-2021-0718>
- Cimini, C., Lagorio, A., Cavalieri, S., Riedel, O., Pereira, C. E., & Wang, J. (2022). Human-technology integration in smart manufacturing and logistics: Current trends and future research directions. *Computers and Industrial Engineering*, 169, 108261. <https://doi.org/10.1016/j.cie.2022.108261>

- Daoud, A. O., Kineber, A. F., Ali, A. H., & Elseknidy, M. (2025). Empowering Sustainable Infrastructure and Sustainable Development Goals Through Industry 5.0 Implementation. *Sustainable Development*, 33 (3), 4309-4332. <https://doi.org/10.1002/sd.3347>
- Demir, K. A., & Cicibaş, H. (2019). The next industrial revolution: Industry 5.0 and discussions on Industry 4.0. In *Industry 4.0 from the MIS perspective*. Peter Lang GmbH.
- Demir, K. A., Döven, G., & Sezen, B. (2019). Industry 5.0 and human-robot co-working. *Procedia Computer Science*, 158, 688-695. <https://doi.org/10.1016/j.procs.2019.09.104>
- Denyer, D., & Tranfield, D. (2009). Producing a systematic review. In D. A. Buchanan & A. Bryman (Eds.), *The Sage handbook of organizational research methods* (pp. 671–689). Sage Publications Ltd.
- Dhirani, L. L., Mukhtiar, N., Chowdhry, B. S., & Newe, T. (2023). Ethical dilemmas and privacy issues in emerging technologies: A review. *Sensors*, 23(3), 1151. <https://doi.org/10.3390/s23031151>
- Doyle-Kent, M., & Kopacek, P. (2021). Do we need synchronization of the human and robotics to make Industry 5.0 a success story? In N. M. Durakbasa & M. G. Gençyılmaz (Eds.), *Digital conversion on the way to Industry 4.0. ISPR 2020. Lecture Notes in Mechanical Engineering*. Springer, Cham. https://doi.org/10.1007/978-3-030-62784-3_25
- Doyle-Kent, M., O'Neill, B., Shanahan, B. W., Organ, J., Doyle, L., O'Neill, S., Costello, O., & Donnelly, N. (2022). A research cluster's vision for a pilot factory in the Southeast Technological University of Ireland. *IFAC-PapersOnLine*, 55, 159-164. <https://doi.org/10.1016/j.ifacol.2022.12.028>
- Duggal, A. S., Malik, P. K., Gehlot, A., Singh, R., Gaba, G. S., Masud, M., & Al-Amri, J. F. (2021). A sequential roadmap to Industry 6.0: Exploring future manufacturing trends. *IET Communications*, 16, 521–531. <https://doi.org/10.1049/cmu2.12284>
- Durmaz, A., & Kitapci, H. (2021). Revisiting customer-involved value chains under the conceptual light of Industry 5.0. *Proceedings on Engineering Sciences*, 3(2), 201-210. <https://doi.org/10.24874/PES03.02.008>
- Emma-Ikata, D., & Doyle-Kent, M. (2022). Industry 5.0 readiness – Optimization of the relationship between humans and robots in manufacturing companies in Southeast of Ireland. *IFAC PapersOnLine*, 55(39), 419-424. <https://doi.org/10.1016/j.ifacol.2022.12.071>
- Espina-Romero, L., Guerrero-Alcedo, J., Goñi Avila, N., Noroño Sánchez, J. G., Gutiérrez Hurtado, H., & Quiñones Li, A. (2023). Industry 5.0: Tracking scientific activity on the most influential industries, associated topics, and future research agenda. *Sustainability*, 15(6), 5554. <https://doi.org/10.3390/su1506555>
- European Commission. (2023a). Industry 5.0 community of practice call for expression of interest. *European Commission*. https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/industry-50-community-practice-call-expression-interest-2023-06-01_en
- European Commission. (2023b). Industry 5.0 award contest opens: Apply by 1 September 2023. *European Commission*. https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/industry-50-award-contest-opens-apply-1-september-2023-2023-05-15_en
- Fonda, E., & Meneghetti, A. (2022). The human-centric SMED. *Sustainability*, 14, 514. <https://doi.org/10.3390/su14010514>
- Frederico, G. F. (2021). From supply chain 4.0 to supply chain 5.0: Findings from a systematic literature review and research directions. *Logistics*, 5(3), 49. <https://doi.org/10.3390/logistics5030049>
- Fukuyama, M. (2018). Society 5.0: Aiming for a New Human-Centered Society. In *Japan Spotlight*; pp. 47–50. Available online: https://www.jef.or.jp/journal/pdf/220th_Special_Article_02.pdf (accessed on 28 July 2025).
- Garcia Rivera, F., Lamb, M., Högberg, D., & Brolin, A. (2022). The schematization of XR technologies in the context of collaborative design. *IOS Press EBooks, Advances in Transdisciplinary Engineering*, 21, 520-529. <https://doi.org/10.3233/ATDE220170>
- Gervasi, R., Mastrogiacomio, L., & Franceschini, F. (2023). An experimental focus on learning effect and interaction quality in human-robot collaboration. *Production Engineering*, 17, 355-380. <https://doi.org/10.1007/s11740-023-01188-5>
- Ghobakhloo, M., Iranmanesh, M., Morales, M. E., Nilashi, M., & Amran, A. (2023a). Actions and approaches for enabling Industry 5.0-driven sustainable industrial transformation: A strategy roadmap. *Corporate Social Responsibility and Environmental Management*, 30, 1473–1494. <https://doi.org/10.1002/csr.2431>
- Ghobakhloo, M., Iranmanesh, M., Foroughi, B., Tikorlaee, E. B., Asadi, S., & Amran, A. (2023b). Industry 5.0 implications for inclusive sustainable manufacturing: An evidence-knowledge-based strategic roadmap. *Journal of Cleaner Production*, 417, 138023. <https://doi.org/10.1016/j.jclepro.2023.138023>
- Ghobakhloo, M., Iranmanesh, M., Mubarak, M. F., Mubarik, M., Rejeb, A., & Nilashi, M. (2022). Identifying industry 5.0 contributions to sustainable development: A strategy roadmap for delivering sustainability values. *Sustainable Production and Consumption*, 33, 716-737. <https://doi.org/10.1016/j.spc.2022.08.003>
- Grabowska, S., Saniuk, S., & Gajdzik, B. (2022). Industry 5.0: Improving humanization and sustainability of Industry 4.0. *Scientometrics*, 127, 3117–3144. <https://doi.org/10.1007/s11192-022-04370-1>
- Guo, L., Sun, D., Warraich, M. A., & Waheed, A. (2023). Does industry 5.0 model optimize sustainable performance of Agri-enterprises? *Sustainable Development*, 1-10. <https://doi.org/10.1002/sd.2527>
- Gürdür Broo, D., Kaynak, O., & Sait, S. M. (2022). Rethinking engineering education at the age of Industry 5.0. *Journal of Industrial Information Integration*, 25, 100311. <https://doi.org/10.1016/j.jii.2021.100311>
- Habash, R. (2022). Phenomenon-based learning for Age 5.0 mindsets: Industry, society, and education. *IEEE Global Engineering Education Conference (EDUCON)*, 1910-1915. <https://doi.org/10.1109/EDUCON52537.2022.9766521>
- Haleem, A., & Javaid, M. (2019). Industry 5.0 and its applications in orthopaedics. *Journal of Clinical Orthopaedics and Trauma*, 10(4), 807-808. <https://doi.org/10.1016/j.jcot.2018.12.010>
- Hein-Pensel, F., Winkler, H., Brückner, A., Wölke, M., Jabs, I., Mayan, I. J., Kirschenbaum, A., Friedrich, J., & Zinke-Wehlmann, C. (2023). Maturity assessment for Industry 5.0: A review of existing maturity models. *Journal of Manufacturing Systems*, 66, 200-210. <https://doi.org/10.1016/j.jmsy.2022.12.009>
- Humayun, M. (2021). Industrial revolution 5.0 and the role of cutting-edge technologies. *International Journal of Advanced Computer Science and Applications*, 12(12). <https://doi.org/10.14569/IJACSA.2021.0121276>
- Iyengar, K. P., Pe, E. Z., Jalli, J., Shashidhara, M. K., Jain, V. K., Vaish, A., & Vaishya, R. (2022). Industry 5.0 technology capabilities in trauma and orthopaedics. *Journal of Orthopaedics*, 32, 125-132. <https://doi.org/10.1016/j.jor.2022.06.001>
- Jafari, N., Azarian, M., & Yu, H. (2022). Moving from Industry 4.0 to Industry 5.0: What are the implications for smart logistics? *Logistics*, 6(2), 26. <https://doi.org/10.3390/logistics6020026>
- Javaid, M., & Haleem, A. (2020). Critical components of Industry 5.0 towards a successful adoption in the field of manufacturing. *Journal of Industrial Integration and Management*, 5(3), 327-348. <https://doi.org/10.1142/S242486220500141>

- Javaid, M., Haleem, A., Singh, R. P., Ul Haq, M. I., Raina, A., & Suman, R. (2020). Industry 5.0: Potential applications in COVID-19. *Journal of Industrial Integration and Management*, 5(4), 507-530. <https://doi.org/10.1142/S2424862220500220>
- Johansson, H. (2017). *Profinet industrial Internet of Things gateway for the smart factory* [Master's thesis, Chalmers University of Technology, University of Gothenburg].
- John, K. K., Adarsh, S. N., & Pattali, V. (2020). Workers to super workers: A brief discussion on important technologies for industry 5.0 manufacturing systems. In *AIP conference proceedings*, 2311(1).
- Johri, P., Singh, J. N., Sharma, A., & Rastogi, D. (2021). Sustainability of coexistence of humans and machines: An evolution of Industry 5.0 from Industry 4.0. *10th International Conference on System Modeling and Advancement in Research Trends (SMART)*, 410-414. <https://doi.org/10.1109/SMART52563.2021.9676275>
- Kemendi, A., Michelberger, P., & Mesjasz-Lech, A. (2022). Industry 4.0 and 5.0 – Organizational and competency challenges of enterprises. *Polish Journal of Management Studies*, 26(2). <https://doi.org/10.17512/pjms.2022.26.2.13>
- Khaimovich, I., Ramzaev, V., & Chumak, V. (2020). Data modelling for analysis of readiness of municipal education in Industry 5.0. In VI International Conference on Information Technology and Nanotechnology (ITNT-2020) (pp. 1-4).
- Khan, W. U., Ihsan, A., Nguyen, T. N., Ali, Z., & Javed, M. A. (2022). NOMA-enabled backscatter communications for green transportation in automotive-industry 5.0. *IEEE Transactions on Industrial Informatics*, 18(11), 7862-7874. <https://doi.org/10.1109/TII.2022.3161029>
- Kolade, O., & Owoseni, A. (2022). Employment 5.0: The work of the future and the future of work. *Technology in Society*, 71, 102086. <https://doi.org/10.1016/j.techsoc.2022.102086>
- Kraaijenbrink, J. *What Is Industry 5.0 And How It Will Radically Change Your Business Strategy?*, Forbes, 2022. Available: <https://www.forbes.com/sites/jeroenkraaijenbrink/2022/05/24/what-is-industry-50-and-how-it-will-radically-change-your-business-strategy/?sh=3b35de6420bd>. Access: 29.06.2023.
- Kukreja, R., & Kumar, R. (2021). Catalytic agents for easy adoption of Industry 5.0 - Indian context. In *9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO)* (pp. 1-5). IEEE. <https://doi.org/10.1109/ICRITO51393.2021.9596187>
- Kumar Singh, D., & Sobti, R. (2022). Long-range real-time monitoring strategy for precision irrigation in urban and rural farming in Society 5.0. *Computers and Industrial Engineering*, 167, 107997. <https://doi.org/10.1016/j.cie.2022.107997>
- Kumar, R., Gupta, P., Singh, S., & Jain, D. (2021). Human empowerment by Industry 5.0 in digital era: Analysis of enablers. In *Lecture Notes in Mechanical Engineering*. Springer. https://doi.org/10.1007/978-981-33-4320-7_36
- Lattanzio, S., Goh, Y. M., Houghton, R., Lazaro, A. G., & Newnes, L. (2022). *European Union conceptualisation of Industry 5.0: Opportunities and challenges for transdisciplinary engineering*. In *Transdisciplinarity and the Future of Engineering*. IOS Press. <https://doi.org/10.3233/ATDE220705>
- Longo, F., Padovano, A., & Umbrello, S. (2020). Value-oriented and ethical technology engineering in Industry 5.0: A human-centric perspective for the design of the factory of the future. *Applied Sciences*, 10(12). <https://doi.org/10.3390/app10124182>
- Li, J., Burnham, J. F., Lemley, T., & Britton, R. M. (2010). Citation analysis: Comparison of Web of Science®, Scopus™, SciFinder®, and Google Scholar. *Journal of Electronic Resources in Medical Libraries*, 7(3), 196-217. <https://doi.org/10.1080/15424065.2010.505518>
- Li, X., Gao, X., Shaikh, S. A., Zeng, M., Huang, G., Qureshi, N. M. F., & Qiao, D. (2022). NOMA-based cognitive radio network with hybrid FD/HD relay in Industry 5.0. *Journal of King Saud University - Computer and Information Sciences*, 1-12. <https://doi.org/10.1016/j.jksuci.2022.08.013>
- Lu, J., Wang, X., Cheng, X., Yang, J., Kwan, O., & Wang, X. (2022b). Parallel factories for smart industrial operations: From big AI models to field foundational models and scenarios engineering. *IEEE/CAA Journal of Automatica Sinica*, 9(12), 2079-2086. <https://doi.org/10.1109/JAS.2022.106094>
- Lu, Y., Zheng, H., Chand, S., Xia, W., Lui, Z., Xu, X., Wang, L., Qin, Z., & Bao, J. (2022a). Outlook on human-centric manufacturing towards Industry 5.0. *Journal of Manufacturing Systems*, 62, 612-627. <https://doi.org/10.1016/j.jmsy.2022.02.001>
- Lykov, D., & Razumovsky, A. (2023). Industry 5.0 and human capital. In *International Scientific and Practical Conference on Environmental Risks and Safety in Mechanical Engineering (ERSME-2023)* (Vol. 376). <https://doi.org/10.1051/e3sconf/202337605053>
- Maddikunta, P. K. R., Pham, Q.-V., Prabadevi, B., Deepa, N., Dev, K., Gadekallu, T. R., Ruby, R., & Liyanage, M. (2022). Industry 5.0: A survey on enabling technologies and potential applications. *Journal of Industrial Information Integration*, 26, 100257. <https://doi.org/10.1016/j.jii.2021.100257>
- Madhavan, M., Wangtueai, S., Sharafuddin, M. A., & Chaichana, T. (2022). The precipitative effects of pandemic on open innovation of SMEs: A scientometrics and systematic review of Industry 4.0 and Industry 5.0. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(3), 152. <https://doi.org/10.3390/joitmc8030152>
- Narkhede, G. B., Pasi, B. N., Rajhans, N., & Kulkarni, A. (2023). Industry 5.0 and sustainable manufacturing: A systematic literature review. *Benchmarking: An International Journal*. <https://doi.org/10.1108/BIJ-03-2023-0196>
- Madsen, D. Ø., & Berg, T. (2021). An exploratory bibliometric analysis of the birth and emergence of Industry 5.0. *Applied System Innovation*, 4(4), 87. <https://doi.org/10.3390/asi4040087>
- Madsen, D. Ø., & Slåtten, K. (2023). Comparing the evolutionary trajectories of Industry 4.0 and 5.0: A management fashion perspective. *Applied System Innovation*, 6(2), 48. <https://doi.org/10.3390/asi6020048>
- Marinelli, M. (2022). Human-robot collaboration and lean waste elimination: Conceptual analogies and practical synergies in industrialized construction. *Buildings*, 12(12), 2057. <https://doi.org/10.3390/buildings12122057>
- Marinelli, M. (2023). From Industry 4.0 to Construction 5.0: Exploring the path towards human-robot collaboration in construction. *Systems*, 11(3), 152. <https://doi.org/10.3390/systems11030152>
- Martins, Y. S., Domingues, J. P. T. D., Poltronieri, C. F., & Leite, L. R. (2022). The emergence of Industry 5.0: A bibliometric analysis. *5th International Conference on Quality Engineering and Management*, Braga, Portugal.
- Martynov, V. V., Shavaleeva, D. N., & Zaytseva, A. A. (2019). Information technology as the basis for transformation into a digital society and Industry 5.0. *International Conference on Quality Management, Transport and Information Security, Information Technologies (ITandQMandIS)*, Sochi, Russia, 539–543. <https://doi.org/10.1109/CSCMP45713.2019.8976493>
- Mladineo, M., Cubić, M., Gjeldum, N., & Žižić, M. C. (2021). Human-centric approach of the lean management as an enabler of Industry 5.0 in SMEs. *International Conference Mechanical Technologies and Structural Materials (MTSM 2021)*, 111–117.
- Möller, D. P. F., Vakilzadian, H., & Haas, R. E. (2022). From Industry 4.0 towards Industry 5.0. *IEEE International Conference on Electro Information Technology (eIT)*, Mankato, MN, USA, 61–68. <https://doi.org/10.1109/eIT53891.2022.9813831>

