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CORPORATE GOVERNANCE AND GREEN INNOVATION: A Systematic Literature Review Using the Proknow-C Method

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1 INTRODUCTION

In recent years, the environmental impact of human activities has become a growing global concern. The frequency and intensity of environmental disasters has increased in all regions of the world. The level of carbon dioxide in the atmosphere has increased by about 40% in the last century (Baser, 2024), resulting in an increase in global temperature. Cases such as extreme heat waves and forest fires in southern Chile (Correal, 2024) and Colombia (Ownby, 2024), severe droughts in eastern Spain (Keeley, 2024), floods and landslides on the west coast of the United States (Gorman and Trotta, 2024), extreme heavy rains and floods in southern Brazil (Zhong and Andreoni, 2024), extreme temperatures in Argentina (Kothari, 2024) and another 517 environmental disasters registered in the International Disaster Database in the last year (EM-DAT, 2024), highlight the legitimacy of environmental concerns.

This scenario requires urgent measures to reduce the consequences of harmful practices on the environment. However, the business models that still exist contribute significantly to these ecological risks (Jay, Gonzalez; Swibel, 2015). This emphasizes the importance of debating organizational strategies to face these challenges (Li et al., 2017). Consequently, attention has been drawn to green innovation, which is gradually being recognized among academics and professionals as a resource to overcome obstacles and allow societies to prosper in an era marked by environmental issues and scarce resources that increasingly require substantial innovations (Jay, Gonzalez, Swibel, 2015).

Green innovation encompasses innovations that aim to reduce the adverse environmental effects of business (Castellacci and Lie, 2017; Melander, Arvidsson, 2022), which may involve innovations in products, processes, and management practices. However, its adoption is hampered by high research and development costs and investment risks (Martinez-Ros; Kunapatarawong, 2019), imposing barriers to the active implementation of green practices in organizations (Chen and Liangb, 2023). Furthermore, a corporate governance (CG) structure that favors environmental innovation is necessary (Shui et al., 2022). Shahab et al. (2022) postulate that corporate governance mechanisms are fundamental predictors of companies' waste production levels. Haque and Ntim (2018) further indicate that companies with inadequate CG structures exhibit lower carbon performance compared to better-governed companies, while those with robust CG mechanisms promote more environmental policy initiatives. Consequently, green innovation in organizations requires commitment from senior management (Burki; Dahlstrom, 2017).

Despite these challenges involved, green innovation is recognized as a crucial element for sustainable management, being of paramount importance for organizations and communities and representing a business trend aimed at environmental preservation and economic growth (Takalo, Tooranloo, Parizi, 2021). It can reinforce market positioning, attract customers, and increase competitive advantages (Takalo; Tooranloo and Parizi, 2021). Furthermore, companies that adopt green innovation strategies can increase resource efficiency (Burki; Dahlstrom, 2017; Glass; Cook; Ingersoll, 2016), have competitive advantages (Aguilera-Caracuel; Ortiz-De-Mandojana, 2013), reduce pollution rates (Castellacci; Lie, 2017; Flammer; Hong; Minor, 2019) reduce waste generation (Kock; Santaló; Diestre, 2011), improve recycling rates (Aguilera-Caracuel; Ortiz-De-Mandojana, 2013), improve ecological reputation (Dangelico; Pujari; Pontrandolfo, 2017), improve its external legitimacy (Li et al., 2017) and have better returns on shares in periods of crisis (Garel; Petit-Romec, 2021).

Green innovation is considered relevant to the long-term strategic orientation, survival of the organization and the achievement of sustainable development (Bos-Bowers, 2010;

Flammer; Hong; Minor, 2019). But for its successful implementation, it requires active involvement of organizations' decision makers, who must have additional skills to favor the incorporation of new concepts, knowledge, and practices to improve environmental sustainability (Burki and Dahlstrom, 2017). Therefore, it is crucial to identify the favorable characteristics of organizations' main decision makers for adopting green innovation strategies.

This study integrates two subjects relevant to this discussion, namely, corporate governance and green innovation. The domain of corporate governance mechanisms is extensive and extends throughout organizational literature. Therefore, to limit the scope, attention is directed to the attributes of key corporate governance actors (CEO, board of directors, and owners). On the other hand, green innovation has only received significant attention in the literature in recent years. Although several studies explore different antecedents of green innovation, such as business competitiveness (Hermundsdottir and Aspelund, 2021), policy interventions (Parker et al., 2009) and organizational factors (Tariq et al., 2017), the interaction of corporate decision-makers with green innovation practices remains ambiguous.

The relationship between key corporate governance actors and green innovation lacks clarity due to limited previous research efforts aimed at consolidating this knowledge from a systematic approach. Consequently, the question remains in the literature of which aspects of key corporate governance actors favor green innovation.

Although environmental issues have been discussed worldwide since the 1972 Stockholm Conference, organizations were only engaged in addressing environmental issues in 2000 with the UN Global Compact. Consequently, research on green innovation in companies is still at an early stage (Tietze; Schiederig; Herstatt, 2011). To date, there is no review covering the domain of corporate governance and green innovation. Therefore, the role of corporate governance actors in green innovation has not yet been determined by the literature, stimulating new dialogues.

To elucidate this issue, this study reviews the existing literature on the attributes of the main corporate governance actors that favor the adoption of green innovation practices, with the aim of expanding understanding of their complexities and nuances. Through this systematic review: (i) the main characteristics of corporate governance actors engaged in green innovation practices are identified; (ii) the fundamental theories that support this thematic relationship are explored; and (iii) a literature map is proposed.

To achieve this objective, a systematic literature review methodology was used using Proknow-C (Knowledge Development Process – Constructivist), developed by Ensslim, Ensslim, Lacerda and Tasca (2010). Proknow-C offers a framework for quantitative and qualitative analyses, with the first involving a descriptive examination of the levels and characteristics of publications, and the second focusing on the identification, selection, critical evaluation, and synthesis of existing literature on the topic investigated (Queiroz; Pereira; Gimenes, 2021).

Through the process, a total of 90 relevant articles on the topic were identified in an analysis of relevant journals, covering the period from 1987 to 2024. A growing trend of investigations into green innovation is noticeable, particularly after 2015, coinciding with the Agreement from Paris. This international agreement links environmental goals between signatory countries, stimulating research in this area.

