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Do green innovation strategies exist? Past, present and future trends in literature

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Abstract

Purpose – For companies to subsist in the highly changeable and competitive market, they must foster innovation. Similarly, for companies to respond to market changes, fluctuations and trends, they need to develop green-oriented strategies. Therefore, reversing the innovation process to be greener is becoming a strategic opportunity for companies. As well as contributing to the company's long-term performance, green innovations can be a differentiation tool for improving the company's competitive position.

Design/methodology/approach – Despite the growth in literature on green innovation strategies, the field is dispersed. This paper therefore provides a comprehensive overview of past, present and future trends in the literature on green innovation strategies through a systematic literature review and a bibliometric analysis, employing two bibliometric techniques: bibliographic coupling and cluster analysis.

Findings – For this purpose, the Web of Science database was used, where 509 documents were collected, which were then subjected to a selection process. In total, 63 scientific studies were selected and analyzed, resulting in the identification and classification of theoretical perspectives on green innovation strategies, in which five main approaches emerged: (1) Implications of green innovation strategies, (2) Drivers of green innovation strategies, (3) Diffusion/diffusers of green innovation strategy, (4) Internal and external drivers of green innovation strategy and (5) Stakeholders in the green innovation process. The review highlighted existing gaps in the literature and illuminated avenues for future research, indicating potential research questions.

Originality/value – Collectively, our findings hold significant implications for organizational strategies by providing a robust framework for firms to understand critical factors influencing green innovation. Beyond its strategic relevance, this study advances the green innovation management literature through a holistic

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framework analyzing how companies can strategically pursue green innovation driven by internal and external factors.

Keywords Organizations, Bibliometric analysis, Strategy, Systematic literature review, Green innovation
Paper type Literature review

1. Introduction

In the past, academics, managers and legislators did not attach importance to environmental issues because they considered that the production process of organizations did not harm the environment too much (Kraus *et al*., 2020). Today, environmental impact is an ever-growing global ethical concern for citizens, organizations and policymakers alike (Leal-Rodríguez *et al*., 2018). As a result, environmental governance and green innovation are placed in a prominent position to promote sustainable development (Liu and Kong, 2020; Papagiannakis *et al*., 2019). In this context, helping companies to become greener and stimulating innovation for new sustainable solutions can contribute substantially to the European goal of achieving carbon neutrality and environmental sustainability, as promoted by the European Green Deal program. From the perspective of the United Nations' 17 Sustainable Development Goals (SDGs), which cover various objectives, including innovation and environmental issues, the role of green innovation is fundamental. Given these facts, green innovation, also known as eco-innovation, environmental or ecological innovation (Block *et al*., 2025; Song *et al*., 2023), has been widely studied in management and economics research in recent decades, arousing special academic interest and becoming an emerging area of research. But it has also earned the attention of political actors, who have focused on developing policies to promote green innovation.

Some authors define green innovation as the development and implementation of new ideas, products, processes, technologies or practices that reduce environmental damage and promote sustainability, with a fundamental role in helping companies face environmental challenges (Block *et al*., 2025; Zhang *et al*., 2025). According to Schumpeter's theory of innovation (1942), green innovation contributes to satisfying customer needs while protecting the environment in which they find themselves. In addition, green innovation is a strategic factor for companies (Chang, 2011), where studies have shown that it improves energy efficiency and reduces carbon emissions (Zhang *et al*., 2022), increasing economic growth (Cao *et al*., 2024; Lee *et al*., 2025) and environmental protection (Soewarno *et al*., 2019). Based on these arguments, it can be said that the development of green innovations mediates the conflict between economic development and environmental protection (Chang, 2011; Chen *et al*., 2018), which can provide solid competitive advantages to innovative companies that hold the rights to such innovations (Forsman, 2013). According to the resource-based view (Barney, 1991), by developing a green innovation strategy, a company accumulates resources and capabilities specialized in environmental sustainability, such as knowledge of green technologies, experience in eco-design and environmental risk management capabilities, becoming a source of competitive advantage, allowing the company to innovate in an economically and environmentally sustainable way. Thus, companies that adopt successful green innovation strategies are able to achieve and maintain a competitive advantage (Albort-Morant *et al*., 2016; Chen *et al*., 2018; Forsman, 2013; Rehman *et al*., 2021), as well as generate surplus profits (García-Marco *et al*., 2020) and increase their economic development. Therefore, managers must recognize the role played by the green innovation strategy so that they can deliver better economic performance and help the market understand its beneficial effects (Lin *et al*., 2020). Chang (2011) also points out that green innovations can increase the value of the product and, consequently, repay the costs of environmental investments. Controversially, He and Jiang (2019) argue that, compared to other environmental practices, green innovation presents stronger externalities that require a greater financial commitment and generally a longer timeframe to obtain returns. However, it can also generate competitive disadvantages in terms of efficiency and risk (Forsman, 2013).

In terms of company size, small companies have a greater tendency to develop radical green product innovations, while large companies are better able to turn green product innovations into market success (Dangelico *et al*., 2017). In order to contribute to environmental efficiency and sustainability, large companies focus mainly on investing in R&D. On the other hand, SMEs strive to allocate their limited resources to implementing new environmental practices and/or developing green innovations (Corrocher and Solito, 2017). It should be noted that there is a differentiation between sectors subject to stricter environmental regulations and sectors without environmental regulations when it comes to implementing green innovative practices (García-Marco *et al*., 2020). Companies subject to regulations are concerned about finding green innovations because they feel a greater need to differentiate themselves. On the other hand, companies operating in sectors without environmental regulation are inspired by competitive pressure to improve their image and capture the green market. Institutional theory highlights the role of pressures and norms in shaping a company's behavior, namely that as social and regulatory expectations around environmental responsibility increase, companies that adopt a green innovation strategy are more likely to respond proactively to these institutional demands.

In particular, companies must invest in qualified human resources and organizational changes that can lead to greater productivity (García-Marco *et al*., 2020). Chen and Hung (2014) point out that in order to be successful in green strategic innovation, companies must also adapt their knowledge absorption capabilities, as well as manage the accumulation of external knowledge. That said, older companies must engage in a rejuvenation of innovation processes in order to keep their knowledge and skills always up-to-date and aligned with market pressures to achieve better performance (Dangelico, 2017). In addition, stakeholders play an extremely important role in green innovation, both by boosting its performance and by creating value (Pucci *et al*., 2020). According to Zhang *et al*. (2025), stakeholder integration is crucial to promoting green innovation, as it ensures that companies' environmental strategies respond to and are informed by the diverse needs and contributions of their stakeholders.

From another perspective, according to Noci and Verganti (1999), the tendency to consider green issues as a source of strategic change can have real implications for a company's technological strategy. According to Wong (2013), in an era where there is increasing pressure from stakeholders, changes in regulation and technology for green innovation and understanding the strategic implications for companies are substantial for change. The main function of innovation in digital technology is to promote green innovation and improve the quality of information disclosure (Wang *et al*., 2024). The results of Zhao and Fang (2023) show that digital transformation has a significant promotional effect on the performance of green innovation, and this effect can be achieved through a green technological process and green financial development. Hao *et al*. (2024) reinforce the facts, indicating that digital transformation plays a crucial role in promoting green innovation and encouraging business development. Recently, Lin *et al*. (2024) highlighted the role of artificial intelligence (AI) in improving environmental performance, particularly through green innovation in products and processes. Wang *et al*. (2024) report that AI accelerates the growth of green innovation, although Zhao and Li (2025) concluded that the adoption of AI negatively affects the efficiency of green innovation. The results of Wang *et al*. (2023) are controversial as they indicate that, in 51 countries, AI had a positive influence on green innovation, more pronounced in developed countries, with this influence being moderated by factors such as green culture, government subsidies and environmental regulation (Lin *et al*., 2024). According to Zhang *et al*. (2024) government subsidies promote substantive and strategic green innovation for companies facing the green transformation dilemma.

The timeliness of this work is due to several reasons. Firstly, before embarking on an extensive systematic review, an exhaustive assessment was made of the previous reviews included in our database that dealt with green innovation strategies. The research carried out on this topic showed that, although there have been attempts to systematize the literature on the phenomenon of green innovation – Khan *et al*. (2021) investigated green process innovation and Niesten and Jolink (2020) environmental and knowledge value - there has been, to our knowledge, no attempt to organize the literature and establish a solid theoretical basis for

collecting the different green innovation strategies that exist. In light of this gap, this study aims to advance the theoretical discussion through a systematic literature review (SLR) on an analysis of past, present and future trends in the literature related to green innovation strategies published to date, in order to provide a comprehensive picture of the issues and challenges faced by companies (Rehman *et al*., 2021). In line with the research objective of this study, the research questions are as follows:

RQ1. What green innovation strategies exist?