- Mourtzis, D., Angelopoulos, J., & Panopoulos, N. (2022a). A literature review of the challenges and opportunities of the transition from Industry 4.0 to Society 5.0. *Energies*, 15(76). <https://doi.org/10.3390/en15176276>
- Mourtzis, D., Angelopoulos, J., & Panopoulos, N. (2022b). Operator 5.0: A survey on enabling technologies and a framework for digital manufacturing based on extended reality. *Journal of Machine Engineering*, 22(1), 43–69. <https://doi.org/10.36897/jme/147160>
- Mondal, S., & Samaddar, K. (2023). Reinforcing the significance of human factor in achieving quality performance in data-driven supply chain management. *The TQM Journal*, 35(1), 183–209. <https://doi.org/10.1108/TQM-12-2020-0303>
- Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics*, 106, 213–228. <https://doi.org/10.1007/s11192-015-1765-5>
- Nahavandi, S. (2019). Industry 5.0—A human-centric solution. *Sustainability*, 11(16), 4371. <https://doi.org/10.3390/su11164371>
- Østergaard, E. H. (2020). Industry 5.0 – Return of the human touch. *Universal Robots*. <https://www.universal-robots.com/blog/industry-50-return-of-the-human-touch/>
- Özdemir, V., & Hekim, N. (2018). Birth of Industry 5.0: Making sense of big data with artificial intelligence, the Internet of Things, and next-generation technology policy. *OMICS: A Journal of Integrative Biology*, 22(1), 1–3. <https://doi.org/10.1089/omi.2017.0194>
- Pathak, P., Pal, P. R., Shrivastava, M., & Ora, P. (2019). Fifth revolution: Applied AI and human intelligence with cyber-physical systems. *International Journal of Engineering and Advanced Technology*, 8(3), 23–27.
- Pessôa, M. V. P., & Becker, J. M. J. (2020). Smart design engineering: A literature review of the impact of the 4th industrial revolution on product design and development. *Research in Engineering Design*, 31, 175–195. <https://doi.org/10.1007/s00163-020-00330-z>
- Piccarozzi, M., Stefanoni, A., & Ilvestri, C. (2023). Industry 4.0 technologies as a lever for sustainability in the communication of large companies to stakeholders. *European Journal of Innovation Management*. <https://doi.org/10.1108/EJIM-11-2022-0641>
- Pizon, J., & Gola, A. (2023). Human-machine relationship: Perspective and future roadmap for Industry 5.0 solutions. *Machines*, 11, 203. <https://doi.org/10.3390/machines11020203>
- Pramanik, P. K. D., Mukherjee, B., Pal, S., Upadhyaya, B. K., & Dutta, S. (2020). Ubiquitous manufacturing in the age of Industry 4.0: A state-of-the-art primer. In A. Nayyar & A. Kumar (Eds.), *A roadmap to Industry 4.0: Smart production, sharp business, and sustainable development* (73–112). Springer Nature. https://doi.org/10.1007/978-3-030-14544-6_5
- Prassida, G. F., & Asfari, U. (2021). A conceptual model for the acceptance of collaborative robots in Industry 5.0. *Procedia Computer Science*, 197, 61–67. <https://doi.org/10.1016/j.procs.2021.12.118>
- Proia, S., Carli, R., Cavone, G., & Dotoli, M. (2022). Control techniques for safe, ergonomic, and efficient human-robot collaboration in the digital industry: A survey. *IEEE Transactions on Automation Science and Engineering*, 19(3), 1798–1819. <https://doi.org/10.1109/TASE.2021.3131011>
- Potoczek, N.R. (2021). The use of process benchmarking in the water industry to introduce changes in the digitization of the company's value chain. *Journal of Entrepreneurship, Management, and Innovation*, 17(4), 51–89. <https://doi.org/10.7341/20211743>
- Rada, M. (2015). Industry 5.0 – From virtual to physical. *LinkedIn*. <https://www.linkedin.com/pulse/industry-50-from-virtual-physical-michael-rada>
- Raja Santhi, A., & Muthuswamy, P. (2023). Industry 5.0 or Industry 4.0S? Introduction to Industry 4.0 and a peek into the prospective Industry 5.0 technologies. *International Journal on Interactive Design and Manufacturing*, 17, 947–979. <https://doi.org/10.1007/s12008-023-01217-8>
- Rauch, E. (2020). Industry 4.0+: The next level of intelligent and self-optimizing factories. In *Advances in design, simulation and manufacturing III. DSMIE 2020. Lecture Notes in Mechanical Engineering* (pp. 176–186). Springer, Cham. https://doi.org/10.1007/978-3-030-50794-7_18
- Rejeb, A., Rejeb, K., Zrelli, I., & Süle, E. (2025). Industry 5.0 as seen through its academic literature: an investigation using co-word analysis. *Discover sustainability*, 6(327). <https://doi.org/10.1007/s43621-025-01166-0>
- Roblek, V., Meško, M., & Podbregar, I. (2021). Mapping of the emergence of Society 5.0: A bibliometric analysis. *Organizacija*, 54(4), 293–305. <https://doi.org/10.2478/orga-2021-0020>
- Romero, D., & Stahre, J. (2021). Towards the resilient Operator 5.0: The future of work in smart resilient manufacturing systems. *Procedia CIRP*, 104, 1089–1094. <https://doi.org/10.1016/j.procir.2021.11.183>
- Rožanec, J. M., Novalija, I., Zajec, P., Kenda, K., Ghinani, H. T., Suh, S., Veliou, E., Papamartzivanos, D., Giannetos, T., Menesidou, S. A., Alonso, R., Cauli, N., Meloni, A., Recupero, D. R., Kyriazis, D., Sofianidis, G., Theodoropoulos, S., Fortuna, B., Mladenici, D., & Soldatos, J. (2022). Human-centric artificial intelligence architecture for Industry 5.0 applications. *International Journal of Production Research*. <https://doi.org/10.1080/00207543.2022.2138611>
- Sachsenmeier, P. (2016). Industry 5.0: The relevance and implications of bionics and synthetic biology. *Engineering*. <https://doi.org/10.1016/j.eng.2016.02.015>
- Saniuk, S., Grabowska, S., & Straka, M. (2022). Identification of social and economic expectations: Contextual reasons for the transformation process of Industry 4.0 into the Industry 5.0 concept. *Sustainability*, 14, 1391. <https://doi.org/10.3390/su14031391>
- Saptaningtyas, W. W. E., & Rahayu, D. K. (2020). A proposed model for food manufacturing in SMEs: Facing Industry 5.0. *5th North American International Conference on Industrial Engineering and Operations Management, Detroit, Michigan, USA*.
- Shahbakhsh, M., Emad, G. R., & Cahoon, S. (2022). Industrial revolutions and transition of the maritime industry: The case of Seafarer's role in autonomous shipping. *The Asian Journal of Shipping and Logistics*, 38(1), 10–18. <https://doi.org/10.1016/j.ajsl.2021.11.004>
- Sharma, M., Sehrawat, R., Luthra, S., Daim, T., & Bakry, D. (2022). Moving towards Industry 5.0 in the pharmaceutical manufacturing sector: Challenges and solutions for Germany. *IEEE Transactions on Engineering Management (Early Access)*, 1–18. <https://doi.org/10.1109/TEM.2022.3143466>
- Slavac, D. (2023). The main concepts of Industry 5.0: A Bibliometric Analysis Approach. *22nd International Symposium Infotech Jahorina Infotech 2023*. 1-5. [10.1109/INFOTEH57020.2023.10094143](https://doi.org/10.1109/INFOTEH57020.2023.10094143)
- Suciu, M. C., Plesea, D. A., Petre, A., Simion, A., Mituca, M. O., Dumitrescu, D., Bocaneala, A. M., Moroianu, R. M., & Nasulea, D. F. (2023). Core competence—As a key factor for a sustainable, innovative and resilient development model based on Industry 5.0. *Sustainability*, 15(9), 7472. <https://doi.org/10.3390/su15097472>
- Taj, I., & Jhanjhi, N. Z. (2022). Towards Industrial Revolution 5.0 and explainable artificial intelligence: Challenges and opportunities. *International Journal of Computing and Digital Systems*, 12(1), 285–310. <https://doi.org/10.12785/ijcds/120124>
- Tavares, M. C., Azevedo, G., & Marques, R. P. (2022). The challenges and opportunities of Era 5.0 for a more humanistic and sustainable society—A literature review. *Societies*, 12(6), 149. <https://doi.org/10.3390/soc12060149>
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British Journal of Management*, 14(3), 207–222. <https://doi.org/10.1111/1467-8551.00375>

- Vacchi, M., Siligardi, C. & Settembre-Blundo, D. (2024). Driving Manufacturing Companies toward Industry 5.0: A Strategic Framework for Process Technological Sustainability Assessment (P-TSA). *Sustainability*, 16, 695. <https://doi.org/10.3390/su1602069>
- Veiga, D.S. (2025). Analysis of the results of the regional innovation policies of the structural funds on business innovation indicators: does size and role matter in Andalusian business performance indicators? *The Annals of Regional Science*, 74(22). <https://doi.org/10.1007/s00168-025-01354-w>
- Welfare, K. S., Hollowell, M. R., Shah, J. A., & Riek, L. D. (2019). Consider the human work experience when integrating robotics in the workplace. *14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), Daegu, Korea (South)*, 75–84. <https://doi.org/10.1109/HRI.2019.8673139>
- WEF (2024). The future of growth. 2024. Retrieved from https://www3.weforum.org/docs/WEF_Future_of_Growth_Report_2024.pdf.
- Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0—Inception, conception and perception. *Journal of Manufacturing Systems*, 61, 530–535. <https://doi.org/10.1016/j.jmsy.2021.10.006>
- Zupic, I., & Cater, T. (2014). Bibliometric methods in management and organization. *Organizational Research Methods*, 18, 429–472. <https://doi.org/10.1177/1094428114562629>

Biographical notes

Camila Fabrício Poltronieri, graduated in Production Engineering from the Federal University of São Carlos - UFSCar (2005). Master's (2014) and Ph.D. (2018) from the University of São Paulo - USP. She was a faculty member in the undergraduate Production Engineering program at the Federal University of Goiás (UFG) between 2018 and 2025. Since 2022, she has been part of the Graduate Program in Production Engineering at the Federal University of Goiás, and since 2025, she has been teaching in the undergraduate Production Engineering program at the University of São Paulo (USP). Currently, she is a postdoctoral researcher at São Paulo State University – UNESP. Research areas: Industry 5.0, Integrated Management Systems, Sustainability. H-index (Scopus): 6.

Luciana Rosa Leite, graduated in Agronomic Engineering from the Federal University of Santa Catarina – UFSC (2007). Master's (2010) and Ph.D. (2014) in Production Engineering from the Federal University of Santa Catarina – UFSC and the Federal University of São Carlos – UFSCar, respectively, with a research internship at Virginia Tech (2011-2012), where she worked as a researcher at the ISE - Grado Department of Industrial and Systems Engineering (USA). Since 2016, she has been a faculty member in the undergraduate Production Engineering program at the State University of Santa Catarina – UDESC, and since 2022, she has been teaching in the Graduate Program in Civil Engineering at the same institution. She coordinates the NUPESI Research Group, Center for Research and Studies in Sustainability and Innovation, and the LAMPS – Process Improvement and Sustainability Laboratory. Research areas: Performance Indicators, Sustainability, Performance Measurement Systems, Environmental Management Systems, Lean, Circular Economy, Industry 4.0/5.0. H-index (Scopus): 6.

Yasmin Silva Martins Xavier, graduated in Production Engineering from the Federal University of São João del Rei – UFSJ (2017). Master's (2019) and Ph.D. (2022) in Production Engineering from the Federal University of Itajubá – UNIFEI, with a research internship at the University of Minho, Braga. Since 2024, she has been a faculty member in the undergraduate Production Engineering program at São Paulo State University (UNESP). Research areas: Management Systems, Risk Management, Quality Management, Sustainability, and Organizational Management. H-index (Scopus): 3.

José Pedro Teixeira Domingues, graduated in Chemistry from the University of Minho – UMinho (1995), with a Master's (2000) in Textile Engineering and a Ph.D. (2013) in Production and Systems Engineering from the same institution. Since 2014, he has been a Senior Consultant at Quality for Excellence Consulting and a Consultant at Bureau Veritas Angola. Principal Researcher at the School of Engineering of the University of Minho. Research areas: Quality, Management Systems, and Sustainability. H-index (Scopus): 19.

José Carlos de Toledo, graduated in Production Engineering from the University of São Paulo – USP (1979), with a Master's (1985) in Production Engineering from the Federal University of Rio de Janeiro - UFRJ, and a Ph.D. (1993) in Production Engineering from the University of São Paulo - USP. Specialization in TQM from AOTS/JUSE, Japan (1990). Currently, he is a Full Professor in the Department of Production Engineering and the Graduate Program at the Federal University of São Carlos – UFSCar. Research areas: Quality Management, Product Development Process Management, Process Control and Improvement, Quality in Agribusiness, Quality Management in Rural Production, Continuous Quality Improvement, and Accreditation in Health Services. H-index (Scopus): 11.

Otávio José de Oliveira, graduated in Civil Engineering from São Judas Tadeu University - USJT (1997), with a Master's in Administration from Pontifícia Universidade Católica de São Paulo – PUC/SP (2001), Ph.D. (2005), and Post-Doctorate (2006) in Civil Engineering from the University of São Paulo - USP. Currently, he is a Full Professor at São Paulo State University - UNESP, working in the areas of Integrated Management Systems (Quality, Environment, Health and Safety, and Social Responsibility), Sustainability/Corporate Environmental Management, and Industry 4.0/5.0. He has served as Head of the Production Department, coordinated the Graduate Program in Production Engineering, and the Undergraduate Production Engineering Program at UNESP. He maintains active scientific collaborations with researchers from Turkey, India, Spain, Portugal, Sweden, and Ireland. H-index (Scopus): 24.

Author contributions statement

Camila Fabrício Poltronieri: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Supervision, Validation, Visualization, Writing –Original Draft Preparation, Writing – Review & Editing. **Luciana Rosa Leite:** Conceptualization, Formal Analysis, Investigation, Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing. **Yasmin Silva Martins:** Conceptualization, Formal Analysis, Investigation, Methodology, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing. **José Pedro Teixeira Domingues:** Conceptualization, Formal Analysis, Investigation, Methodology, Validation, Visualization, Writing – Original Draft Preparation. **José Carlos de Toledo:** Writing – Original Draft Preparation, Writing – Review & Editing. **Otávio José de Oliveira:** Writing – Review & Editing.

Conflicts of interest

The authors declare no competing interests.

Citation (APA Style)

Poltronieri, C.F., Leite, L.R., Martins, Y.S., Teixeira Domingues, J.P., de Toledo, J.C., & de Oliveira, O.J. (2025). Toward Industry 5.0: Mapping technologies, competencies, and research opportunities. *Journal of Entrepreneurship, Management and Innovation*, 21(4), 103-129. <https://doi.org/10.7341/20252145>

Capability and resource orchestration of triple bottom line enterprises: Mediating role of social entrepreneurial orientation

Reni Mutiarani Saraswati¹ , Noor Raihani Binti Zainol² , Sam Toong Hai³ 

Abstract

PURPOSE: Triple bottom line framework (TBL)—encompassing social, environmental, and economic—is a fundamental objective for social enterprises (SEs) to ensure their long-term viability, address societal challenges, and contribute to sustainable development goals (SDGs). Nevertheless, SEs often encounter obstacles in attaining these objectives due to resource constraints and inadequate capabilities that hinder their operational effectiveness. Additionally, there is a lack of research on understanding the relationship between these factors, particularly within the context of emerging countries. Grounded in the social resource-based view (SRBV) theory and social entrepreneurial orientation (SEO), this study seeks to investigate how SEs can orchestrate their resources and capabilities to enhance sustainable performance effectively. **METHODOLOGY:** This study employed a quantitative approach to investigate the relationships between resources, capabilities, SEO, and sustainable performance among social enterprises in Greater Jakarta, Indonesia. 438 data were collected using a structured survey questionnaire designed with items measured on a 5-point Likert scale. Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to analyze the model. **FINDINGS:** A total of 438 responses were obtained from social enterprises in Indonesia. The findings suggest that social resources, social capabilities, and social entrepreneurial orientation have a positive influence on sustainable performance. The findings also reveal that social resources and social capabilities influence the achievement of SEO. Furthermore, the findings indicate that SEO mediates the relationship between social capabilities and sustainability performance more effectively than social resources. This implies that SEO enhances sustainable performance by reinforcing organizational capabilities, including strategic decision-making, resource optimization, and risk management. **IMPLICATIONS:** This study contributes to the literature on sustainability by emphasizing the critical role of resources, capabilities, and social entrepreneurial orientation in the success of SEs. It offers valuable insights for SEs on how to navigate challenges and make strategic decisions to meet sustainable outcomes. Moreover, the findings have practical implications for researchers, enterprises, and policymakers to improve the structural support and operational environment for SEs. **ORIGINALITY AND VALUE:** This study provides a unique integration of the SRBV theory. It contributes new insights into the role of resources, capabilities, and social entrepreneurial orientation for TBL enterprises.

Keywords: triple bottom line (TBL), social enterprises, social entrepreneurial orientation (SEO), resource-based view (RBV), social resource-based view (SRBV), resource orchestration, capability orchestration, sustainable performance, strategic capabilities, emerging economies, sustainable development goals (SDGs), partial least squares structural equation modelling (PLS-SEM)

1 Reni Mutiarani Saraswati, Ph.D., Associate Professor, Department of Bio Management, School of Business, i3L University, Jl. Pulomas Barat Kav. 88, RT.4/RW.9, Kayu Putih, Pulo Gadung, East Jakarta, Jakarta, 13210, Indonesia, e-mail: reni.saraswati@i3l.ac.id (ORCID: <https://orcid.org/0000-0003-2619-3923>).

2 Noor Raihani Binti Zainol, Ph.D., Associate Professor, Universiti Malaysia Kelantan, UMK KAMPUS KOTA, Pengkalan Chepa, 16100 Kota Bharu, Kelantan, Malaysia, e-mail: raihani@umk.edu.my (ORCID: <https://orcid.org/0000-0002-6091-2509>).

3 Sam Toong Hai, Ph.D., Professor, Inti International University and Colleges, No. 3, Jalan SS15/8, 47500 Subang Jaya, Selangor Darul Ehsan, Malaysia, e-mail: toonghai.sam@newinti.edu.my (ORCID: <https://orcid.org/0000-0001-7145-5625>).

Received 3 March 2025; Revised 3 August 2025; Accepted 10 September 2025.

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INTRODUCTION

Resilient People, Resilient Planet: A Future Worth Choosing, a report developed by the United Nations (UN) Secretary General, emphasizes the world's commitment to achieving global sustainability. The commitment stems from the acknowledgment of prevailing unsustainable practices, including the excessive use of resources and the release of hazardous pollutants into the environment (Ahmed et al., 2020; Kraus et al., 2020). The unsustainable utilization of resources has resulted in negative impacts on the environment, ecosystems, and public health (Rasul, 2021), as well as significant adverse effects on business operations and the economy (World Bank & ADB, 2021). They present considerable risks to the well-being of people and the planet (U.N., 2012). Building on this urgency, all UN member states collectively adopted the Sustainable Development Goals (SDGs) in 2015. These goals offer a comprehensive framework that aims to eradicate poverty, protect the environment, and promote prosperity (Tjahjadi et al., 2021). Three important priorities are highlighted: (1) promoting sustainable production and consumption practices, addressing climate change, and adhering to various environmental limits; (2) empowering people to make sustainable decisions and fostering responsible behavior; (3) optimizing resource management to meet the demand of the 21st century across multiple sectors (Sala, 2020; U.N., 2012). This sustainable development could be accomplished through an integrated policy framework that encompasses all three pillars known as the “people, planet, profit” or „triple bottom line” (Elkington, 1998; Satar, 2022; U.N., 2012).

The triple bottom line (TBL) framework and sustainability are intricately connected, as both seek to achieve long-term goals while protecting the interests of present and future generations simultaneously (Ruggerio, 2021; Stenn, 2017). At its core, TBL highlights three primary objectives: social, environmental, and economic, each of which is essential in fostering sustainability (Hourneaux et al., 2018). The attainment of TBL requires environmentally sustainable approaches for resource utilization. Other important strategies include reducing resource intensity, ensuring cost efficiency, maintaining high product quality, and significantly enhancing profitability (Pralhad & Hart, 1999). This framework has been widely adopted worldwide, leading to changes in how enterprises approach and integrate sustainability into their operations (Høgevold et al., 2019; Solovida & Latan, 2021). These changes have impacted various aspects of business, including the costs associated with production and the provision of final services, as well as the costs incurred in the distribution of goods. The pursuit of using sustainable resources involves ensuring broad accessibility to resources and replacing raw materials with more sustainable alternatives. Enterprises also emphasize the importance of collaboration within their supply chain to cultivate new markets that are accessible to others. This suggests that they value both competitive and collaborative advantages (Longoni et al., 2024).

Despite its widespread use, the relationships between the dimensions of TBL – social, environmental, and economic – remain largely unexplored. The dimensions of TBL in sustainability studies have mostly been examined independently in prior research. While TBL is fundamentally a multifaceted concept that integrates the three dimensions (Naegler et al., 2021), a significant number of studies tend to focus predominantly on a singular dimension, such as economic (Madaleno & Vieira, 2020), or on a dual perspective, such as the economic and social dimensions, thereby neglecting the environmental dimension in their analyses (Solovida & Latan, 2021).

