

Towards a Holistic Understanding of Green Innovation Adoption: A Systematic Review of Determinants, Barriers, and Outcomes

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Abstract. This study conducts a systematic literature review (SLR) to investigate the determinants, barriers, and outcomes of green innovation adoption (GIA) in organizations. Following the PRISMA framework and Inordinatio guidelines, a total of 56 articles published between 2001 and 2024 were selected from the WOS Core Collection and Scopus databases. The bibliometric analysis, performed using VOSviewer, reveals a growing interest in GIA research, with 91.07% of the articles published between 2014 and 2023. The majority of the leading research countries are located in the European Union, with the Journal of Cleaner Production being the most productive journal in this field. Quantitative analysis dominates the literature, accounting for 76.79% of the studies. The SLR identifies six clusters of research themes, focusing on supply chain management, stakeholder influence, the European context, comprehensive determinants and barriers, performance outcomes, and organizational capabilities. The study contributes to the literature by providing the first comprehensive examination of the factors, barriers, and outcomes influencing GIA and proposing a framework that can be applied across industries. The findings offer valuable insights for decision-makers, managers, and researchers seeking to promote sustainable innovation practices in organizations.

Keywords: Green innovation adoption; Systematic reviews; VOSviewer; Determinants factors; Barriers; Outcomes.

1. Introduction

1.1 Background

Increased energy production, transportation and greenhouse gas emissions have caused significant damage to the Earth's ecosystem, posing a global problem (Wang and Yang 2021; El-Kassar and Singh 2019; Peyravi et al. 2023). Business operations rely on natural resources to produce the necessary materials and services (Haibo et al. 2019). For example, in the logistics industry which is vast and concentrated, negative impacts on the natural environment through air pollution, hazardous leaks, solid waste management and fuel consumption can occur (Chu et al. 2019). Therefore, in order to combat this challenge, green innovation was introduced and is a key catalyst for reducing ecological damage (Xu et al. 2020). Utilizing green technology and environmental innovation to tackle the environmental challenges arising from carbon dioxide emissions and foster economic growth and sustainable development (Sharif et al., 2024). Furthermore, eco-friendly technological innovations can contribute to the sustainable management of natural resources (Fang & Chang, 2023). Green innovation and economic globalization have a mutually beneficial impact on human well-being, as there exists a bidirectional causal relationship between the two (Ahmad et al., 2023). Green innovation technologies enhance the financial and economic performance of organizations, particularly small and medium-sized enterprises, thereby improving corporate image and profitability. For instance, as stated by Wasiq et al. (2023), the adoption of green innovation by small and medium enterprises in Saudi Arabia has a positive impact on their economic, social, and environmental performance.

Ma and He (2023) conducted a study using data from Chinese listed companies in an emerging market spanning from 2007 to 2019. The study aimed to empirically examine the relationship between the environmental air quality index and green innovation. The findings indicated that companies responded to environmental pollution issues by implementing green innovation. Companies can “go green” by promoting sustainable development and mitigating environmental hazards and costs through green innovation (Hojnik and Ruzzier 2016). The increase in energy production, transportation, and greenhouse gas emissions has resulted in significant damage to the Earth's ecosystem, presenting a global problem (Wang and Yang, 2021; El Kassar and Singh, 2019; Peyravi et al., 2023). Commercial operations heavily rely on natural resources for the production of essential materials and services (Haibo et al., 2019). For instance, in large and concentrated logistics industries, air pollution, hazardous spills, solid waste management, and fuel consumption can have adverse effects on the natural environment (Chu et al., 2019). Moreover, companies face both internal and external pressures to engage in green innovation activities (El Kassar & Singh, 2019). Therefore, in order to address this challenge, green innovation has been introduced as a crucial catalyst for reducing ecological damage (Xu et al., 2020). Enterprises can strive towards adopting environmentally friendly practices by promoting sustainable development and reducing environmental hazards and costs through green innovation (Hojnik and Ruzzier, 2016).

According to Bossle et al (2016), environmental innovation is any innovative means (typically strategic) used by a company to produce products and services that reduce the impact on the environment. Growing public awareness of environmental challenges has encouraged various stakeholders, including customers, suppliers and employees, to push for more environmentally responsible business practices (Huang et al. 2009). Organizations play a crucial role in causing issues and developing solutions (Wright and Nyberg 2017; Liu et al., 2024). Companies are also seen adopting green innovation to gain sustainable competitive advantages and reduce their environmental impact (Arranz et al. 2021; Afshari et al. 2020). Adopting green innovation goes beyond mere legal compliance and offers companies a way to increase their environmental responsibility and profits, allowing them to surpass regulatory requirements and competition (Huang et al. 2009).

Widespread adoption and dissemination of ecological innovation by enterprises can minimize their environmental impact and promote environmentally sustainable consumption (Bossle et al. 2016).

Environmental innovation, with its knowledge and environmental spillover effects, holds particular value for society as a whole in mitigating environmental risks (Rennings 2000). Nevertheless, studies have revealed that two-thirds of eco-innovation exists in small market areas, and only a third of its scale can effect social change, emphasizing the need for faster dissemination of such innovation rather than a lack of it (Clausen and Fichter 2019; Fichter and Clausen 2021).

1.2. Relevant studies

Recent research has explored the antecedents of enterprises' adoption of green innovation in various national conditions and industries, as well as the obstacles and performance outcomes (Aboelmaged and Hashem 2019; Bhatia 2021; Cai and Li 2018; Fahad et al. 2022; Ghisetti et al. 2017; Han and Chen 2021; Hartmann et al. 2022; Hermundsdottir et al. 2022; Hojnik et al. 2018; Ramkumar 2020; Triguero et al. 2022; Ullah et al. 2021).

Table 1 provides a thorough summary of the extensive body of literature pertaining to the field of GIA. This includes an examination of determinants, barriers and outcomes.

Table 1. Relevant literature of GIA

Topics	Findings	Methodology Type	Reference
Determinants for adoption	CEO tenure boosts green innovation quantity and quality.	Survey (linear regression)	Liu et al., 2024
Outcomes of adoption	Green innovation may reduce environmental damage in the research nation. It lowers relationship between ecological and carbon intensity.	MMQR-OLS	Satrovic et al.,2024
Determinants for adoption	The author interviewed customers in Croatia, Spain, and the UK to determine how emotions affect green energy innovation consumption.	Survey (interviews)	Valor et al.2023
Determinants for adoption	The author focuses on green innovation uptake in Brazil's cassava farm integrated business sector.	Survey (Semi-structured interviews)	da Silva et al.2023
Determinants for adoption	The author studies technical, environmental, and organisational aspects that influence Indonesia's pineapple-based food industry's small and medium-sized firms' GIA. Organizational variables are key in this study.	Survey (PLS-SEM)	Indrawati et al.2023
Determinants for adoption	A GIA model based on the Unified Theory of Technology Acceptance and Use was created. The approach was used to verify green innovation technology uptake in Pakistan's manufacturing sector, focusing on green behavioral intents and organizational scale.	Survey (PLS-SEM-ANN)	Shahzad et al.2022
Determinants for adoption	The author surveyed Pakistani and Malaysian SMEs on green dynamic capabilities and green innovation uptake. The research also examined how environmental dynamics and intensive data analysis moderate the association between green dynamic capabilities and innovation uptake.	Survey (PLS-SEM)	Yu et al.2022
Determinants for adoption	The author focuses on green relationship capital and corporate integration skills' effects on China's manufacturing industry's environmental innovation adoption.	Survey (multiple linear regression)	Long and Liao 2023
Determinants for adoption	The author provides a thorough conceptual framework to show how organizations might use external information from parallel organizational failures, including internal and external variables, to generate green innovation.	Qualitative methodology (four-quadrant multidimensional framework)	Amankwah-Amoah 2023
Determinants for adoption	The author focuses on how individual innovation abilities and environmental concerns affect Chinese customers' electric car purchases. The research also explores positive and negative utility mediation.	Survey (PLS-SEM)	He et al. 2018
Determinants for adoption	How Copenhagen and Stockholm Consumers Adopt Green Innovation (Shared E-Bikes and E-Scooters).	Survey (CFA)	Flores and Jansson 2022

Determinants for adoption	The author focuses on R&D spending, organizational capability, and collaboration in Vietnamese SME green innovation uptake.	Quantitative research (logit model)	Ha et al.2022
Determinants for adoption	The author examined Murcian consumers' green consumerism. The research also examined their views on green consumerism's technical and symbolic components and how societal pressure and importance affect low-involvement eco-innovation.	Survey (PLS-SEM)	Cubillas-Para et al.2023
Determinants for adoption	Brazilian slaughterhouses' ecological innovation drivers were studied by the author.	Qualitative methodology (MSDO/MDSO csQCA)	Dias and Braga 2021
Determinants for adoption	The author focuses on how incentive methods affect green innovation uptake.	Survey (PLS-SEM)	Lioutas and Charatsari 2018
Determinants for adoption	The author examines the factors that influence energy efficiency and ecological innovation in households in the United Kingdom.	Quantitative research (Econometric models)	Diaz-Rainey and Ashton 2015
Barriers to adoption	The author focuses on perception hurdles for sustainable innovation technologies, particularly metal additive printing.	Qualitative methodology (thematic analysis and NVivo)	Chatterjee et al.2023
Barriers to adoption	The author ranked the main impediments to green innovation in developing country SMEs. To aid corporate decision-making, 25 hurdles and 15 solutions were identified. Legal hurdles were the biggest challenge for Pakistani SME GIA.	Fuzzy TOPSIS	Fahad et al.2022
Outcomes of adoption	Specifically, the author evaluated how ecological innovation affects EU greenhouse gas emissions. Socioeconomic achievements are the most important environmental innovation in greenhouse gas reduction.	Quantitative research (econometric methodology)	Khan and Idrees 2023
Outcomes of adoption	The author focuses on how Solar Home Systems, a low-cost, energy-efficient, and environmentally beneficial innovative technology, affects Pakistani small-scale companies.	Survey	Ali et al. 2023
Outcomes of adoption	The author examined natural resources, renewable energy, human capital, and consumption-based carbon emissions in G7 countries from 1976 to 2020. The research examined how sustainable resources and human capital affect environmental protection.	Econometric statistical models	Wang et al.2023
Outcomes of adoption	GIA's influence on Saudi Arabia's SME sustainability is the author's main focus.	Survey (PLS-SEM)	Wasiq et al.2023
Outcomes of adoption	The author focuses on how ecological innovation affects Brazilian hotel enterprises.	Survey (PLS-SEM)	Lopes and Basso 2023

Notes: Small and medium-sized enterprises=SMEs

Eco-innovation adoption is a transitional approach to reducing environmental impacts and creating sustainable societies (de Jesus and Mendonça 2018) , yet there is little clarity on how to conduct green innovation (Ullah et al. 2022). Understanding the reasons for and drivers of ecological innovation adoption in organizations is crucial (Chappin et al. 2020; El-Kassar and Singh 2019). Additionally, according to Bossle et al. (2016),the investigation on how these driving factors lead to green innovation outcomes is important for practical implications in strategy and public policy.According to Pellegrini et al (2019, p.3) , driver is characterized as a catalyst for sustained innovation, capable of functioning as either a motivation-driven element or a facilitating factor.

Bossle et al. (2016) conducted a systematic literature review from 1994 to 2013 to understand the drivers and motivations for companies to adopt ecological innovation. However, some scholars have noted a lack of a comprehensive framework to explain the drivers of green innovation (Ullah et al. 2022). While the research framework of Singh et al. (2020) explored the role of green absorption potential in regulating the relationship between organizational factors and green innovation, their conclusions lack multidimensional and comprehensive organizational factors. They did not review the barriers to GIA or performance results or explore the mediating or regulatory effects between drivers and GIA. Therefore, further exploration is needed to understand new developments in this process.