RQ2. What opportunities exist for companies resulting from green innovation strategies?

In order to synthesize the literature and broaden the understanding of the field of study, it was considered pertinent to adopt a systematic literature review with a bibliometric analysis. First, 509 documents were collected through a Web of Science (WoS) search. In a second phase, inclusion/exclusion criteria were applied based on the reputation of the journals according to the ABS-24 list and the relevance of the articles in relation to the research objective. Finally, the bibliometric technique of bibliographic coupling was applied using the VOSviewer software, obtaining a final sample of 63 articles.

Our study has contributed to the existing literature in several ways. Firstly, it contributes to the literature on innovation by synthesizing and reinforcing previous research on the impact and importance of general innovation on company performance (Niesten and Jolink, 2020; Khan *et al*., 2021; Rehman *et al*., 2021). In addition, it also contributes to research on sustainable development by highlighting the link between green development and the development of innovation (Zhao and Fang, 2023; Hao *et al*., 2024). This study breaks new ground by examining strategies for a specific type of innovation, namely green innovations aimed at reducing pollution, promoting the rational use of natural resources and achieving efficiency, productivity, performance and competitive advantage. It also provides a theoretical framework on the different green innovation strategies – based on theory – discussing their contribution to the environmental and economic performance of companies, considering their establishment at the levels of adoption, implementation and development of green innovation practices, as well as the influence of stakeholders in promoting them. The identification of emerging topics in the field of green innovation, from a strategically competitive perspective, provides a potential contribution to future studies. Finally, we contribute elements to the areas of innovation, strategic management, business management and technological development. The specific attention given to the role and main contributions between innovation strategies and green innovation will go some way to benefiting managers and limiting the intensity of the barriers and problems related to green progress. In addition, this study provides some insights into how companies can create strategies and which strategies around green innovation, since there is a positive relationship between green innovation and the development of the industry and even the sector, which will help companies to better understand how to select plans that will generate future green innovations. The publication also provides researchers, senior managers and policy-makers with decision-making knowledge and a baseline assessment for improving companies' economic performance and securing a competitive advantage through green innovation initiatives.

The article is structured in six points. This introduction presents the background to the topic and illustrates its relevance. The next point summarizes the methodology and procedure of the systematic review. The third section presents the main results. The third to fifth sections present and discuss the results. It ends with the main conclusions and limitations of the study.

It is hoped that this study will not only summarize the research carried out to date, but also advance the theory and practice related to green innovation strategies.

2. Research design

In this study, we chose to apply a hybrid methodology (Gomes *et al*., 2018) combining a systematic literature review through a keyword search with a bibliometric analysis (Abarca

et al., 2020) using the Biblioshiny software (Aria and Cuccurullo, 2017) from the Bibliometrix R v.4.4.2 package (Team, 2021) and the VOSviewer v.1.6.20 software (van Eck and Waltman, 2010). The systematic review offers a holistic view of the state of the art (Adams *et al*., 2017) that allows gaps to be identified and future avenues of research to be signaled (Paul and Criado, 2020) and, in turn, bibliometric analysis allows the evolutionary nuances of a specific domain to be uncovered, revealing the emerging areas of that domain (Donthu *et al*., 2021).

In February 2025, the Web of Science (WoS) database (Clarivate Analytics, 2019) was used to identify and select articles that, due to their breadth in the social sciences and prestige in the academic community, ensure a comprehensive and high-quality article base (Elkhwesky, 2022; Gusenbauer, 2022; Paul and Criado, 2020; Silvério *et al*., 2023). WoS has the Social Science Citation Index (SSCI), which leads to a relatively greater focus on this subject (Gusenbauer, 2022). The documents were searched by topic - TOPIC assumes that the focus of the relevant documents is mentioned in the title, abstract and/or keywords (Kraus *et al*., 2022), using the search equation: "green innovat*" AND strateg*". The keyword "green innovation" was considered because it was the most widely used of all the connotations in the literature. After identifying the articles, an initial database of 1769 documents were obtained. Subsequently, to further guarantee the legitimacy of the review, the analysis was limited to full articles published in peer-reviewed journals and review articles in the "management", "economics" and "business" categories included in the SSCI (Kraus *et al*., 2022). In addition, the sample was limited to articles written in English, and conference proceedings and book chapters were excluded to strengthen quality and cohesion (Kraus *et al*., 2022). No restrictions were placed on the year of publication, as the aim of this article is to explore the field of research. The sample included 509 documents, which were then stratified by the most reputable journals according to the ABS List 2024 (Academic Journal Guide), with at least one importance factor of 4*, 4 or 3 (Table 1) (Kraus *et al*., 2022; Paul and Rosado-Serrano, 2019). A total of 291 articles were excluded from the sample because they were published in journals not on the ABS-24 List or because they had a lower relevance factor. Once this criterion had been applied, a total of 218 articles remained, which were subjected to another filtering process. At this stage, the document relevance criterion was used to exclude/include articles in the sample according to the research objective (Fernandes *et al*., 2024; Kraus *et al*., 2022). A total of 132 articles met the criteria and were then subjected to a bibliometric analysis using the VOSviewer software (v.1.6.20) specifically designed to create bibliometric maps (van Eck and Waltman, 2010). In accordance with the defined objective and considering the characteristics of the article base, namely its size, bibliographic coupling (Donthu *et al*., 2020, 2021) was the bibliometric technique selected to group the articles into clusters, assuming a minimum of five citations per article. Bibliographic coupling is based on the list of references and is useful for explaining the relationships between citing publications to understand the periodic or current development of topics in a field of research (Donthu *et al*., 2020; Gusenbauer, 2022). In VOSviewer, the "documents" unit of analysis was used as a criterion for grouping the articles, and the

Table 1. Distribution of selected articles according to ABS list

ABS list	Number (*n*) (initial database)	Sample (*n*)	Sample (%)
4*	1	1	1.59%
4	7	6	9.52%
3	70	56	88.89%
2	22	–	–
1	26	–	–
NABS	5	–	–

Note(s): NABS-were not on the ABS list
Source(s): Authors' own work

"full counting" method was used, as it has the most advantages in this grouping method (Perianes-Rodriguez *et al*., 2016). This analysis resulted in a database of 63 articles, distributed into five clusters (see Appendix, Table A1). Figure 1 shows the significant information that emerged from the article identification and selection phases.

Table 1 shows the number of articles that were analyzed ($n = 63$) distributed according to the categorization of the ABS-24 list (see Appendix, Table A1). It should be noted that, with an eminent disparity, "Business Strategy and the Environment" proved to be the journal that publishes the most in this field of research, which translates into 32% of publications ($n = 42$) and with notable evidence in terms of citations (502 citations). It is followed by "Corporate Social Responsibility and Environmental Management" with 8.4% of publications ($n = 11$) and "Technological Forecasting and Social Change" with around 7% ($n = 9$) and 134 citations. These results highlight a relevant aspect of the exploration of the topic in management, strategy, business and social change journals.

3. Results

3.1 Initial data statistics

This section uses the 509 articles that were identified in WoS and which constitute the input data for the bibliometric study. The analysis of scientific production, authors and sources are among the most widely used bibliometric indicators, generally adopted in widely cited reviews to carry out statistics (Acerbi and Taisch, 2020). Figure 2 shows the trends in literature from 1998 to 2025 in the field of green innovation strategies. From the graphical analysis, it can be seen that the first study to incorporate the concept of "green innovation" into "strategies" took place in 1998 with an explosion of contributions since 2018. In the last five years (2021–2025), around 80% ($n = 409$) of the articles on green innovation strategies have been published in