This study, therefore, discusses and analyzes the three dimensions simultaneously to provide a comprehensive and better understanding of their interconnectedness. Focusing on social enterprises in Indonesia, this examination explores how these enterprises achieve and balance the three aspects of the TBL, while also identifying the key resources and capabilities required to achieve these objectives. This analysis is grounded in the social resource-based view (SRBV) theory, which will be discussed further in the next section. Furthermore, this study discusses the mediating role of social entrepreneurial orientation in linking resources and capabilities to sustainability outcomes. The next section outlines the research background and the development of hypotheses, which leads to the proposed conceptual framework. The research methodology is subsequently detailed through the use of Partial Least Squares Structural Equation Modeling (PLS-SEM), followed by a presentation of results, a discussion of key findings, and practical recommendations.

CONCEPTUAL BACKGROUND AND HYPOTHESES DEVELOPMENT

Triple bottom line (TBL) enterprises prioritize the pursuit of social, environmental, and economic objectives concurrently. Nonetheless, achieving these objectives for social enterprises, particularly those in emerging countries, can be challenging. Among these challenges, achieving environmental objectives presents difficulties stemming from resource and capability limitations. One prominent hurdle is the establishment of sustainable supply chains, which require the procurement of

eco-friendly resources (Ruggerio, 2021). This process is further complicated by limited access to these resources and the substantial costs associated with acquiring them, making it difficult for social enterprises to fully implement sustainable practices (Bacq & Eddleston, 2018; Sinthupundaja et al., 2019). To overcome these challenges, social enterprises need to embrace sustainable development practices that align with the objectives of the triple bottom line (Rasul, 2021).

Social factors are as significant as environmental dimensions in achieving TBL objectives. Various indicators that represent important social dimensions have been identified within the literature, encompassing social welfare, social impacts, social missions (Gali et al., 2020), enhancements to quality of life (Hutchins & Sutherland, 2008), energy, education (Tate & Bals, 2018), community health and security, and social well-being (Yusliza et al., 2020). Despite the diverse social objectives proposed by academics in this field, accomplishing them remains a hurdle. Several critical issues are evident in social enterprises in Indonesia, including insufficient opportunities for skill development (Council, 2021) and a lack of practical experience, which culminates in a workforce that is insufficiently equipped to meet the demands of social enterprise operations (Council & ESCAP, 2020). These limitations can potentially hinder the effectiveness of social enterprises in achieving their social goals and, in turn, their TBL objectives.

The attainment of environmental and social objectives had a significant impact on the achievement of economic goals, highlighting the interconnectedness of these three objectives. These interconnected dimensions emphasize the need for a holistic approach associated with TBL. Achieving these objectives requires the mobilization of sufficient resources, including effective risk management and access to financial assets necessary for capital investment, technology advancement, and operational efficiency (Pinheiro et al., 2021). Nevertheless, within the context of social enterprises, the acquisition of these resources presents a considerable obstacle. Studies conducted in Indonesia have identified several barriers, including limited access to financial resources, rising energy costs, technological constraints, inefficient production processes, inadequate managerial capabilities, and difficulties in sourcing raw materials (Council, 2020, 2021; Maksum et al., 2020). These limitations hinder the efficient allocation of resources and limit the capability of social enterprises to achieve their full economic potential.

Social resource-based view (SRBV) theory

Glavas and Mish (2015) assert that employing a strategy for resource management, grounded in the resource-based view (RBV) theory, allows conventional or traditional businesses to achieve a competitive advantage (Kabue & Kilika, 2016). However, in the context of social enterprises, the emphasis extends beyond this objective, as they must use resources and capabilities to provide social value while also attaining sustainability (Bacq & Eddleston, 2018). The social resource-based view (SRBV) theory, in this regard, elucidates the mechanisms by which social enterprises implement socially sustainable practices, minimizing environmental costs and providing positive impacts throughout their value chain. The implementation encompasses three interrelated strategies: (1) the proactive approach of pollution prevention aimed at reducing waste, emissions, and effluents; (2) the concept of product stewardship focused on lowering overall product costs; and (3) the principle of sustainable development designed to foster organizational growth while mitigating environmental impact (Solovida & Latan, 2021). In addition, strategically leveraging these capabilities, social enterprises not only foster innovative capabilities but also develop meaningful social and environmental impacts. This innovation-driven approach enables them to address persistent social problems in emerging countries and protect the environment (Guo & Wang, 2022; Nair & Bhattacharyya, 2019). Based on these perspectives, the adoption of SRBV as the theoretical basis of this study is derived from the pursuit of competitive advantage that drives sustainable performance through social sustainable practice (Wang et al., 2022).

The relationship between resources, capabilities, and sustainable performance

The management of organizational resources is essential not merely for enhancing performance but also for securing a competitive advantage. For social enterprises to achieve this objective, it is crucial that they conduct a thorough evaluation of their internal strengths and limitations, thereby enabling them to manage their resources effectively (Othman & Arshad, 2015). Enhancing the efficiency of core businesses can facilitate the acquisition of social resources through the efficient use of resources, minimizing detrimental outputs such as pollution, reengineering, or creating new processes to benefit society (Rangan et al., 2015), and generating sustainable products (Othman & Arshad, 2015; Tate & Bals, 2018).

Social enterprises can draw upon a diverse array of resources (Tate & Bals, 2018). A study conducted in Indonesia revealed several significant resources that impact social enterprises, including physical, financial, and experiential resources

(Council, 2021; Harsanto et al., 2022). The importance of physical resources is highlighted by scholars, emphasizing their role in an organization's competitive capabilities in the market (Alhazmi et al., 2018; Alsyof et al., 2021). Physical resources play a crucial role in mitigating the adverse effects of organizational operations within the framework of environmental management (Roxas, 2021). Such resources include labor, equipment, machines, plants, raw materials, financial assets (Othman & Arshad, 2015; Ramon-Jeronimo et al., 2019; Sinthupundaja et al., 2019), and information technology (Pee & Kankanhalli, 2016), all of which are crucial for ensuring operational efficiency and sustainability.

Similarly, experiential resources are important to enhance the performance of organizations (Ramon-Jeronimo et al., 2019). In social enterprises, skills, knowledge, and abilities cultivated through experiences and education are crucial. These capabilities are not only fundamental for recognizing and assessing market opportunities and risks but also for comprehending the organizational resources and effectively synthesizing existing resources (Chadwick et al., 2015).

Like other profit-driven organizations, social enterprises must also secure financial resources to remain competitive in the market (Sinthupundaja et al., 2019). Access to financial resources, such as private credit coverage, is crucial for funding and sustaining business operations (Sahasranamam & Nandakumar, 2020; Urbano et al., 2020). In the absence of sufficient resources, social enterprises may struggle to maintain their competitive advantage within the marketplace.

Likewise, capabilities are as important as resources, as they enable the social enterprises to solve societal problems such as inequality, poverty, and social conflicts (Sinthupundaja et al., 2019) and fulfill their social, environmental, and economic objectives (Bacq & Eddleston, 2018). A variety of attributes can be categorized as capabilities that encompass social and economic goals-oriented, environmentally-related management (Sinthupundaja et al., 2019), entrepreneurial skills (Zainol & Al Mamun, 2018), informational capabilities (Magesa et al., 2020), management capabilities (Tate & Bals, 2018), and innovation capabilities (Testi et al., 2018), among other attributes.

Many studies have identified entrepreneurial capabilities in different skills, behaviors, and competencies (Nikitina et al., 2020). Zainol and Al Mamun (2018) proposed opportunity recognition, management, commitment, conceptualization, and relationship as the key components of entrepreneurial capabilities. While Nikitina et al. (2020) identified three core areas: (i) ideas and opportunity capability, which include factors such as identifying opportunities, creativity, vision, ideas recognition, ethics, self-awareness, self-efficacy, and sustainable thinking; (ii) resources capability, which include motivation and perseverance, resources management, financial and economic knowledge and skills, and initiative; and (iii) into action capability, which include planning and management, risk management, collaboration, and experiential-based learning.

Informational capabilities play a crucial role in enabling social enterprises to make informed business decisions. It pertains to the ability for social enterprises to seek, nurture, and discern information derived from culture, social, and economic perspectives (Magesa et al., 2020). Furthermore, it facilitates collaboration among enterprises and their stakeholders by improving the sharing and dissemination of information (Tate & Bals, 2018). Informational capabilities encompass a range of practices, including the ability to acquire significant market insights (Lans et al., 2014), identify potential customers, establish and expand networks, and continuously monitor products and industry trends (Ramon-Jeronimo et al., 2019). Leveraging these capabilities empowers social enterprises to foster strategic decision-making processes, fortifying their market positioning and, consequently, promoting sustainable performance.

Another aspect of social capabilities examined in this study pertains to management capabilities, which encompass the ability to develop, organize, and oversee management systems (Lans et al., 2014). A substantial number of studies have explored these capabilities, including Tate and Balls (2018), which emphasize the importance of stakeholder management capabilities. Other scholars highlight the governance, resources, legal form, learning, and monitoring capabilities (Weerawardena & Sullivan Mort, 2006), management commitment, and employee involvement (Wong et al., 2014), along with the processes of recruiting, training, and retaining employees that are consistent with social and organizational objectives (Rahdari et al., 2016).

The final aspect of capabilities discussed in this study is innovativeness, which is a determinant factor for social enterprises, given its capacity to foster economic growth through entrepreneurial activities (Hatak et al., 2016; Pinheiro et al., 2021). Innovation refers to the implementation of innovative concepts encompassing models, products, and services aimed at addressing societal challenges while promoting collaboration (Testi et al., 2018). It not only enhances the competitiveness of production processes but also enables social enterprises to capitalize on opportunities to penetrate new markets (Galindo-Martín et al., 2020).

While both social resources and social capabilities hold considerable significance, social enterprises in Indonesia encounter substantial challenges that hinder their growth and sustainability. Of the primary limitations, one stems from

inefficiencies in factors such as high production costs, difficulties in acquiring raw materials, energy pricing, and sales competencies (ILO, 2019). Additionally, lack of access to funding and financial resources remains a persistent challenge, with many social enterprises struggling to secure financial support (Council, 2021; Desiana et al., 2022; Katsushi, 2020). Another difficulty arises from factors such as difficulties in acquiring entrepreneurial expertise (Council & ESCAP, 2020), a lack of multi-sector collaboration, and inadequate networks (Council, 2021). Past studies also revealed that technological advancements have been one of the contributors to the country's lack of informational capabilities (ILO, 2019; Magesa et al., 2020; World Economic Forum, 2019). Addressing these challenges is crucial, as is the need to find effective approaches to investigate these relationships. By examining the relationship between resources, capabilities, and the three dimensions of the triple bottom line—social, environmental, and economic—this study aims to provide valuable insights for social enterprises to thrive in today's dynamic environment. Hence, this study proposes the following hypotheses:

- H1. Social resources have a positive relationship with sustainable performance in social enterprises in Indonesia.
- H2. Social capabilities have a positive relationship with sustainable performance in social enterprises in Indonesia.

The relationship between social resources, social capabilities, and social entrepreneurial orientation (SEO)

The significance of social impact in business strategy is underscored by two perspectives: the social resource-based view (SRBV) and social entrepreneurial orientation (SEO). While both approaches share a common objective of generating social, environmental, and economic impacts, they differ in their strategic approach. The SRBV emphasizes the significance of resources and capabilities in attaining objectives (Tate & Bals, 2018), whereas SEO highlights the importance of an enterprise's ability to identify and pursue new opportunities (Gali et al., 2020; Halberstadt et al., 2020). Both approaches strive to achieve social impacts, which are considered important for social enterprises (Halberstadt et al., 2020; Tate & Bals, 2018).

Social enterprises often shape and strengthen their unique resources and capabilities through their social entrepreneurial orientation. In this context, social enterprises develop their capabilities to create products and services that address social needs while ensuring financial viability, thereby fostering sustainable performance. SEO, in particular, helps enterprises enhance their capabilities in identifying opportunities and risks and adopting innovative strategies to tackle social challenges. Additionally, it has the ability to effectively utilize various organizational resources – including financial, human, social capital, and social networks – to enhance operational efficiency and sustainability (Turpin & Shier, 2020). By integrating these approaches, social enterprises can strategically leverage their resources and entrepreneurial capabilities to achieve social, environmental, and economic performance, ultimately reinforcing their role as key drivers of positive social change. Drawing upon the above discussion, the following hypotheses are developed:

- H3. Social resources have a positive relationship with social entrepreneurial orientation in social enterprises in Indonesia.
- H4. Social capabilities have a positive relationship with social entrepreneurial orientation in social enterprises in Indonesia.

The relationship between SEO and sustainable performance

The preceding discussions surrounding social entrepreneurial orientation (SEO) reveal a scholarly consensus that social enterprises equipped with the SEO capabilities are better positioned to achieve organizational objectives. Prior research has also established a positive correlation between SEO and organizational sustainable performance (Monteiro et al., 2017). The potential for enhancing SEO within social enterprises can foster sustainable performance (Alvarez-Torres et al., 2019; Gali et al., 2020). Several factors of SEO contribute to these objectives, with proactiveness, risk-taking, and social innovation identified as critical factors (Dwivedi & Weerawardena, 2018; Gali et al., 2020; Satar & Natasha, 2019).

Proactiveness enables social enterprises to create new environments and transform the business landscape (Dai et al., 2014), as well as to influence the market through the introduction of innovative products, services, processes, and technologies (Zhai et al., 2018). At the same time, risk-taking enables social enterprises to recognize and effectively manage the inherent risks associated with assessing business opportunities and initiatives (Adel & Habib, 2018; Chavez et al., 2020). Social innovation is another facet of SEO, recognized as essential in today's dynamic environment (Satar & Natasha, 2019). The integration of social innovation is strongly linked to an enterprise's social mission in achieving social impact (Kraus et al., 2017). Social innovation enables social enterprises to develop innovative methods for addressing

social needs, integrating social mission-driven and business-driven approaches to formulate sustainable solutions (Halberstadt et al., 2020).

The comprehensive integration of proactiveness, risk-taking, and social innovation fortified the enterprise's strategic orientation and enhanced its ability to achieve TBL objectives—social, environmental, and economic. These perspectives lead to the formulation of the following hypothesis in this study:

H5. Social entrepreneurial orientation has a positive relationship with sustainable performance in social enterprises in Indonesia.

The mediating role of social entrepreneurial orientation (SEO)

Past research has investigated the mediating role of social entrepreneurial orientation (SEO) (Adel & Habib, 2018; Khedhaouria et al., 2020), specifically exploring its role within the framework of a resource-based view theory (Miao et al., 2017). In social enterprises, SEO serves as a foundational framework for the attainment of environmentally and socially responsible outcomes (Turpin & Shier, 2020). It fosters the cultivation of creative problem-solving skills, ethical decision-making, and an emphasis on sustainability-related goals (Roxas, 2021). Scholars suggest that the presence of SEO as a mediator enables the efficient allocation of resources and the development of effective capabilities that contribute to successful social, environmental, and economic performance (Miao et al., 2017).

Despite extensive research in this field, a significant gap remains in the literature regarding the mediating role of SEO in the relationship between various organizational resources and sustainable performance. In particular, existing studies have not sufficiently explored how SEO mediates the impact of physical resources, experiential resources, and financial resources on sustainable performance. Furthermore, there is a lack of studies investigating SEO as a mediator between entrepreneurial capability, informational capability, management capability, and innovativeness in relation to sustainable performance (Miao et al., 2017). Thus, this study seeks to investigate these relationships and proposes the following hypotheses:

H6. Social entrepreneurial orientation mediates the relationship between social resources and sustainable performance in social enterprises in Indonesia.

H7. Social entrepreneurial orientation mediates the relationship between social capabilities and sustainable performance in social enterprises in Indonesia.

Research framework

The framework designed for this study was underpinned by a literature review encompassing four dimensions, including social resources, social capabilities, social entrepreneurial orientation, and sustainable performance. Furthermore, it employs a multidimensional, higher-order model that aims to simplify the model, reduce model complexity (Hair et al., 2022), and enhance the instrument's capability to predict psychological and behavioral outcomes (Lindner et al., 2015). The use of higher-order constructs also aligns with previous studies in this field, such as those undertaken by Gali et al. (2020), Masud et al. (2019), Ramon-Jeronimo et al. (2019), and Sinthupundaja et al. (2019). In this study, social resources have three lower-order components (physical, experiential, and financial resources). Social capabilities have four lower-order components (entrepreneurial, managerial, informational, and innovativeness). Social entrepreneurial orientation (SEO) as a mediation dimension branches into three lower-order components (proactiveness, risk-taking, and social innovation). Finally, sustainability performance was categorized into social, environmental, and economic performance. Figure 1 illustrates the research framework, while Table 1 provides descriptions of the variables.

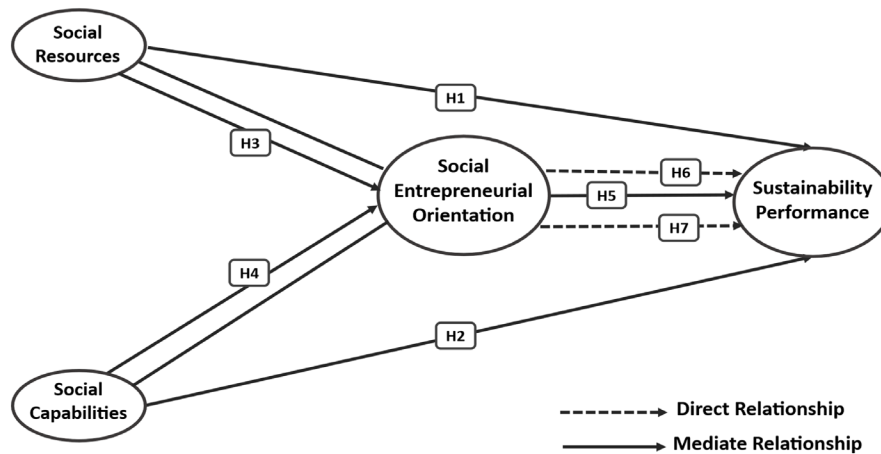


Figure 1. Research framework

Table 1. Description of variables

Variable description	Sample manifest variables	Source
Physical Resources	Better technology equipment; availability of production capacities; improved access to key sources	Othman & Arshad, 2015; Ramon-Jeronimo et al., 2019; Sinthupundaja et al., 2019
Experiential Resources	Managerial experience in the current business, experience in running a business	Ramon-Jeronimo et al., 2019; Staniewski, 2016
Financial Resources	Financial resources availability associated with the social entrepreneurship activities	Ramon-Jeronimo et al., 2019; Sinthupundaja et al., 2019; Tate & Bals, 2018
Entrepreneurial Capability	Capabilities to generate revenue, achieve environmental and/or social objectives	Sinthupundaja et al., 2019; Tate & Bals, 2018
Management Capability	Communication ability with stakeholders; support from stakeholders	Bacq & Eddleston, 2018; Sinthupundaja et al., 2019
Informational Capability	Capability of acquiring important market information; capability of identifying prospective customers; social network capability related to the market, capability in monitoring competitive products in the market	Ramon-Jeronimo et al., 2019
Innovativeness	Continuous renewal and social innovation, new development, and ideas to increase social impact and solve social issues	Hatak et al., 2016; Ramon-Jeronimo et al., 2019
Social Entrepreneurial Orientation	Social proactiveness Social risk-taking Social innovation	Dwivedi & Weerawardena, 2018; Gali et al., 2020; Halberstadt et al., 2020; Kraus et al., 2017; Sinthupundaja et al., 2019
Social Performance	Social element/ awareness / cognitive, such as stakeholder welfare; health and safety awareness of the community; and intellectual property rights	Bacq & Eddleston, 2018; Gali et al., 2020; Kraus et al., 2017; Sinthupundaja et al., 2019; Tate & Bals, 2018
Environmental Performance	Waste reduction; resource consumption reduction; environmental improvement	Sinthupundaja et al., 2019; Tate & Bals, 2018
Economic Performance	Higher revenue; higher profits; affordable product innovation; high sales growth; good reputation	Gali et al., 2020; Ramon-Jeronimo et al., 2019; Sinthupundaja et al., 2019; Tate & Bals, 2018

RESEARCH METHODOLOGY

This study aims to investigate the relationships between factors essential for sustainable performance, utilizing a research design designed to provide a thorough assessment and test the hypotheses derived from the theoretical framework. This investigation focuses on social enterprises in Indonesia as the primary unit of analysis, with the characteristics of these enterprises conforming to the criteria set forth by the Indonesian government. The government defines a social enterprise as having the following characteristics: (i) the enterprise is required to derive its major income from the sale of items

or the provision of paid services; (ii) the principal objective of the enterprise is a “social mission,” an “environmental mission,” or a combination of both (Council & ESCAP, 2020). Furthermore, this study focuses on several key industries that represent the most prominent and prevalent areas of social enterprise activity in Indonesia. This includes education, which constitutes 15% of the sector, agriculture (16%), and the creative industry (22%) (Council & ESCAP, 2020).