The second phase involved the recognition of green innovation practices in various domains, such as product, process, organization, and other dimensions covering scales, environmental metrics, ESG criteria, among others. Subsequently, the investigation highlighted specific structural elements of organizational decision makers, along with individual characteristics, including biodemographic aspects, psychosocial characteristics, experience, and training, which can favor the integration of green innovation practices in companies. Based on these findings, a conceptual map on corporate governance and green innovation was

proposed, illustrating how structural and personal aspects of decision makers can elucidate corporate engagement in green innovation initiatives.

According to the best knowledge of the authors, this study represents the pioneering effort to introduce this literature map, resulting from a systematic review focused on elucidating the main attributes of corporate governance actors that favor green innovation practices in firms. Consequently, this research aims to enrich the field of corporate governance by identifying the crucial mechanisms and attributes for advancing green innovation. Based on the literature map, this study helps researchers, students and organizations interested in exploring the intricate facets of decision makers that can favor ecological practices.

The study is structured into six sections: this initial section, which describes the research objectives, followed by an overview of the concepts and terminologies that involve green innovation and corporate governance, in the second section. The third section outlines the methodological steps involved in selecting the bibliographic portfolio and conducting the analyses. Subsequently, the fourth section investigates the results and discussions about the main findings of the investigation, culminating in the presentation of a literature map. Finally, in the fifth section, conclusions are presented.

2 THEORETICAL FOUNDATIONS

To direct the systematic literature review, it is necessary to understand the fundamental concepts and establish terminologies relevant to the subject (Klewitz and Hansen, 2014). This understanding is fundamental to identify the key terms and conceptual frameworks essential for analyzing aspects related to green innovation and corporate governance.

2.1 Green innovation concept and terminologies

The Organization for Economic Co-operation and Development (OECD, 2009) defines green innovation as the generation or implementation of new or significantly improved products (goods and services), processes, marketing strategies, organizational and institutional configurations that generate environmental improvements compared to existing alternatives. This definition highlights the substantial environmental gains associated with green innovation (Driesse; Hillebrand, 2002), differentiating it from conventional innovation, due to the degree of reduction in environmental impacts and the establishment of a new operational reference for organizations (Hazarika; Zhang, 2019).

In the field of commonly used terminologies, concepts such as green innovation, ecological innovation and environmental innovation are widely used interchangeably in the literature, while sustainable innovation or sustainability-based innovation (SOI) expands the concept by also involving social aspects (Takalo; Tooranloo; Parizi, 2021).

The literature does not present a consensus regarding terminologies and metrics associated with green innovation. An example of this is that the term green innovation is predominantly used in the literature as a metric for green patents (as indicated in the study results). Burkhardt, Nguyen and Poincelot (2020) use the term corporate environmental performance, while García-Sánchez, Aibar-Guzmán and Aibar-Guzmán (2020) use the term eco-innovation to evaluate ESG, and Francoeur, Lakhal, Gaaya and Saad (2021) use the same term only as a measure of the environmental pillar of ESG.

For the purposes of standardizing this research, only articles that incorporated terms related to green innovation were considered in the analysis, with the aim of understanding how the literature positions itself in relation to the use of terminology and the metrics used to capture its associations.

2.2 Corporate Governance and Green Innovation

Sustainable development requires the company's comprehensive involvement for its effectiveness and involves identifying new priorities rooted in the collective interests of stakeholders. Therefore, corporate governance (CG), serving as a balancing mechanism between stakeholders, plays a fundamental role in the advancement of environmental strategies. Consequently, corporate governance and green innovation converge in the interests of diverse stakeholders, aligning with solid corporate practices for sustainable development. Furthermore, contemporary CG approaches have considered in their guidelines attention to specific issues linked to market trends, including green innovation (Flammer; Hong; Minor, 2019).

Several studies have investigated the correlation between corporate governance mechanisms and conventional innovation, covering CEO attributes (Nie; Yu; Zhai; Lin, 2022) and board characteristics (Attah-Boakye; Adams; Kimani; Ullah, 2020), indicating a link between CG and innovation. In the field of environmental strategies, previous research documents the impact of organizational structures on environmental efficiency.

However, in the literature, there is still a lack of in-depth exploration of the interactions between corporate governance and green innovation. Therefore, conducting a systematic review of the literature on green innovation and corporate governance is necessary for several reasons. First, each publicly traded entity follows guidelines regarding corporate governance policies and practices, although they vary by size, sector, or geographic location. Second, the distinctive attributes of corporate governance agents imply that they will influence companies' strategies for green innovation in different ways. Thirdly, organizations are considered primarily responsible for global pollution. Therefore, understanding how corporate decision-makers engage in the green innovation process is crucial to understanding the characteristics of structures driven by private interests and those that are strongly guided by values, capable of improving their innovation capabilities in a sustainable way.

3 METHODOLOGY

A systematic literature review was conducted to explore how corporate governance actors affect the adoption of green innovation strategies in firms, aiming for a methodical, transparent, and replicable synthesis of knowledge (Tanfiel et al., 2003). The review can provide relevant theoretical and conceptual evidence to guide policies and practices (Thorpe et al., 2005) and has some advantages including increasing validity and quality, being replicable and reducing biases, in addition to allowing literature mapping and favoring the integration of existing knowledge (Queiroz, Pereira and Gimenes, 2021).