These studies have examined different external and internal conditions that encourage green innovation. However, they lack a comprehensive framework for understanding the factors that determine, barriers, and outcomes from GIA. Therefore, it is necessary to further investigate this research gap. By establishing a comprehensive GIA framework, we can enhance our understanding of GIA and facilitate the development of specific strategies to promote sustainable innovation in organizations.

Due to the previous study of Geographic Information Analysis (GIA) being limited to a single perspective of examining driving factors or obstacles, there is a need to further investigate it within a more comprehensive framework. Additionally, it is important to explore the clustering results in the research field of GIA. **Response #2 (Comment #3-3)** Hence, the objective of this research is to investigate the determinants, barriers, and performance outcomes of GIA within an organizational context. Our review was driven by the following research questions:

RQ1. What determinants, barriers, and performance outcomes influence the success of GIA?

RQ2. What are the metrics, journal sources, research methods, countries of study and clustering of research topics in the field of GIA research?

The article utilizes relevant publications from the WoS and Scopus databases from 2001 to 2024. Based on the results of a SLR, it further reveals the research and development stages of determinants, barriers, and outcomes of GIA, as well as high-yield journals, high-impact journals, major countries and regions, and highly cited authors. Through the clustering analysis of the Bibliography coupling network, this article can help scholars identify the main research areas, which also contributes to the practical application of GIA. This study provides a comprehensive perspective for policymakers, organizational stakeholders, and researchers to better examine the determinants, barriers, and outcomes of GIA organizational level.

To fill the research void and enhance the study, The SLR approach assists in the identification of recurring themes across several research and enables the testing and development of theories by analyzing the distinctions and commonalities across these studies (Petticrew and Roberts 2006). As Thomé et al. (2016) highlighted, SLR is a crucial research work that answers specific research questions, which involves selecting, evaluating, analyzing and synthesizing existing studies to provide clear evidences about what is known and unknown in a field. A SLR necessitates a comprehensive, transparent, and reproducible process of retrieving and analyzing literature. This approach may be used by researchers to examine and evaluate research domains that are associated with certain research themes. It is extensively used in the fields of business and management (Macpherson and Holt, 2007). Implementing the PRISMA procedure (Liberati et al. 2009) improves the precision and thoroughness of the present SLR, hence enhancing the quality of the study findings. Therefore, opting for this method is appropriate. A SLR review that investigates the determinants, barriers, and outcomes of GIA within organizations is relatively uncommon. Therefore, the SLR method is adequate for supporting the examination of knowledge structures related to determinants, barriers and outcomes in the field of GIA.

In order to accomplish our research objectives, this study is structured with a brief definition in introduction section and a description of the methodology used in this study in the review methodology section, which include the search strategy and article identification. The main results are presented in the results section and a cluster framework for studying GIA drivers, barriers and outcomes is proposed and discussed. Finally, the main conclusions are drawn in conclusion section.

2. Review Methodology

This article introduces a SLR that has the objective of identifying, evaluating, and synthesizing pertinent literature on the topic of GIA. According to Denyer and Tranfield (2009 p. 671) , SLR is a methodology that enables researchers to report evidences in a way that allows reasonable constraints to be reached. Certain research studies combine qualitative and quantitative SLR in order to advance their

objectives (Fahad et al., 2024). Qualitative SLR seeks to get a more profound comprehension of a chosen topic and develop concepts or theories beyond what individual studies can achieve (Campbell 2003). In addition, guidelines for qualitative content analysis were proposed (Seuring and Gold 2012). Cobo et al. (2012) used quantitative methods to do content analysis on the co-occurrence of citations and keywords, therefore tracking the development of research subjects and areas.

This research adhered to the protocols for performing a SLR as specified by Seuring and Gold (2012). The recommendations are derived using a methodical five-stage procedure, namely (1) formulating research questions, (2) conducting a thorough examination of existing literature, (3) choosing pertinent studies to be included in the review, (4) completing a comprehensive descriptive assessment (5) doing thematic content analysis. The first step was revealed in the preceding section.

Step (2) involved a rigorous search of the literature using the PRISMA framework, which is one of the publication guidelines for SLR. PRISMA is generally recognized as the benchmark. The standard reporting tool for systematic reviews and meta-analyses is designed to ensure that authors provide transparent and comprehensive reports (Liberati et al. 2009). It is a set of guidelines that provides a standardized format for reporting these types of research studies (Thomé et al. 2016). Thus, this research generated a rigorous SLR by adhering to the PRISMA procedure, ensuring its high quality. The following sections provide detailed descriptions of Steps 2 through 5.

2.1 Search strategy

This study focuses on a review of the determinants, barriers and performance outcomes of GIA, rather than mapping all literature related to green innovation. The reason is because GIA and green innovation are two distinct concepts. In order to address the research topics, the Scopus and WOS databases were chosen for this study because to their comprehensive coverage and dependable dependability. These databases were used to extract pertinent articles. Prior to selecting Scopus and WOS, other databases such as Google Scholar were also taken into account.

In order to ensure conformity with previous studies, we searched for the terms as “green innovation”, “eco-innovation”, “environmental innovation” and “sustainable innovation” (Zubeltzu-Jaka et al., 2018). Therefore, multiple keywords were used to search for relevant literature on GIA. As demonstrated in Table 2, an assortment of screening strategy combinations. We refined the search by using citation databases to search for keywords. Only journals and articles were considered as the source of materials, and only papers written in English were included. Journal articles are the most reliable source as they have been validated through academic processes, making them most suitable for a SLR (Kraus et al. 2020). The data was converted to a Microsoft Excel file for further systematic analysis and thorough quality inspection. Initially, using the aforementioned approach, Scopus conducted a collective search of 199 articles. Next, in WOS, select the core collection (SCI Extended & SSCI) of WOS and select Topic, which yielded a total of 109 documents. Figure 1 depicts the PRISMA framework used in this investigation.

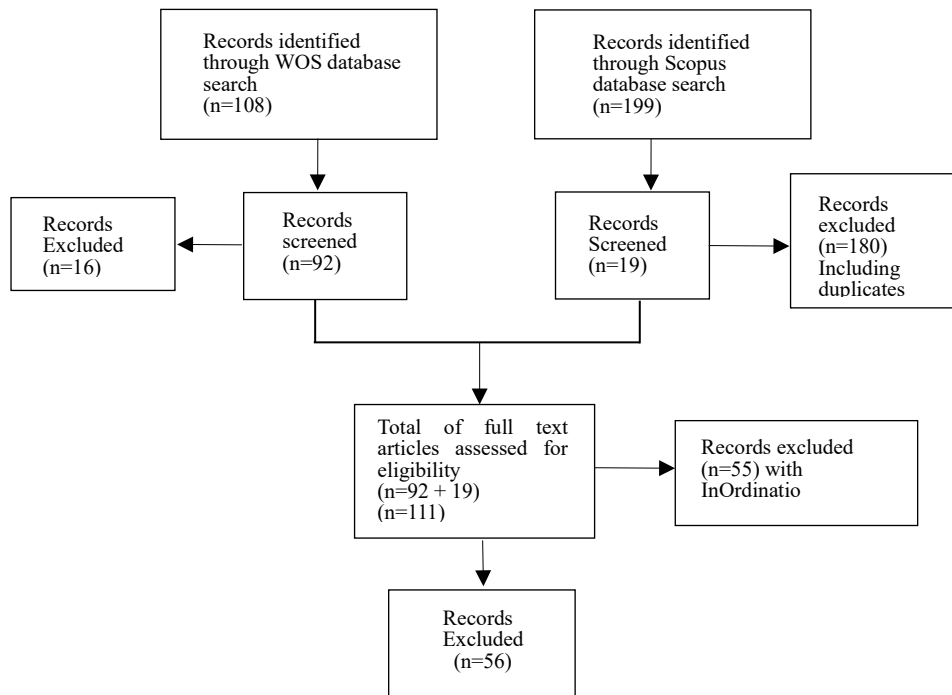


Fig. 1. PRISMA framework of study selection process

Table 2. Retrieved result and strategies to acquire data

Retrieval account	Retrieved result and contents	
Database	Scopus collection	WOS collection
Retrieval mode	TS=(“GIA” OR “eco* innovation adoption” OR “sustain* innovation adoption” OR “environment* innovation adoption” OR “adop* of green innovation” OR “adop* of eco* innovation” OR “adop* of sustain* innovation” OR “adop* of environment* innovation”)	TS=(“GIA” OR “eco* innovation adoption” OR “sustain* innovation adoption” OR “environment* innovation adoption” OR “adop* of green innovation” OR “adop* of eco* innovation” OR “adop* of sustain* innovation” OR “adop* of environment* innovation”)
Publication type	Article	Article
Year	2001-2024	2001-2024
Language	English	English
Retrieval time	January 9, 2024	January 9, 2024
Retrieval result	199	108
Search terms	Original journal articles reporting GIA by firms	
Inclusion Criteria	Keywords used in search strings should exist in the title, keywords or abstract section of the literature Peer-reviewed journals (Including articles) only Literature that focusses on green innovation (eco-innovation, sustainable innovation, or environmental innovation) adoption by firms Literature written in English	
Exclusion Criteria	Grey literature including books, book sections, trade journals, sectors reports, conference proceedings, dissertations, thesis and review articles Literature that are not accessible online Literature written in any language other than English Non-empirical research	

Note: TS-Retrieve the subject words, including the title, abstract, and keywords of the article.
 Web of science (WOS) was limited to core collection (SCI-Expanded & SSCI)
 GIA=Green innovation adoption

This first database has 307 publications. First, remove 180 duplicates from two datasets, 17 of which were non-empirical. Second, the abstract was examined for relevance and inclusion requirements (empirical study on industry green innovation drivers and incentives). Initial relevance for each document is established by title. If the subject covers literature review methods, we will get a comprehensive reference list including author, year, title, and abstract for additional assessment (Tremmel et al., 2017). According to Shela et al. (2023), if the abstract is contentious, the whole text undergoes examination. Then, nine replicates were used, however two literature review papers were discarded. After reviewing the complete text, we removed 16 articles about governments, farmers, and consumers embracing green innovation that did not focus on corporations. Also omitted is research on green innovation standards or other material, not adoption. A careful examination and vetting yielded 111 entire articles.

2.2 Selecting articles and quality assessment

The extensive collection of work requires careful selection of the most significant ones (Small et al. 2014) to construct the portfolio (Pagani et al. 2015). Therefore, Pagani et al. (2015) introduced a protocol called *Methodi Ordinatio*, which is a multi-criteria decision-aid (MCDA) tool that enables researchers to use three variables (impact factor, citation count and publication year) to assess the scientific relevance of papers independently. According to Pagani et al. (2015, p. 2,121), the paper's relevance to the portfolio increases as the *InOrdinatio* value increases. Unlike all other protocols found in the literature, this protocol generates an index called *InOrdinatio*, which indicates the scientific relevance of a paper based on the consideration of these variables. Using this index, papers can be ranked individually (Da Silva et al. 2020).

In accordance with the PRISMA framework and *InOrdinatio* (1) for the purpose of index computation, a thorough screening process was conducted on all publications, including numerous reviews to exclude any duplicates and studies that were not relevant. By carefully considering the inclusion and exclusion criteria at each step, a total of 111 articles were chosen (refer to Figure 1).