The question statements delineated in this study employ a 5-point Likert scale. The Likert scale is favored, as it captures a broader spectrum of transactional coping behaviors compared to alternative assessment methods (Bougie & Sekaran, 2019). Furthermore, it allows for both relative and absolute evaluations to be conducted on various attitude measurements (Maeda, 2015). The 5-point Likert scale has been employed in prior research addressing a comparable subject to this study, including the works of Bacq and Eddleston (2018), Hatak et al. (2016), and Sinthupundaja et al. (2019).

A purposive sampling technique was utilized to identify participants who fulfilled the predetermined criteria (Creswell, J. W., & Creswell, 2018). These individuals occupy positions ranging from low to top managerial levels within social enterprises located in Jakarta, Bogor, Depok, Tangerang, and Bekasi. In addition, snowball sampling was used to enhance the methodology used in this study. This technique enables researchers to access targeted populations through peer networks or referrals, thereby ensuring a diversity of perspectives aligned with the study’s objectives (Lohr, 2021).

This study employed the Partial Least Squares Structural Equation Modeling (PLS-SEM) method due to its ability to handle large sample sizes and complex models involving multiple constructs and mediation paths. The method is particularly suitable for exploratory research, especially in contexts where the interrelationships among constructs are not well-defined, as it helps explain the causal relationships and provides deeper insight into the phenomenon under investigation (Hair Jr et al., 2021). It also assists in handling non-normal data (Hair Jr et al., 2021) and in examining the predictive value of exogenous variables (Kock, 2016). Furthermore, this method is consistent with prior studies within the same field, including studies by Aranda-Usón et al. (2019), Maletič et al. (2018), Masud et al. (2019), and Ramon-Jeronimo et al. (2019).

The proposed assessment for the PLS-SEM involves a two-stage process. The initial phase involves a thorough evaluation of the measurement model, with a focus on assessing reliability and validity. The subsequent phase involves analyzing the structural model, focusing on assessing the path analysis, confidence interval, variance inflation factor, and effect size (Hair Jr et al., 2021).

RESULTS

Following a data cleaning process that rectified data entry errors, addressed missing values, and removed outliers, a total of 438 valid data points were gathered from the social enterprises in the Greater Jakarta area of Indonesia. Upon evaluating this dataset, it was observed that 55.02% of the survey participants identified as female, while 44.98% identified as male. The present findings contradict earlier research concerning social enterprises in the country, which indicated that the majority of respondents were male (Council & ESCAP, 2018). This observation suggests a significant increase in the participation of women in this field compared to previous periods. The findings indicate that most respondents were young adults, specifically those aged 24 to 33. This finding aligns with previous studies, which indicate that a significant proportion of participants in social enterprises falls within the 25-34 age range (Council & ESCAP, 2018, 2020). Additionally, the analysis indicates that 74.43% of respondents held an undergraduate degree, with 64.84% classifying their roles within the social enterprises as low-level management positions. Although the representation of high- and middle-level managers in this study was limited, the existing literature substantiates that low response rates are commonly observed and often deemed acceptable in surveys that encompass different levels of management. This phenomenon can be attributed to factors such as restricted availability, gatekeeping practices, and the substantial volume of unsolicited inquiries they encounter (Borgholthaus et al., 2025). Additionally, the response rates of high-level managers generally fall around 32%, which is considered acceptable (Cycyota & Harrison, 2006).

Table 2. Demographic profile of respondents and social enterprises

Variable	Description	Frequency	Percentage
Profile of the respondent			
Gender	Male	197	44.98
	Female	241	55.02
Age	Below 24	74	16.89
	24 – 33	212	48.40
	34 – 43	105	23.97
	Above 43	47	10.73
Education	High School Graduate	89	20.32
	Undergraduate	326	74.43
	Graduate	23	5.25
Position in the Organization	High-Level Managers	46	10.50
	Middle-Level Managers	108	24.66
	Low-Level Manager	284	64.84
Profile of the social enterprises			
Business industry	Creative industry	350	79.91
	Agriculture	72	16.44
	Education	16	3.65
Business location	Jakarta	253	57.76
	Bogor	22	5.02
	Depok	19	4.34
	Tangerang	134	30.59
	Bekasi	10	2.28
Business establishment	Less than 5 years	191	43.61
	5 -10 years	212	48.40
	11 – 15 years	14	3.20

The findings also revealed a diverse range of social enterprise sectors, including the creative industry (79.91%), agriculture (16.44%), and education (3.65%). These results are consistent with the British Council's (2021) findings, which identified creative industries as the leading social enterprise sector in Indonesia, while agriculture and education ranked second and third, respectively. Table 2 presents the demographic profiles of the respondents and the social enterprises.

Following the examination of the respondents' demographic profile, the subsequent step included analyzing the data using PLS-SEM with SmartPLS version 4. This analysis employed a two-stage approach, consisting of the measurement model followed by the structural model. During the initial phase, the measurement model is employed to analyze the loading of the indicators corresponding to each research construct (Hair Jr et al., 2021). Hair et al. (2019) assert that an item exhibiting a factor loading within the range of 0.50 to 0.70 demonstrates acceptable reliability levels, whereas loadings that surpass 0.70 are considered to be well-defined. Items with values below 0.5 are excluded from the model. The study's findings, presented in Table 3, indicated that the item loadings ranged from 0.564 to 0.887. The results suggest an acceptable outcome between the indicators and the latent construct being examined (Hair, Risher, et al., 2019; Jun et al., 2021). Although it is typically advisable for item loadings to exceed 0.7 (Hair, Risher, et al., 2019) or 0.708 (Hair Jr et al., 2021), it is not uncommon for scholars, particularly within the social sciences, to observe indicator loadings below these thresholds (Hulland, 1999). In this study, six items were eliminated, including one from the higher-order items and five from the lower-order items. These items were removed since they contain values that did not meet the minimum requirement of 0.5 suggested by Hair et al. (2021). Figure 2 illustrates the findings using SmartPLS 4.

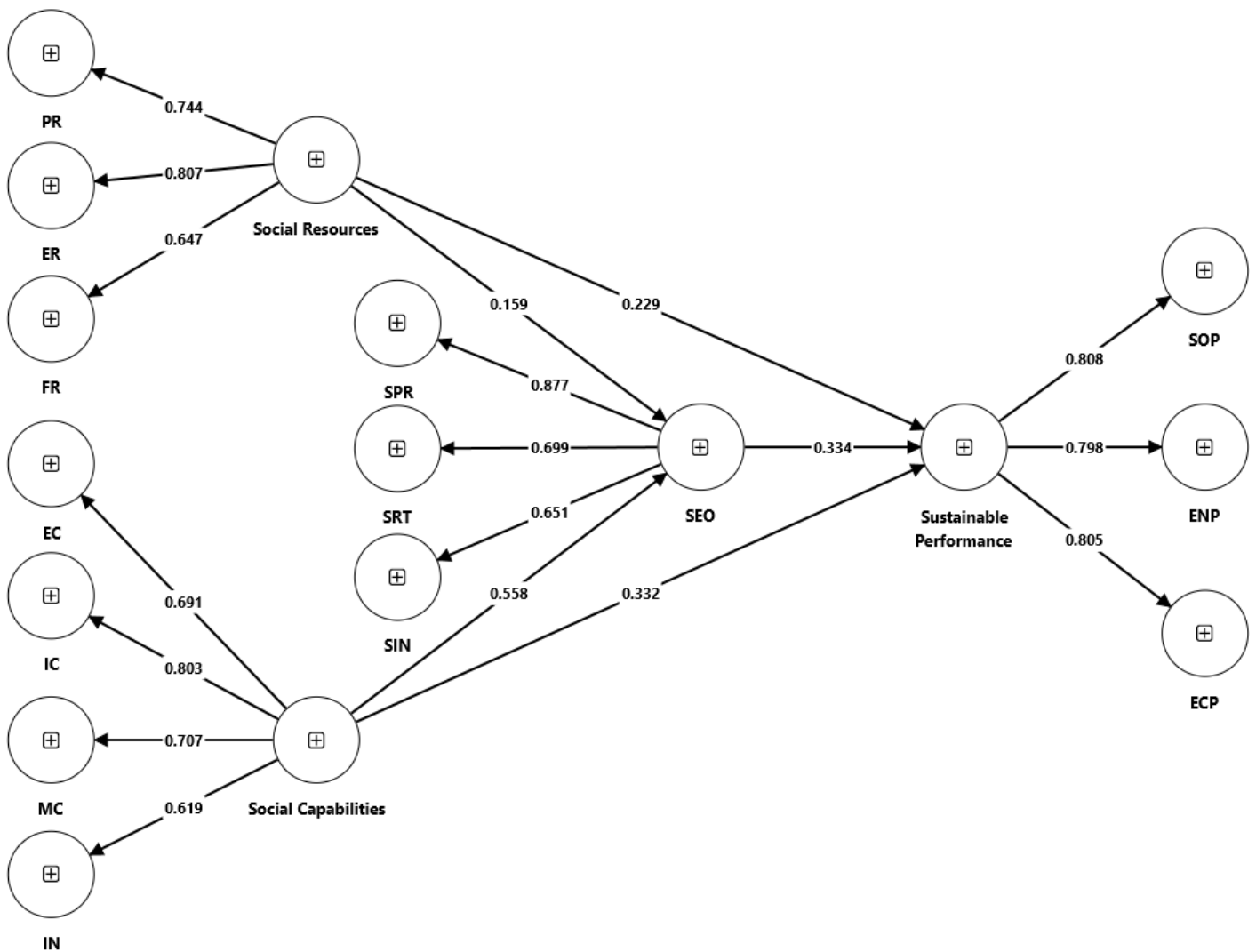


Figure 2. The measurement model

Following a thorough examination of the indicator loading, the assessment of construct reliability and validity was conducted using SmartPLS, such as composite reliability (CR) and average variance extracted (AVE). Composite reliability evaluates the items or indicators in relation to their loadings. The existing literature indicates that a composite reliability (CR) assessment falling within the range of 0.70 to 0.90 is deemed acceptable (Hair Jr et al., 2021). The results presented in Table 3 indicate that the composite reliability of all constructs ranges from 0.778 to 0.875, suggesting that the model’s composite reliability is both acceptable and valid.

This study further examined the convergent validity, commonly known as average variance extracted (AVE). The designation “AVE” refers to the mean value of the extracted variance associated with items pertinent to a specific construct. The findings of this study indicated that AVE values vary from 0.500 to 0.777. Values between 0.5 and 0.6, while not as desirable as 0.7, remain acceptable (Hair Jr et al., 2021). This indicates that the construct exhibits moderate convergent validity.

Another approach to the measurement model is discriminant validity, particularly through heterotrait-monotrait (HTMT) analysis. Hair Jr et al. (2021) define HTMT as the average values of indicator correlations across all constructs. The HTMT cutoff value of 0.90 or 0.85 serves as a criterion for discerning structural models that encompass constructs that are conceptually closely related (Henseler et al., 2015). An HTMT value that surpasses 0.90 signifies a lack of discriminant validity. This study evaluated the datasets related to HTMT analysis using SmartPLS. The findings presented in Table 4 revealed that the majority of the HTMT values ranged from 0.336 to 0.851. The values fell below the conservative threshold of 0.90, indicating that the results of HTMT were considered acceptable.

Table 3. Reliability and validity constructs

Higher-order construct	Lower-order construct	Item	Loading	CR	AVE
	Physical Resources	PR1	0.764	0.830	0.620
		PR2	0.846		
		PR3	0.749		
	Experiential Resources	ER1	0.813	0.814	0.594
		ER2	0.774		
		ER3	0.723		
	Financial Resources	FR1	0.876	0.875	0.777
		FR2	0.887		
	Entrepreneurial Capabilities	EC1	0.734	0.801	0.505
		EC2	0.758		
		EC3	0.767		
		EC4	0.564		
	Informational Capabilities	IC1	0.743	0.814	0.523
		IC2	0.753		
		IC3	0.726		
		IC4	0.668		
	Management Capabilities	MC1	0.778	0.800	0.572
		MC2	0.760		
		MC3	0.729		
	Innovativeness	IN1	0.699	0.803	0.577
		IN2	0.815		
		IN3	0.762		
	Social Proactiveness	SPR1	0.659	0.800	0.502
		SPR2	0.748		
		SPR3	0.788		
		SPR4	0.627		
	Social Risk-Taking	SRT1	0.793	0.791	0.560
		SRT2	0.668		
		SRT3	0.777		
	Social Innovation	SIN1	0.595	0.791	0.563
SIN2		0.844			
SIN3		0.788			
Economic Performance	ECP1	0.804	0.814	0.525	
	ECP2	0.781			
	ECP3	0.687			
	ECP4	0.611			
Environmental Performance	ENP1	0.762	0.831	0.551	
	ENP2	0.740			
	ENP3	0.729			
	ENP4	0.737			
Social Performance	SOP1	0.725	0.799	0.500	
	SOP2	0.752			
	SOP3	0.620			
	SOP4	0.724			
Social Resources	Physical Resources	PR	0.744	0.778	0.541
Social Capabilities	Experiential Resources	ER	0.807	0.799	0.501
	Financial Resources	FR	0.647		
	Entrepreneurial Capabilities	EC	0.691		
	Informational Capabilities	IC	0.803		
Social Entrepreneurial Orientation	Management Capabilities	MC	0.707	0.790	0.561
	Innovativeness	IN	0.619		
	Social Proactiveness	SPR	0.877		
Sustainable Performance	Social Risk-Taking	SRT	0.699	0.845	0.646
	Social Innovation	SIN	0.651		
	Economic Performance	ECP	0.805		
	Environmental Performance	ENP	0.798		
	Social Performance	SOP	0.808		

Table 4. Discriminant Validity (Heterotrait–monotrait (HTMT)) analysis

	ECP	ER	ENP	IC	IN	MC	PR	SOP	EC	FR	SPR	SRT	SIN
ECP													
ER	0.676												
ENP	0.612	0.660											
IC	0.605	0.638	0.648										
IN	0.531	0.622	0.524	0.538									
MC	0.630	0.851	0.617	0.598	0.586								
PR	0.643	0.532	0.468	0.553	0.663	0.387							
SOP	0.734	0.681	0.655	0.723	0.499	0.558	0.451						
EC	0.751	0.545	0.584	0.588	0.455	0.429	0.494	0.648					
FR	0.528	0.478	0.363	0.439	0.467	0.424	0.336	0.404	0.698				
SPR	0.641	0.481	0.605	0.647	0.491	0.554	0.438	0.675	0.722	0.473			
SRT	0.668	0.697	0.630	0.527	0.491	0.629	0.443	0.624	0.607	0.479	0.763		
SIN	0.617	0.628	0.644	0.593	0.419	0.791	0.414	0.743	0.622	0.487	0.543	0.554	

Note: 438 Dataset. PR=Physical Resources; ER=Experiential Resources; FR=Financial Resources; EC=Entrepreneurial Capabilities; IC=Informational Capabilities; MC=Management Capabilities; IN=Innovativeness; SPR=Social Proactiveness; SRT=Social Risk-Taking; SIN=Social Innovative; ECP=Economic Performance; SOP=Social Performance; ENP=Environmental Performance.

The second phase of the PLS-SEM methodology involves a structural model that illustrates the relationships among latent variables (Sung & Park, 2018). PLS-SEM assessed these relationships through percentile bootstrapping (Chin W, 1998), employing a computation based on 10,000 bootstrap samples (Streukens & Leroi-Werelds, 2016). Multiple analyses were performed using this methodology, including significance level, t-value, p-value, confidence interval, variance inflation factor (VIF), and the effect size (f^2). A hypothesis is deemed valid if the beta value corresponds with the hypothesis direction, the t-value is larger than or equal to 1.645, and the p-value is less than or equal to 0.05. Furthermore, collinearity among predictors was assessed using the Variance Inflation Factor (VIF). A VIF value less than 3.3 is considered acceptable (Hair et al., 2017; Hair, Black, et al., 2019; Hair Jr et al., 2021). The confidence interval (CI) must not include zero between the lower limit (LL) and upper limit (UL) of the interval (Hair, Risher, et al., 2019). Effect size (f^2) values of 0.35 are considered large; 0.15 represents medium; and 0.02 represents a small effect for direct relationships (Chin, 2010; Cohen, 1988). For indirect relationships, effect size values of 0.25 signify a large effect, 0.09 denotes a medium effect, and 0.01 represents a small effect (Hair Jr et al., 2021; Kenny, 2018).

This study proposed seven hypotheses, with the findings outlined in Table 5. Hypothesis 1 examines the direct relationship between social resources and sustainable performance. The findings indicated a statistically positive outcome, as shown by the parameters ($\beta = 0.229$, $SE = 0.047$). The t-value of 4.921 is well above the threshold of 1.645 (Hair, Risher, et al., 2019), and the p-value of 0.000 confirms significance at the 5% level (Hair, Risher, et al., 2019). The VIF value of 2.040 falls below the threshold of 3.3, indicating no collinearity issues in the model (Hair et al., 2017). These results ensure that social resources contribute to sustainable performance. The confidence interval (CI) did not include zero between the lower level (LL = 0.152) and upper level (UL = 0.305), indicating satisfactory findings. The effect size was 0.067, indicating a small effect.

Hypothesis 2 examines the direct relationship between social capabilities and sustainable performance. The findings demonstrated that the path coefficient and confidence interval all pointed to a positive outcome ($\beta = 0.332$, $SE = 0.052$, $t = 6.329$, $p = 0.000$, $LL = 0.245$, $UL = 0.418$). The VIF values were 2.57, which is below the recommended threshold of 3.3 set by Hair et al. (2021). This evidence suggests that the predictor’s construct does not exhibit collinearity issues, allowing for a confident interpretation of the results. Regardless, the results may require further evaluation, given that the constructs might share some conceptual proximities that contribute to the observed VIF levels. The effect size was 0.111, indicating a small effect. The findings suggest that both H1 and H2 are supported, indicating a positive relationship between social resources, social capabilities, and sustainable performance in social enterprises in Indonesia.