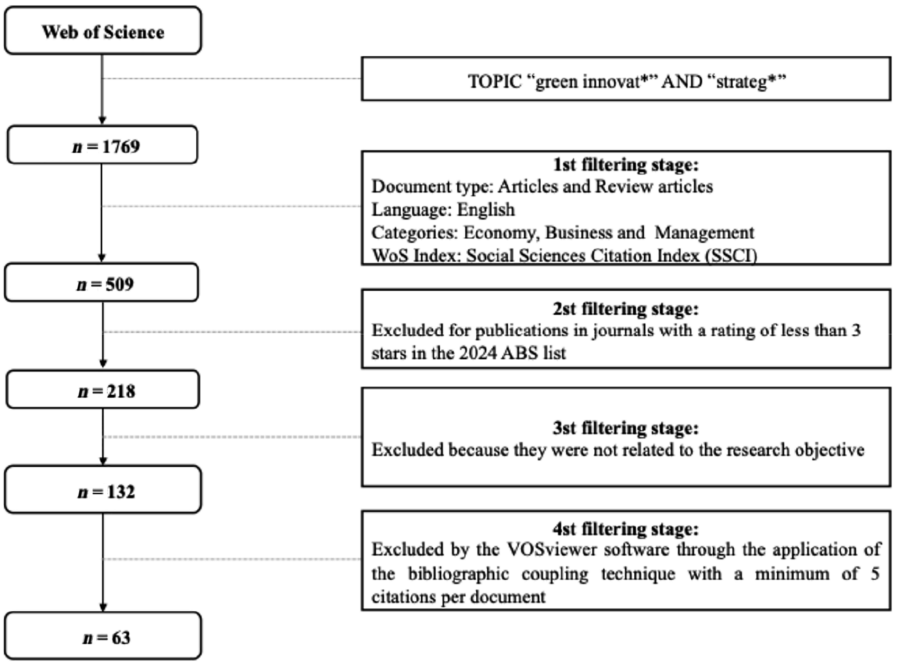

Figure 1. Process of selecting articles for qualitative analysis. Source: Authors' own work

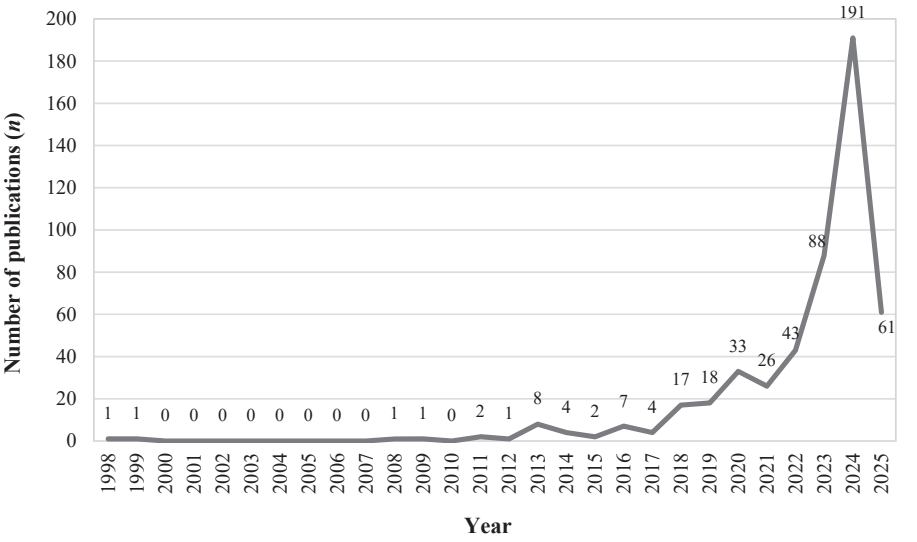

Figure 2. Evolution of scientific production on green innovation strategies. Source: Authors' own work

WoS. Between 2024–2025, 49.51% of the papers were published. This distribution shows that interest in this topic has been increasing.

Table 2 lists the authors with the greatest impact. Juanru Wang (School of Management, Northwestern Polytechnical University) and Ying Qu (School of Economics and Management, Dalian University of Technology) are the authors who have produced the most in the field of green innovation strategies, where they began publishing in 2020. This shows that both have actively contributed to the literature on strategic management and innovation.

Table 3 shows the ten most cited journals distributed according to the number of citations. Most of the journals considered aim to publish on environmental and strategic issues. The "Journal of Cleaner Production" ranks first, with an eminent disparity, having obtained 2,843 citations. "Business Strategy and the Environment" proved to be the journal that publishes the

Table 2. TOP 10 most cited authors

Author(s)	TC	NP	Py_start
Chen, Yu-Shan	92	2	2008
Rehman, Saif Ur	81	4	2020
Chang, Ching-Hsun	71	4	2011
Song, Wenhao	56	2	2020
Yu, Hongyan	56	1	2022
Kraus, Sascha	52	2	2020
Wang, Juanru	46	5	2020
Wang, Chao Hung	39	2	2019
Qu, Ying	38	5	2020
Shahzad, Mohsin	38	4	2020

Note(s): NP-number of publications, TC-total citations, PY-Start-the year in which first article on guilt was published
Source(s): Authors' own work

Table 3. Top 10 most cited journals

Fonte	Citations (*n*)	Impact fator	AJG 2024
Journal of Cleaner Production	2,843	9.8	1
Business Strategy and the Environment	2,139	12.5	3
Journal of Business Ethics	1,379	5.9	3
Technological Forecasting and Social Change	1,159	12.9	3
Strategic Management Journal	1,087	6.5	4*
Journal of Business Research	900	10.5	3
Research Policy	843	7.5	4*
Sustainability	748	3.3	*
Corporate Social Responsability and Environmental Management	647	8.3	1
Academy of Management Journal	616	9.5	4*

Source(s): Authors' own work

most in this field of research (98 publications), with notable evidence in terms of citations (n = 2,139). In third place is the Journal of Business Ethics with a total of 1,379 citations. Although the "European Journal of Innovation Management" does not appear in the table, it should be noted that it ranks fifth among the journals that publish the most on this subject (n = 16).

3.2 Thematic cartography

Figure 3 shows clusters defined by "keywords plus", in which the titles of all the references are reviewed and the relevant additional keywords are highlighted, using the eigenvalues as weightings. The size of the clusters, represented by the circles, indicates the number of articles in each group, where the three most recurrent themes are represented. The distribution of the

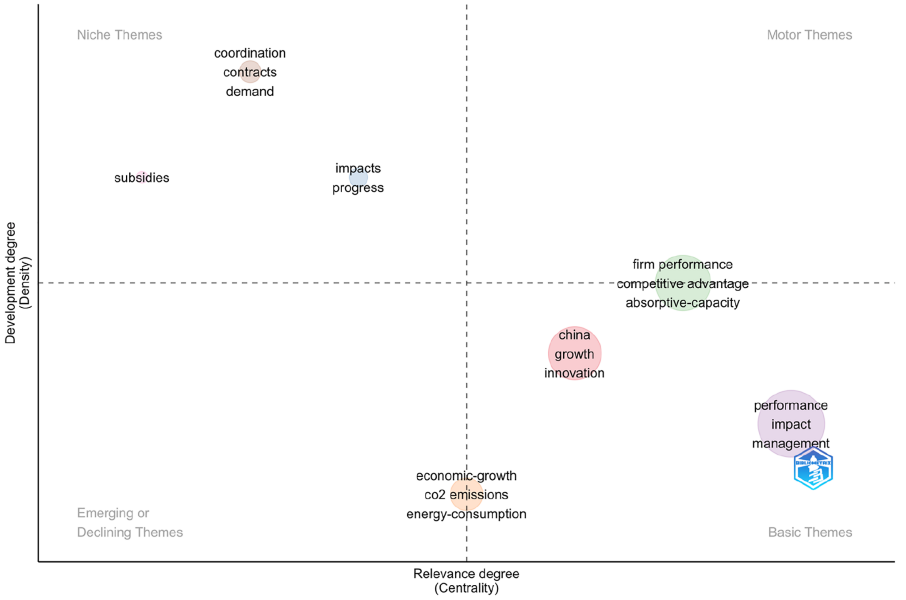

Figure 3. Thematic map. Source: Authors' own work

clusters into four quadrants is determined by their centrality and density. The analysis reveals that studies discussing absorptive capacity in terms of company performance and competitive advantage are the driving force behind the advancement of the research field. The themes in the top left quadrant, related to the impact of subsidies on the progress of the green innovation strategy, show well-developed links. The issues of CO2 emissions and energy consumption for the economic growth of companies, located in the lower left quadrant, represent emerging themes that could become driving themes. Finally, the themes related to the impact of innovation on the growth and performance of companies are important for the field of research, but are not yet sufficiently developed.