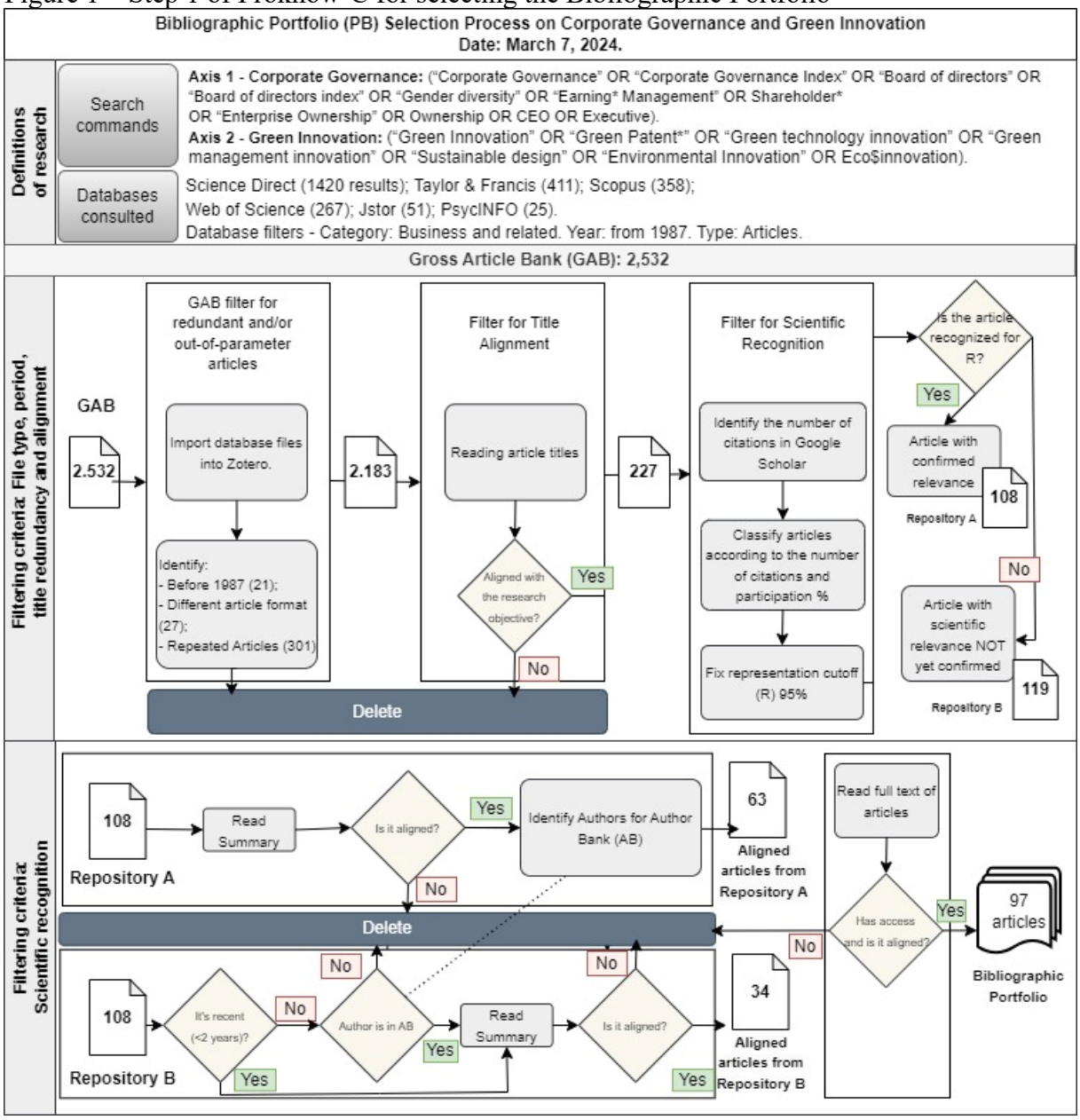
Bibliographical, exploratory, and inductive research includes quantitative and qualitative approaches, through bibliometric and systemic analysis. To increase the reliability of the process, the Knowledge Development Process-Constructivist (Proknow-C) methodology was adopted, which guides the systematic literature review in five stages: selection of the Bibliographic Portfolio, bibliometric analysis, systemic analysis, literature mapping and identification of evidence and gaps for future research (Ensslin et al., 2010; Welter and Ensslin, 2022).

3.1 Data collection procedure

The process of selecting the bibliographic portfolio (Figure 1) began with outlining the research axes and search terms that represent the topic (Afonso et al., 2011). For this study, the keywords were defined with the help of specialized researchers and validated by an adherence test, carried out through a preliminary search to adjust the terms as necessary. After this analysis,

the search terms were established, including the usual Boolean operators, namely: ("Corporate Governance" OR "Corporate Governance Index" OR "Board of directors" OR "Board of directors index" OR "Gender diversity" OR "Earning* Management" OR Shareholder* OR "Enterprise Ownership" OR Ownership OR CEO OR Executive) AND ("Green Innovation" OR "Green Patent*" OR "Green technology innovation" OR "Green management innovation" OR "Sustainable design" OR "Environmental Innovation" OR Eco$innovation).

Figure 1 – Step 1 of Proknow-C for selecting the Bibliographic Portfolio



Source: Adapted from Ensslin et al (2024).

A comprehensive list of expressions was developed to ensure that relevant terms were not excluded, even if this resulted in a surplus of irrelevant articles, which would be filtered out later (Kauppi, Salmi, and You, 2018). The search was carried out in six databases, chosen for their relevance in the business area, accessibility, and compatibility of search results with the Zotero software. Only peer-reviewed articles from business-related areas were included to ensure quality and standardization of analysis. Considering the increased attention to the

concept of green innovation since the Brundtland report (1991), the coverage period was defined between 1987 and 2024. The research reported a gross article bank (GAB) composed of 2,532 documents, according to Table 1.

Table 1 – Article bases, filters and number of documents collected.

Data base	Category Filters	Articles
Jstor	*Business; Finance*	51
PsycINFO	*Journals*	25
Science Direct	*Economics, Econometrics and Finance; Social Sciences; Business, Management and Accounting*	1420
Scopus	*Business, Management and Accounting; Social Sciences; Economics, Econometrics and Finance*	358
Taylor & Francis	*Economics, Finance, Business & Industry; Social Sciences*	411
Web of Science	Business; Management; Economics; Business Finance	267
TOTAL		2.532

Source: Study data.

3.2 Filtering criteria for building the Bibliographic Portfolio

After surveying the raw article database, the articles were filtered using Proknow-C. Publications prior to 1987 (21), duplicates (301) and documents in formats other than articles (27) were excluded. Next, an analysis of the titles was carried out to check thematic adherence, those considered misaligned were excluded, and 227 articles with titles compatible with the research themes were kept in the process.

In the phase of identifying the scientific relevance of articles, the number of Google Scholar citations was adopted as a metric, establishing a representativeness cutoff point of 95%, following Proknow-C (Pires, Ensslin, Sonensi and Bornia, 2019). Thus, 108 articles with 12 or more citations (in March/2024) were highlighted (Repository A) and the rest reserved for further analysis (Repository B).