Table 5. Direct and indirect relationship of the constructs

Hypothesis	Relationship	Beta coefficient	SE	t-value	p-value	LL	UL	VIF	f ²	Decision
H1	Social Resources → Sustainable Performance	0.229	0.047	4.921	0.000	0.152	0.305	2.040	0.067	Supported
H2	Social Capabilities → Sustainable Performance	0.332	0.052	6.329	0.000	0.245	0.418	2.573	0.111	Supported
H3	Social Resources → Social Entrepreneurial Orientation	0.159	0.060	2.638	0.004	0.061	0.257	1.993	0.023	Supported
H4	Social Capabilities → Social Entrepreneurial Orientation	0.558	0.056	9.986	0.000	0.466	0.649	1.993	0.291	Supported
H5	SEO → Sustainable Performance	0.334	0.044	7.541	0.000	0.260	0.406	1.859	0.156	Supported
H6	Social Resources → SEO → Sustainable Performance	0.053	0.023	2.340	0.010	0.020	0.093	-	0.002	Supported
H7	Social Capabilities → SEO → Sustainable Performance	0.186	0.029	6.430	0.000	0.143	0.238	-	0.030	Supported

Hypotheses 3 and 4 examine the relationship between social resources and social entrepreneurial orientation (SEO), as well as the relationship between social capabilities and SEO, respectively. The findings revealed that hypothesis 3 was supported and deemed satisfactory ($\beta = 0.159$, $SE = 0.060$, $t = 2.638$, $p = 0.004$, $VIF = 1.993$, $LL = 0.061$, $UL = 0.257$). The effect size was 0.023, indicating a small effect. Hypothesis 4 yields a substantial result ($\beta = 0.558$, $SE = 0.056$, $t = 9.986$, $p = 0.000$, $VIF = 1.993$, $LL = 0.466$, $UL = 0.649$) with an effect size of 0.291, indicating a medium effect. While both findings indicate a positive relationship between the constructs, the results reveal that social capabilities exert a greater influence on SEO for social enterprises in Indonesia than social resources.

Hypothesis 5 examines the relationship between SEO and sustainable performance in social enterprises. The results indicated a favorable relationship among the constructs, thereby supporting H5 ($\beta = 0.334$, $SE = 0.044$, $t = 7.541$, $p = 0.000$, $VIF = 1.859$, $LL = 0.260$, $UL = 0.406$). Furthermore, the effect size ($f = 0.156$) of this relationship falls within the medium range. These findings emphasize the importance of SEO in enhancing sustainable performance within the context of the study.

Hypotheses 6 and 7 examine the mediating role of SEO in the relationship between social resources, social capabilities, and sustainable performance. The findings for hypothesis 6 revealed a statistically positive outcomes ($\beta = 0.053$, $SE = 0.023$, $t = 2.340$, $p = 0.010$, $LL = 0.020$, $UL = 0.093$). Similarly, the result for hypothesis 7 also showed a positive outcomes ($\beta = 0.186$, $SE = 0.029$, $t = 6.430$, $p = 0.000$, $LL = 0.143$, $UL = 0.238$). The effect size for hypothesis 6 was 0.002, indicating no effect, whereas hypothesis 7 had an effect size of 0.030, indicating a small effect. This suggests that, although the path relationship for hypothesis 6 is present, its practical impact on the coefficient of determination is negligible and should be interpreted with caution (Hair Jr et al., 2021). Nonetheless, hypothesis 6 is supported and can still contribute to the overall model. The findings also indicate that SEO mediation has a more significant impact on the relationship between social capabilities and sustainable performance compared to its effect on the association between social resources and sustainable performance. It highlights the significance of social capabilities through SEO for enhancing sustainable performance.

DISCUSSION

The findings derived from the PLS-SEM analysis provide empirical evidence of both direct and indirect relationships with sustainable performance. The analysis of direct relationships between social resources and sustainability performance reveals that, although the effect of these resources – namely, physical, entrepreneurial, and financial – was small, they still positively influence sustainability performance in social enterprises in Indonesia. These findings align with prior investigations conducted by Roxas (2021), Pee and Kankanhalli (2016), Alsyof et al. (2021), and Aboelmaged (2018). They suggest that key physical resource factors, including the utilization of advanced technologies, access to essential supply sources, and the availability of manufacturing capacity, are crucial for social enterprises to be competitive in the market. In contrast to these findings, a previous study presented a contradictory perspective (Klimas, 2019). Klimas (2019) argued that physical resources were not as significant as the other forms of resources in enhancing the performance of enterprises. In particular, when physical resources exhibit a lack of uniqueness, they become easily imitated by competitors, and their impact on sustainable performance becomes less significant (Adnan et al., 2018). Instead, social enterprises can enhance their entrepreneurial capabilities by developing skills in building brand reputation and fostering

innovation capabilities. This strategic approach will empower them to tackle social and environmental challenges effectively. Despite the importance of physical resources on sustainable performance not being universally accepted, and their effect may appear small, recognizing and leveraging the resources – physical, entrepreneurial, and financial – is still crucial for social enterprises (Aboelmaged, 2018; Roxas, 2021). Effectively managing these resources enables enterprises to allocate them in ways that enhance operational efficiency, address social and environmental challenges, and promote sustainability (Maletič et al., 2018). This strategic approach can significantly contribute to the resilience of social enterprises in Indonesia in achieving their objectives (Ramon-Jeronimo et al., 2019; Roxas, 2021).

The experiential dimension, another aspect of social resources investigated in this study, yielded unique findings. Although the findings suggest that these resources provide a positive influence on sustainable performance, the effect was small. A study conducted by the British Council (2021) indicates that over 40% of individuals engaged in social enterprises in Indonesia lack experience. These inadequacies often result in poor decision-making, ineffective resource management, and inadequate risk assessment (Chadwick et al., 2015). This obstacle highlights a significant gap in the operational resources of social enterprises, which frequently undervalue or overlook experiences. The skills, knowledge, and abilities gained from various experiences can help identify market opportunities and risks, enhance an organization's understanding of its strengths, and encourage the creative use of available resources. The broader implications of experiential resources are evident in a study in emerging economies, which revealed that prior work experience significantly enhances confidence and self-efficacy in pursuing entrepreneurial endeavors (Matos & Hall, 2020). Therefore, raising awareness about the importance of experience in social enterprises is crucial for fostering innovative ideas that enable them to remain competitive in the market.

The availability of adequate financial support and funding from investment for social activities is as important as other resources to ensure growth and sustainability. Nevertheless, previous research concerning Indonesian social enterprises indicates that they encountered challenges in securing finance and funding (Council, 2021; Desiana et al., 2022; Katsushi, 2020). These challenges are often attributed to a lack of information on financing opportunities and the burden of collateral requirements imposed by formal financial institutions, which many social enterprises struggle to meet (Saraswati et al., 2024). As a result, these obstacles impede the growth of social enterprises and limit their capabilities to compete in the market. Considering the obstacles faced by social enterprises in the country, researchers emphasize that financial resources are critical to the enterprises' capacity to address societal issues, scale their business, and achieve long-term impact (Council & ESCAP, 2018, 2020). This perspective aligns with the findings of this study, which indicated that financial resources positively influenced sustainable performance. Therefore, addressing the financial barriers of social enterprises and for the government to assist in this matter is essential. The government has the capacity to facilitate progress by enacting initiatives that bolster the ecosystem, including the creation of private finance infrastructure aimed at fostering social impact (Saraswati et al., 2024). These initiatives have demonstrated success in Central and Eastern Europe (European Commission, 2020). Other initiatives can include providing access to cost reduction, microfinance loans, market potential and market data, and sales prospects. The implementation of these programs has proven effective, consistently offering support to social enterprises in India (Sengupta et al., 2018). Beyond offering financial support, the government has the capacity to enhance the visibility of social enterprises' objectives within its agenda and to facilitate their growth through the enactment of relevant laws and regulations (Bacq & Eddleston, 2018).

Several social capabilities factors were taken into consideration in this investigation, including entrepreneurial, informational, management, and innovation capabilities. Social enterprises in Indonesia emphasize entrepreneurial capabilities through effective internal governance and operational efficiency, along with a strategic commitment to their social and economic missions. These capabilities, when integrated with social and environmental objectives, offer a competitive advantage for enterprises (Sinthupundaja et al., 2019; Tate & Bals, 2018). Similarly, informational capabilities make a positive contribution to sustainable performance. Prior investigations have demonstrated that the strategic utilization of information empowers enterprises to improve their market position (Lans et al., 2014). These capabilities enable them to gather valuable market information, observe competitive dynamics, build relationships with customers, and effectively engage with stakeholders (Tate & Bals, 2018), all of which play a significant role in improving decision-making and fostering sustainable performance (Magesa et al., 2020; Whitmore et al., 2017). Developing strategic management practices in social enterprises also enable them to effectively coordinate and manage abilities in achieving objectives (Bacq & Eddleston, 2018; Sinthupundaja et al., 2019). Furthermore, innovative strategies such as improving current products in response to market demand and adopting new ideas for production processes allow social enterprises to efficiently address social issues (Council & ESCAP, 2018), and economic challenges (Sinthupundaja et al., 2019). These capabilities,

in turn, enable social enterprises to enhance their performance and growth rate (Clemente-Suárez et al., 2021; Saraswati et al., 2024) and achieve favorable outcomes (Hendarman & Cantner, 2018).

The analysis of the relationship between social entrepreneurial orientation (SEO) and sustainable performance also yielded favorable outcomes. This is characterized by acceptable path analysis results and a moderate effect size. The higher effect size than other direct factors associated with sustainable performance in this study demonstrates that SEO significantly enhances the performance of social enterprises. These findings align with previous research by Alvarez-Torres et al. (2019), Gali et al. (2020), Halberstadt et al. (2020), and Monteiro et al. (2017), which emphasize the important role of SEO on sustainable performance. Their perspectives on SEO underscore its critical role as a strategic tool for social enterprises to enhance their operations, thereby fostering advancements in sustainable performance (Martínez-Climent et al., 2019). Through proactivity, risk-taking behaviors with efficacy, and cultivation of innovation, SEO enables social enterprises to navigate challenges better, effectively address societal problems, and adapt to changing environments (Saraswati et al., 2024).

This study further clarifies the role of SEO as a mediating factor in the observed relationships. Two relationships were examined. First, SEO mediates the relation between social resources and sustainability performance; second, SEO mediates the relationship between social capabilities and sustainability performance. The results demonstrated that both relationships were positively influenced by SEO, highlighting the significance of SEO as a mediator between these variables. Nonetheless, two primary distinctions exist between these relationships. The observation that the impact on social capabilities demonstrated a small effect, whereas social resources exhibited no apparent effect, is noteworthy. The fact that SEO had little effect as a mediator between social resources and sustainable performance resembles observations made in European social enterprises, especially in countries with lower purchasing power parity, where there is a tendency to prioritize capability development over strategies that require significant resources (European Commission, 2020). Despite being conceptually relevant, the influence of SEO as a mediator without effective execution may prove to be insignificant. Furthermore, resources might have a more profound impact on sustainable performance when directly linked, rather than relying on SEO as a mediator. The role of SEO as a mediator between social capabilities and sustainable performance demonstrated a larger effect size, indicating a significantly heightened importance of its influence. The findings align with the management capabilities theory proposed by Helfat and Martin (2015), which posits that SEO serves as a mediating factor in improving social enterprises' decision-making capabilities. This enhancement enables them to embrace risk-taking, engage in proactive decision-making, stimulate innovation, and adeptly leverage their capabilities to execute strategic initiatives that bolster the organization's sustainability performance. These perspectives were supported by scholars such as Deslatte and Swann (2020), Huebeck (2023), Imran et al. (2019), and Khedhaouria (2015).

CONCLUSIONS

This study aimed to bridge the knowledge gap by enhancing the understanding of the triple bottom line (TBL) – encompassing social, environmental, and economic aspects – within the context of social enterprises in Indonesia. TBL framework has emerged as a significant concept in recent years owing to apprehensions over the effects of business activities on the environment (Ruggerio, 2021). Scholars and policymakers worldwide have continually expressed their concerns about the escalating crises of environmental degradation, social issues, and economic difficulties (Sung & Park, 2018). TBL, conversely, emphasizes the attainment of social, environmental, and economic outcomes and ensures that development is sustainable.

This study addresses a theoretical gap in literature. While most past studies on social enterprises have focused on one or two aspects of sustainability performance, this study investigates all three pillars of TBL. It also integrates the factors associated with resources and capabilities as outlined in the social resource-based view (SRBV) theory. These factors, including financial access, unique physical resources, and entrepreneurial capabilities, have been identified as the most prominent impediment for social enterprises in Indonesia (Council, 2021; Desiana et al., 2022; Harsanto et al., 2022; Maksum et al., 2020; Saraswati et al., 2024). The findings revealed that optimizing the orchestration of these factors enables the social enterprises to enhance social, environmental, and economic performance, thereby fostering sustainable development.

This study also investigates SEO, which is widely recognized for its potential to foster innovation and strengthen strategic adaptability in social enterprises. Nonetheless, there has been a lack of empirical research on the direct and indirect influence of SEO on sustainable performance in the Indonesian context. This research explores this relationship, aiming to

fill the existing gap. The findings show that SEO influences both social resources and social capabilities on sustainability performance. Although the mediation paths were statistically acceptable, they differed in practical relevance. The mediation role of SEO between social resources and sustainability performance was negligible, suggesting that resource-related strategies may contribute directly rather than through SEO. On the other hand, the mediation effect between social capabilities and sustainability performance was more meaningful. This implies that SEO improves sustainable performance by strengthening organizational capabilities, such as strategic decision-making, resource optimization, and risk management. These capabilities enable social enterprises to address social and environmental challenges effectively, leading to more favorable sustainability outcomes.

This study delineates significant implications for social enterprises and scholars regarding the enhancement of sustainable performance. It emphasizes the potential to concurrently utilize resources and capabilities, strategically harnessing them within a particular framework of the social entrepreneurial process. Furthermore, it underscores the integration of social entrepreneurial orientation into their strategy to influence the efficacy of each operational behavior, presenting a valuable opportunity to bolster the success of social enterprises and, consequently, their sustainable performance. The results are pertinent and potentially replicable in other emerging markets with similar characteristics, which could improve the sustainability performance of social enterprises. The study further establishes the implications for policymakers, suggesting that they can enhance the visibility of social enterprises by integrating social objectives into the governmental agenda. This can be achieved through the formulation of programs and initiatives that bolster the ecosystem, including the establishment of private finance infrastructure, facilitating access to cost-reduction opportunities, microfinance loans, market potential and market data, sales prospects, essential raw materials, and pertinent laws and regulations.

This study is limited to particular geographic and sectoral areas, potentially impacting the generalizability of the findings. Additionally, it highlights specific influential factors and employs a quantitative methodology, which may not fully encapsulate the complexities of the underlying dynamics. Future research should investigate a variety of industries and include enterprises from a broader range of geographical locations. Furthermore, the examination of additional factors, including research and development (R&D), technological investment, and stakeholder engagement, may be investigated concerning sustainable performance (Adnan et al., 2018). Exploring the dynamic aspects of resource orchestration over time is also encouraged, particularly through longitudinal studies, as well as investigating other mediating and moderating variables. Furthermore, future research may employ qualitative methodologies to help elucidate the complexities and nuances associated with these phenomena.

References

- Aboelmaged, M. (2018). The drivers of sustainable manufacturing practices in Egyptian SMEs and their impact on competitive capabilities: A PLS-SEM model. *Journal of Cleaner Production*, 175, 207–221. <https://doi.org/10.1016/j.jclepro.2017.12.053>
- Adel, G., & Habib, A. (2018). Mediating role of entrepreneurial orientation on the relationship between relational network and competitive advantages of Tunisian contractors. *Journal of the Knowledge Economy*, 9(2), 665–679. <https://doi.org/10.1007/s13132-016-0358-8>
- Adnan, M., Abdulhamid, T., & Sohail, B. (2018). Predicting firm performance through resource based framework. *European Journal of Business and Management*, 10(1), 31–40.
- Ahmed, U., Mozammel, S., & Zaman, F. (2020). Impact of ecological innovation, entrepreneurial self-efficacy and entrepreneurial orientation on environmental performance and energy efficiency. *International Journal of Energy Economics and Policy*, 10(3), 289–295. <https://doi.org/10.32479/ijeep.9227>
- Alhazmi, N., Lavy, S., & Lai, J. (2018). A theoretical framework for physical asset management practices. *Facilities*, 34(1), 1–5. <https://doi.org/10.1108/F-02-2016-0025>
- Alsyouf, I., Alsuwaidi, M., Hamdan, S., & Shamsuzzaman, M. (2021). Impact of ISO 55000 on organisational performance: Evidence from certified UAE firms. *Total Quality Management and Business Excellence*, 32(1–2), 134–152. <https://doi.org/10.1080/14783363.2018.1537750>
- Alvarez-Torres, F. J., Lopez-Torres, G. C., & Schiuma, G. (2019). Linking entrepreneurial orientation to SMEs' performance - Implications for entrepreneurship universities. *Management Decision*, 57(12), 3364–3386. <https://doi.org/10.1108/MD-11-2018-1234>
- Aranda-Usón, A., Portillo-Tarragona, P., Marín-Vinuesa, L. M., & Scarpellini, S. (2019). Financial resources for the circular economy: A perspective from businesses. *Sustainability (Switzerland)*, 11(3). <https://doi.org/10.3390/su11030888>
- Bacq, S., & Eddleston, K. A. (2018). A resource-based view of social entrepreneurship: How stewardship culture benefits scale of social impact. *Journal of Business Ethics*, 152(3), 589–611. <https://doi.org/10.1007/s10551-016-3317-1>
- Borgholthaus, C. J., Bourgoin, A., Harms, P. D., White, J. V., & Fezzey, T. N. A. (2025). Surveying the Upper Echelons: An update to Cycyota and Harrison (2006) on top manager response rates and recommendations for the future. *Organizational Research Methods*, January. <https://doi.org/10.1177/10944281241310574>
- Bougie, R., & Sekaran, U. (2019). *Research methods for business: A skill building approach*. John Wiley & Sons.
- Chadwick, C., Janice, S., & Kwon, K. (2015). Resource orchestration in practice: CEO emphasis on SHRM, commitment-based HR systems, and firm performance. *Strategic Management Journal*, 36(3), 360–376. <https://doi.org/doi:10.1002/smj.2217>