3.3 Co-occurrence of keywords

By analyzing the co-occurrence of general keywords in the documents, it is possible to determine the main themes and the evolution of research into green innovation strategies in companies. To create the map in Figure 4, the VOSviewer software was used with the "keywords plus" option and the "full counting" method, which assigns the same weight to each co-occurrence link. The minimum number of keyword co-occurrences was set at five, a number considered reasonable and recommended to indicate a strong correlation between articles, allowing relevant results to be obtained when identifying *clusters*. This configuration accounts for 6,039 links organized into six clusters. Cluster 1 (red) is the most numerous (70 terms) and is mostly characterized by the terms "green innovation" (304 occurrences), "performance" (180 occurrences), "impact" (129 occurrences) and "management" (110 occurrences). This may be related to the search for green innovation strategies, given the approach of this study. In cluster 2 (green), the most frequent associated keywords are "absorptive-capacity" (36 occurrences), "knowledge" (27 occurrences) and "supply chain"

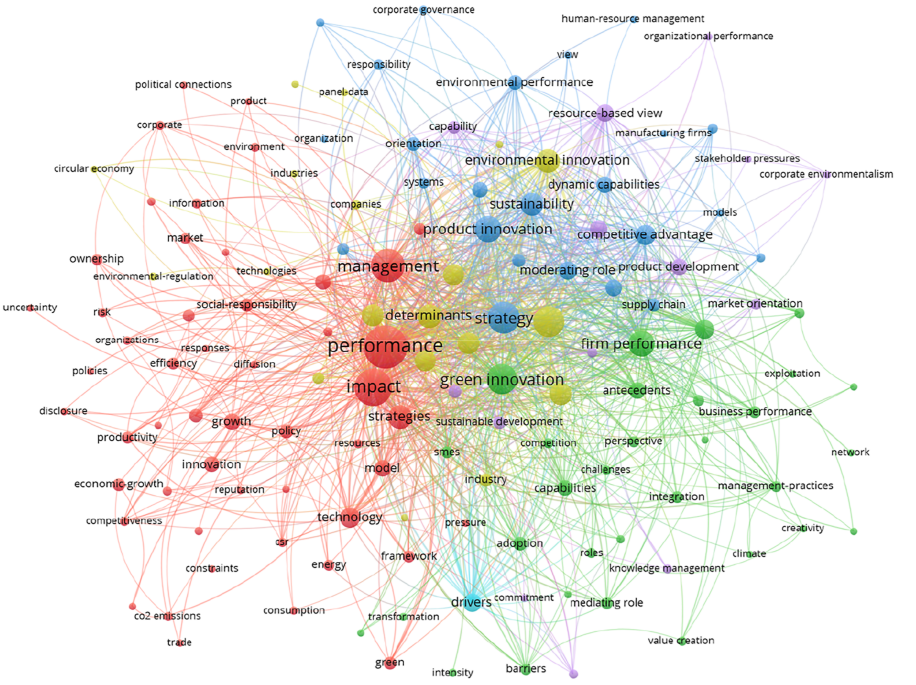

Figure 4. Co-occurrence network of general keywords. Source: Authors' own work

(16 occurrences). The third cluster (blue) essentially includes research on topics related to "firm performance" (76 occurrences), "product innovation" (72 occurrences) and "sustainable development" (54 occurrences). Cluster 4 (yellow) is made up of "strategies" (51 occurrences), "drivers" (33 occurrences) and "antecedents" (28 occurrences). Cluster 5 (lilac) highlights the terms "eco-innovation" (110 occurrences), "environmental innovation" (64 occurrences) and "determinants" (51 occurrences). Finally, cluster 6 (turquoise) is represented by the domain's "strategy" (95 occurrences), "sustainability" (72 occurrences) and "firms" (22 occurrences).

3.4 Scientific mapping

In a second phase, in order to analyze the main themes in the literature on green innovation strategies, it was decided to apply the bibliometric technique of bibliographic coupling, considering a minimum number of five citations to integrate the visual model of the cluster network. The VOSviewer software was used to produce the bibliometric map of the 63 documents (see Appendix, Table A1), grouping them into five clusters - 1,307 links (Figure 5): (1) implications of green innovation strategies (cluster 1); (2) drivers of green innovation strategies (cluster 2); (3) diffusion/diffusers of the green innovation strategy (cluster 3); (4) internal and external drivers of the green innovation strategy (cluster 4) and; (5) stakeholders in the green innovation process (cluster 5).

Table 4 shows the composition of each cluster according to the authors in the sample ($n = 63$).

4. Description of the clusters

At this stage, all the articles contained in the bibliographic coupling database were read and analyzed (63 documents; see Appendix, Table A1). The analysis made it possible to identify points of similarity and divergence, which gave rise to different clusters. Furthermore, when analyzing the articles, we found that there is no balance between conceptual and empirical

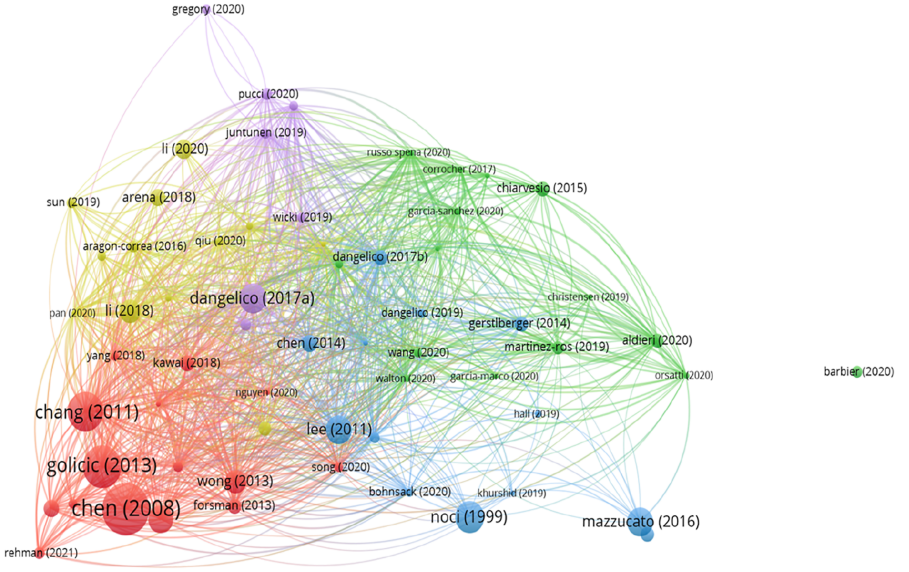

Figure 5. Clusters based on the bibliographic coupling of documents. Source: Authors' own work

Table 4. Constitution of each cluster by author and year

Clusters	Author (Year)
Cluster 1 Implications of green innovation strategies	(1) Albort-Morant *et al*. (2016), (2) Chang (2011), (3) Chen (2008), (4) Chen *et al*. (2018), (5) Forsman (2013), (6) Golicic and Smith (2013), (7) Kawai *et al*. (2018), (8) Kraus *et al*. (2020), (9) Leal-Rodríguez *et al*. (2018), (10) Lin *et al*. (2020), (11) Liu and Kong (2020), (12) Nguyen *et al*. (2020), (13) Rehman *et al*. (2021), (14) Song *et al*. (2020), (15) Yang *et al*. (2018) and (16) Wong (2013)
Cluster 2 Drivers of green innovation strategies	(1) Aldieri *et al*. (2020), (2) Barbier (2020), (3) Chiarvesio *et al*. (2015), (4) Christensen *et al*. (2019), (5) Corrocher and Solito (2017), (6) de Medeiros *et al*. (2018), (7) García-Marco *et al*. (2020), (8) García-Sánchez *et al*. (2020), (9) Oh *et al*. (2020), (10) Orsatti *et al*. (2020), (11) Salo *et al*. (2020), (12) Wang *et al*. (2020), (13) Russo Spena and Di Paola (2020), (14) Martínez-Ros and Kunapatarawong (2019), (15) Wong (2013)
Cluster 3 Diffusion/Diffusers of the green innovation strategy	(1) Bohnsack *et al*. (2020), (2) Chen and Hung (2014), (3) Dangelico (2017), (4) Dangelico *et al*. (2019), (5) Falcone *et al*. (2018), (6) Gerstlberger *et al*. (2014), (7) Hall *et al*. (2019), (8) Khurshid *et al*. (2019), (9) Lampikoski *et al*. (2014), (10) Lee and Kim (2011), (11) Mazzucato (2016), (12) Noci and Verganti (1999) and (13) Shou *et al*. (2018)
Cluster 4 Internal and external drivers of green innovation strategy	(1) Aragon-Correa and Leyva-de la Hiz (2016), (2) Arena *et al*. (2018), (3) Galbreath (2019), (4) Hao *et al*. (2019), (5) He and Jiang (2019), (6) Pan *et al*. (2020), (7) Forcadell *et al*. (2021), (8) Leyva-de la Hiz *et al*. (2019), (9) Li *et al*. (2018), (10) Li *et al*. (2020), (11) Qiu *et al*. (2020) and (12) Sun *et al*. (2019)
Cluster 5 Stakeholders in the green innovation process	(1) Dangelico *et al*. (2017), (2) Gregory *et al*. (2020), (3) Juntunen *et al*. (2019), (4) Papagiannakis *et al*. (2019), (5) Pucci *et al*. (2020), (6) Thurner and Proskuryakova (2014) and (7) Wicki and Hansen (2019)

Source(s): Authors' own work

articles, with 100% being empirical (98.4% quantitative) and 0% theoretical. Therefore, this RSL is a matter of urgency.