After complete analysis of thematic adherence, 58 articles from Repository A met the inclusion criteria. Next, the authors of the articles (182) that made up the Database of Authors (AB) were identified. The analysis of Repository B considered recent articles (<2 years), since there was no time for expressive citations, and the presence of authors in the AB, resulting in the inclusion of 116 articles in the analysis, of which 32 were considered aligned, after detailed examination. The final Bibliographic Portfolio was composed of 90 relevant articles – 58 articles from Repository A and 32 articles from Repository B. These are presented in Table 3, in the results section.

A content analysis of the articles was carried out, considering bibliometric aspects such as scientific recognition, relevance of journals and prominent authors, which provide means to identify the general nature of existing literature (Ensslin et al., 2016). Subsequently, the systemic analysis categorized the articles by methods used, geographic region, industry, period of analysis, advanced variables, theoretical focus, among others, to map and synthesize the field of study.

4 RESULTS AND DISCUSSION

This section presents the main results and analyzes of the systematic review, which seeks to provide information, discuss implications of the evidence, and map the literature, identifying gaps for future research (Queiroz; Pereira; Gimenes, 2021). The characteristics of the articles that make up the Bibliographic Portfolio are described, highlighting the articles, periodicals, regions, authors, and methodologies of greatest importance for the topic.

4.1 Bibliometrics: study of basic variables

Table 2 lists BP articles and their scientific recognition, indicated by the number of citations on Google Scholar.

Table 2 – Bibliographic Portfolio

ID	Article	Number of citations
1	Arena, Michelon, and Trojanowski (2018)	270
2	Nadeem, Bahadar, Gull, and Iqbal (2020)	214
3	He e Jiang (2019)	185
4	Galbreath (2019)	172
5	Xia, Gao, Wei, and Ding (2022)	160
6	Quan, Ke, Qian, and Zhang (2023)	154
7	Ren, Wang, Hu, and Yan (2020)	135
8	Ortiz-de-Mandojana, Aguilera-Caracuel, and Morales-Raya (2016)	125
9	Huang, Li, and Liao (2021)	126
10	Liao e Zhang (2020)	110
11	Horbach and Jacob (2017)	109
12	Ma, Zhang, and Yin (2021)	117
13	Galia, Zenou, and Ingham (2015)	101
14	Liao, Zhang, and Wang (2019)	106
15	He, Chen, and Zhang (2021)	113
16	Konadu, Ahinful, Boakye, and Elbardan (2022)	105
17	García-Sánchez, Aibar-Guzmán, and Aibar-Guzmán (2020)	87
18	Liu, Li, Peng, and Lee (2020)	84
19	Konadu et al. (2020)	77
20	García-Sánchez, Gallego-Álvarez, and Zafra-Gómez (2020)	81
21	Zhou, Chen, and Chen (2021)	78
22	Jiang and Bai (2022)	85
23	Wang, Shen, Chen, and Carmeli (2021)	74
24	Wang and Jiang (2021)	88
25	Hao, Fan, Long, and Pan (2019)	67
26	Bammens and Hünermund (2020)	58
27	Liao and Long (2018)	55
28	Wang, Zeng, and Li (2022)	55
29	Aibar-Guzmán, García-Sánchez, Aibar-Guzmán, and Hussain (2022)	48
30	Aibar-Guzmán and Frías-Aceituno (2021)	44
31	Kuzey, Fritz, Uyar, and Karaman (2022)	47
32	Liao, Dong, Weng and Shen (2019)	34
33	Sun, Zeng, Lin, Yu, and Wang (2023)	32
34	Wang, Qiu, and Luo (2023)	32
35	Javed, Wang, Usman, Ali Gull, and Uz Zaman (2023)	38
36	Bueno-Garcia, Ortiz-Perez, and Mellado-Garcia (2021)	26
37	Yousaf, Ullah, Jiang, and Wang (2022)	26
38	Yu, Shen, and Jiang (2022)	27
39	Zhang, Zhang, and Jia (2022)	23
40	Yang, Shi, and Wang (2021)	25
41	Issa and Bensalem (2023)	25
42	Gao, Wang, Liu, and Zhao (2022)	25
43	Roud and Thurner (2018)	20
44	Phung, Trinh, Nguyen, and Trinh (2023)	26
45	Asni and Agustia (2022)	22
46	Shui, Zhang, Smart, and Ye (2022)	21
47	Zhao, Zhang, Shao, and Wang (2021)	19
48	Zhao, Qu, Wei, Yin, and Xi (2023)	18
49	Wang, Chang, Wang, and Wang (2022)	18

50	Moreno-Ureba, Bravo-Urquiza, and Reguera-Alvarado (2022)	18
51	Zhang, Li, Deng, and Zheng (2022)	15
52	Chen, Zhu and Wang (2023)	20
53	Sun and Sun (2021)	17
54	Naveed, Khalid, and Voinea (2023)	23
55	Zhou, Zhou, Zhang, and Miao (2022)	14
56	Khan, Johl, Kumar, and Luthra (2023)	13
57	Ma, Shu, Wang, and Wang (2022)	13
58	Farza, Ftiti, Hlioui, and Louhichi, Omri (2022)	17
59	Xu, Zeng, Qi, and Cui (2023)	13
60	Zhang, Li, Gou, Feng, and Gao (2022)	9
61	Zaman, Asiaei, Nadeem, Malik, and Arif (2023)	13
62	Ullah, Jebran, Umar, and Yousaf (2023)	9
63	García-Sánchez, Monteiro, Piñeiro-Chousa, and Aibar-Guzmán (2023)	12
64	Hameed, Naeem, Mishra, Chotia, and Malibari (2023)	9
65	Shah and Ivascu (2023)	6
66	Lin, Yu, Zhang, Lin, and Zhong (2022)	8
67	Huang, Chang, and Zhang (2023)	7
68	Yang, Shang, Li, and Lan (2024)	5
69	Wang, Li, Lu, and Boasson (2023)	5
70	Wang, Liang, Yu, and Su (2022)	5
71	Zhao, Li, and Zhang (2022)	3
72	Bai and Lyu (2023)	5
73	Liu, Liu, and Li (2023)	2
74	García-Meca, Ramón-Llorens, and Martínez-Ferrero (2023)	3
75	Chang et al. (2023)	2
76	Lee and Huang (2023)	2
77	Javeed, Latief, and Akram (2023)	2
78	Peng, Fang, Lee, e Zhang (2022)	1
79	Yang, Su, Xu, and Han (2023)	3
80	Lakhal, Hamrouni, Jilani, Mahjoub, and Benkraiem (2024)	1
81	Özgül (2023)	0
82	Tang, Guo, Zha, and Zheng (2024)	0
83	Makpotche, Bouslah and M'Zali (2024)	1
84	Agnese, Battaglia, Busato, and Taddeo (2023)	1
85	Zheng, Li, and Zhang (2023)	2
86	Ruiz-Castillo, Aragón-Correa, and Hurtado-Torres (2023)	1
87	Jin, Monfort, Chen, Xia, and Wu (2024)	4
88	Wu, Chen, Li, Xu, Liu, and Wu (2024)	2
89	Wang, Wang, Li, and Liu (2023)	0
90	Tawiah, Gyapong, and Usman (2024)	0