- Chavez, R., Yu, W., Sadiq Jajja, M. S., Lecuna, A., & Fynes, B. (2020). Can entrepreneurial orientation improve sustainable development through leveraging internal lean practices? *Business Strategy and the Environment*, 29(6), 2211–2225. <https://doi.org/10.1002/bse.2496>
- Chin, W. W. (2010). How to write up and report PLS analyses. In V. Esposito Vinzi, W. W. Chin, J. Henseler, & H. Wang (Eds.), *Handbook of partial least squares* (pp. 655–690). Springer. https://doi.org/10.1007/978-3-540-32827-8_29
- Chin W, M. G. (1998). The partial least squares approach to structural formula modeling. *Advances in Hospitality and Leisure*, 8(2), 5. <https://doi.org/10.4324/9781410604385-10>
- Clemente-Suárez, V. J., Navarro-Jiménez, E., Moreno-Luna, L., Saavedra-Serrano, M. C., Jimenez, M., Simón, J. A., & Tornero-Aguilera, J. F. (2021). The impact of the covid-19 pandemic on social, health, and economy. *Sustainability (Switzerland)*, 13(11), 1–25. <https://doi.org/10.3390/su13116314>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates. <https://doi.org/https://doi.org/10.4324/9780203771587>
- Council, B. (2020). *Investing in Creative and Social Enterprise in Indonesia*. https://www.britishcouncil.id/sites/default/files/dice_creative_and_social_enterprise_in_indonesia_report_en_final.pdf
- Council, B. (2021). *Supporting Social Enterprises in Indonesia* (Issue July). <https://www.ilo.org/media/234126/download>
- Council, B., & ESCAP, U. N. (2018). *Developing an Inclusive and Creative Economy: The State of Social Enterprise in Indonesia*. https://www.britishcouncil.org/sites/default/files/the_state_of_social_enterprise_in_indonesia_british_council_web_final_0.pdf
- Council, B., & ESCAP, U. N. (2020). *Creative and Social Enterprise in Indonesia*. https://www.britishcouncil.id/sites/default/files/dice_creative_and_social_enterprise_in_indonesia_report_en_final.pdf
- Creswell, J. W., & Creswell, J. D. (2018). Research design: qualitative, quantitative, and mixed methods approaches. In *Writing Center Talk over Time* (5th ed.). <https://doi.org/10.4324/9780429469237-3>
- Cycyota, C. S., & Harrison, D. A. (2006). What (not) to expect when surveying executives: A meta-analysis of top manager response rates and techniques over time. *Organizational Research Methods*, 9(2), 133–160. <https://doi.org/10.1177/1094428105280770>
- Dai, L., Maksimov, V., Gilbert, B. A., & Fernhaber, S. A. (2014). Entrepreneurial orientation and international scope: The differential roles of innovativeness, proactiveness, and risk-taking. *Journal of Business Venturing*, 29(4), 511–524. <https://doi.org/10.1016/j.jbusvent.2013.07.004>
- Desiana, P. M., Ma'arif, M. S., Puspitawati, H., Rachmawati, R., Prijadi, R., & Najib, M. (2022). Strategy for sustainability of social enterprise in Indonesia: A structural equation modeling approach. *Sustainability (Switzerland)*, 14(3). <https://doi.org/10.3390/su14031383>
- Dwivedi, A., & Weerawardena, J. (2018). Conceptualizing and operationalizing the social entrepreneurship construct. *Journal of Business Research*, 86(January), 32–40. <https://doi.org/10.1016/j.jbusres.2018.01.053>
- Elkington, J. (1998). Triple bottom line. *Environmental Quality Management*, 8(1), 37–51.
- European Commission. (2020). *Social enterprises and their ecosystems in Europe. Comparative synthesis report*. <https://doi.org/10.2767/567551>
- Gali, N., Niemand, T., Shaw, E., Hughes, M., Kraus, S., & Brem, A. (2020). Social entrepreneurship orientation and company success: The mediating role of social performance. *Technological Forecasting and Social Change*, 160(June), 120230. <https://doi.org/10.1016/j.techfore.2020.120230>
- Galindo-Martín, M. A., Castaño-Martínez, M. S., & Méndez-Picazo, M. T. (2020). The relationship between green innovation, social entrepreneurship, and sustainable development. *Sustainability (Switzerland)*. <https://doi.org/10.3390/su12114467>
- Guo, Y., & Wang, L. (2022). Environmental entrepreneurial orientation and firm performance: The role of environmental innovation and stakeholder pressure. *SAGE Open*, 12(1). <https://doi.org/10.1177/21582440211061354>
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis*. Cengage. <https://doi.org/10.1002/9781119409137.ch4>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). Sage.
- Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Sage.
- Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1), 2–24. <https://doi.org/10.1108/EBR-11-2018-0203>
- Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial least squares structural equation modeling (PLS-SEM) using R: A workbook*. Springer. <https://doi.org/10.1007/978-3-030-80519-7>
- Halberstadt, J., Niemand, T., Kraus, S., Rexhepi, G., Jones, P., & Kailer, N. (2020). Social entrepreneurship orientation: Drivers of success for start-ups and established industrial firms. *Industrial Marketing Management*. <https://doi.org/10.1016/j.indmarman.2020.06.012>
- Harsanto, B., Mulyana, A., Faisal, Y. A., & Shandy, V. M. (2022). Open Innovation for sustainability in the social enterprises: An empirical evidence. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(3). <https://doi.org/10.3390/joitmc8030160>
- Hatak, I., Kautonen, T., Fink, M., & Kansikas, J. (2016). Innovativeness and family-firm performance: The moderating effect of family commitment. *Technological Forecasting and Social Change*, 102, 120–131. <https://doi.org/10.1016/j.techfore.2015.02.020>
- Helfat, C. E., & Martin, J. A. (2015). Dynamic managerial capabilities: Review and assessment of managerial impact on strategic change. *Journal of Management*, 41(5), 1281–1312. <https://doi.org/10.1177/0149206314561301>
- Helfat, C. E., & Peteraf, M. A. (2015). Managerial cognitive capabilities and the microfoundations of dynamic capabilities. *Strategic Management Journal*, 36(6), 831, 1–43. <https://doi.org/doi:10.1002/smj.2247>
- Hendarman, A. F., & Cantner, U. (2018). Soft skills, hard skills, and individual innovativeness. *Eurasian Business Review*, 8(2), 139–169. <https://doi.org/10.1007/s40821-017-0076-6>
- 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>
- Høgevold, N. M., Svensson, G., Rodriguez, R., & Eriksson, D. (2019). Relative importance and priority of TBL elements on the corporate performance. *Management of Environmental Quality: An International Journal*, 30(3), 609–623. <https://doi.org/10.1108/MEQ-04-2018-0069>
- Hourneaux, F., Gabriel, M. L. da S., & Gallardo-Vázquez, D. A. (2018). Triple bottom line and sustainable performance measurement in industrial companies. *Revista de Gestao*, 25(4), 413–429. <https://doi.org/10.1108/REGE-04-2018-0065>
- Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Acta Pharmacologica Sinica*, 20(2), 195–204. <https://doi.org/10.1038/aps.2012.31>
- Hutchins, M. J., & Sutherland, J. W. (2008). An exploration of measures of social sustainability and their application to supply chain decisions. *Journal of Cleaner Production*, 16(15), 1688–1698. <https://doi.org/10.1016/j.jclepro.2008.06.001>

- ILO. (2019). *Financing Small Businesses in Indonesia: Challenges and Opportunities*. <https://www.ilo.org/publications/financing-small-businesses-indonesia-challenges-and-opportunities>
- Jun, W., Ali, W., Bhutto, M. Y., Hussain, H., & Khan, N. A. (2021). Examining the determinants of green innovation adoption in SMEs: A PLS-SEM approach. *European Journal of Innovation Management*, 24(1), 67–87. <https://doi.org/10.1108/EJIM-05-2019-0113>
- Kabue, L. W., & Kilika, J. M. (2016). Firm resources, core competencies and sustainable competitive advantage: An integrative theoretical framework. *Journal of Management and Strategy*, 7(1), 98–108. <https://doi.org/10.5430/jms.v7n1p98>
- Katsushi, N. (2020). Social enterprise development in Indonesia by transdisciplinary approach. *IOP Conference Series: Earth and Environmental Science*, 536(1). <https://doi.org/10.1088/1755-1315/536/1/012010>
- Kenny, D. A. (2018). *Moderator*. <http://davidakenny.net/cm/moderation.htm>
- Khedhaouria, A., Nakara, W. A., Gharbi, S., & Bahri, C. (2020). The relationship between organizational culture and small-firm performance: Entrepreneurial orientation as mediator. *European Management Review*, 17(2), 515–528. <https://doi.org/10.1111/emre.12383>
- Klimas, P. (2019). Key resources in game developers' business models. *Journal of Management and Financial Sciences*, XI(31), 135–149. <https://doi.org/10.33119/jmfs.2018.31.11>
- Kock, N. (2016). Non-normality propagation among latent variables and indicators in PLS-SEM simulations. *Journal of Modern Applied Statistical Methods*, 15(1), 299–315. <https://doi.org/10.22237/jmasm/1462076100>
- Kraus, S., Niemand, T., Halberstadt, J., Shaw, E., Syrjä, P., Kraus, S., & Niemand, T. (2017). *Social entrepreneurship orientation: Development of a measurement scale*. <https://doi.org/10.1108/IJEER-07-2016-0206>
- Kraus, S., Rehman, S. U., & García, F. J. S. (2020). Corporate social responsibility and environmental performance: The mediating role of environmental strategy and green innovation. *Technological Forecasting and Social Change*, 160(July), 120262. <https://doi.org/10.1016/j.techfore.2020.120262>
- Lans, T., Blok, V., & Wesselink, R. (2014). Learning apart and together: Towards an integrated competence framework for sustainable entrepreneurship in higher education. *Journal of Cleaner Production*, 62, 37–47. <https://doi.org/10.1016/j.jclepro.2013.03.036>
- Lindner, C., Nagy, G., & Retelsdorf, J. (2015). The dimensionality of the Brief Self-Control Scale-An evaluation of unidimensional and multidimensional applications. *Personality and Individual Differences*, 86, 465–473. <https://doi.org/10.1016/j.paid.2015.07.006>
- Lohr, S. L. (2021). *Sampling Design and Analysis*. CRC Press. <https://doi.org/10.1111/rssa.12820>
- Longoni, A., Luzzini, D., Pullman, M., Seuring, S., & van Donk, D. P. (2024). Social enterprises in supply chains: Driving systemic change through social impact. *International Journal of Operations and Production Management*, 44(10), 1814–1830. <https://doi.org/10.1108/IJOPM-10-2023-0835>
- Madaleno, M., & Vieira, E. (2020). Corporate performance and sustainability: Evidence from listed firms in Portugal and Spain. *Energy Reports*, 6, 141–147. <https://doi.org/10.1016/j.egy.2020.11.092>
- Maeda, H. (2015). Response option configuration of online administered Likert scales. *International Journal of Social Research Methodology*, 18(1), 15–26. <https://doi.org/10.1080/13645579.2014.885159>
- Magesa, M. M., Michael, K., & Ko, J. (2020). Access and use of agricultural market information by smallholder farmers: Measuring informational capabilities. *Electronic Journal of Information Systems in Developing Countries*, 86(6), 1–21. <https://doi.org/10.1002/isd2.12134>
- Maksum, I. R., Sri Rahayu, A. Y., & Kusumawardhani, D. (2020). A social enterprise approach to empowering micro, small and medium enterprises (SMEs) in Indonesia. *Journal of Open Innovation: Technology, Market, and Complexity*, 6(3). <https://doi.org/10.3390/JOITMC6030050>
- Maletič, M., Maletič, D., & Gomišček, B. (2017). The role of contingency factors on the relationship between sustainability practices and organizational performance. *Journal of Cleaner Production*, 171, 423–433. <https://doi.org/10.1016/j.jclepro.2017.09.172>
- Maletič, M., Al-Najjar, B., & Gomišček, B. (2018). Development of a model linking physical asset management to sustainability performance: An empirical research. *Sustainability (Switzerland)*, 10(12). <https://doi.org/10.3390/su10124759>
- Martínez-Climent, C., Rodríguez-García, M., & Zeng, J. (2019). Ambidextrous leadership, social entrepreneurial orientation, and operational performance. *Sustainability (Switzerland)*, 11(3). <https://doi.org/10.3390/su11030890>
- Martínez-Román, J. A., & Romero, I. (2017). Determinants of innovativeness in SMEs: disentangling core innovation and technology adoption capabilities. *Review of Managerial Science*, 11(3), 543–569. <https://doi.org/10.1007/s11846-016-0196-x>
- Masud, A. K., Rashid, H. U., Khan, T., Bae, S. M., & Kim, J. D. (2019). Organizational strategy and corporate social responsibility: The mediating effect of triple bottom line. *International Journal of Environmental Research and Public Health*, 16(22). <https://doi.org/10.3390/ijerph16224559>
- Matos, S., & Hall, J. (2020). An exploratory study of entrepreneurs in impoverished communities: When institutional factors and individual characteristics result in non-productive entrepreneurship. *Entrepreneurship and Regional Development*, 32(1–2), 134–155. <https://doi.org/10.1080/08985626.2019.1640476>
- Miao, C., Coombs, J. E., Qian, S., & Sirmon, D. G. (2017). The mediating role of entrepreneurial orientation: A meta-analysis of resource orchestration and cultural contingencies. *Journal of Business Research*, 77, 68–80. <https://doi.org/10.1016/j.jbusres.2017.03.016>
- Monteiro, A. P., Soares, A. M., & Rua, O. L. (2017). Linking intangible resources and export performance: The role of entrepreneurial orientation and dynamic capabilities. *Baltic Journal of Management*, 12(3), 329–347. <https://doi.org/10.1108/BJM-05-2016-0097>
- Naegler, T., Becker, L., Buchgeister, J., Hauser, W., Hottenroth, H., Junne, T., Lehr, U., Scheel, O., Schmidt-Scheele, R., Simon, S., Sutardhio, C., Tietze, I., Ulrich, P., Viere, T., & Weidlich, A. (2021). Integrated multidimensional sustainability assessment of energy system transformation pathways. *Sustainability (Switzerland)*, 13(9), 1–28. <https://doi.org/10.3390/su13095217>
- Nair, A., & Bhattacharyya, S. S. (2019). Mandatory corporate social responsibility in India and its effect on corporate financial performance: Perspectives from institutional theory and resource-based view. *Business Strategy and Development*, 2(2), 106–116. <https://doi.org/10.1002/bsd2.46>
- Othman, R., & Arshad, R. (2015). Organizational resources and sustained competitive advantage of cooperative organizations in Malaysia. *Procedia - Social and Behavioral Sciences*, 170, 120–127. <https://doi.org/10.1016/j.sbspro.2015.01.021>
- Pinheiro, P., Daniel, A., & Moreira, A. (2021). Social Enterprise Performance: The role of market and social entrepreneurship orientations. *Voluntas*, 32(1), 45–60. <https://doi.org/10.1007/s11266-020-00266-x>
- Pralhad, C., & Hart, S. (1999). Strategies for the bottom of the pyramid: Creating sustainable development. *Ann Arbor*, 1001, 48109., January 1999, 1–26. http://www.bus.tu.ac.th/usr/wai/xm622/conclude_monsanto/strategies.pdf
- Rahdari, A., Sepasi, S., & Moradi, M. (2016). Achieving sustainability through Schumpeterian social entrepreneurship: The role of social enterprises. *Journal of Cleaner Production*, 137, 347–360. <https://doi.org/10.1016/j.jclepro.2016.06.159>
- Ramon-Jeronimo, J. M., Florez-Lopez, R., & Araujo-Pinzon, P. (2019). Resource-based view and SMEs performance exporting through foreign intermediaries: The mediating effect of management controls. *Sustainability (Switzerland)*, 11(12). <https://doi.org/10.3390/SU1112324>

- Rangan, K., Chase, L., & Karim, S. (2015). The truth about CSR. *Harvard Business Review, January-February 2015*, 1–9. <https://hbr.org/2015/01/the-truth-about-csr>
- Rasul, G. (2021). Twin challenges of COVID-19 pandemic and climate change for agriculture and food security in South Asia. *Environmental Challenges*, 2(January). <https://doi.org/10.1016/j.envc.2021.100027>
- Roxas, B. (2021). Environmental sustainability engagement of firms: The roles of social capital, resources, and managerial entrepreneurial orientation of small and medium enterprises in Vietnam. *Business Strategy and the Environment*, 30(4), 2194–2208. <https://doi.org/10.1002/bse.2743>
- Ruggerio, C. A. (2021). Sustainability and sustainable development: A review of principles and definitions. *Science of the Total Environment*, 786, 147481. <https://doi.org/10.1016/j.scitotenv.2021.147481>
- Sahasranamam, S., & Nandakumar, M. K. (2020). Individual capital and social entrepreneurship: Role of formal institutions. *Journal of Business Research*, 107(February), 104–117. <https://doi.org/10.1016/j.jbusres.2018.09.005>
- Sala, S. (2020). Triple bottom line, sustainability and sustainability assessment, an overview. *Biofuels for a More Sustainable Future: Life Cycle Sustainability Assessment and Multi-Criteria Decision Making*, 47–72. <https://doi.org/10.1016/B978-0-12-815581-3.00003-8>
- Saraswati, R. M., Vong, J., & Zainol, N. R. B. (2024). An exploratory study on the impact of social entrepreneurship orientation on business survival during the COVID-19 Pandemic in Indonesia. *The International Journal of Interdisciplinary Civic and Political Studies*, 19(1). <https://doi.org/10.18848/2327-0071/CGP/v19i01/1-28>
- Satar, M. S. (2022). Sustainability and triple bottom line planning in social enterprises: Developing the guidelines for social entrepreneurs. *International Journal of Sustainable Development and Planning*, 17(3), 813–821. <https://doi.org/10.18280/ijstdp.170311>
- Satar, M. S., & Natasha, S. (2019). Individual social entrepreneurship orientation: Towards development of a measurement scale. *Asia Pacific Journal of Innovation and Entrepreneurship*, 13(1), 49–72. <https://doi.org/10.1108/apjie-09-2018-0052>
- Sengupta, S., Sahay, A., & Croce, F. (2018). Conceptualizing social entrepreneurship in the context of emerging economies: An integrative review of past research from BRIICS. *International Entrepreneurship and Management Journal*, 14(4), 771–803. <https://doi.org/10.1007/s11365-017-0483-2>
- Sinthupundaja, J., Kohda, Y., & Chiadamrong, N. (2019). Examining capabilities of social entrepreneurship for shared value creation. *Journal of Social Entrepreneurship*, 11(1), 1–22. <https://doi.org/10.1080/19420676.2018.1543726>
- Solovida, G. T., & Latan, H. (2021). Achieving triple bottom line performance: Highlighting the role of social capabilities and environmental management accounting. *Management of Environmental Quality: An International Journal*, 32(3), 596–611. <https://doi.org/10.1108/MEQ-09-2020-0202>
- Stenn, T. (2017). *Social Entrepreneurship as Sustainable Development: Introducing the Sustainability Lens*. Palgrave Macmillan. <https://doi.org/10.1007/978-3-319-48060-2>
- Streukens, S., & Leroi-Werelds, S. (2016). Bootstrapping and PLS-SEM: A step-by-step guide to get more out of your bootstrap results. *European Management Journal*, 34(6), 618–632. <https://doi.org/10.1016/j.emj.2016.06.003>
- Sung, C. S., & Park, J. Y. (2018). Sustainability orientation and entrepreneurship orientation: Is there a tradeoff relationship between them? *Sustainability (Switzerland)*, 10(2). <https://doi.org/10.3390/su10020379>
- Tate, W. L., & Bals, L. (2018). Achieving shared triple bottom line (TBL) value creation: Toward a social resource-based view (SBRV) of the firm. *Journal of Business Ethics*, 152(3), 803–826. <https://doi.org/10.1007/s10551-016-3344-y>
- Testi, E., Biggeri, M., Bellucci, M., & Persson, H. T. R. (2018). An introduction to social entrepreneurship in Europe. In *Social Entrepreneurship and Social Innovation* (pp. 1-12). Routledge. (1st ed.). <https://doi.org/10.1002/9781119176558.ch11>
- Tjahjadi, B., Soewarno, N., & Mustikaningtiyas, F. (2021). Good corporate governance and corporate sustainability performance in Indonesia: A triple bottom line approach. *Heliyon*, 7(3), e06453. <https://doi.org/10.1016/j.heliyon.2021.e06453>
- Turpin, A., & Shier, M. L. (2020). Social Entrepreneurial orientation in human service organizations: A scoping review. *Human Service Organizations Management, Leadership and Governance*, 44(2), 144–168. <https://doi.org/10.1080/23303131.2019.1700580>
- U.N. (2012). *Resilient People Resilient Planet: A Future Worth Choosing*. <https://sustainabledevelopment.un.org/index.php?page=view&nr=374&type=400&menu=35>
- Urbano, D., Audretsch, D., Aparicio, S., & Noguera, M. (2020). Does entrepreneurial activity matter for economic growth in developing countries? The role of the institutional environment. *International Entrepreneurship and Management Journal*, 16(3), 1065–1099. <https://doi.org/10.1007/s11365-019-00621-5>
- Wang, X., Yang, M., Park, K., Um, K. H., & Kang, M. (2022). Social sustainability of a firm: Orientation, practices, and performances. *International Journal of Environmental Research and Public Health*, 19(20). <https://doi.org/10.3390/ijerph192013391>
- Weerawardena, J., & Sullivan Mort, G. (2006). Investigating social entrepreneurship: A multidimensional model. *Journal of World Business*. <https://doi.org/10.1016/j.jwb.2005.09.001>
- Whitmore, R., Crookes, V. A., & Snyder, J. (2017). A qualitative exploration of how Canadian informal caregivers in medical tourism use experiential resources to cope with providing transnational care. *Health and Social Care in the Community*, 25(1), 266–274. <https://doi.org/10.1111/hsc.12302>
- Wong, W. P., Tseng, M. L., & Tan, K. H. (2014). A business process management capabilities perspective on organisation performance. *Total Quality Management and Business Excellence*, 25(5–6), 602–617. <https://doi.org/10.1080/14783363.2013.850812>
- World Bank, & ADB. (2021). *Climate Risk Profile: Indonesia*. [https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15504-Indonesia Country Profile-WEB_0.pdf](https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15504-Indonesia%20Country%20Profile-WEB_0.pdf)
- World Economic Forum. (2019). *The Global Competitiveness Report*. https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
- Yusliza, M. Y., Yong, J. Y., Tanveer, M. I., Ramayah, T., Noor Faedah, J., & Muhammad, Z. (2020). A structural model of the impact of green intellectual capital on sustainable performance. *Journal of Cleaner Production*, 249, 119334. <https://doi.org/10.1016/j.jclepro.2019.119334>
- Zainol, N. R., & Al Mamun, A. (2018). Entrepreneurial competency, competitive advantage and performance of informal women micro-entrepreneurs in Kelantan, Malaysia. *Journal of Enterprising Communities*, 12(3), 299–321. <https://doi.org/10.1108/JEC-11-2017-0090>
- Zhai, Y. M., Sun, W. Q., Tsai, S. B., Wang, Z., Zhao, Y., & Chen, Q. (2018). An empirical study on entrepreneurial orientation, absorptive capacity, and SMEs' innovation performance: A sustainable perspective. *Sustainability (Switzerland)*, 10(2). <https://doi.org/10.3390/su10020314>