To select the final sample of papers from the application of filtering criteria, *InOrdinatio*, was applied. This stage allows for the qualification and ranking of papers based on their scientific relevance, impact factor, publication year and citation count. This method is based on the calculation of an index called *InOrdinatio* (1), including: impact factor (IF), citation count (C_i) and publish year. The *InOrdinatio* equation (1) incorporates the Research Year as a variable, providing weighted weights between 1 and 10. As there was no time limit for the articles searched in this study, a weight of 5 was selected to provide a balance over time (Afif et al. 2022).

$$\text{InOrdinatio} = (\text{IF}/1000) + \alpha * [10 - (\text{Research Year} - \text{Publish Year})] + \left(\sum C_i \right)$$

To select the final sample of papers for IF, We used Thomson Reuters Journal Citation Reports (JCR), a reputable journal report utilized for journal evaluation (Afif et al. 2022). If only Scopus database retrieval is available, SJR (Scimago) is chosen as the indicator (Souza et al., 2022). Firstly, we identified the journals indexed in JCR, SJR as key metric that covered various fields, where the 111 articles were published. For citation, we used Google Scholar and searched directly from the articles by research year. Papers with low inconsistency and unrelated to the research theme were excluded (Yoshino et al. 2020). Based on the ranking of the papers, researchers can define the number of full-text papers they will search for based on their priorities (e.g. the top 10 or 50, and so on) (Pagani et al. 2015). This study selected the top 50% of papers ($\text{InOrdinatio} \geq 52.0035$) for inclusion in the review database. The top 56 articles are used as the data for analysis. The research conducted by Pagani, Kovaleski and Resende (2015) demonstrates the effectiveness of the proposed research objectives through the use of *InOrdinatio*. This method utilizes an adapted version of ProKnow-C to select publications, employing a multi-criteria evaluation model to rank publications based on influencing

factors, publication year, and number of citations. The use of this method offers an effective solution for ranking papers (Pagani, Kovaleski, & Resende, 2015). However, it is important to note that InOrdinio does have potential limitations. Firstly, its application principle requires the identification of combinations with a large number of publications. Additionally, the selected databases for this method are limited to WOS and Scopus, which restricts the use of two different metrics, namely JCR and SJR, to calculate inconsistency.

Finally, a total of 56 full-text papers were retained. All of these studies are empirical and mostly focused on investigating the GIA to reach their intended aim. It has been suggested that using a total of 40 to 50 or more documents (such as the number of articles included in this study, which is 56) to develop a SLR is considered appropriate (Paul and Criado 2020). These 56 articles were used for in-depth analysis by thoroughly reviewing their full texts. The final example review template has the following elements: i) the concept, classification, research methods and main findings of GIA; ii) the driving factors, barriers and performances of GIA by enterprises; and iii) the moderating and mediating effects of the driving factors on GIA.

2.3 Eligibility and inclusion

Based on the explanations in the previous sections, it was found that 56 articles met the criteria for qualitative synthesis and bibliographic coupling. These papers of superior quality will assist in addressing GIA research inquiries. The attributes of these articles are as follows:

1. Primary research papers published in scholarly journals;
2. Categorized in interdisciplinary fields such as management, environment, business and social sciences;
3. Published in WoS core collection (SCI-Expanded & SSCI) or Scopus databases;
4. Published between 2001 and 2024 (Up to January 9, 2024);
5. Published in English language. These articles provide the latest insights on the relationship between greenness and innovation adoption to address the research questions.

2.4 Qualitative synthesis

Descriptive analysis was conducted to summarize the main trends in the literature, including by year, source title, contributing country, citations, research type and methods. Next, to achieve the aim of this study, the VOSviewer software (Kraus et al. 2020; van Eck and Waltman 2009) was used for bibliometric coupling analysis. Bibliometric coupling is a method that applies shared references between two articles to measure their mutual similarity (Suchek et al. 2021).

The higher the overlap of references in the article bibliographies, the stronger the level of connection between the articles. Bibliometric coupling does not require cumulative references and can be applied to new publications (not yet cited), emerging fields and underdeveloped sub-fields (Zupic and ater, 2014).

According to Suchek et al. (2021), the primary themes and patterns of the study were determined using cluster analysis. Finally, future research directions were discussed based on the identified gaps in the literature and limitations of this study were emphasized.

3. Results

3.1 Descriptive analysis

The SLR of “GIA” yielded 56 papers, which provide the findings. These articles include information on the distribution of the studies by year, source title, contributing nation, author, citation, and research type.

Figure 2 depicts the yearly publication trend. The number of publications has generally increased from 2001 to 2023, with a dip in 2023 compared to 2022. Notably, 2022 has seen a surge in research publications and dedicated journals. From 2014 to 2023, 51 papers were published, representing 91.07% of the total.

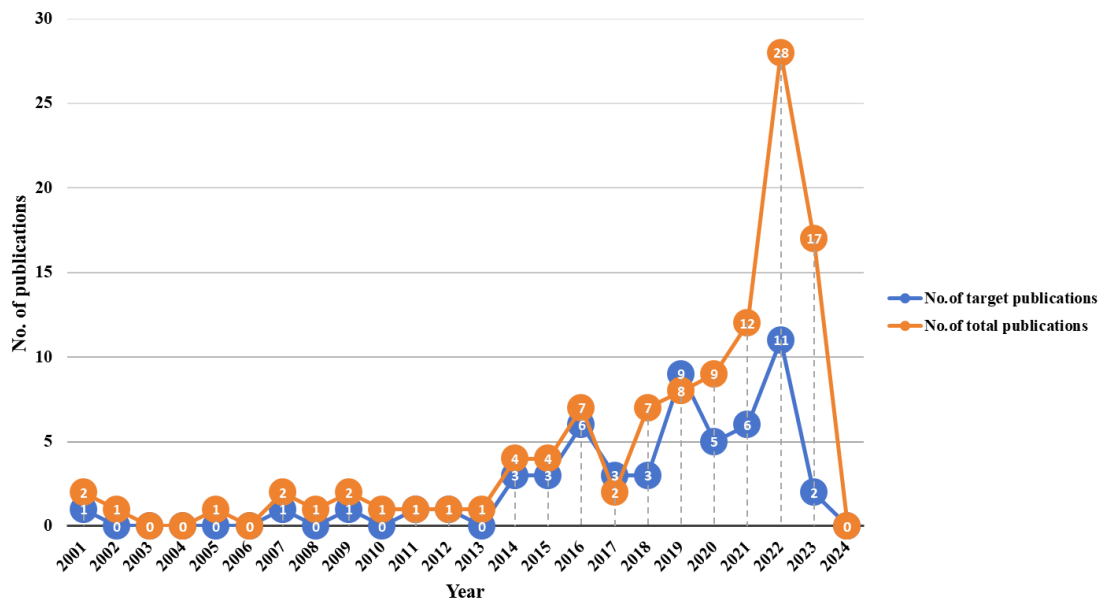


Fig. 2. Distribution of publications by year

Figure 2 depicts the yearly publication trend. The graph illustrates the division of research in the field of GIA into three stages. The first stage, spanning from 2001 to 2013, exhibited a period of slow development in GIA research. From Figure 2, it can be observed that the number of publications from 2001 to 2013 was around 0-2 articles. During this stage, there was a preliminary understanding of the adoption of green innovation in organizations. In the second stage, from 2014 to 2016, there was a growth rate that gradually weakened by 2016. The number of posts has significantly increased in comparison to the initial stage, which indicates a heightened focus on green innovation within the organization. The third stage, occurring from 2018 to 2023, demonstrated a clear growth trend and reached its peak in 2022. However, research in 2023 experienced a slight decline. Throughout the period from 2014 to 2023, a total of 51 papers were published, accounting for 76.79% of the overall research output.

Based on the study (refer to Figure 3), the majority of research produced quantitative articles (76.79%), with qualitative papers being the next most common (17.86%), and mixed-method studies (5.35%) that combined quantitative and qualitative approaches. For 111 original articles, quantitative research still accounts for the most significant proportion (70.27%).

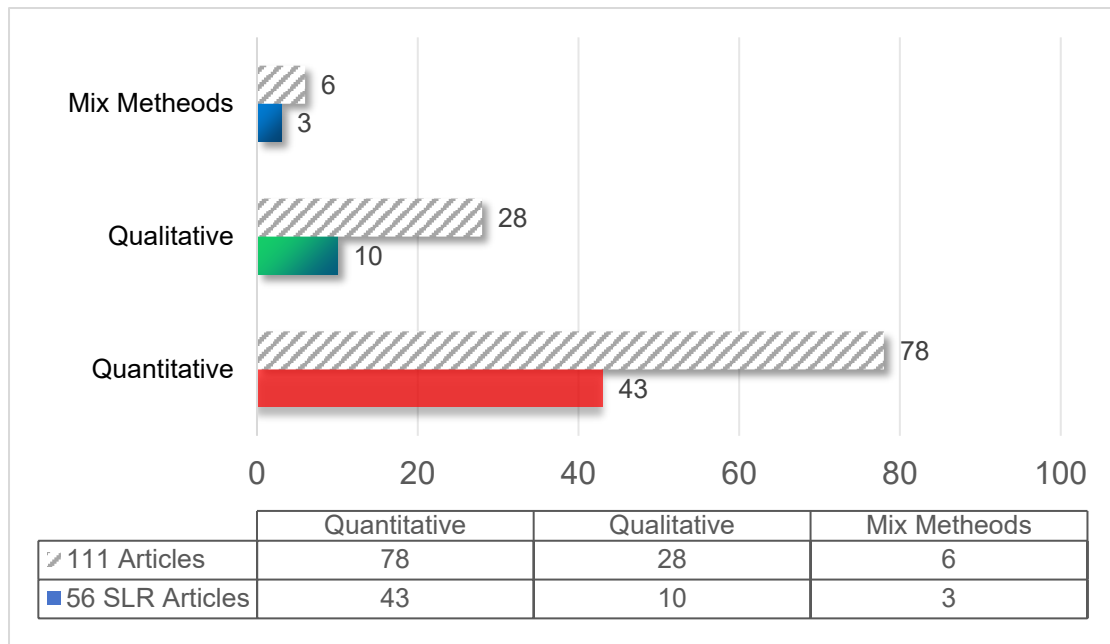


Fig.3. Distribution by research types and methods

Table 3 and Figure 4 presents the distribution of studies on GIA by 71 countries/regions. The overall distribution indicates that the top area with the highest productivity in the studied topic is the EU. The top four are Spain (10 publications), Italy (9 publications), Slovenia (9 publications) and Pakistan, Luxembourg, Finland, Portugal, Malta, Sweden, Cyprus, Netherlands (8 publications). Spain is the country with the highest number of publications. Pakistan is the only Asian country among the top 4 with the most publications. There was no relevant research on South Africa yet, as shown in Figure 4. Among them, the number of developed and developing countries is comparable, indicating that GIA has been widely accepted by countries at different levels of development.