4.1 Cluster 1: implications of green innovation strategies

In this subsection of the core of our review, we discuss the articles ($n = 16$) that belong to the "implications of green innovation" group, which focuses on research to understand how green innovation strategies influence economic performance, create value and generate competitive advantage.

Green practices are closely linked to companies' ability to innovate, with a direct impact on company performance (Golicic and Smith, 2013), enabling them to achieve and maintain competitive advantages (Albort-Morant *et al*., 2016; Lin *et al*., 2020). Therefore, companies should focus on the performance of product and process green innovation to improve their green innovation and image and gain a competitive advantage (Chen, 2008). Chen *et al*. (2018) add that adopting green innovation strategies not only generates competitive advantage and improves corporate image, but also helps to improve quality, reduce costs and develop new markets. But for companies to develop green innovation strategies and competitive advantages, they must invest more in resources to improve environmental ethics (Chang, 2011). Because companies' environmental ethics not only directly affect competitive advantage, but also indirectly influence green product innovation. On the other hand, Forsman (2013) argues that although the green innovations developed are related to the creation of competitive advantages, they can also lead to competitive disadvantages in terms of efficiency and risk.

From the perspective of Leal-Rodríguez *et al*. (2018), organizational performance and company performance in green innovation are improved when a company relies on market-oriented strategies. In this sense, companies must respond to stakeholder pressures in order to acquire social legitimacy, since the implementation of formal environmental management systems translates into an important mechanism that transforms pressures into green innovation initiatives (Kawai *et al*., 2018). In other words, companies must adopt management practices that are consistent with the needs of society and customers in order to achieve levels of organizational performance and green innovation. Customers' green innovation taxonomies influence environmental measures and financial performance differently, with the main differences being based on the level of investment in green improvement initiatives and direct customer investment in green activities (Nguyen *et al*., 2020).

Knowledge sharing and green process innovation may be the points where leverage can be applied to better ensure innovation success (Wong, 2013). To achieve superior green innovation, managers must ensure that their companies interpret, assimilate and exploit shared knowledge, such as green technology and customers' green needs, more quickly, accurately and effectively than their competitors (Song *et al*., 2020). These authors add that stakeholder pressure can motivate and enable a company to make better use of knowledge sharing to develop its absorptive capacity and green innovation. The study by Rehman *et al*. (2021) adds that green innovation mediates the relationship between green intellectual capital and green human resource management.

Corporate social responsibility (CSR) also has a positive relationship with environmental strategy and green innovation, helping to improve environmental performance (Kraus *et al*., 2020). In addition, the effect of listed industry peers is also an important antecedent of environmental strategy that allows further improvement of the sustainable development of non-listed companies (Yang *et al*., 2018). On the other hand, companies that follow prospecting strategies adopt fewer sustainable development behaviors than those that follow defense strategies, confirming that there is a negative relationship between corporate strategy and green innovation when addressing robustness with corporate strategy alternatives (Liu and Kong, 2020).

4.2 Cluster 2: drivers of green innovation strategies

The "drivers of green innovation strategies" cluster, made up of fifteen articles, focuses research on understanding the factors that drive the adoption of green innovation strategies.

National and European regulations widely encourage the adoption of green innovation strategies (Corrocher and Solito, 2017; Salo *et al*., 2020). However, green innovation practices differ depending on the environmental regulations to which the industry is subject (García-Marco *et al*., 2020). Oh *et al*. (2020) add that green innovation can also create economic benefits in the absence of additional social and governmental pressures. According to Aldieri *et al*. (2020), government policies that promote greater complementarity of knowledge and coordination between environmental fields help to promote greater knowledge transfer, allowing for more sustainable development. Although investments in environmental innovations for full integration are more expensive, they allow for better performance in the medium and long term. In addition, the authors pointed out that both the characteristics of the company and the specificities of the sector in terms of product tangibility, knowledge intensity and consumer orientation are important for the adoption of different green innovation strategies.

Christensen *et al*. (2019) highlight the importance of collaboration for innovation. For example, renewable energy innovators generally have a greater propensity for external collaboration and a greater degree of collaboration within organizations, although in the latter case, green innovation performance depends more on R&D investment than collaboration. Russo Spena and Di Paola (2020) consider that open and collaborative relationships are increasingly paving the way for the strategic challenges of the open green innovation strategy.

In particular, Martínez-Ros and Kunapatarawong (2019) have shown that there is a shift in the focus of the sources of knowledge used to create green innovations, from internal to external knowledge, as companies grow from small to large. According to Wang *et al*. (2020), companies should not only focus on acquiring external knowledge through cooperation with external entities, but also pay attention to the degree of breadth and depth of research in order to facilitate green innovation. Furthermore, in order to develop green innovation, companies need to align physical resources with intangible resources so that they can achieve knowledge and learning (Wong, 2013). In this sense, de Medeiros *et al*. (2018) state that companies can organize their green innovation practices based on investments related to people, laboratories, equipment and technological research. The vision and dynamism of leaders are also essential to trigger important interrelationships between (1) knowledge of the market and legislation, (2) cross-functional collaboration and (3) learning factors oriented towards green innovation.

Companies that involve innovators with previous experience in filing green patents are more likely to generate a green innovation (Orsatti *et al*., 2020). In addition, green innovation is more effective if it involves the entire value chain and is perceived by customers (Chiarvesio *et al*., 2015). For example, companies that outsource and rely on non-local suppliers are less likely to engage in environmental innovation. In other words, geography also plays a decisive role in the activities of green companies. García-Sánchez *et al*. (2020) add the importance of the types of institutional investors in the development of green innovation strategies, having shown that short-term investors seek an immediate economic return, while long-term investors are positively associated with green innovation. In a more recent study, which does not fit into our sample, the question was raised whether institutional investors with sustainable preferences integrate long-term environmental goals into their investment strategies, thus improving the results of green innovation. On the other hand, it is necessary to adopt priority policies for a green stimulus that requires long-term public spending commitments (Barbier, 2020).

4.3 Cluster 3: diffusion/diffusers of the green innovation strategy

This group consists of thirteen articles that help us identify the role of diffusion agents in the adoption and implementation of green innovation strategies.

The process of diffusing innovation in green products and processes depends above all on the systemic changes taking place in the industry. Bohnsack *et al*. (2020) noted the important role that early companies with divergent behavior can play in driving a movement of convergent behavior to help move the industry as a whole towards green product innovation. Mazzucato (2016) considers the need for government policy to transform, catalyze, create and shape markets to help reshape key economic policy issues into more dynamic ones that will enable the formation of the kinds of public-private interactions that can create new green innovation strategies. Financial institutions also play an important role in the development of green innovations and therefore institutional actors must behave in a targeted, proactive and entrepreneurial manner and act in the context of pressure from global actors in order to promote green innovation through institutional and informal channels (Falcone *et al*., 2018).

Companies need to invest in the development of new technologies (Hall *et al*., 2019) and environmental competencies in order to perform in the green products market and create differentiation (Dangelico, 2017). But for the differentiation strategy to be successful, managers must obtain certification and protect their products through patents or brand strengthening. In addition, companies must adopt a more proactive approach to take advantage of the competitive edge resulting from green innovation. From another perspective, to achieve effective green innovation, companies must leverage their social capital to produce additional competitive advantages through environmental collaboration (Chen and Hung, 2014). Internal objectives for the development of new green products in relation to production facilities, especially efficiency considerations, market attention and the greening of innovation also have a significant positive effect on green product innovation and company efficiency (Gerstlberger *et al*., 2014).