Appendix

Appendix 1. Measurement items

Construct	Code	Measurement Items	Source
Social Resources			
Physical Resources	PR1	We use cutting-edge technology equipment	(Ramon-Jeronimo et al., 2019)
	PR2	We have access to valuable supply sources	
	PR3	We meet capacity availability for production	
Experiential Resources	ER1	We achieve a very good entrepreneurship performance	(Ramon-Jeronimo et al., 2019)
	ER2	We have experience based on number of years	
	ER3	We have experience based on number of products being marketed	
Financial Resources	FR1	We have sufficient financial support for social activities	(Ramon-Jeronimo et al., 2019)
	FR2	We have sufficient funds derived from investments	(Aranda-Usón et al., 2019)
Social Capabilities			
Entrepreneurial Capabilities	EC1	We focus on social economic mission-driven commitments	(Tate & Bals, 2018)
	EC2	We implement strategies capable of sustaining social entrepreneurship's multiple goals	
	EC3	We implement internal governance to drive social behaviour	
	EC4	We are able to maximize profits by minimizing costs	
Informational Capabilities	IC1	We capture important market information	(Ramon-Jeronimo et al., 2019)
	IC2	We identify potential customers	
	IC3	We maintain good relationship with customers	
	IC4	We monitor competitive products in the market	
Management Capabilities	MC1	We respond to the dynamic environment's expectation	(Helfat & Peteraf, 2015)
	MC2	We have sufficient education in entrepreneurship	
	MC3	We communicate effectively with various stakeholders	
Innovativeness	IN1	We transform product development into new product or services	(Hatak et al., 2016; Martínez-Román & Romero, 2017; Ramon-Jeronimo et al., 2019)
	IN2	We improve current products in response to market demand	
	IN3	We adopt new ideas of production process.	
Social Entrepreneurial Orientation			
Social Proactiveness	SPR1	We use forecasting to prevent unexpected events	(Dwivedi & Weerawardena, 2018; Sinthupundaja et al., 2019)
	SPR2	We use financial modelling to plan for the future.	
	SPR3	We monitor external influences regularly	
	SPR4	We recognize opportunities in every social problem	
Social Risk-Taking	SRT1	We manage the risks associated with our business	(Kraus et al., 2017)
	SRT2	We perform cost & benefit analysis for every project we undertake	
	SRT3	We make careful decisions on resource allocation	
	SRT4	We avoid taking the cautious approach if it means missing out on social opportunities.	
Social Innovation	SIN1	Social innovation is crucial to our business	(Gali et al., 2020; Sinthupundaja et al., 2019)
	SIN2	We make investment in social innovation	
	SIN3	We regularly develop innovative approaches to solve societal issues	
Sustainability Performance			
Economic Performance	ECP1	We have a high-profit growth rate	(Gali et al., 2020; Maletič et al., 2017; Sinthupundaja et al., 2019)
	ECP2	We have high sales growth	
	ECP3	We have a high return on investment	
	ECP4	We have a good reputation	
Environmental Performance	ENP1	We have achieved substantial progress in solving social problem	(Bacq & Eddleston, 2018; Maletič et al., 2017; Sinthupundaja et al., 2019)
	ENP2	We generate stakeholder welfare	
	ENP3	We improve health conditions of people in the community	
	ENP4	We protect the rights of persons in the community served.	
Social Performance	SOP1	We use resources efficiently	(Maletič et al., 2017; Sinthupundaja et al., 2019)
	SOP2	We reduce our use of resources.	
	SOP3	We reduce waste (liquid and solid).	
	SOP4	We enhance community environmental conditions.	

Biographical notes

Reni Mutiarani Saraswati is the Head of the Bio Management Department at i3L University, Jakarta, Indonesia, where she also contributes as a senior faculty member. She holds a Bachelor's degree in Economics from the University of Nottingham, United Kingdom, and a Master's degree in Business Information Systems from Monash University, Australia. She earned her Doctorate in Entrepreneurship from the University of Malaysia Kelantan, where her research advanced the understanding of sustainability-oriented entrepreneurship. Her academic and research interests lie in social entrepreneurship, sustainability, and innovation. She has served as principal investigator and project leader on several research projects funded by the Directorate General of Higher Education (DIKTI), Ministry of Education, Indonesia, securing competitive national research grants. These projects have examined areas such as innovation capabilities, green design, sustainable performance, circular economy, and AI-driven risk management.

Noor Raihani Binto Zainol is a senior lecturer at the Faculty of Entrepreneurship and Business, Universiti Malaysia Kelantan, where she has been a faculty member since 2012. She received her Master of Science (Management) (2011) and a Bachelor of Business Administration from Universiti Utara Malaysia (2008). She completed her Ph.D. in social entrepreneurship at UNISZA, Terengganu, Malaysia. Currently, she serves as the Director of ANGKASA-UMK Research Academy (AURA), where she is responsible for training, consulting, producing research and publications, and contributing to policy development in the cooperative sector. With a prolific academic career marked by ground-breaking research and scholarly contributions, she has established herself as a leading figure in social entrepreneurship. Her work, spanning numerous publications, has been widely recognized and indexed in prestigious databases, including Scopus and the Web of Science (WOS). She received many grants, including international and national grants. She was the leader of two projects under the Ministry of Higher Education in Malaysia, namely KPT-PACE and KPT-CAP, aimed at producing student entrepreneurs. Furthermore, she has been awarded more than twenty grants for entrepreneurship projects, including the Fundamental Research Grant Scheme (FRGS), the Ministry of Finance Grant, International Matching Grant with UMRI, Indonesia-UMK, and UMK-Mercu Buana, Indonesia. She has actively participated in policy development, primarily focusing on entrepreneurship, including Entrepreneurship Integrated Education (EIE) under the Ministry of Higher Education, Social Accountability, and SIRIM (as chairman), as well as the Malaysian Digitalisation of Cooperatives (DigiKOP). She is also actively involved in consultations and training with international and national entrepreneurs, in collaboration with international governments, local agencies, and the Cooperative Sector.

Sam Toong Hai is a Professor, a distinguished academic, a multidisciplinary researcher, and an entrepreneur with over 20 years of global business expertise. Honored as a Young Talented Scientist for ASEAN by China, he represents Malaysia at ASEAN forums. His research spans intelligent and precision agriculture, earning acclaim for advancing international scientific research, higher education, and talent cultivation in business and academia, seamlessly integrating his achievements in science, research, and innovation.

Author contributions statement

Reni Mutiarani Saraswati: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Resources, Software, Validation, Visualization, Writing, Review & Editing. **Noor Raihani Binti Zainol:** Conceptualization, Data Curation, Formal Analysis, Methodology, Project Administration, Resources, Software, Validation, Visualization, Writing, Review & Editing. **Toong Hai Sam:** Conceptualization, Formal Analysis, Funding Acquisition, Project Administration, Resources, Writing, Review & Editing.

Conflicts of interest

The authors declare no competing interests.

Citation (APA Style)

Saraswati, R. M., Binti Zainol, N.R., & Sam, H.S. (2025). Capability and resource orchestration of triple bottom line enterprises: Mediating role of social entrepreneurial orientation. *Journal of Entrepreneurship, Management and Innovation*, 21(4), 130-151. <https://doi.org/10.7341/20252146>

Hackathons as engines of innovation: A review essay

By Joanna Pousset¹  and David Stolin² 

Abstract

*This review examines Maciej Rys's book *Sparks for Innovation: Why Hackathons Work and How to Organize One* (Columbia University Press, 2025), an interdisciplinary exploration of how hackathons have evolved from grassroots programming events into institutionalized tools of innovation, education, and civic engagement. The book's ambition lies in bridging academic theory with practitioner insight, combining conceptual analysis, ethnographic observation, and practical frameworks. It situates hackathons within broader innovation theory, linking them to Schumpeterian creative destruction, open innovation, and learning-by-doing. Rys's hybrid perspective as both researcher and organizer enables a reflexive treatment of hackathons as 'organized creativity' – spaces where structure and improvisation co-exist. While the book's inclusiveness sometimes results in conceptual dispersion, its interdisciplinary synthesis remains a notable strength. The review argues that *Sparks for Innovation* is essential reading for scholars, practitioners, and policymakers seeking to understand the evolving infrastructure of innovation and collaboration. It also suggests that Rys's approach invites a reflexive application: the adaptation of hackathon logic to academic research contexts as catalysts for collective knowledge creation.*

Keywords: *hackathons, innovation, open innovation, organized creativity, collective intelligence, research collaboration*

Review of the book by Rys, M. (2025). *Sparks for innovation: Why hackathons work and how to organize one*. New York, NY: Columbia University Press. ISBN: 9780231214681

INTRODUCTION

Hackathons have evolved from niche gatherings of programmers into emblematic rituals of the contemporary innovation economy. Initially conceived as time-bound competitions to develop software prototypes, they have since been adopted across domains ranging from civic technology and education to healthcare and finance. Today, corporations, public institutions, and universities employ hackathons not only as vehicles for rapid problem-solving but also as instruments of organizational learning and community engagement. Yet, despite their proliferation, academic research on hackathons remains fragmented across disciplinary boundaries – computer science, management studies, and the social sciences – each treating the phenomenon through its own lens.

In this landscape, Maciej Rys's (2025) *Sparks for Innovation* represents a major effort to consolidate these dispersed insights into a coherent framework. The book seeks to explain how hackathons operate as structured processes of organized

¹ Joanna Pousset, Ph.D., Professor of Economics and Finance, TBS Business School, Carrer de Vençuela, 116, 08019 Barcelona, Spain, e-mail: j.pousset@tbs-education.es (ORCID ID: <https://doi.org/0000-0002-8300-6816>).

² David Stolin, Ph.D., Professor of Finance, TBS Business School, 20 bd. Lascrosses, 31000 Toulouse, France, e-mail: d.stolin@tbs-education.fr (ORCID ID: <https://doi.org/0000-0003-2235-4873>).

Received 16 October 2025; Accepted 17 October 2025.

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creativity, exploring their design principles, participant dynamics, and broader implications for innovation ecosystems. Rys positions hackathons as both a microcosm and a metaphor for contemporary innovation – spaces where temporal constraint, interdisciplinarity, and collective intelligence converge to accelerate ideation and experimentation.

What sets Rys's contribution apart is his dual identity as both scholar and practitioner. Drawing on his experience as a hackathon organizer and participant, he combines empirical observations with conceptual reflection, offering a narrative that is at once analytical and experiential. This methodological hybridity grants the work a level of depth that purely theoretical accounts often lack. Rys does not merely describe hackathons; he situates them within the genealogy of innovation thought, from Schumpeter's notion of creative destruction to the contemporary emphasis on open and distributed innovation.

The book's central claim – that hackathons constitute a unique organizational form of creativity under constraint – is developed across six chapters that blend theory, ethnography, and practice. These chapters examine the conceptual roots of innovation, the psychological and social dynamics of hackathon teams, the design of events and evaluation mechanisms, and the long-term trajectories of post-hackathon projects. Each component reveals a different facet of how hackathons mediate between structure and spontaneity, competition and collaboration, short-term creativity and long-term impact.

Rys's account is ambitious in scope and interdisciplinary in spirit. It draws upon management theory, design studies, and the sociology of technology to frame hackathons as arenas where institutional structures are temporarily suspended, allowing participants to engage in accelerated cycles of ideation, prototyping, and reflection. The book is equally concerned with outcomes – the tangible prototypes that emerge – and with the process itself: the learning, motivation, and social bonds forged through participation.

Importantly, Rys's narrative situates hackathons within the larger innovation discourse that includes design thinking, lean startup methodologies, and open innovation (Chesbrough, 2003; Bogers et al., 2017). Like these approaches, hackathons operationalize the idea that innovation can be engineered through the deliberate orchestration of diversity, time pressure, and feedback. Nevertheless, unlike continuous innovation frameworks, hackathons embrace discontinuity and intensity: they condense creativity into a single temporal burst. In this sense, Rys portrays them not as exceptions but as exemplars of twenty-first-century innovation culture.

While the book's breadth and hybridity are among its greatest strengths, they also introduce challenges. The narrative occasionally shifts between conceptual analysis and anecdotal reportage, risking a sense of fragmentation. Yet this fragmentation mirrors the nature of hackathons themselves: transient, pluralistic, and inherently hybrid. As Rys's review of the phenomenon suggests, to write about hackathons coherently may already mean to embrace a certain degree of methodological messiness.

In doing so, Rys produces a work that bridges academic inquiry and professional practice. His reflections resonate with both researchers seeking conceptual clarity and practitioners searching for insight into why hackathons succeed – or fail – as innovation mechanisms. Ultimately, *Sparks for Innovation* contributes not only to understanding hackathons but also to reframing how we conceptualize innovation as a distributed, participatory, and time-compressed process.

Conceptual foundations: From innovation theory to the logic of hackathons

At its foundation, Rys's book undertakes a careful reconstruction of the intellectual lineage of innovation theory. The discussion begins with Schumpeter's (1934) view of innovation as the driving force of economic evolution – “creative destruction” – where entrepreneurial energy continually reshapes the industrial landscape. By linking this classic economic model to more recent frameworks of organizational learning and cognitive psychology, Rys builds a bridge from the macroeconomic to the micro-social level of creativity.

He pairs Schumpeter with Edward de Bono's (1970) distinction between lateral and vertical thinking, arguing that hackathons are structured environments for lateral thinking under temporal constraint. They institutionalize divergence and convergence within fixed boundaries of time and theme. This connection between cognitive theory and organizational design exemplifies Rys's interdisciplinary approach.

From there, he engages with open innovation theory (Chesbrough, 2003), which holds that valuable ideas can originate both inside and outside organizational boundaries. Hackathons, Rys contends, are among the most visible instantiations of open innovation in practice: they mobilize external contributors, internal employees, and diverse stakeholders to co-create solutions in public view. This mechanism dissolves the boundary between producers and users of innovation, reflecting von Hippel's (2005) concept of user innovation.

Rys situates hackathons within the broader family of organized creativity mechanisms – including design sprints, idea challenges, and innovation labs – but highlights their distinctive temporality and intensity. The “temporal compression” of a hackathon, he argues, is not merely logistical but epistemic: it accelerates learning cycles by forcing participants to externalize and test ideas rapidly. This resonates with Schön’s (1983) theory of the reflective practitioner, where action and reflection are intertwined in iterative loops of experimentation.

To illustrate this, Rys revisits historical episodes such as Thomas Edison’s Menlo Park laboratory, the Wright brothers’ workshop, and the discovery of penicillin. Each example, while far removed from modern hackathons, demonstrates how constrained collaboration and prototyping have long been engines of discovery. By positioning hackathons as the latest iteration of this lineage, Rys transforms what could have been a trendy topic into a historically grounded argument about the evolution of innovation practices.

The theoretical framework is further enriched by engagement with innovation systems literature (Lundvall, 1992; Etzkowitz & Leydesdorff, 2000). Hackathons are portrayed as microcosms of the “Triple Helix” model – university, industry, and government collaboration compressed into a short-lived, high-intensity form. In this view, hackathons simulate the dynamics of broader innovation ecosystems but in a controlled, time-bounded experiment.

Yet Rys does not romanticize this model. He recognizes the paradox that institutionalizing creativity may undermine its spontaneity. By formalizing hackathons, organizations risk turning them into performative rituals devoid of genuine innovation. This tension between authenticity and instrumentalization – between the creative and the corporate – is one of the recurring motifs of the book.

In articulating these contradictions, Rys contributes to ongoing debates about the commodification of innovation (Boltanski & Chiapello, 2005). The hackathon, in his reading, exemplifies how contemporary capitalism celebrates creativity while disciplining it within measurable, manageable formats. Yet Rys’s tone remains balanced: he neither dismisses hackathons as empty spectacle nor glorifies them as revolutionary. Instead, he treats them as organizational artefacts that crystallize both the promises and perils of innovation culture.