Source: Study results (2024).

BP articles are distributed across 27 different journals, Table 3 presents the most recurrent ones. Notably, Business Strategy and the Environment stands out, due to the substantial number of articles in BP, totaling 11. The relevance of the journals was evaluated based on the JCR (Journal Citations Report) indicator, a widely used metric that facilitates the comparative analysis of recognition in the scientific community. The 2022 JCR (most recent), used in this study, considers citations to the journal's publications in the penultimate year, that is, articles published in 2020. The percentile is also provided to indicate the journal's position within its specific thematic category. Thus, the JCR provides a broad metric, while the percentile indicates that a score greater than 50 means the journal's impact factor exceeds the category median.

Table 3 – Frequency and relevance of BP periodicals

Periodical	Frequency	JCR	Category Ranking
Business Strategy and the Environment	11	13.40	95.80 / Business
Corporate Social Respons. and Environ. Manag.	8	9.80	84.10 / Business
Sustainability	8	3.90	58.70 / Environmental Sciences
Journal of Cleaner Production	6	11.10	92.20 / Environmental Sciences
Journal of Business Research	5	11.30	91.20 / Business
Technological Forecasting & Social Change	5	12.00	93.20 / Business
Journal of Business Ethics	3	6.10	97.40 / Ethics
Journal of Innovation & Knowledge	3	18.10	98.40 / Business
Energy Economics	2	12.80	99.60 / Economics
Frontiers in Environmental Science	2	4.60	56.74 / Environmental Sciences
Frontiers in Psychology	2	3.80	77.20 / Multidisciplinary
Journal of Product Innovation Management	2	10.50	90.60 / Business
Research in International Business and Finance	2	6.50	96.30 / Business
Technology in Society	2	9.20	97.75 / Social Issues

Source: Study results (2024).

Most BP journals have high JCR ratings, with a high impact factor and relevant percentiles in their categories. The Journal of Innovation & Knowledge stands out, with the highest impact factor in the sample (18.1), classified as the third largest journal out of 154 in the Business category; and Business Strategy and the Environment, is notable not only as the journal with the highest volume of articles in BP, but also as the second highest impact factor in the sample (13.4) and the seventh best rated journal in the Business category. Furthermore, the Journal of Business Ethics draws attention because, although it does not have such a significant impact factor in BP (6.1), it is the best rated in its category.

The engagement of countries in the development of the CG-GI theme was evaluated considering the number of authors from each country in BP, based on their institutional affiliation. China leads with 169 authors in BP, followed by Spain with 26 authors, the United Kingdom with 20 authors, France with 14 authors, Australia, the Netherlands, Italy and the USA with 5 authors each; India, New Zealand, Pakistan and Tunisia with 4 authors each; Saudi Arabia with 3 authors; Canada, Ghana, Indonesia, Malaysia, Russia and Taiwan with 2 authors each; Germany, Algeria, Egypt, Philippines, Ireland, Israel, Kuwait, Portugal, Romania, Thailand, Turkey and Vietnam with 1 author each.

Regarding the focus regions of research, China stands out, with 57 articles; the USA, with 5 articles; Germany and the United Kingdom, with 3 articles each; France, with 2 articles; and Saudi Arabia, Australia, Spain, Ghana, Indonesia, Romania, Russia, and Turkey with 1 article each. Additionally, 12 studies analyze multiple countries.

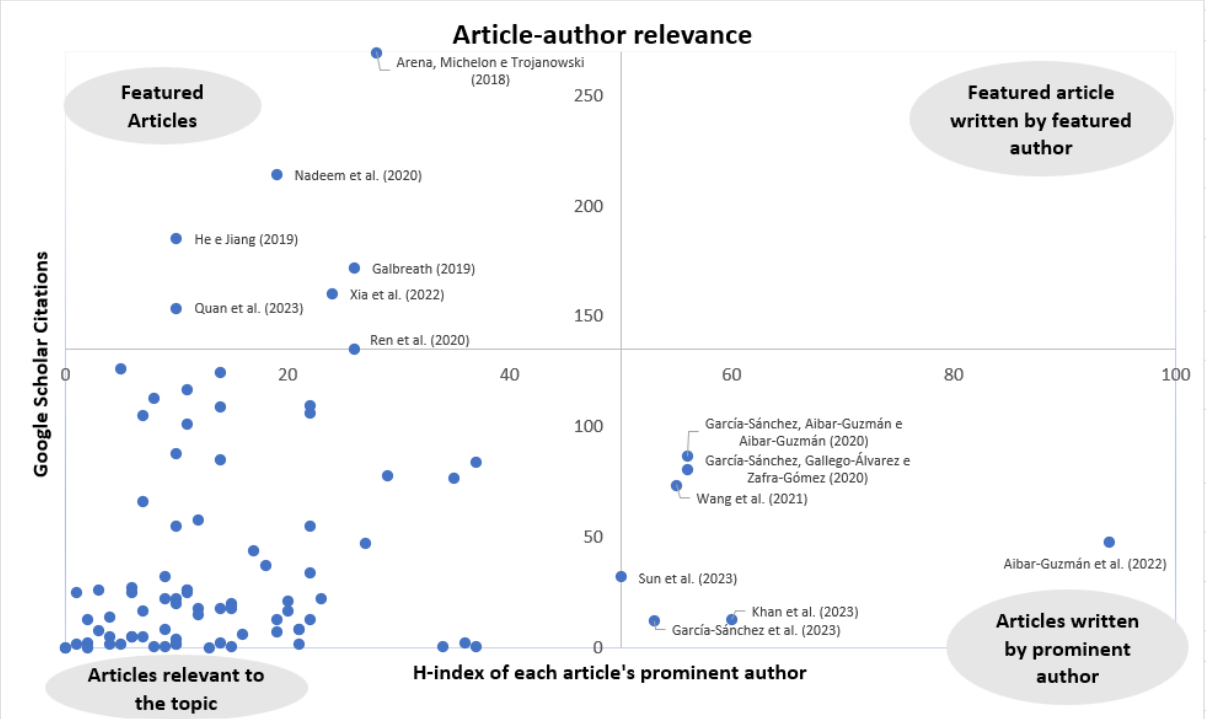
It is essential to highlight that, although the CG-GI topic is frequently discussed in global forums, the main researchers and focus regions of study are concentrated in a few nations, mainly in developed regions. This highlights the need for research contributions in other countries, particularly those that are signatories to significant agreements, such as the Paris Agreement, which involves 195 nations.