Table 3. Distribution of articles by Geographic Focus

ID	Geographic Focus	Publications	ID	Geographic Focus	Publications
1	Spain	10	37	Israel	2
2	Italy	9	38	Egypt	2
3	Slovenia	9	39	Myanmar	1
4	Pakistan	8	40	Taiwan	1
5	Luxembourg	8	41	Switzerland	1
6	Finland	8	42	Norway	1
7	Portugal	8	43	Japan	1
8	Malta	8	44	Hong Kong	1
9	Sweden	8	45	Australia	1
10	Cyprus	8	46	Brazil	1
11	Netherlands	8	47	Baltic Sea	1
12	Austria	7	48	Ghana	1
13	Belgium	7	49	Vietnamese	1
14	Bulgaria	7	50	Comoros	1
15	Croatia	7	51	Djibouti	1
16	Czechia	7	52	Somalia	1
17	Denmark	7	53	Afghanistan	1
18	Estonia	7	54	Iran	1
19	France	7	55	Lebanon	1
20	Germany	7	56	Oman	1
21	Greece	7	57	Iraq	1
22	Hungary	7	58	Bahrain	1
23	Ireland	7	59	Mauritania	1
24	Latvia	7	60	Saudi Arabia	1
25	Lithuania	7	61	Qatar	1

26	Poland	7	62	Yemen	1
27	Romania	7	63	Syria	1
28	Slovakia	7	64	Kuwait	1
29	China	5	65	Jordan	1
30	USA	5	66	Palestine	1
31	Malaysia	4	67	Libya	1
32	Italia	4	68	Sudan	1
33	UK	2	69	Algeria	1
34	India	2	70	Morocco	1
35	Turkey	2	71	The United Arab Emirates	1
36	Tunisia	2			

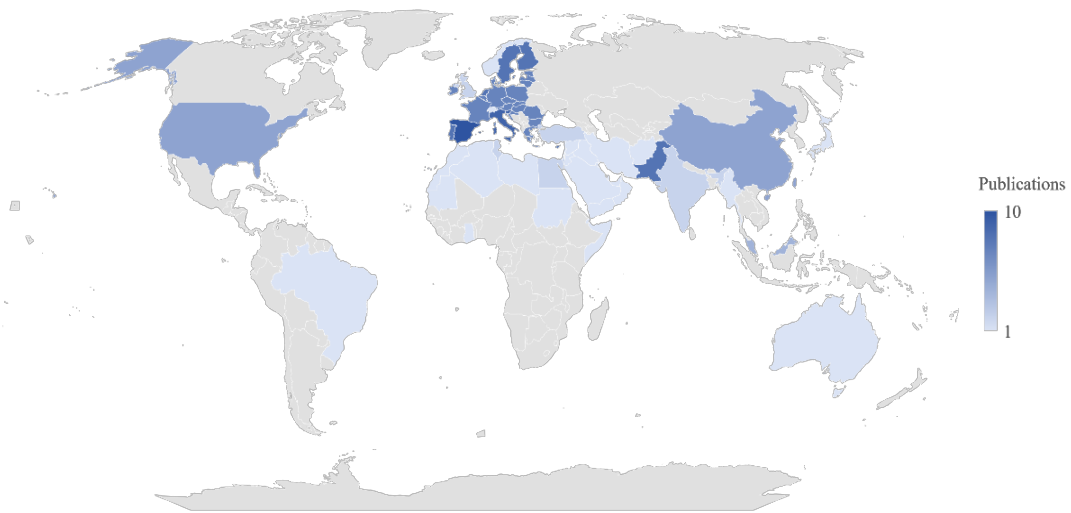


Fig. 4. Geographical Focus

From a national perspective, Pakistan has the highest number of literatures in the Asian region, and its main industry of study is manufacturing (Fahad et al., 2022; Shahzad et al., 2022; Jun et al., 2021; Ullah et al., 2022; Ullah et al., 2021; Ali et al., 2023). In Europe, the research industry is predominantly industry-wide, encompassing sectors such as Innovative SMEs, the agricultural and food industry (Pancino et al., 2019), Ghana's research on the cocoa industry in Africa (Yamaah et al., 2020), and Tunisia's research on agriculture in North Africa (Ben Amara and Chen, 2022). Scholars studying the hotel industry hail from the United States (Smerecnik and Andersen, 2011), Malta (Pace, 2016), Italy (González and León, 2001), and Malaysia (Asadi et al., 2020). From a regional geographical perspective, developed countries and regions, such as Europe and North America, have conducted research on green innovation earlier and have primarily focused on green innovation in the service industry. In contrast, most Asian countries have focused on research related to industrial green innovation. Furthermore, from a temporal perspective, green innovation has been flourishing in recent years. In Africa, countries like Ghana primarily concentrate on green innovation research in the agricultural sector.

Figure 5 displays the name of the publication source, the number of publications and the publication years. Figure 6 illustrates the number of citations for each publication source. The distribution of the studied journals is dispersed among many different sources, with 25 sources containing one article each, accounting for 75.76% of the total publications. The number of articles and publication time for each source are shown in Figure 5. The *Journal of Cleaner Production* is the most common source, with 12 articles per source. Additionally, the *Journal of Cleaner Production* is also the most cited source, with a total of 2838 citations (See Figure 6). On the other hand, the *Research Policy* has only one article but contributed 424 citations. It is suggested that these highly-cited articles should consider both the

benefits of accumulating citations over time and the potential for their research to have a greater contribution to its audience. The top five cited articles and their authors, as well as the journal sources, are listed in Table 4.

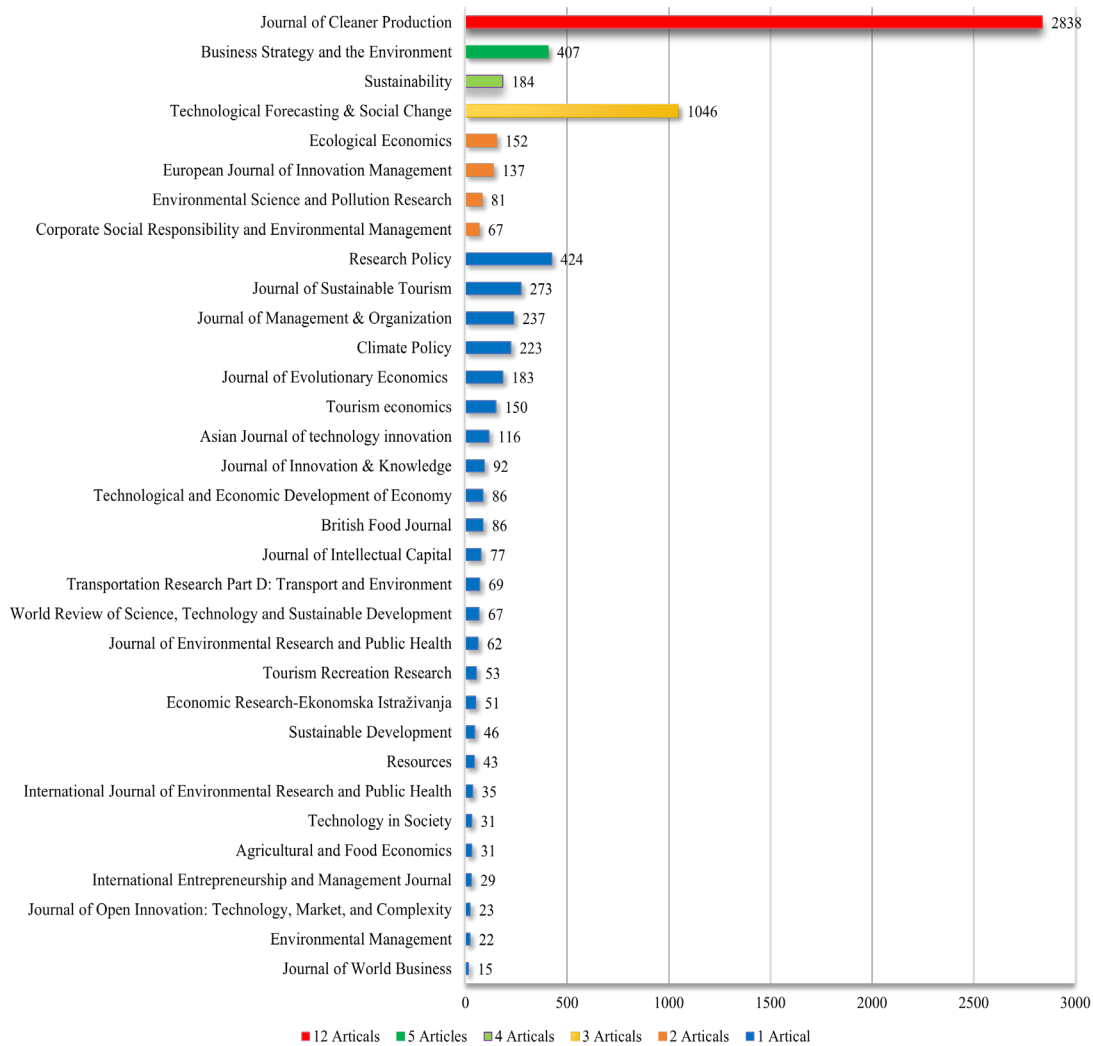


Fig.5. Distribution of source title and citations



Fig.6. Chronological development of publication sources.

Table 4. Distribution of top 5 highly-cited authors, source title and citations

#	Author	Source	No. of citations
1	(El-Kassar and Singh 2019)	Technological Forecasting & Social Change	855
2	(Bossle et al 2016)	Journal of Cleaner Production	656
3	(Cai and Li 2018)	Journal of Cleaner Production	548
4	(Pace et al. 2016)	Journal of Cleaner Production	424
5	(Zailani et al.2015)	Journal of Cleaner Production	401

VOSviewer software (van Eck and Waltman 2009) was used to perform bibliometric coupling analysis on all 56 articles to discover clusters of the main research themes on GIA (See Figure 7). The comprehensive descriptive and bibliographic analysis conducted using VOS viewer software (van Eck and Waltman, 2010) provides a range of information and research directions (Shela et al. 2023). The following sections discuss each of the six clusters based on the main knowledge contributions of the themes and authors. Table 5 summarizes the content of each group of articles.

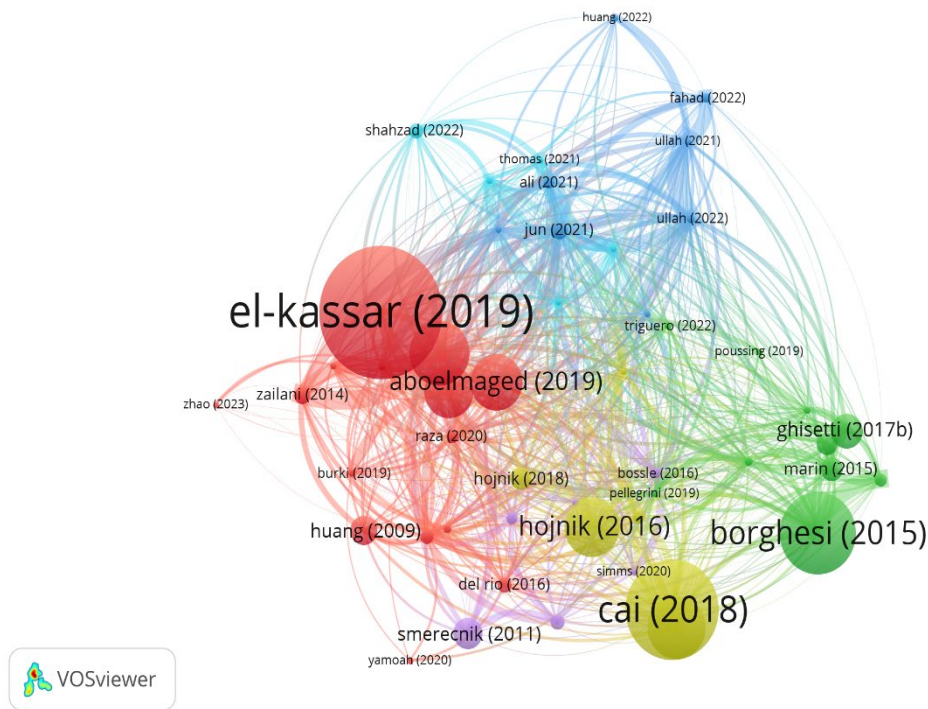


Fig.7: Bibliography coupling network

According to Vosviewer's clustering of 56 literatures, six clustering results are obtained in Table 5. Each cluster indicates the number of works of literature and the author of the works.