Perhaps the most significant theoretical insight of Rys’s book lies in its treatment of hackathons as liminal spaces – borrowing from anthropological theory (Turner, 1969). During a hackathon, normal organizational hierarchies and routines are suspended, creating a temporary community bound by shared focus and intensity. This liminality enables experimentation, but it also ensures that the space remains exceptional and ephemeral. When the event ends, participants must re-enter the structured world of work or academia, often facing the dissonance between the temporary freedom of the hackathon and the constraints of their everyday environments.

Rys’s conceptualization of hackathons as both process and metaphor is particularly compelling. As process, they are concrete methods for generating ideas; as metaphor, they symbolize the broader societal drive toward speed, agility, and collaboration in innovation. This dual framing allows Rys to speak simultaneously to scholars of management, cultural sociology, and design.

If there is a limitation in this theoretical section, it lies in the challenge of synthesis. The book draws upon such a wide range of theoretical traditions that some readers may feel disoriented. However, this very eclecticism mirrors the interdisciplinary nature of hackathons themselves, which bring together coders, designers, marketers, and strategists. In this sense, the theoretical “messiness” of the book becomes conceptually appropriate – a reflection of its object of study.

Hackathons as organized creativity

One of the most illuminating contributions of *Sparks for Innovation* lies in its portrayal of hackathons as laboratories of organized creativity. Rys demonstrates that hackathons do not represent a spontaneous burst of innovation but rather a carefully designed framework that channels creativity through constraint. This paradox – freedom through structure – sits at the heart of his analysis.

The author conceptualizes hackathons as “innovation microcosms,” where time, space, and social interaction are deliberately configured to foster accelerated problem-solving. They rely on temporal limitation (usually 24 – 72 hours), interdisciplinary composition of teams, iterative feedback loops, and the ritual of final presentations. These design elements serve not to restrict creativity but to generate focus and momentum. The result is a temporary social order oriented toward experimentation, in which failure is not only tolerated but expected as part of the process.

Rys situates this within the broader scholarship on creative process design (Moeran & Christensen, 2013; Hargadon & Bechky, 2006), showing that innovation is rarely a product of individual genius but of carefully staged collective interaction. Hackathons, in this view, exemplify the managed spontaneity of contemporary innovation culture: a choreography of

serendipity. What appears chaotic from the outside is, in practice, the product of deliberate orchestration – schedules, mentoring frameworks, and milestone reviews ensure that creativity remains bounded yet productive.

The book's ethnographic insights vividly illustrate this tension. Rys recounts how hackathon facilitators balance logistical efficiency with the creation of a psychologically safe environment that invites play, improvisation, and risk-taking. He describes the “liminal intensity” of late-night coding sessions, the improvisational negotiations between designers and engineers, and the role of mentors as both catalysts and constraints. These episodes reveal the fragile equilibrium between autonomy and coordination that sustains innovation under pressure.

A particularly compelling aspect of Rys's argument is his interpretation of hackathons as ritualized performances of innovation. Drawing on anthropological perspectives, he argues that hackathons serve a symbolic function within organizations: they make innovation visible, tangible, and measurable. Through slogans, visual identity, and ceremonial closure (awards, pitches, applause), organizations reaffirm their commitment to creativity and agility. This “innovation theatre” dimension may be criticized for superficiality, yet Rys suggests it performs an important cultural role – transforming innovation from abstract aspiration into embodied practice.

The book also advances a nuanced typology of hackathon formats – corporate, civic, academic, and grassroots – each reflecting distinct institutional logic. Corporate hackathons emphasize product pipelines and employer branding; civic hackathons prioritize open data and collective problem-solving; academic hackathons foster interdisciplinarity and experiential learning; and grassroots hackathons emphasize community and autonomy. Rys's comparative treatment underscores how hackathons adapt flexibly to the objectives of their hosts while maintaining a recognizable structural core.

Nevertheless, Rys remains cautious about managerial appropriation of the hackathon form. When corporate settings instrumentalize hackathons for public relations or low-cost ideation, the participatory ethos that once defined them risks erosion. Here, Rys aligns with critical innovation scholars who warn that the institutionalization of creativity can neutralize its transformative potential (Boltanski & Chiapello, 2005). Yet he concludes that even when outcomes are symbolic or fleeting, hackathons retain pedagogical and cultural value – they train participants to think experimentally and to collaborate across boundaries.

Methodological and analytical reflections

Rys's methodological stance mirrors the hybridity of his subject. He combines literature synthesis, qualitative interviews, and participant observation across multiple events, blending academic analysis with practitioner reflexivity. This mixed-method approach yields a text that oscillates between theory, narrative, and self-reflection. It may challenge readers seeking linear argumentation, yet it is uniquely suited to capture the emergent, improvisational quality of hackathon dynamics.

The book does not claim methodological purity. Instead, it embodies what Denzin and Lincoln (2018) describe as the interpretive turn in qualitative research: the acknowledgement that researchers are not neutral observers but active participants in meaning-making. Rys's insider position – as organizer, mentor, and analyst – becomes a methodological asset. It allows him to access backstage processes often invisible to external researchers, such as facilitator decisions, team conflicts, or the subtle cues that shape collaboration under stress.

This reflexive embeddedness distinguishes Rys's work from survey-based studies that treat hackathons as isolated events. His field observations reveal how participant motivation evolves throughout the event, how time pressure shapes decision-making, and how feedback mechanisms influence team trajectories. The ethnographic vignettes – ranging from corporate to grassroots hackathons – create an empirical texture that grounds theoretical claims.

At the same time, Rys recognizes the epistemological tension of studying a phenomenon that celebrates speed and iteration. Hackathons privilege immediacy, while academic inquiry values depth and reflection. The book, therefore, embodies a productive methodological paradox: it is itself an exercise in slowing down to study acceleration. Rys's method can be read as a meta-hackathon – a reflective prototype of how to research rapid innovation processes without succumbing to their tempo.

Analytically, the book balances interpretive and evaluative lenses. On one hand, Rys aims to understand hackathons as social systems that generate meaning and community. On the other hand, he evaluates their effectiveness as innovation mechanisms. This dual focus results in a multidimensional model of hackathon impact that extends beyond traditional metrics such as the number of prototypes or patents. He identifies four interrelated levels of value creation:

- 1) Individual learning and empowerment, as participants acquire technical, social, and emotional skills.
- 2) Team and network formation, as temporary collaborations evolve into long-term professional ties.

- 3) Organizational renewal, through exposure to external ideas and cross-functional experimentation.
- 4) Ecosystemic contribution, whereby hackathons strengthen local or thematic innovation communities.

This model resonates with contemporary innovation-ecosystem frameworks (Bogers et al., 2017; Lifshitz-Assaf, 2018) and with theories of learning-by-interaction (Lundvall, 1992). By integrating these perspectives, Rys extends hackathon research beyond the question “Do they work?” to “How, for whom, and under what conditions do they create value?”

Methodologically, this is significant: it reframes hackathons not as one-off events but as nodes in continuous learning systems. The analytical emphasis thus shifts from artefacts (prototypes) to relationships and capabilities. Rys encourages readers to evaluate hackathons not by the survival of projects but by the transformations they trigger in participants and institutions. This reorientation provides a conceptual foundation for longitudinal and comparative studies of innovation rituals.

The book’s methodological openness also invites future researchers to experiment with participatory and design-based inquiry approaches that treat the research process itself as an intervention. In that sense, Rys’s work models a scholarly ethos consistent with the hackathon spirit: iterative, collaborative, and oriented toward practical insight.

Implications and future directions

Beyond description and critique, Rys’s book gestures toward the future of innovation practice and research. Its implications unfold along three interrelated dimensions: conceptual, practical, and reflexive.

Conceptually, the book expands the vocabulary of innovation studies. By treating hackathons as both process and metaphor, it bridges micro-level creativity studies with macro-level institutional analysis. It reframes innovation as a performative, time-bounded, and collective practice – an insight relevant to scholars exploring the temporalities of innovation and organizational learning. The notion of “temporal laboratories” that compress experimentation into bounded intervals could, for instance, inform comparative studies of accelerators, bootcamps, or policy sprints.

Practically, *Sparks for Innovation* functions as a reflective guide for organizers, educators, and policymakers. It distils design principles – time pressure, diversity, mentorship, narrative framing – that determine hackathon outcomes. For corporate innovation managers, it offers a lens to evaluate hackathons not only by immediate results but by their contribution to organizational culture and capability building. For educators, it illustrates how hackathons can serve as pedagogical tools that combine experiential learning with interdisciplinary collaboration. For policymakers, it highlights the potential of hackathons as agile instruments of civic participation and digital transformation.

For academics, an interesting question is whether academia could adopt hackathon-like formats to accelerate collaboration, co-creation, and dissemination. This idea of “research hackathons” – time-bound, interdisciplinary gatherings organized around shared datasets or societal challenges – invites a rethinking of scholarly practice. It echoes the ethos of open science and aligns with calls for more collaborative, problem-driven research (Etzkowitz & Leydesdorff, 2000; Fecher & Friesike, 2014).

Such reflexive application underscores the book’s broader message: hackathons are not merely organizational tools but cultural prototypes of how innovation might be organized across domains. They exemplify the transition from hierarchical R&D to networked, participatory models of knowledge creation. Rys’s optimism is cautious – he acknowledges that hackathons often produce short-lived outcomes – but his analysis suggests that their greatest value lies in reshaping how people relate to creativity, uncertainty, and collective intelligence.

Looking ahead, the book opens multiple research avenues. Empirically, there is a need for longitudinal studies tracing the afterlives of hackathon projects, networks, and careers. Conceptually, further work could explore the ethical dimensions of unpaid creative labor, inclusion, and sustainability within hackathon ecosystems. Methodologically, scholars could test hybrid research designs – combining ethnography, digital trace analysis, and experimental interventions – to capture the multilayered dynamics of time-bounded innovation.

In conclusion, Rys’s work stands as both a synthesis and an invitation. It consolidates dispersed insights from management, sociology, and design, while encouraging scholars and practitioners to continue iterating on the hackathon model itself. The book’s imperfections – its breadth, its occasional fragmentation – are inseparable from its ambition to capture a phenomenon that resists linear explanation. *Sparks for Innovation* thus succeeds not by offering definitive answers but by articulating new questions about how creativity can be organized, accelerated, and sustained in an era defined by speed and collaboration.

Relevance for scholars, practitioners, and policymakers

Rys's *Sparks for Innovation* stands out for its capacity to speak across audiences. It contributes simultaneously to academic theory, managerial practice, and public policy – an achievement rare in a domain often polarized between technical manuals and abstract conceptual work.

For scholars, the book offers the first comprehensive and interdisciplinary synthesis of hackathons as both organizational and cultural phenomena. It systematically connects hackathon practice to core frameworks of innovation theory – open innovation (Chesbrough, 2003), user innovation (von Hippel, 2005), and innovation systems (Lundvall, 1992; Etzkowitz & Leydesdorff, 2000) – while also engaging with design research and the sociology of work. Its conceptualization of hackathons as liminal spaces of organized creativity introduces a theoretical lens with potential to enrich adjacent literatures on temporary organizations, project-based learning, and innovation rituals. For scholars of entrepreneurship and management, Rys provides both a taxonomy of hackathon types and a model of their multi-level impact, which can inform empirical and comparative studies.

For practitioners, especially innovation managers, educators, and community organizers, the book functions as a reflective toolkit. It moves beyond prescriptive “how-to” guides by illuminating the subtle organizational and psychological conditions that underpin successful hackathons. By framing hackathons as social experiments rather than linear pipelines, Rys offers practical insight into cultivating environments that balance pressure with play, diversity with coherence, and ambition with learning. His emphasis on mentoring, narrative framing, and evaluation design provides concrete principles for practitioners striving to maximize both creative and developmental outcomes.

For policymakers, the book underscores the potential of hackathons as participatory instruments in public-sector innovation. Civic hackathons, in particular, emerge as platforms for mobilizing distributed expertise around complex social challenges – from urban mobility to digital inclusion. Rys demonstrates how hackathons can function as boundary-spanning events that connect government, academia, and civil society, aligning with the “Triple Helix” logic of collaborative innovation. He also warns, however, that without structural follow-up and inclusion mechanisms, such initiatives risk reproducing technological optimism without societal transformation. This cautionary note is particularly relevant in an era where policy discourses often fetishize speed and novelty.

The book's distinctive contribution lies in bridging theory and praxis. Its hybrid tone – analytical yet accessible, critical yet constructive – makes it a resource that can circulate across academic, professional, and civic settings. Rys's insistence on examining both the promise and the paradoxes of hackathons enriches the debate on how institutions orchestrate creativity in the twenty-first century.

Sparks for Innovation, therefore, provides a versatile foundation for future inquiry and practice. It equips scholars with conceptual clarity, practitioners with actionable insight, and policymakers with an evidence-based understanding of participatory innovation. Each of these audiences can find in Rys's book not merely a description of the hackathon phenomenon but a framework for reimagining how collective creativity is organized and sustained.

CONCLUSION

Rys's *Sparks for Innovation* transforms a transient organizational trend into a substantive object of academic reflection. By combining theoretical synthesis, ethnographic sensitivity, and practitioner insight, the book captures hackathons not as managerial curiosities but as cultural prototypes of how creativity is organized in contemporary society.

Its imperfections – occasional fragmentation, uneven integration of theory and narrative – are inseparable from its ambition to encompass a multifaceted and fast-evolving field. These very tensions make the book a productive contribution to ongoing debates on innovation, collaboration, and learning.

Beyond its empirical and conceptual contributions, Rys's work performs a meta-function: it invites both scholars and practitioners to rethink the institutional conditions under which innovation and research themselves take place. In this sense, *Sparks for Innovation* is not only a study of hackathons but also a call to hack the processes of knowledge creation.

As such, the book should find a lasting place in the interdisciplinary literature on innovation and entrepreneurship – offering scholars theoretical grounding, practitioners reflective insight, and policymakers an example of how experimentation can be institutionalized without losing its creative edge.

References

- Bogers, M., Chesbrough, H., & Moedas, C. (2017). Open innovation: Research, practices, and policies. *California Management Review*, 60(2), 5–16.
- Boltanski, L., & Chiapello, E. (2005). *The new spirit of capitalism*. Verso.
- Chesbrough, H. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Harvard Business School Press.
- de Bono, E. (1970). *Lateral thinking: Creativity step by step*. Harper & Row.
- Denzin, N. K., & Lincoln, Y. S. (2018). *The SAGE handbook of qualitative research* (5th ed.). SAGE Publications.
- Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: From national systems and “Mode 2” to a triple helix of university–industry–government relations. *Research Policy*, 29(2), 109–123.
- Fecher, B., & Friesike, S. (2014). *Open science: One term, five schools of thought*. In S. Bartling & S. Friesike (Eds.), *Opening science* (pp. 17–47). Springer.
- Hargadon, A., & Bechky, B. (2006). When collections of creatives become creative collectives: A field study of problem solving at work. *Organization Science*, 17(4), 484–500.
- Lifshitz-Assaf, H. (2018). Dismantling knowledge boundaries at NASA: The critical role of professional identity in open innovation. *Administrative Science Quarterly*, 63(4), 746–782.
- Lundvall, B.-Å. (1992). *National systems of innovation: Towards a theory of innovation and interactive learning*. Pinter.
- Moeran, B., & Christensen, B. T. (2013). *Exploring creativity: Evaluative practices in innovation, design, and the arts*. Cambridge University Press.
- Rys, M. (2025). *Sparks for innovation: Why hackathons work and how to organize one*. New York, NY: Columbia University Press.
- Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.
- Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle*. Harvard University Press.
- Turner, V. (1969). *The ritual process: Structure and anti-structure*. Aldine.
- von Hippel, E. (2005). *Democratizing innovation*. MIT Press.

Biographical notes

Joanna Pousset (Ph.D., Universitat Autònoma de Barcelona) is Professor of Social Influence, Entrepreneurship and Finance at TBS Business School. She has also taught at Universitat de les Illes Balears and EADA Business School, and is a startup mentor and coach with Demium and Impactivs. She has published in *Society and Business Review* and *Research Handbook on Boards of Directors*. Joanna is passionate about entrepreneurship, and has lead an innovative initiative fostering collaborations between business academics and startup founders at Future Finance Fest (3f), where she is co-chair.

David Stolin (Ph.D., London Business School) is Professor of Finance at TBS Business School. He has published in leading business and finance journals, such as *Journal of Business*, *Journal of Finance*, *Journal of Financial and Quantitative Analysis*, and *Management Science*. His research interests include investment management, corporate governance, business education, fintech, and innovation more generally. For his work on innovation in teaching and research outreach, David has received awards from the Academy of Management, QS-Wharton’s Reimagine Education, Financial Management Association, and European Economic Association, among others.

Citation (APA Style)

Pousset, J., & Stolin, D. (2025). Hackathons as engines of innovation: A review essay. *Journal of Entrepreneurship, Management and Innovation*, 21(4), 152-158. <https://doi.org/10.7341/20252147>

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Nose, Yoshiaki – Doshisha University Business School, Japan
Núñez Morales, Nicolás – CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Perú
Ortega-Colomer, Francisco Javier – University of Valencia, Spain
Paliwoda-Matiolańska, Adriana – Cracow University of Economics, Poland
Patena, Wiktor – GBSB Global Business School, Spain
Pauli, Urban – Cracow University of Economics, Poland
Peñate Valentín, María Concepción – COTEC Foundation, Spain
Pereira Sánchez, Ángeles – Universidade de Santiago de Compostela, Spain
Pereira, Olga Filipa Andrade de Andrade Brites – Polytechnic Institute of Porto, Portugal
Pleśniak, Agnieszka – Warsaw School of Economics, Poland
Portuguez Castro, May – CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Perú
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Sabolovic, Mojmir – Prague University of Economics and Business, Czechia
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Sande Veiga, Diego – Universidade de Santiago de Compostela, Spain
Sanguinetti Cordero, Sol – CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Perú
Scanella, Enzo – Università degli Studi di Palermo, Italy
Shaikh, Erum – Shaheed Benazir Bhutto University, Pakistan
Sierpińska, Maria – Cracow University of Economics, Poland
Sierpińska-Sawicz, Agata – Poznań University of Economics and Business, Poland
Staduto, Jefferson Andronio Ramundo – Universidade Estatal de Paraná Occidental (Unioeste), Brazil
Suder, Marcin – AGH University, Poland
Syrek, Robert – Jagiellonian University, Poland
Szopa, Anna – University of Central Florida, USA
Tokbolat, Yerzhan – Queen's University Belfast, United Kingdom
Triguero, Rafael – CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Perú
Tripes, Stanislav – Prague University of Economics and Business, Czechia
Ujwary-Gil, Anna – Institute of Economics, Polish Academy of Sciences, Warsaw, Poland
Valcárcel Aguiar, Beatriz – Universidade de Santiago de Compostela, Spain
Vasquez Neyra, Jessika – CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Perú

Véliz Palomino, José Carlos – CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Perú
Vignochi, Luciano – CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú, Perú
Vila Vázquez, Guadalupe – Universidade de Santiago de Compostela, Spain
Vilchez, Carlos – CENTRUM Católica Graduate Business, Pontificia Universidad Católica del Perú, Perú
Willesson, Magnus – University of Gothenburg, Sweden
Wójtowicz, Tomasz – Chief Statistical Editor, AGH University, Poland
Wronka-Pośpiech, Martyna – Uniwersytet of Economics in Katowice, Poland
Wszendybył-Skulska, Ewa – Jagiellonian University, Poland
Zabala-Zarauz, Alaitz – University of Deusto, Spain

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