Understanding the critical organizational barriers unique to the various green innovation games is the key to overcoming the obstacles that make corporate sustainability a competitive advantage (Lampikoski *et al*., 2014). This means that a company must follow the right new game strategy to create and capture value and play the game according to its specific scope, relative strengths and acquired knowledge of environmental issues. These rules of the game constitute the first guideline for integrating corporate sustainability objectives into green strategic innovation. Involving key suppliers in the development of new green products for environmentally demanding customers and markets can bring green and commercial success (Lee and Kim, 2011). On the other hand, inter-organizational complementarity and compatibility play a crucial role in achieving the best results in terms of green innovation (Shou *et al*., 2018). While inter-organizational complementarity facilitates incremental green innovation, inter-organizational compatibility plays a more crucial role in radical green innovation. In addition, previous experience in green innovation and internal knowledge about outsourced components play a complementary role in improving green performance (Dangelico *et al*., 2019; Khurshid *et al*., 2019).

According to Dangelico *et al*. (2019), family and non-family businesses are similar in terms of the characteristics of green innovation, the characteristics of the green innovation process, the challenges faced and the results achieved. On the other hand, they differ in terms of motivations, pressures and the company's vision of green innovation. Noci and Verganti (1999) add that some SMEs are highly committed to developing green innovations, which means that green product innovation can occur and can also have strategic implications for SMEs.

4.4 Cluster 4: internal and external drivers of green innovation strategy

This group consists of twelve articles that relate internal and external drivers to green innovation strategies.

The effects of green innovations in industry play an important role in the behavior of individual companies. But even when green motivations are not the main driver of managers' efforts to generate corporate innovations, a company's overall innovations can generate a positive effect in terms of reducing its environmental impact (Aragon-Correa and Leyva-de la Hiz, 2016).

CEO arrogance represents a key factor motivating companies to undertake green innovation, compensating for their risk aversion and the uncertainties surrounding innovative projects (Arena *et al*., 2018). Hao *et al*. (2019) reinforce the moderation that exists between managerial ties and environmental regulation on the positive relationships between returning directors and green innovation performance, i.e. a greater number of returning directors indicates that the company has more international green resources. Companies therefore need to improve the academic qualifications and innovation skills of local directors. Recently, the work of Tawiah *et al*. (2024) corroborates these findings, stating that returnee directors can affect green innovation in at least two ways. First, returnee directors can link companies to green technologies abroad due to foreign exposure and global connections gained through foreign education or work experience. Second, as board members with experience abroad, returnee directors can increase green innovation by increasing their companies' absorptive capacity for green technologies through the performance of their consultancy and advisory roles. However, this evidence varies depending on different assumptions, such as the role of the director, ownership structures, the type of industry and the internal and external governance of the company. On the other hand, the division of green innovation into green process innovation and green product innovation shows that environmental regulation increases financial performance, especially through green process innovation (Qiu *et al*., 2020).

Galbreath's study (2019) provided more information on the drivers of green innovations. They showed that as companies intensify their exports, they tend to implement green

innovations at a higher rate. He and Jiang (2019) state that the occurrence of green innovation at the company level is systematically related to female representation on the board of directors. Pan *et al*. (2020) add that companies with more female executives are more effective in pursuing green behaviors. In other words, the participation of female executives has a double effect on the company's green competitive advantage, which includes both the inhibiting effect of unethical environmental behavior and the stimulating effect of proactive environmental strategies.

Companies that promote CSR improve their innovative profile, both in terms of input (R&D or technological effort) and output (product and process innovation) (Forcadell *et al*., 2021). This shows that environmental responsibility is an important antecedent of competitive advantages based on companies' capacity for innovation and green innovation. That said, companies must strengthen their sense of environmental responsibility in order to increase their competitive advantages, corporate innovation capacity and company value (Li *et al*., 2020).

At the international level, the institutional characteristics of innovation and the environment can affect companies' involvement in green orientation behavior (Leyva-de la Hiz *et al*., 2019). Thus, companies from countries with weak environmental institutions are strengthening the use of their technological capabilities to generate green innovations in international contexts. Adopting a higher level of green orientation in their international innovation portfolio can be considered a strategy to meet legitimacy requirements in international contexts. Li *et al*. (2018) reinforce the idea by arguing that companies should increase informal and formal mechanisms, i.e. external environmental legitimacy and internal green process innovation. For Sun *et al*. (2019), managers must be consistent with the government's determination to protect the environment and adopt positive and effective environmental measures to maintain their political legitimacy, such as setting up a special environmental information department to deal with the corresponding issues for companies' green decision-making.

4.5 Cluster 5: stakeholders in the green innovation process

This group includes seven articles on the role of stakeholders in green innovation processes.

As other antecedents of green innovation, the emerging literature on sustainability highlights the importance of integrating stakeholders (suppliers, customers and the local community) in promoting environmentally sustainable practices, such as green innovation (Zhang *et al*., 2025). However, other collaborative partners, such as universities, research organizations and competitors, also contribute to green innovation. Today's rapid technological development, the introduction of new regulations and customer pressure for greener products require companies to innovate, but to succeed in green innovation strategies, they need to collaborate more with external organizations, as no company can have all the knowledge in-house (Goodman *et al*., 2017). Thurner and Proskuryakova (2014) report that green innovation originates from international cooperation for industry leaders or internal knowledge generated by R&D institutes themselves. Dangelico *et al*. (2017) report that investing in environmental R&D or improving cross-functional collaboration between specialized environmental units may not be enough to develop green innovations. Instead, companies need to explore new solutions related to the integration of environmental knowledge and skills that often belong to external actors. Involving external partners offers benefits such as access to knowledge, enabling the development of new products and faster market introduction (Melander, 2018). According to Pucci *et al*. (2020), a company can involve different stakeholders at different times. For example, employees can provide practical suggestions for reducing waste and improving energy efficiency, while customers can highlight their preferences for sustainable products, prompting companies to innovate accordingly. In addition, suppliers are involved to provide new technologies and innovative materials, improving the overall green innovation process. Hiring an external, qualified person

to facilitate the innovation strategy can also be an excellent investment for companies wishing to navigate the green innovation journey (Wicki and Hansen, 2019). In this regard, Melander (2018) stresses the importance of finding a suitable partner, for example, partners with environmental experience who can contribute new knowledge or technologies to the company.

By integrating stakeholder perspectives into strategic decision-making, companies can identify and prioritize environmental issues more effectively, leading to the creation and implementation of green innovation that not only addresses stakeholder concerns, but also increases the company's competitive advantage and long-term sustainability.

5. Discussion and future lines of research

Growing environmental issues demand that all economic entities, including companies, adopt responsible ways of doing business. In response to these calls and with the growing recognition of the SDGs, companies and their stakeholders are increasingly focused on implementing green innovation. Green innovation, which encompasses both environmental sustainability and innovative development, is an effective way of reducing an organization's negative impact on the environment, while simultaneously creating market opportunities and increasing companies' competitive advantage (Block *et al*., 2025; Sun *et al*., 2024).

But while the literature provides a convincing theoretical explanation that investments in green innovation can lead to improved organizational and environmental performance and competitive advantage, it offers few insights into existing green innovation strategies (Rehman *et al*., 2021). Therefore, this research decided to embark on this path, seeking to answer the following research questions: (RQ1) What green innovation strategies exist? and (RQ2) What opportunities exist for companies resulting from green innovation strategies? Considering and integrating the existing literature, the following integrative framework is proposed (Figure 6), which combines the discussions on green innovation in the strategic framework for organizational and environmental performance and for the competitiveness of companies, regardless of the sector in which they operate.

Green innovation performance is considered a key factor in achieving a sustainable competitive advantage under the dual objectives of economic development and environmental protection (Chang, 2011; Chen, 2008; Forsman, 2013; Kraus *et al*., 2020; Leal-Rodríguez *et al*., 2018; Rehman *et al*., 2021; Zhao and Fang, 2023). The work of (Maldonado-Guzmán

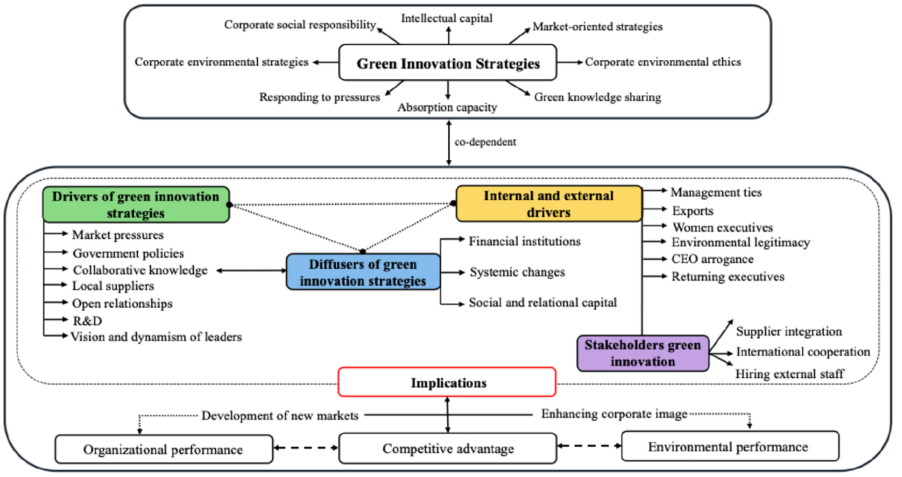

Figure 6. Framework for integrating green innovation strategies into companies. Source: Authors' own work

et al., 2023) reiterates this perspective by stating that green innovation mediates the association between environmental and financial performance, varying according to sector and region. The results of this research confirmed the conclusions of these studies, showing that there is a close link between green innovation strategies, competitive advantage, environmental performance and organizational performance. But the previous results are extended by the authors, who show that the development of new markets, the enhancement of corporate image, quality and cost reduction are also implications of the adoption and implementation of green innovation strategies. Dangelico *et al*. (2019) also add that green innovations have a positive impact on company performance in terms of reputation, customer satisfaction, operational and market performance, as well as financial performance.