Regarding authors, BP has 291 authors, with emphasis on Beatriz Aibar-Guzmán (University of Santiago de Compostela), and Zhongju Liao (Zhejiang University of Science and Technology), both with 4 articles, and Isabel-María García- Sánchez (University of Salamanca) with 3 articles. The other authors have recurrence in one or two articles.

For a more comprehensive assessment of the academic relevance of publications based on the article-author in BP in relation to general literature, a classification matrix was created. This matrix incorporates two dimensions: (i) the number of Google Scholar citations and (ii) the H-index (Scopus) of the most prominent author of each article. To collect the h-index, the author's full name and affiliation were carefully observed to ensure the reliability of the data.

In the matrix, the articles were classified into four categories: (i) Featured articles written by prominent authors – these are articles with citations above the median of the total number of citations in BP, with at least one author with an H-index above the median from the authors of BP; (ii) Articles written by prominent authors – these are articles that have at least one author with an h-index above the median of BP authors; (iii) Featured articles – these are articles in which the number of citations is above the BP median; and (iv) Articles relevant to the topic – contains the other BP articles. Figure 2 presents this categorization.

Figure 2: Classification of articles according to academic relevance article-author



Source: Study results.

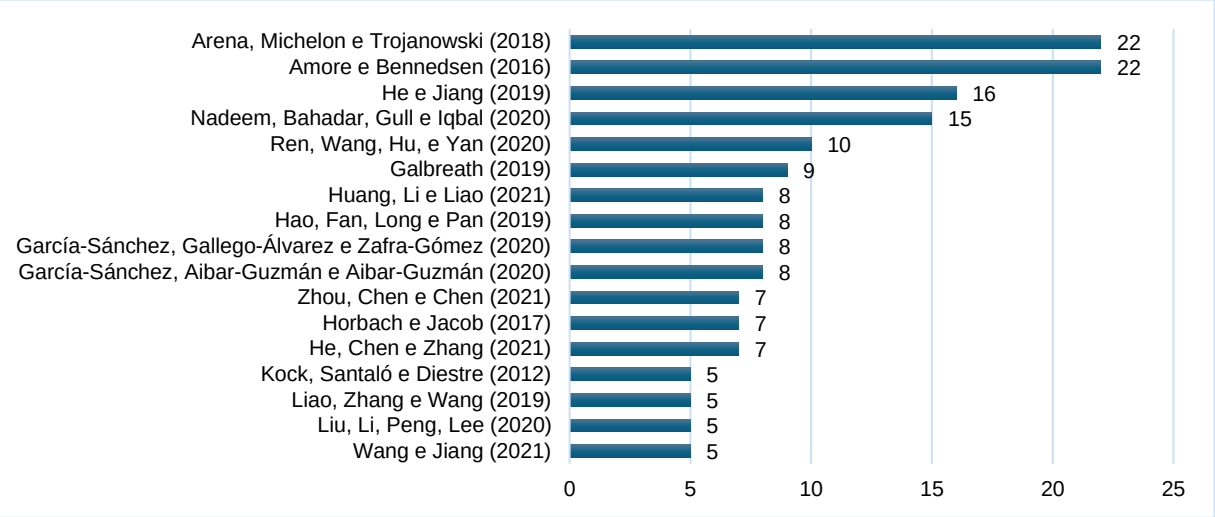
No BP article was classified in the category (i) Outstanding articles written by prominent authors. In category (ii) Articles written by prominent authors, Nazim Hussain stands out, with an h-index of 94, who published the article "Sustainable product innovation in agri-food industry: Do ownership structure and capital structure matter?" with 48 citations (Mar/24); Sunil Luthra, with h-index 60, who published with other authors the article "Hope-hype of green innovation, corporate governance index, and impact on firm financial performance: a comparative study of Southeast Asian countries"; Isabel-María García-Sánchez, with an h-index of 56, which placed three articles in this category with 87, 81 and 12 citations, respectively; and Abraham Carmeli, with an h-index of 55, who published with other authors the article "CEO environmentally responsible leadership and firm environmental innovation: A socio-psychological perspective" with 74 citations.

In category (iii) Featured articles, researcher Giovanna Michelon stands out, with an h-index of 28, and Muhammad Nadeem, with an h-index of 19, both with publications in BP with more than 200 citations each. Category (iv) Relevant articles, positions the other BP articles. It is important to note, in this last category, the number of new researchers (generally with a low h-index) who stand out on the topic, due to the number of citations to their work, which indicates the prominence of the topic and the importance of the debate that is emerging. current.