Table 5.Summary of articles by clusters

Cluster 1 (n=16 items)		Cluster 3 (n=11 items)
Huang et al. 2009	Zailani et al.2015	Antonioli et al. 2013
Bhatia 2021	Raza et al.2020	Ghisetti 2017
Zhang et al. 2020a	Gauthier and Wooldridge 2012	Ghisetti et al. 2017
Asadi et al 2020	Pancino et al.2019	Borghesi et al. 2015
Noppers et al., 2014	Cluster 2 (n=6 items)	Costa et al. 2021
Burki et al 2019	Carfora et al 2021	Gilli et al. 2014
Del Río et al. 2016	Han and Chen 2021	Marin et al. 2015
El-Kassar and Singh 2019	Hartmann et al 2022	Pellegrini et al 2019
Hermundsdottir et al.2022	Shahzad et al 2022	Poussing et al 2019
Zailani et al.2014	Thomas et al 2022	Triguero et al. 2022
Zhao et al.2023	Yu et al.2022	González and León 2001
Aboelmaged and Hashem 2019		
Cluster 4 (n=8 items)	Cluster 5 (n=8 items)	Cluster 6 (n=7 items)
Ali et al 2021	Ben amara et al. 2022	Bell et al. 2016
Fahad et al 2022	Cai et al. 2014	Zhou et al. 2018
Huang et al 2022	Cai and Li 2018	Bossle et al. 2016
Jun et al 2021	Hazarika and Zhang 2019	Pace et al. 2016
Nasiri et al 2022	Hojnik et al. 2018	Simms et al. 2020
Ullah et al. 2021	Hojnik and Ruzzier 2016	Long and Liao, 2022
Ullah et al. 2022	Singh et al.2020	Rothenberg and Zyglidopoulos
Polas et al. 2022	Ali et al. 2023	2007

3.2 Analysis of bibliographic coupling

3.2.1 Cluster 1 Research combined with supply chain (SC)

Logistics firms, which are crucial to the supply chain, work with suppliers and customers at various

levels, are included in Cluster1. These articles examined how sustainable development skills and traits effect company's innovation and adoption. Small and medium-sized enterprises' issues and solutions in sustainable development are also discussed.

El-Kassar and Singh (2019) assess competitive advantage and sustainable performance by integrating stakeholder perspectives, corporate environmental principles, and the demand for green products. Specifically, when faced with pressure from stakeholders, a greater commitment to green practices by top management will enhance the likelihood of achieving green innovation practices. Additionally, organizational performance is influenced by environmental ethics, which are manifested through green innovation practices. Gauthier and Wooldridge (2012) analyze the relationship between LEED certification and sustainable innovation in terms of internal and external stakeholder behavior, leadership, and corporate culture. For this study conducted in the United States, it is observed that companies that strategically position themselves as environmental leaders are more inclined to adopt green practices. Conversely, companies situated in states where political leaders demonstrate less commitment to environmental protection tend to exhibit the opposite behavior.

In numerous studies, the external perspective of the organization is analyzed. Burki et al. (2019) discovered that collaboration between customers and supply chain partners increases the likelihood that the partners will adopt green innovation. In their investigation of food supply chains. Specifically, the adoption of green innovation in the supply chain leads to the development of sustainable competitive advantages. The collaboration of supply chain partners in a cooperative and reliable manner contributes to the promotion of green innovation adoption. Additionally, research has demonstrated that top management commitment has a positive influence on green processes and the implementation of green management innovation. Zhang et al. (2020a) emphasize the impact that e-commerce platforms and governmental entities have on the implementation of environmentally friendly practices within courier organizations. In addition, they stress the significance of taking consumer ecological demands into account. Ecological innovation, according to Del Río et al. (2016), necessitates cooperation among the government, research institutions, universities, consumers, competitors, and suppliers. Specifically, resources, capabilities, and skills play a crucial role in driving the success of GIA.

Ecological innovation is significantly influenced by the internal perspective of the organization, given that it is dependent on its resources and capabilities (Del Río et al., 2016). The provision of organizational support for the implementation of green innovation is significantly influenced by top management (Zailani et al., 2014). It is imperative that senior management recognizes the significance of their dedication to safeguarding the environment, whereas intermediate management is tasked with the execution of novel policies (Huang et al., 2009). This, in turn, fosters a heightened consciousness among staff members regarding environmental concerns (Bhatia, 2021). An example of a determinant in the adoption of sustainable innovation by 98 Finnish companies is the implementation of waste and energy-saving digitization technologies (Nasiri et al., 2022).

3.2.2 Cluster 2 The impact of stakeholders cannot be ignored

Cluster 2 highlights the stakeholders including governments, consumers, workers and suppliers in GIA. This study examines how organizations' green knowledge, competences, relational capital and intellectual capital affect GIA. Not all stakeholders will have an impact on the organization's GIA from clustering.

For example, Thomas et al. (2022) identified a multitude of stakeholders as critical elements, including but not limited to customers, suppliers, financiers/investors, employees, public administration, universities, research centers, and other institutions, communities, and competitors. The conclusion showed that overly strict regulations may weaken the enthusiasm of small and medium-sized innovative organizations towards GIA. The objective of the survey and analysis of manufacturing companies by Shahzad et al. (2022) was to identify environmentally friendly innovative technologies that have the potential to expedite sustainable development. The main challenges and influencing factors associated

with the implementation of these technologies were also deliberated. Internal factors identified as influencing both internal and external stakeholders included environmental consciousness, personnel, and the organization's capabilities; external factors were primarily impacted by regulations and laws (Carfora et al., 2021). Environmental legislation-induced regulatory pressure positively affects green innovation in the short sea shipping sector, as demonstrated by Raza (2020). Moreover, an examination of ecological innovation within diverse national contexts and limitations is imperative (Han and Chen, 2021).

3.2.3 Cluster 3 The study under the the European context

The third cluster is on the green innovation made by SMEs and industrial industries in Europe. The authors investigate the determinants and obstacles that influence ecological innovation, including the administration of human resources (Antonioli et al., 2013, Italian manufacturing data). Pellegrini et al. (2019) argue that the cases of water companies in Italy, Israel, and Spain provide evidence that networks and sustainable internal entrepreneurship are key driving factors for both internal and external sustainable innovation. Based on particular characteristics, Marin et al. (2015) identified four clusters of barriers that impede the adoption of green innovation in the European Union. Following this, Costa (2021) examines the effects of policy measures implemented in Portugal with regards to promoting the uptake of ecological innovation. The study conducted by Gilli et al. (2014) examines the extent to which the implementation of environmental innovation measures in Europe complements other forms of technological and organizational innovation. Specifically, this study identified a lack of comprehensive innovation as a contributing factor to the environmental productivity performance of the EU. In their study, Triguero et al. (2022) examines the factors that contribute to the establishment of GIA in the European industrial sector. Specifically, they investigate the impact of knowledge networks, financial capacity, technological capacity, and public support. Additionally, the influence of GIA on the circular economy is assessed. The impact of Emission Trading System (ETS) participation on the environmental innovation capabilities of Italian manufacturers is examined by Borghesi et al. (2015). Participation in the ETS is significantly and positively correlated with environmental innovation, specifically technological capacity and environmental management, according to the study. In his study, Ghisetti (2017) examines the potential and ramifications of blockchain technology on the sustainable development of manufacturing firms across the 27 member states of the European Union. Financial obstacles are identified as a significant impediment to the implementation of environmentally friendly innovations by the manufacturing sector.

3.2.4 Cluster 4 Comprehensive perspective review factors

Cluster 4 comprises the preponderance of research that evaluates the driving factors and barriers of GIA from a more comprehensive standpoint.

The adoption of green innovation is sometimes examined by scholars employing integrated frameworks, as in the case of a comprehensive analysis of its barriers (Ulla et al., 2021b) or the examination of 18 determinant factors (Ullah et al., 2022). Adoption of sustainable innovation is a dynamic and incremental process, according to Adims et al. (2016) (Pellegrini et al., 2019). Chappin et al. (2020) propose that there is a dearth of comprehensive comprehension concerning the possible variations in factors that impact different sectors and the scale of businesses. Green dynamic capabilities and GIA are moderated in a positive way by comprehensive data analysis (Yu et al., 2022). MICMAC analysis was utilized by Ullah et al. (2021) to classify twenty identified barriers into four distinct categories. Using the ISM-MICMAC framework, Fahad et al. (2022) analyzed and quantified the relationship between propelling forces and dependencies of green innovation. By reviewing the literature, Ullah et al. (2022) identified eighteen driving factors for green innovation. Through the use of explanatory structural models and an expert perspective, Huang et al. (2022) identified thirteen fundamental obstacles that Vietnamese manufacturers must surmount prior to employing green innovation.

3.2.5 Cluster 5 Performance outcomes

The predominant focus of the articles in Cluster 5 is on the performance outcomes that arise from the implementation of environmentally friendly innovations.

Hojnik and Ruzzier (2016) postulate that the implementation of ecological innovation processes yields favorable outcomes for organizational performance. A noteworthy positive correlation was identified by Hojnik et al. (2018) between internationalization and firm-level economic performance; ecological innovation partially mitigates this effect. Specifically, the study collected data from 223 Slovenian companies and found that GIA promotes increased profitability, growth, and competitive advantages for these companies. Hazarika and Zhang (2019) propose empirical research outcomes within the construction sector that indicate the significant mediating function of ecological innovation practices in relation to the impact of regulations and managers' apprehensions concerning the feasibility of adoption. This cluster analysis suggests that GIA has a positive influence on organizational performance outcomes.

3.2.6 Cluster 6 Importance of organizational capability

Voluntary implementation of green innovation by organizations operating in dynamic environments is the subject of the sixth cluster.

The adoption of environmental innovation may be impacted by both internal and external factors, as stated by Pace (2016). Additionally, the research indicates that policy measures should be integrated with programs that prioritize the dissemination of environmental technologies to foster the advancement of energy management capabilities. Their research is particularized to a single supply chain level; Simms et al. (2020) emphasize the significance of consensus among stakeholders, such as food manufacturers and retailers. The primary focus of the study by Zhou et al. (2018) is to determine how dynamic capabilities influence the intention to adopt environmentally friendly innovations voluntarily. In a similar vein, the findings of Bell et al. (2016) regarding the Australian tourism sector suggest that the GIA was more likely to be propelled by the self-motivation and environmental principles of key enterprise participants rather than by external factors. According to a study conducted by Long and Liao (2022), which examined the Chinese manufactory industry, Green relational capital has a positive impact on the speed and comprehensiveness of adopting environmental innovation, and the integration ability of enterprises plays a mediating role between green relational capital and the adoption of environmental innovation. Additionally, the study also discovered that regulatory pressure positively influences the relationship between green relational capital and integration ability. Research indicates that the integration capability of enterprises acts as a bridge that positively affects the relationship between green relational capital and the adoption of environmental innovation. Rothegeen and Zyglidopoulos (2007) found that in environments characterized by high levels of dynamism, organizations that embrace productive innovation, such as American printing companies, demonstrate a greater propensity to implement green innovation as well. Organizational ability plays a significant role, both directly and indirectly, in GIA.

4. Discussion of results

4.1 Discussion of bibliographic coupling

The analysis identifies the future major research themes by grouping previous studies into six clusters, as below:

Cluster 1, ecological innovation, asserts that system-type ecological innovation requires collaboration among many stakeholders such as governments, research institutes or universities, customers, suppliers and rivals (Del Río et al. 2016). Previous research on technology and ecological innovation adoption has mainly focused on a single level of the supply chain. Future research can combine the supply chain to further study the adoption of green innovation in businesses.

According to Cluster 2, not all stakeholders will have an impact on the organization's GIA from clustering. sustainable development is defined as a series of internal choices made by organizations to self-regulate their operational methods to align with respect for the external environment. In the future, based on the stakeholder theory, further exploration is needed to determine which positive effects and obstacles the adoption of green innovation may encounter from stakeholders. Additionally, research is needed to investigate how green innovation can diffuse between stakeholders and organizations.

According to Cluster 3, in addition to studying the EU, there is still an opportunity to contribute further to existing research by comparing different approaches in similar industries between developed and developing countries, as well as the different drivers and barriers to adopting green innovation.

Cluster 4 of the current research framework presents a synopsis of the barriers that impede the GIA. Future empirical investigations may be undertaken to examine the validity of these studies' hypotheses, with a specific emphasis on diverse countries and regions.

Cluster 5 asserts that the examination of how factors that stimulate innovation impact eco-innovative behavior and other associated variables has gained significant significance in the context of industries (Cai and Li 2018), and is also significant for accelerating the diffusion process and achieving social benefits of environmental innovation. There is still a need for further research in the GIA field in developing countries. Little is known about why some companies adopt environmental innovation faster and better than others. When faced with strong regulatory pressures, companies may consider the benefits to outweigh the costs.