However, the majority of green innovation initiatives taken by companies today are influenced by policies. Environmental regulations (national and European) and market incentives were considered strategies that condition the adoption and development of green innovation. These results are in line with those of Dangelico *et al*. (2017) and Hao *et al*. (2024) who attest that market incentives and government intervention are necessary for green innovation to thrive. Governments can use environmental laws and policies to affect companies' green innovation efforts (Jia *et al*., 2024). Government support induces companies to become more involved in green innovation than traditional innovation by stimulating motivations and providing resources. In addition, government inspection forces companies to be more aware of environmental issues and to engage in green innovation (Qi *et al*., 2020). According to this perspective, when managers see regulatory inspection as an opportunity for environmental management, they tend to proactively adopt a green innovation strategy. In other words, external policy guidance is an important influencing factor for companies to take green innovation initiatives. At the same time, Aldieri *et al*. (2020) concluded that government policies promote complementary knowledge and coordination in environmental fields and help promote greater knowledge transfer, allowing for greater development of green strategies.

To develop green innovations, managers can use different strategies, such as promoting a culture of knowledge exchange. By doing so, managers can find suitable solutions, understand consumer demands and meet stakeholder expectations. As a result, several studies have explored the role of knowledge sharing in promoting green innovation (Song *et al*., 2020). Notably, alongside corporate science, collaborations with external entities can also be important when seeking to promote and respond to the challenges of green innovations (Christensen *et al*., 2019; Dangelico *et al*., 2017; Russo Spena and Di Paola, 2020; Thurner and Proskuryakova, 2014; Wang *et al*., 2020). For example, collaborations with universities and research institutions, since these institutions are continuously involved in R&D projects and are increasingly adopting a green vision in relation to innovation. In short, consistent with the innovation literature, there is a broad consensus that investment in research and involvement in collaborations are the main drivers of green innovation, although a more recent and more specific approach is still needed to analyze how they affect green innovation strategies.

In addition, the integration of stakeholders into green innovation processes is recognized as an important category for its implementation and development (Gregory *et al*., 2020). Stakeholder theory argues that companies are not only accountable to their shareholders, but also to a wide range of stakeholders, including employees, customers, suppliers and the community (Papagiannakis *et al*., 2019). The results of the work by Zhang *et al*. (2025) coincide with ours when they highlight the importance of viewing stakeholder integration as a strategic asset in the direct promotion of green innovation. These results offer valuable information on the mechanisms by which stakeholder integration promotes green innovation, contributing to both business strategy and environmental management literature.

Previous studies have also paid close attention to the factors that drive the introduction of green innovation. For example, company-specific factors (e.g. technological capabilities, R&D investments, external collaborations and CSR practices) (Dangelico *et al*., 2017;

Forcadell *et al*., 2021; Kraus *et al*., 2020; Leyva-de la Hiz *et al*., 2019) and external factors (e.g. customer requirements, regulations and subsidies) (Aldieri *et al*., 2020; Jia *et al*., 2024; Kawai *et al*., 2018; Lin *et al*., 2024; Liu and Kong, 2020; Mazzucato, 2016) lead to green innovations. Given the importance of green innovation for organizations and society, the literature has investigated a large number of individual, organizational and institutional factors of green innovation, including CEO personality (Arena *et al*., 2018), company size (Corrocher and Solito, 2017; Martínez-Ros and Kunapatarawong, 2019), certification (Dangelico, 2017), absorptive capacity (Chen and Hung, 2014; Song *et al*., 2020), social and institutional investors (Galbreath, 2019), exports (Cao *et al*., 2024), social and environmental legitimacy (Kawai *et al*., 2018; Li *et al*., 2018), exports (Galbreath, 2019), institutional investors (Cao *et al*., 2024; García-Sánchez *et al*., 2020) and technological progress (Hall *et al*., 2019; Song *et al*., 2020). Khurshid *et al*. (2019) also concluded that prior experience in green innovation plays a key role in the diffusion of green innovation strategies.

Green innovation not only helps to minimize pollution emissions in companies' production processes, in line with the dual objectives of increasing economic efficiency and environmental protection, but also allows companies to create distinctive green products. This stimulates new demand in the market, effectively increasing companies' green competitiveness. Thus, when managers see environmental pressure as an opportunity for companies to gain potential competitive advantages, rather than a threat to companies, they will be more inclined to adopt green innovation strategies.

This research goes further, contributing a solid strategic basis for companies to become environmentally competitive by adopting, implementing and developing green innovation strategies. In addition, the creation of new categorizations for the examples analyzed (see section 4) provides a comprehensive overview of the strategic applications of green innovation for companies' environmental and economic competitiveness. In the future, the integrative conceptual framework can be used to categorize new examples of green innovation strategies appropriately distributed across the adoption, implementation and development phases to help companies respond to the competitive market. The proposed framework is based only on scientific literature, so further research is suggested to provide practical and empirical evidence for the results obtained.

Based on the literature analyzed, some deficiencies in the research were identified and, as such, Table 5 proposes the main themes and delves into the unexplored dimensions to offer inspiring ground for future researchers.

So far, research has focused predominantly on the strategies that enable the adoption and development of green innovation, but there are other factors that inhibit companies from adopting green practices that should be studied. Topics such as the intersection of green innovation with digital transformation or behavioral economics also require more attention. In addition, a comparative analysis of different industries or regions could provide valuable information on the contextual factors that shape green innovation strategies. For example, there are significant differences between countries in terms of government incentives for green innovation, so we recommend that future research take samples from several countries. In methodological terms, much of the research was carried out using quantitative approaches. To contribute to the paradigm, more qualitative and mixed methods should be used. In fact, it is believed that these approaches can be beneficial due to the need for generalizations and in-depth knowledge in the field. Transversely, researchers in the field of innovation and strategic management need to join forces with researchers in the fields of engineering, environmental sciences and sociology for a more comprehensive understanding of green innovation. In order to understand the dynamics of the phenomenon of green innovation strategies, academics should seek to develop longitudinal studies to track the evolution of green innovation strategies. Emerging topics such as energy consumption and CO2 emissions for companies' economic growth and the impact of green innovation on companies' growth and performance present promising avenues of research.

Table 5. Future research agenda by cluster

Cluster	Future research
Cluster 1 Implications of green innovation strategies	- Researchers should focus on analyzing the impact of the green innovation strategy on competitive advantage in relation to the different stages of the company's development - We recommend investigating and comparing the different conditions in companies that enable them to develop green innovation strategies. In this way, companies should be able to identify what they really need to drive and direct their strategies towards green innovations - In order to understand the generation of competitive advantage, it is also pertinent to analyze the intensity of innovation, as well as to identify and differentiate the types of innovation developed in companies with green approaches in mind
Cluster 2 Drivers of green innovation strategies	- What role does market demand (e.g. consumer behavior) play in the adoption of green innovation strategies? Present the issues and challenges faced by companies as a result of market and consumer pressures - Future research could analyze whether the geography of exports is intrinsically related to the ecological strategies adopted and whether it influences their propensity to include ecological issues in their innovation activities - It is also hoped that this article will inspire new research that addresses the particularities of green innovation strategies, such as potential obstacles and facilitators and the longitudinal effects of green innovation performance
Cluster 3 Diffusion/diffusers of the green innovation strategy	- Studies could focus on the real importance and influence of government policies geographically linked to green innovation strategies for companies - Given the importance of knowledge capacity in the development of green innovation, it is suggested that future research study how the process of inter- and intra-organizational learning can affect it
Cluster 4 Internal and external drivers of green innovation strategy	- Advance with studies that seek to analyze the impact of internal and external factors on changes in green innovation processes over time, i.e. as new companies are formed - Environmental regulations, market orientation and stakeholder pressure are all factors that influence the development of green innovation strategies. Future research could therefore consider these and other internal/external factors and compare their effects
Cluster 5 Stakeholders in the green innovation process	- Analyze the importance of integrating stakeholder interests in green innovation strategies. What are the strategies for integrating stakeholders in the development of green innovations?