BP has a total of 5055 bibliographic references. Of these, the work of Hambrick and Mason (1984) stands out, who present the Upper Echelons Theory, and the study by Berrone et al. (2013), who analyze green innovation based on institutional theory, which appear in 42% of

BP articles. In addition to them, the work of Rennings and Rammer (2011), on eco-innovation, is referenced in 28% of articles and Hambrick (2007), which refines the theory of upper echelons, is cited in 24% of BP articles (analysis by CitNetExplorer). It is observed that the BP articles themselves are emphasized in the references, as 44 BP articles are cited in at least one other BP article. The most frequent citations are shown in Figure 3:

Figure 3 – BP article cited by other BP articles.



Source: Study results.

In relation to methodologies used in BP, quantitative models were heavily used, used in 90% of the articles, while a small portion adopted qualitative methods such as case studies, content analysis and qualitative comparative analysis. The most common technique in quantitative analyzes was panel data regression (31 articles), followed by ordinary least squares (OLS) estimation (15 articles). Most studies are imbued with an underlying assumption of a static relationship between CG and GI and may expose inherent endogeneity biases in research. Methodologies that deal with dynamic endogeneity, such as generalized method of moments (GMM) (5 articles), two-stage least squares (2SLS) (5 articles), and structural equation modeling (SEM) (6 articles), were employed with lesser frequency in BP articles. Of the BP articles, 94.5% (85) are longitudinal in nature and 5.5% are cross-sectional studies. Among the longitudinal studies, 24.7% (21) adopted the short term (up to five years), 25.9% (22) the medium term (6 to 10 years), and 49.4% (42) the long term (more than 10 years).

4.2 Systemic analysis: advanced variable analysis

The analysis of corporate governance actors was conducted by identifying and categorizing the data into types of actors and their main characteristics, such as biodemographic, psychosocial, educational level and experience. The main theoretical perspectives that explain how these characteristics contribute to green innovation were also identified.

Most studies focus on a single corporate governance actor, disregarding the context of joint action, which represents an analysis limitation, as corporate governance involves an interaction between multiple agents. Table 4 details the types and quantities of actors analyzed in the BP models.

Table 4 - Corporate Governance Actors covered by BP articles.

Number and different types of CG actors		
One Types		
	CEO	22
	Executives	7
	Board of Directors	24
	Owners	15
Two Types		
	CEO and Executives	5
	CEO/Executives and Board of Directors	9
	CEO and Owners	3
	board of directors e Owners	2
Three Types or more		
	CEO, Board of Directors, and Owners	2
	CG Index	1

Source: Prepared by the authors.

The corporate governance variables analyzed in BP studies emphasize personal and internal characteristics. Few studies address external CG mechanisms, such as the work of Huang, Li and Liao (2021) who analyzed the external governance environment through the CEO's political connections.

Regarding data sources, 13 articles used primary sources through questionnaires. The others used secondary sources, with 19 articles using organizational reports, websites, and corporate statutes; and the majority used databases, the main ones being: China Stock Market and Accounting Research (CSMAR) (30); Thomson Reuters (15) and Bloomberg (3), among others less frequently.

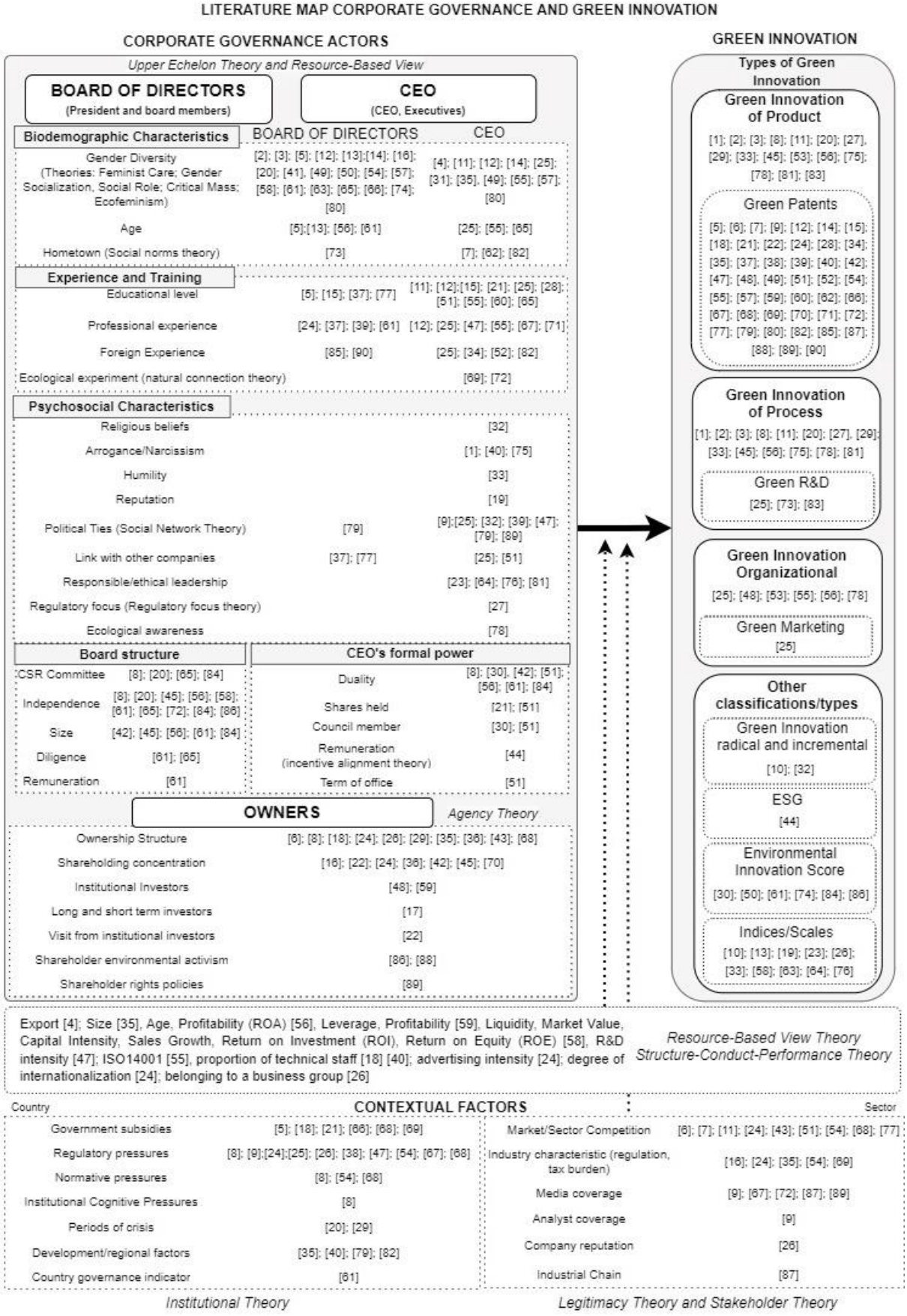
For the green innovation variables, green patents were the most common, used in 46 articles, mainly from China, except for one from France. As for data sources, 17 studies used primary data through questionnaires or National Innovation Surveys, such as from France and Russia. The others used secondary data from reports (9) and databases such as China National Intellectual Property Base (CHIPA) (39), Thomson Reuters (20), Baiten (3), Bloomberg (1) and Wan Fang (1).