According to Cluster 6, organizational capability has a positive impact on GIA Chain managers should prioritize various environmental beliefs and values to promote the company's organizational capability when developing business relationships with major supply chain customers.

In general, the framework provides a thorough representation of the current state and patterns of GIA's primary issues (See figure 8). This study comprehensively addresses its research objectives by examining the interconnected notions found in the mainstream literature, providing a comprehensive understanding of the topic. To enhance the value of the current SLR, Table 6-9 describes the determinant factors, barriers and performance outcomes; while a third variable is used as a mediator and moderator in empirical studies to supplement previous research gaps.

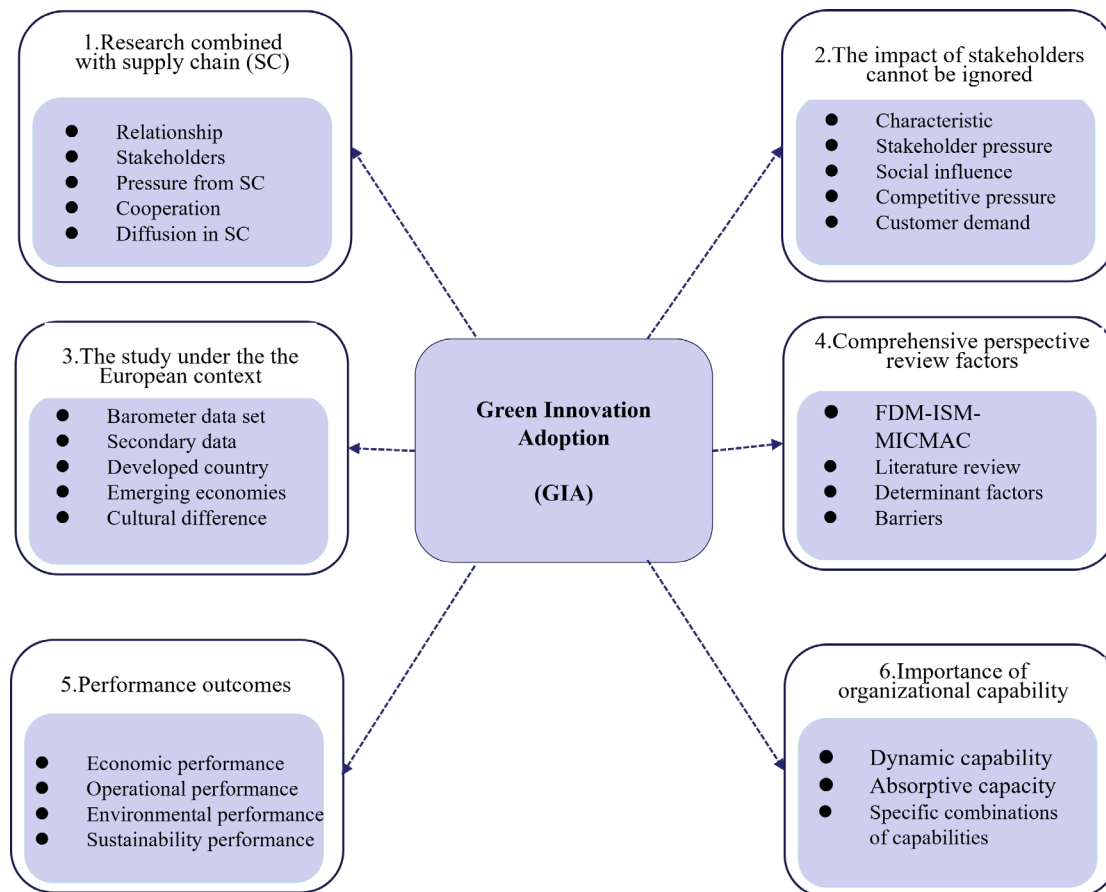


Fig. 8. Framework of themes and trends in GIA

4.2 Discussion of determinant factors

Further summarization and analysis were conducted on the determinant factors of organization GIA, as depicted in Figure 6. According to Table 6, the external factors that have been extensively studied by scholars include customer demands, customer green demand, market and customer, and customer pressure (Han and Chen 2021; Cai and Zhou 2014; Jun et al. 2021; Hojnik and Ruzzier 2016; Cai and Li 2018; Zailani et al. 2015; Ullah et al. 2022; El-Kassar and Singh 2019; Gauthier and Wooldridge 2012; González and León 2001; Pellegrini et al. 2019). Additionally, environmental regulations, regulatory stringency, and command and control instruments have also been studied (Hartmann et al. 2022; Zailani et al. 2015; Asadi et al. 2020; Han and Chen 2021; Cai and Zhou 2014; Cai and Li 2018; Ullah et al. 2022; Costa 2021; Borghesi et al. 2015; Hazarika and Zhang 2019; Pellegrini et al. 2019; Jun et al. 2021).

The internal factors that scholars primarily focus on include top management commitment, management environmental concerns, and organizational support (Burki et al. 2019; Han and Chen, 2021; Hojnik and Ruzzier 2016; Ullah et al. 2022; Zailani et al. 2014; González and León 2001; Hazarika and Zhang 2019; Gauthier and Wooldridge 2012; Bhatia 2021; Pellegrini et al. 2019). Additionally, stakeholders (including regulatory stakeholders and market stakeholders) and stakeholder pressure are also considered (Huang et al. 2009; Zhang et al. 2020a; El-Kassar and Singh 2019; Pellegrini et al. 2019; Yamaah et al. 2020). In recent years, research has expanded to the field of big data, specifically focusing on the influential role of digital orientation (Nasiri et al., 2022). Additionally, there has been a growing interest in examining the effects of dynamic changes in the external environment on GIA, such as the analysis of the impact of COVID-19 on the environmental innovation of manufacturing enterprises (Hermundsdottir et al., 2022).

Table 6. Use of determinant factors in GIA

#	Origin of the determinant factors	Description	Source
-External factors			
1	Customer demands/ customer green demand/ Market and customer/ customer pressure	Customers' propensity to acquire a product or service in the market is called consumer demand.	(Han and Chen 2021; Cai and Zhou 2014; Jun et al. 2021; Hojnik and Ruzzier 2016; Cai and Li 2018; Jun et al. 2021; Zailani et al. 2015; Ullah et al. 2022; El-Kassar & Singh 2019; Zailani et al. 2014; Gauthier and Wooldridge 2012; González and León 2001; Pellegrini et al. 2019)
2	Rivalry pressures	The corporation must compete for market share. Stakeholder environmental protection concerns have become competitive pressures, enhancing its inventive talents to react to competition.	(Hojnik and Ruzzier 2016; Han and Chen 2021; Cai and Zhou 2014; Cai and Li 2018; Ullah et al. 2022)
3	Regulatory pressure	Regulations may raise a company's awareness, putting pressure on innovation.	(Raza 2020)
4	Environmental regulations/ Regulatory stringency/ Command-and-control instrument	People, companies, and other organizations must comply with environmental regulations to protect or restore ecosystems. Hard instruments—market-based, regulatory, or command-and-control—impose unambiguous requirements. Consider the European Emissions Trading Scheme (EU ETS).	Sanni 2017; Jun et al. 2021; Hartmann et al. 2022; Zailani et al. 2015; Asadi et al. 2020; Han and Chen 2021; Cai and Zhou 2014; Cai and Li 2018; Jun et al. 2021; Ullah et al. 2022; Costa 2021; Borghesi et al. 2015; Hazarika and Zhang 2019; Pellegrini et al. 2019
5	Environmental policy instruments (economic incentive instrument)	Soft tools like economic incentive devices depend on voluntary activity.	Hojnik and Ruzzier 2016; Costa 2021
6	Low emission zones/ Reduction in carbon emission	Manufacturing using green technology reduces carbon emissions. Thus, many companies use green technology.	Hartmann et al. 2022; Ullah et al. 2022
7	Government institutional support/Public support	The government may encourage green transition using tax incentives, financing, subsidies, etc.	Djibo et al. 2022 Jun et al. 2021 Ullah et al. 2022 Zailani et al. 2014; Jun et al. 2021; Gauthier and Wooldridge 2012; Triguero et al 2022
8	Internationalization	Exporting lets companies service demanding overseas clientele, watch competent global competition, and cooperate with tech-savvy foreign partners. Internationalization involves satisfying market norms, standards, and expectations.	Hojnik et al. 2018
9	External partnership and cooperation	Green collaborations are essential for collaborative innovation.	Jun et al. 2021 Ullah et al. 2022
10	Customer cooperation (CC)	CC is an exchange partner's willingness to collaborate and attain sustainability.	Burki et al. 2019
11	Structural characteristics of	A company's technological regime, scale,	Costa 2021

	firms	open innovation involvement, skill level, management methods like demand pull or cost push, and public policy instruments.	
12	Stakeholders (regulatory stakeholders, market stakeholders)/Stakeholder pressure	Any entity that affects or is influenced by the organization's goals. supplier, consumer, government, and environmentalists.	Huang et al. 2009; Zhang et al.2020; El-Kassar amd Singh 2019; Pellegrini et al. 2019;Yamoah et al.2020
13	Non contractual stakeholders	University, research centers, agencies, public administrations, competitors, community.	Thomas et al. 2022
	Contractual stakeholders	Customers, suppliers, financiers/investors, employees.	Thomas et al. 2022
14	Networks/ Inter-firm networks and relationships/Knowledge networks	Networks seek external technical expertise on new technology and solutions and give forums to exchange market trends, stakeholder requests, and new regulatory requirements.	Pellegrini et al. 2019; Ramkumar et al. 2022; Triguero et al 2022
15	Technological factors	Businesses may gain a competitive advantage by investing in green technology.	Jun et al. 2021; Ullah et al. 2022
16	Technology characteristics	Perceived green usefulness and perceived integration ease of use.	Zhang et al.2020
17	Social influence	Social impact, mostly subjective norms and perceptions, boosts technology and product acceptance.	Zhang et al.2020
18	Global environmental pressures	International organizations, awareness campaigns, foreign NGOs, publications, and media outlets are promoting green practices.	Ullah et al. 2022
19	Public procurement	Using public procurement as an additional or substitute policy tool for innovative initiatives.	Ghissetti 2017
20	Munificence	Munificence refers to the 'wealth' or 'poverty' of the business firm's environment in terms of available resources.	Rothenberg and Zyglidopoulos 2007
21	Dynamism	Dynamism refers to the degree of instability and/or turbulence that characterizes the environment of a business.	Rothenberg and Zyglidopoulos 2007
22	Environmental uncertainty	For example, negative impact from COVID-19	Zailani et al. 2014; Hermundsdottir et al., 2022
23	Big data	Big data divided three dimensions: big data adoption/acceptance, big data routinization, and big data assimilation.	El-Kassar and Singh 2019
24	External environment	The company's external environment is shaped by increasing market and technological turbulence.	Nasiri et al.2022
	-Internal factors		
1	Cost reduction/ low investment and operational cost reductions.	Reduce energy use and wasteful use of raw materials by using better methods. For a sustained competitive edge, businesses use green innovation.	Ullah et al. 2022; González and León 2001
2	Improve financial and economic performance	The financial advantages of eco-products also influence a company's enthusiasm for green activities.	Ullah et al. 2022
3	Availability of resources	The availabilities of men, material, and money take organization towards innovative process.	Ullah et al. 2022
4	Resources, capabilities and competences (RCCs)	RCCs, which are essential determinants of corporate strategies and innovation performance, are resources, capabilities, and competencies.	Del Río et al. 2016
5	Top management commitment/ Managerial	Firm-stop management's tangible support for sustainable operations and practices. A firm's	Burki et al. 2019; Han and Chen 2021;