Source(s): Authors' own work

6. Conclusions and limitations

As the world deals with the growing impacts of climate change, the urgency of reducing carbon emissions and advancing low-carbon transitions in the economy has become an urgent agenda for governments and companies. In this context, green innovation, defined as innovation in technologies related to green products or processes, including pollution prevention and the environmental management of companies, acts as a key catalyst for strengthening a company's strategic orientation towards sustainable development. In addition, companies can be better positioned to improve competitiveness, which can translate into better financial performance, a higher reputation and a better image.

The existing literature has focused particularly on companies' environmental issues, but innovation with specific reference to green strategies has not yet been sufficiently studied. Therefore, this study aimed to bring the debate on innovation from a strategic ecological

perspective to the heart of the matter. In this way, it contributes important elements to the fields of business management, strategic management and the theory of competitive advantage. Our analysis extends previous reviews by including articles published up to 2025, providing additional light on strategies for adopting, implementing and developing green innovation, using stricter inclusion and exclusion criteria combined with a more in-depth evaluation, thus providing a more reliable and meaningful overview.

The results show that this field of research has been underway since 1998 and has evolved significantly. However, despite how far it has come, it is still in the construction phase, since a significant segment still adopts only empirical methodologies. Trends in terms of scientific production showed an increasing level of academic interest in the year 2024 (191 contributions), which resulted in the following dilemma: Are green innovation strategies the economic, environmental and competitive future of companies? Fictional or reality? This question remains for future research.

The literature makes it clear that the adoption of green innovation processes requires the interaction and involvement of stakeholders, including employees, customers, suppliers and the community, both to create value and to drive, promote and develop green innovation strategies. In addition, it was found that, with an increasingly competitive market, green innovation strategies represent a key factor in achieving the dual objective of economic development and environmental protection. In this sense, managers should seek to act by recognizing and considering the factors that can facilitate the implementation and development of green innovation strategies towards sustainable development, without neglecting economic performance and competitive advantage - defined in sections 4 and 5.

The thematic map also provides promising information for researchers in the field of innovation and strategic management, as it shows the level of development and relevance of each of the topics covered. From its analysis, it is possible to conclude that studies related to absorptive capacity in terms of company performance and competitive advantage correspond to the development trends in this field of research.

This study makes important theoretical contributions. First, it systematically reviews the literature on green innovation strategies, identifying research topics and summarizing objectives and findings. This is the first attempt to create a comprehensive framework of antecedents, mediators, drivers and outcomes of green innovation strategy performance and diffusion, filling a gap in the literature. This study contributes to the understanding of the green innovation paradigm as a strategic opportunity to respond to sustainability issues, while elucidating its role for the competitiveness and profitability of companies, and is therefore relevant from the point of view of management studies. In addition, it provides research guidelines for academics to further investigate green innovation as a business strategy for industry sustainability in the competitive marketplace. This article also highlights the importance of universities as knowledge-intensive establishments that should pursue knowledge-sharing efforts with the aim of promoting strategic green innovation practices. Managers trying to identify strategies for acquiring green innovation can also benefit from our study. We advise companies to identify the importance of knowledge and to protect it, since new and innovative knowledge is at the basis of corporate green innovation. Finally, obtaining green patents has strategic implications for achieving green innovation. The research presents pertinent conclusions for multi-stakeholder groups seeking to identify the potential challenges and opportunities that green innovation presents when it is implemented.

This study provides theoretical clarity on the impact of government on the adoption, implementation and promotion of green innovation within companies, so it is imperative that policy recommendations are drawn up to promote an ecosystem where such innovation can thrive. Governments and industry should strive to alleviate bureaucracy for citizens by providing companies with more effective and timely information, thus reducing uncertainty during their green innovation efforts. In addition, the government should provide some support tactics (e.g. technical assistance, environmental subsidies) to help companies improve their compliance capacity by enforcing strict regulations. Many companies respond with short-term strategic green innovation actions to comply with policy and public pressure. To address this, the government

must further improve incentive mechanisms by introducing long-term policy guidelines and regulations, ensuring that green innovation is not just a short-term strategy, but a driver of companies' green transformation. This approach would not only encourage green innovation, but also mitigate the adverse effects of climate change. In addition, governments should consider implementing a series of fiscal and financial incentives that go beyond traditional tax exemptions and subsidies, including the creation of green investment zones or special economic areas dedicated to sustainable industries, which could give a specific boost to green innovation. On the other hand, promoting the integration of AI technology into green innovation efforts should be a priority. For example, the government can promote the sustainable application of AI by creating a cross-sectoral green innovation cooperation platform and facilitating collaboration between companies, research institutions, universities and other entities. The aim is to achieve organic integration of AI investment and improve the transformation of green innovation. The protection of intellectual property rights is another critical area where governments can have a significant impact, providing companies with the confidence that their green innovations will be protected, thus encouraging greater investment in R&D.

Managers, professionals and policymakers can make use of this research in emerging economies to survive in the market, creating value and generating competitive advantages. But it is necessary to encourage companies to adopt innovation strategies and provide appropriate indicators to promote and develop them.

However, this study has certain limitations, mainly due to its qualitative nature. The first limitation corresponds to the data collection process, which was restricted to the *WoS* database because it is one of the most reputable, which does not mean that other relevant information was left out of the research. Future research could benefit from using several databases to capture a wider range of studies. Another limitation refers to the selection process, which focused only on peer-reviewed articles and review articles published in English from the management, economics and business categories included in the Social Sciences Citation Index (SSCI) to avoid losing knowledge. The fact that only a few terms were considered when searching for data ("green innovation" and "strategies") inevitably represents a limitation. For very relevant works in the field, but which used another combination of keywords, were omitted from these results. On the other hand, another limitation is the fact that only articles with an impact of 4*, 4 and 3, according to the ABS-24 list, considered to be the most impactful, were selected for analysis. Given the characteristics of the article base, namely its size, we opted for the bibliometric technique of bibliographic coupling, assuming a minimum of five citations, which may also be conditioning the results, since articles that do not share common references and do not have at least five citations, but which are important to the topic, may have been left out. For example, this could be the case with the most recent articles. These limitations may provide a promising starting point for future research into green innovation strategies.

Given the preliminary nature of this work, it is intended to provide an effective reference framework for researchers, management and administration professionals and policymakers operating in the field of innovation, sustainability and strategic management, as well as promising avenues for further scientific research.

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Table A1. Summary table of articles in the sample ($n = 63$)

Title (DOI)	Author(s)	Year of publication	Journal	Citations (all)
The driver of green innovation and green image - green core competence. https://doi.org/10.1007/s10551-007-9522-1	Chen, Y.S.	2008	Journal of Business Ethics	505
A Meta-Analysis of Environmentally Sustainable Supply Chain Management Practices and Firm Performance. https://doi.org/10.1111/jscm.12006	Golicic, S.L. and Smith, C.D.	2013	Journal of Supply Chain Management	335
The Influence of Corporate Environmental Ethics on Competitive Advantage: The Mediation Role of Green Innovation. https://doi.org/10.1007/s10551-011-0914-x	Chang, C.H.	2011	Journal of Business Ethics	297
Managing 'green' product innovation in small firms. https://doi.org/10.1111/1467-9310.00112	Noci, G. and Verganti, R.	1999	R & D Management	186
Green Product Innovation in Manufacturing Firms: A Sustainability-Oriented Dynamic Capability Perspective. https://doi.org/10.1002/bse.1932	Dangelico, R.M., Pujari, D. and Pontrandolfo, P.	2017a	Business Strategy and The Environment	168
Integrating Suppliers into Green Product Innovation Development: an Empirical Case Study in the Semiconductor Industry. https://doi.org/10.1002/bse.714	Lee, K.H. and Kim, J.W.	2011	Business Strategy and The Environment	160
From market fixing to market-creating: a new framework for innovation policy. https://doi.org/10.1080/13662716.2016.1146124	Mazzucato, M.	2016	Industry and Innovation	158
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