4.3 Literature map

BP articles mostly indicate a perspective of green innovation as a corporate governance function, that is, different configurations of GC systems, structures and processes impact the GI of firms (Jain and Jamali, 2016). Thus, certain aspects of corporate governance agents are approached as promoters of green innovation. From this perspective, a map of the interaction between characteristics of corporate governance actors and the types of green innovation addressed in BP was created.

This map details how corporate governance agents favor green innovation in processes, products and at the organizational level. Innovation efforts initially based on the search for cleaner production can expand to practices that promote quality and organizational efficiency. The analysis presents how each actor interacts with the types of green innovation, answering the research question of this study, highlighting the aspects of the key corporate governance actors that favor green innovation, according to the literature.

Figure 8 – Literature map of the interaction of Corporate Governance and Green Innovation



Source: Prepared by the authors.

5 CONCLUSIONS

Corporate sustainable development approaches emphasize a genuine interest in developing innovations that combine growth and sustainability. Thus, the challenge of innovation is based not only on the economic potential, but on the social changes it induces and the environmental consequences it produces (Smith; Voß; Grin, 2010). Therefore, green innovation is today the main objective of many organizations to achieve strategic environmental advantages, and this requires the engagement of the organizations' key decision-makers.

Systematic reviews can provide researchers with a solid understanding of the current frontier of knowledge on the topic studied. The findings expose what is known and unknown about the research question formulated in the review work (Briner; Denyer, 2012). In this way, this work reports aspects of a growing literature on the relationship between corporate governance and green innovation.

In this study, 90 articles considered relevant on corporate governance and green innovation, following the Proknow-C method, were systematically analyzed. The main bibliometric and methodological characteristics were explored, and the nature of the CG-GI relationship presented by the articles was identified.

Based on institutional theory, organizations would adopt green innovation as a regulatory imposition. According to the resource-based vision theory, the theoretical approach most used in PB articles, green innovation would be adopted by organizations to take advantage of competitive advantages. The agency-stakeholder theory would mediate the conflict between stakeholders and management, since the different parties of interest may be more motivated by social and environmental issues, which would require greater commitment from management and time for implementation, and this, in turn, would have greater interest in quick and less laborious results, this conflict would then be mediated by the adoption of better governance practices. The top management theory, also widely used in PB articles, indicates that leadership favors the adoption of green innovation. Several other theories are used to explain the CG-GI relationship, in total 27 theories. These theoretical approaches give rise to empirical analyses.

The analysis of the articles allowed us to map studies with corporate governance indicators that have a positive relationship with green innovation, such as the adoption of a legal and regulatory system, the influence of stakeholders on the board, the age diversity of the board, the independence of the board, CEO duality, CEO political participation, the quality of companies' environmental disclosures and disclosures, and the responsible leadership index. Other studies present controversial results in some constructs, with positive results in some analyzes and unrelated in others, such as diversity and the degree of board training. This indicates the need for further investigations to evaluate different proxies of green innovation and corporate governance.

Regarding green innovation mechanisms, Xia et al. (2022) indicates that investigations have difficulty in differentiating green innovation from “non-green” innovation, which requires greater engagement to obtain data, and this would bring more effective results on the analysis of the relationship between aspects of corporate governance and green innovation. Nadeem et al. (2020) indicates that there are four categories of green innovation, namely, product innovation, process innovation, management innovation and technological innovation, however, no bibliographic BP article investigates the relationship based on these categories, indicating that future research can exploit this weakness. The most common Green Innovation approach is green products, indicated by the number of green patents. However, approaching a broad concept such as green innovation (Nadeem et al. 2020) from only one aspect may not fully represent organizations' efforts in green innovation. The criteria adopted to measure innovation may also not be standardized for all companies, requiring caution when generalizing.

Limitations and directions for future research were presented. As a suggestion, future investigations that are interested in the CG-GI link may seek to answer some questions. Is there an adequate design of governance arrangements and mechanisms that can coordinate the relationship between man and nature, through green innovation? What is the effect of governance systems on environmental efficiency, through new sustainable products or processes? What role do organizational structures play in increasing green innovation capacity? Is there a causal direction in the relationship between organizational structures and environmental sustainability activities? How do environmental regulations influence the determinants of green innovation? And what is its impact on the competitiveness of organizations? Does worse governance reduce environmental innovations? How have shareholders and the market reacted to companies that adopt green innovation practices? These and other questions remain open in the literature. The cause of these questions is partly the lack of a consolidated index of green innovation, the difficulty in accessing this information from companies or the lack of data standardization, making more robust analyzes difficult and challenging new investigations.

The research decisions of this investigation are delimiters and limitations of the research, and new investigations should be considered that consider more specific search terms for corporate governance and green innovation, not in a generalized way, this will make it possible to envisage new searches with other CG indicators that could enrich the debate on the topic.

This study was not carried out to understand all interactions and relationships in the field of CG-GI, but to easily understand how different aspects of Corporate Governance actors can favor green innovation. Therefore, this review does not intend to incorporate all publications that deal with the comprehensive concept of green innovation and corporate governance. Because our sample only provides a brief overview of the literature on the topic, since limitations can be pointed out regarding the definition of key words and searches in the databases, for example the Web of Science database is limited to 26 Boolean operators, while Science Direct has a limitation of 8 Boolean operators, so search decisions include articles that fit the search strategies adopted. Future studies could explore how other aspects of corporate governance affect green innovation strategies.

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