	environmental concerns/Organizational support	management's environmental concern and innovation strategy are its managerial environmental issues.	Hojnik and Ruzzier 2016; Ullah et al. 2022; Zailani et al 2014; González and León 2001; Hazarika and Zhang 2019
6	Environment strategy/ Innovation strategy	A corporation whose senior managers actively manage the environment, meeting legal obligations and giving environmental issues greater attention.	Gauthier and Wooldridge 2012; Bhatia 2021; Pellegrini et al. 2019
7	Quality of Human Resource	Adopting technical innovations requires qualified employees with competent learning and innovative capabilities.	Zailani et al 2014
8	Environmental awareness, education and training	Environmental education and training raise awareness of environmental challenges.	Ullah et al. 2022
9	Digital orientation	Digital orientation drives sustainable innovation in economic, environmental, and social areas.	Nasiri et al.2022
10	Corporate social responsibility (CSR)/ Environmental conservation/ Increasing landfills/Corporate Environment Ethics	Environmental commitment may affect the company's ability to align operations with society expectations to ensure legitimacy (standards, values, and expectations).	Cai and Zhou 2014; Ullah et al. 2022; Poussing 2019; El-Kassar and Singh 2019
11	Firm innovation capabilities	Firm innovation capabilities are defined as the firm's ability to upgrade ideas, products, and services to meet higher innovation requirements.	Han and Chen 2021
12	Technological capabilities	Technological capabilities are an organization's material and intellectual capital to produce new goods and processes.	Cai and Zhou 2014; Cai and Li 2018; Triguero et al 2022
13	Financial capabilities	Circular economy practice is accompanied by additional financial costs.	Triguero et al 2022
14	Organizational capabilities/ Environmental management systems (EMS)/ environmental organizational capabilities	EMS-related organizational competencies. EMS are a firm's systematic, thorough, planned, and recorded environmental initiatives and procedures that reduce its environmental effect.	Cai and Li 2018; Cai and Zhou 2014; Cai and Li 2018
15	Absorptive capacity	A firm's capacity to appraise, digest, and use new knowledge.	Aboelmaged and Hashem 2019; Pace 2016
16	Green performance expectancy	The UTAUT model's performance expectation affects behavioral intentions. It is "the degree to which an individual believes that using the system will help him or her attain gains in job performance".	Shahzad et al. 2022
17	Green effort expectancy	A major UTAUT concept is effort expectation, which is "the degree of ease of use associated with the usage of a new technology or a technology product".	Shahzad et al. 2022
18	Green hedonic motivation	Hedonic motivation—internal pleasure, amusement, or satisfaction from using new technology—contributes to UTAUT2.	Shahzad et al. 2022
19	Green social influence	"The degree to which an individual perceives that important others believe he or she should use the new system"	Shahzad et al. 2022
20	Green facilitating conditions	"The factors in an environment that hinder or make an activity easier to perform for an individual".	Shahzad et al. 2022
21	Green innovation cost	Product cost strongly impacts technology adoption, making innovation cost another important component in the UTAUT2 model.	Shahzad et al. 2022
22	Green intellectual capital	The knowledge, skills, connections, and other illusive resources used for individual or	Ali et al. 2021

23	Green human capital	organizational ecological safety. GHC is the totality of workers' environmental assurance skills, innovativeness, abilities, competences, and responsibilities.	Ali et al. 2021
24	Green structural capital	Hierarchical assets comprise organizational skills, information, executive arrangement, incentives, licenses, trademarks, administrative component, enlightened innovation framework, corporate culture, image, copy rights, and environmental protection databases.	Ali et al. 2021
25	Green relational capital	It involves a company partnering with customers, dealers, platforms, and information exchange on environmental preservation and cost reduction.	Ali et al. 2021; Long and Liao 2022
26	Green Innovation Strategy	Green innovation, one of the most significant environmental projects, transforms industrial processes to reduce resource consumption, pollution, and corporate environmental management systems.	Asadi et al. 2020
27	Green organizational culture	Organizational ideals, symbols, and artifacts represented a desire or necessity to function sustainably.	Asadi et al. 2020
28	Energy Conservation	Giving visitors public transport. Hotels acquire green or energy- and water-efficient equipment. The hotel has hybrid or alternative-fuel automobiles.	Asadi et al. 2020
29	Dynamic capabilities/Green dynamic capability	The firm's ability to quickly integrate, generate, and reconfigure internal and external capabilities. Examples include sensing, seizing, and rearranging.	Pace 2016; Zhou et al. 2018; Yu et al.2022
30	Stakeholders	Three types of stakeholders exist: internal, regulatory, and market.	Huang et al. 2009
31	Intrapreneurship	Intrapreneurship is organizational conduct that deviates from the norm.	Pellegrini et al. 2019
32	Firm internal initiatives	Quality staff, top management support, and organizational motivation.	Zailani et al. 2015)
33	Expected benefits	Businesses realize the benefits of GIA.	Hojnik and Ruzzier 2016
34	Company Size	Companies listed, small and medium-sized, and micro companies are evaluated for green innovation.	Pellegrini et al. 2019
35	Financial resource	Budget for GIA investment.	Pellegrini et al. 2019
36	Innovation Structure	The innovation department responsible for managing innovation activities.	Pellegrini et al. 2019
37	Knowledge and competence	Their extensive professional knowledge, basic technology, and ability to absorb external information.	Pellegrini et al. 2019

For instance, research studies conducted on water companies in Italy, Israel, and Spain have demonstrated that networks and sustainable internal entrepreneurship act as mutually influential factors, stimulating both internal and external sustainable innovation. This finding can also be utilized as a point of reference for water companies in diverse countries or regions with varying cultural contexts. Additionally, different types of organizations can conduct further investigations to ascertain if these factors are equally efficacious.

4.3 Discussion of barriers in GIA

As presented in Table 7, the obstacles of GIA are summarized. In comparison to the driving factors of GIA, there has been relatively less research conducted on the obstacles. Specifically, the research

primarily focuses on the barriers to GIA in the manufacturing industry, with a limited number of studies conducted in other industries such as the UK and the Netherlands. The food processing sector faces several GIA barriers, including barriers related to technology providers/suppliers, food processors/producers, retailers, and consumers. In the manufacturing industry, the barriers differ between developing countries in Asia and developed countries in the West. More specifically, the GIA barriers in the manufacturing industry of the EU mainly consist of financial barriers, while GIA barriers in countries like Vietnam and Pakistan also encompass internal capabilities and external environmental barriers.

Compared to the study of decisions regarding the adoption of green innovation, there are fewer research barriers. The primary countries where research has been conducted are the EU (Marin et al. 2015; Ghisetti et al. 2017), the UK, and the Netherlands (Simms et al. 2020). Additionally, there is research from developing countries (Fahad et al., 2022; Huang et al. 2022). In the manufacturing sector, all research encompasses financial and economic barriers.

Table 7. Use of barriers in GIA

#	Origin of the barrier	Country (Area)/ Sector	Source
1	Agricultural Firm related barriers technology provider/supplier related barriers Food processor/producer related barriers Retailer related barriers Consumer related barriers	UK and the Netherlands/ The food processing sector	Simms et al. 2020
2	Lack of top management commitment Lack of training and seminars related to green innovation Insufficient human resources for green practices Lack of employees' capability to identify environmental opportunities Lack of collaboration with government and environmental institutions Uncertainty about the effectiveness of green innovation Fear of failure about green innovation Lack of new technology Lack of information about the market Lack of capital/resources Lack of government subsidy The high cost of implementing green innovation system Lack of knowledge related to green innovation and practices Lack of reverse logistics and recycling infrastructure Lack of rules and regulations for green practices Lack of awareness about reverse logistics and green SCM Lack of enforceable laws regarding returned and recycled products Uncertain demand for green innovative products	Pakistan/Manufacturing industry	Ullah et al. 2021
3	Cost barriers knowledge barriers Market barriers	EU/manufacturing, environmental service industries	Marin et al. 2015
4	Legal barriers, information barriers, technical barriers, managerial barriers, economic barriers and market barriers.	Pakistan/ SME sector	Fahad et al. 2022
5	Financial barriers	EU/ manufacturing sector	Ghisetti et al. 2017
6	Lack of training course; lack of environmental knowledge; lack of collaboration in partnership; green technology constraints; the complexity green system design; unwillingness to implement green innovation; lack of customer demands about green innovation product; lack of green human capital; low financial performance; lack of involvement of top management; lack of government support; financial capacity constraints.	Vietnam/Manufacturing Sector	Huang et al. 2022

Origin of the barrier	Barrier description	Source
Customer demands	Knowledge externality lets rivals learn from implementation issues. Environmental externality hurts short-term corporate profits. Customers' propensity to acquire a product or service in the market is called consumer demand. Social and environmental awareness have impacted customer buying habits, driving demand for eco-products.	Han and Chen 2021; Cai and Zhou 2014 Ullah et al. 2022

From Table 8, it is evident that a greater amount of research focuses on the economic performance following GIA (Asadi et al. 2020; Hojnik et al. 2018; Cai and Li 2018; Nasiri et al. 2022; Raza 2020; González and León 2001; Zailani et al. 2015) and the environmental performance (Zailani et al. 2014; Zailani et al. 2015; Nasiri et al. 2022; El-Kassar and Singh 2019; Raza 2020; Cai and Zhou 2014; Cai and Li 2018; Asadi et al. 2020). This is consistent with previous findings. The research institute stated, "The adoption of green innovation offers enterprises a means to enhance environmental responsibility and profits" (Huang et al. 2009). Environmental innovation, with its knowledge and environmental spillover effects, holds significant value for society as a whole in mitigating environmental risks (Rennings 2000).

Table 8. Use of performance outcomes in GIA

#	Origin of the performance outcome	Source
1	Economic performance	Hojnik et al. 2018; Asadi et al. 2020; Cai and Li 2018; Zailani et al. 2015; Nasiri et al.2022; Raza 2020
2	Firm/Company/Organizational performance (company growth and company profitability) Competitive benefits	Hojnik and Ruzzier 2016; Hojnik et al. 2018; El-Kassar and Singh 2019; Ali et al. 2023 Hojnik and Ruzzier 2016; El-Kassar and Singh 2019
3	Operational performance	Bhatia 2021
4	Environmental performance	Zailani et al. 2014; Asadi et al. 2020; Cai and Li 2018; Zailani et al. 2015; Nasiri et al.2022; El-Kassar and Singh 2019; Raza 2020
5	Social performance	Asadi et al. 2020; Zailani et al. 2015; Nasiri et al.2022
6	Financial profitability	Hazarika and Zhang 2019

4.4 Discussion of third variables in GIA

This study categorizes the third variable into two types: mediating variables and moderating variables. The mediating variables primarily consist of Sustainable orientation, sustainable /customer collaboration, sustainable human capital, green behavioural intention, integration/ technological/ integrative/ integration capabilities, organizational learning, Eco-innovative practices, managerial interpretation, Sustainability attitude and awareness and understanding of Technology. The moderators primarily consist of external network strength, Organizational size, maturity, social position, top management commitment, HR practices/training practices, big data analytics capability, environmental dynamism and green strategic responses. A noteworthy discovery is that research on the influence of mediating or moderating variables on GIA has been extensively conducted since 2019. In previous studies on mediating variables in 2014, the primary focus was on the moderating effect of external network forces on GIA. In recent years, more attention has been given to the impact of new capacity mediators or regulatory roles within enterprises on GIA. Specifically, this includes integration/technical capabilities (Long and Liao, 2022; Bhatia, 2021).

Table 9. Use of third variables in GIA

#	Mediators	Description	Source
1	Sustainable orientation	An organizational skill that tracks current and future environmental possibilities to avoid negative	Aboelmaged and Hashem

		environmental impacts (Graham and Potter, 2015).	2019;Polas et al.2022
2	Sustainable collaboration	A network of supply chain partners with common aims, trust, vision, and resources for environmental solutions, compliance, and relational advantages.	Aboelmaged and Hashem 2019
3	Customer cooperation	Customer cooperation is a partner's desire to work together and generate long-term outcomes.	Burki et al. 2019
4	Sustainable human capital	Critical capacity that affects an employee's behaviors, attitudes, skills, experience, commitments, innovativeness, and knowledge's environmental effect.	Aboelmaged and Hashem 2019
5	Green behavioural intention	The extent to which a person has consciously planned to perform or not perform some specified future behavior(s).	Shahzad et al. 2022
6	Integration capabilities	Integration skills allow organizations to combine internal and external knowledge and resources.	Long and Liao 2022
7	Technological capabilities	A collection of routines and activities aimed at executing and coordinating the variety of tasks required to manage the technology.	Bhatia 2021;
8	Organizational learning	A dynamic knowledge-based process that creates, acquires, transfers, and integrates information and adapts business behavior to new cognitive conditions to improve performance.	Bhatia 2021
9	Integrative/ Integration capabilities	Establishing, integrating, and reconfiguring internal and external organizational skills, resources, and functional capabilities achieves external environment compatibility and innovative responses.	Cai and Zhou 2014
10	Eco-innovative practices	A corporation with great innovation capabilities will succeed in innovation. The route requires this.	Hazarika and Zhang 2019
11	Managerial interpretation	An innovation's managerial interpretation involves management judgments and assessments.	Zhou et al. 2018
12	Sustainability attitude	People's environmental behavior was influenced by their attitude.	Polas et al.2022
13	Awareness and understanding of Technolog	Awareness and knowledge are best disseminated by word of mouth by educating rural communities.	Ali et al.2023
#	Moderators	Description	Source
1	External network strength	External network strength is the frequency of business-stakeholder links, which implies social network cooperation.	Cai and Zhou 2014
2	Organizational size	The number of employees at any particular geographical location is known as organizational size.	Shahzad et al. 2022; Nasiri et al.2022
3	Maturity	The level of a company's maturity influences how much its internal and external settings contribute to sustainable innovation.	Nasiri et al. 2022
4	Social position	Despite seeing Emission Trading Scheme as a threat, central enterprises will welcome it to maintain their industry image and social status.	Zhou et al. 2018
5	Top management commitment	Firm-stop management's tangible support for sustainable operations and practices. A firm's management's environmental concern and innovation strategy are its managerial environmental issues.	El-Kassar and Singh 2019
6	HR practices/ Training practices	Environmental education and training raise awareness of environmental challenges.	El-Kassar and Singh 2019
7	Environmental dynamism	Environmental dynamism is defined as the unpredictable frequency of external environmental changes	Yu et al.2022
8	Big data analytics capability	Big data analytics capability is described as an organizational capability to examine, analyze, process, and deploy big data resources in order for business growth and added values.	Yu et al.2022
9	Green strategic responses	It includes questions about different green strategic responses of enterprises related to COVID-19, such as new green products, services, and customer groups.	Hermundsdottir et al., 2022

Based on the aforementioned analysis of bibliographic coupling, previous studies on green innovation adoption have primarily concentrated on practical activities, while comprehensive examinations of the decision-making process and barriers to adoption have been limited. Additionally, in order to enhance the significance of SLR, empirical research has suggested the inclusion of mediating and moderating variables, which can assist future researchers in gaining a deeper understanding of the topics that have already been explored. Furthermore, this approach aims to establish a more comprehensive framework for understanding the drivers, obstacles, and outcomes associated with green innovation adoption, thereby providing researchers with guidance for future investigations. Response #1 (Comment #4-1)

In the study of mediators, two articles have focused on the regulatory role of Sustainable orientation (Aboelmaged and Hashem 2019; Polas et al. 2022). In the research of moderators, the latest hot topics are big data analytics capability (Yu et al. 2022), maturity (Nasiri et al. 2022), and green strategic responses (Hermundsdottir et al. 2022). The extension of GIA research has expanded from its early focus on internal and external research to newer fields.

5. Limitations of this study

5.1 Limitations

This article enhances the SLR on the innovation adoption in a green context by accumulating and synthesizing current research on GIA. However, one limitation is the reliance on databases for retrieving pertinent content. While Scopus and WoS were used as databases for SLR in this research, it is important to note that this review may also include pertinent and high-caliber articles from other databases. Additionally, the limitation is the SLR focuses on the adoption of green innovation rather than green innovation and its specific practices because it is highly relevant to the topic under review. However, other circumstances beyond the scope of this review may require attention.

5.2 Opportunities for future study

There has been almost no SLR on the different determinants, barriers, and outcomes of GIA by organizations in other countries and regions under a comprehensive framework, and there is still a gap in the literature.

The comprehensive findings of the studies included in this SLR indicate that most current empirical research has adopted either quantitative or qualitative methods. Therefore, it is recommended that upcoming researchers use mixed methods to enhance knowledge contribution by supplementing the shortcomings of the two methods. For researchers intending to conduct empirical research, It is crucial to consider the mediators and moderators that have been examined in the adoption of innovation in the green environment in order to prevent redundancy. The determinant factors, barriers and performance outcomes of GIA vary between nations, regions and sectors. In the future, comparative analyses on the real state of the same industry in other nations and areas will be possible. In various industries and national cultural contexts, future research should aim to conduct further comparisons across industries and countries in order to derive conclusions from multiple perspectives. Another recommendation is to examine the variables in GIA (Global Innovation Agility) among different industries within the same geographical area. Additionally, there is a need for further exploration of the interrelationships between determinants, barriers, and outcomes.

For instance, when stakeholders exert pressure, the increased dedication of top management to environmentally friendly practices will result in a higher implementation of green innovation practices (El Kassar & Singh, 2019). Consequently, to overcome the hindrance posed by stakeholder pressure on the adoption of green innovation, the adverse effects of stakeholder pressure will be mitigated through the acknowledgment and active promotion of green innovation adoption by top management.

In the future, there is potential for further exploration into how supplier cooperation can enhance our understanding of the factors, challenges, and results of Global Innovation Alliances (GIA). Additionally, it would be beneficial to conduct further research on the influence of supply chain information pressure on GIA.

6. Conclusion and implications

This study provides a comprehensive overview of the determinants, barriers, and outcomes of green innovation adoption (GIA) through a systematic literature review (SLR) using the PRISMA methodology. The proposed framework integrates the key themes and patterns identified in the literature, offering a holistic perspective on the factors influencing GIA in organizations. The findings highlight the growing interest in GIA research, particularly in the European Union, and the dominance of quantitative methods in the field. The six clusters of research themes identified in the study encompass supply chain management, stakeholder influence, the European context, comprehensive determinants and barriers, performance outcomes, and organizational capabilities. These themes provide valuable guidance for future research and practice in promoting sustainable innovation practices. The study contributes to the literature by addressing the lack of a comprehensive framework for understanding GIA and offering insights that can be applied across industries and countries. However, the study has limitations, such as the focus on organizational business and the reliance on specific databases for article selection. Future research should expand the scope to include other sectors, such as public utility organizations and agriculture, and explore the variations in GIA determinants and barriers across industries and regions. By addressing these limitations and building on the findings of this SLR, researchers can further advance the understanding of GIA and support the development of targeted strategies for promoting sustainable innovation in organizations. A literature review of this system offers a more profound comprehension of the interconnectedness among drivers, barriers, and outcomes, as well as GIA. Furthermore, it elaborates on the mediating and regulatory relationship between drivers and GIA, presenting a comprehensive framework for the research community and practitioners. It provides influential insights for future scholars to utilize the comprehensive framework of this study to further investigate the driving forces, obstacles, and outcomes of organizations on the GIA relationship.

The theoretical contribution of this study lies in the summarization of the determinants of Green Innovation Adoption (GIA) from both internal and external factors. These external factors include customer demands, customer green demand, market and customer dynamics, customer pressure, environmental regulations, regulatory stringency, and command control instruments. The internal factors include top management commitment, management environmental concerns, organizational support, stakeholders, firm internal initiatives, and firm size. This aligns with existing theories of innovation adoption, specifically the technology adoption model of the enterprise (Davis, 1989; Venkatesh, et al., 2003; Rogers, 2003; Tornatzky & Fleischer, 1990), which focuses on the decision-making process of whether to adopt new technologies that the enterprise does not currently possess. This study further enhances and expands the driving factors of the theory of innovation adoption by adjusting variables and mediating variables within the research framework of GIA. Additionally, it extends the understanding of the outcomes of innovation adoption.

For businesses and policymakers, the research findings provide valuable insights for business organizations interested in adopting green innovation, particularly for enterprises that are the primary contributors to carbon emissions. These organizations play a vital role in promoting global sustainable development by encouraging green technology innovation. Furthermore, these findings hold both theoretical and practical significance. Organizational managers can strategically apply the insights obtained from this study to enhance their GIA efforts.

Both developed nations and regions, such as Europe and the United States, as well as developing countries and regions, have shown interest in GIA, but their specific areas of concentration may vary. Developed nations, such as EU, have undertaken comprehensive industry-wide research and have also prioritized service industries such as hotels and tourism. Manufacturing sector has been given more

priority in developing nations such as Pakistan. Furthermore, there is a substantial amount of work that investigates the GIA of small and medium-sized firms. Tunisia and Ghana in North Africa have done research on GIA as it pertains to the agriculture sector. Compared to the analysis of decision-making processes on the implementation of environmentally friendly innovations, the investigation of obstacles in GIA encounters less research limitations. The newest focus has been on the emergence of big data analytics capacity and other organizational skills. Further extensive research is required to investigate the factors, challenges, and results of GIA in different nations and locations globally.

This research created a thorough framework for GIA combining SLR using the PRISMA method. The framework provides a comprehensive overview of prior research on the three crucial areas of causes, obstacles, and outcomes in the field of GIA. It takes a rigorous and expansive approach, surpassing previous academic studies. Furthermore, the driving and barrier variables have a crucial role in mediating or regulating the interaction between GIA, so offering a more complete perspective for study in this particular topic. Furthermore, by employing quantitative analysis and utilizing journal sources, research methods, research countries, and cluster research thematic analysis in the field of GIA, we offer valuable guidance for future research. This includes investigating areas of knowledge that have not been adequately explored and aiding decision-makers and stakeholders in gaining a deeper understanding of the subject matter of GIA.

In light of the described constraints, future researchers who want to perform a SLR may consider broadening their search databases and refining their selection of keywords in order to reduce limitations. Additional sectors, like public utility organizations and agriculture, may be included in the inquiry if they are relevant to the developing challenges being studied. Moreover, doing comparisons of meanings across other sectors might provide additional information. Additionally, it is worth investigating the disparities in GIA factors and obstacles within the same sector across various nations or locations. Furthermore, the current GIA study topics for SLR are limited to organizational business, economics, agricultural organization, policy, green initiatives, and sustainable development. As GIA continues to grow, its influence has spread to individual consumers, farmers, non-governmental groups, and more distinguished researchers are expected to contribute to GIA research in other sectors.

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Appendix A

Ranking	Articles on GIA (authors, year, journal)	Impact Factor(IF)	Citations(C _i)	Year	InOrdinatio
1	Bossle, M. B., de Barcellos, M. D., Vieira, L. M., & Sauvée, L. (2016). The drivers for adoption of eco-innovation. <i>Journal of Cleaner production</i>	11.072	547	2016	562. 011072
2	Cai, W., & Li, G. (2018). The drivers of eco-innovation and its impact on performance: Evidence from China. <i>Journal of Cleaner Production</i>	11.072	400	2018	425. 011072
3	Noppers, E. H., Keizer, K., Bolderdijk, J. W., & Steg, L. (2014). The adoption of sustainable innovations: Driven by symbolic and environmental motives. <i>Global Environmental Change</i>	3.154	417	2014	422. 003154
4	Zailani, S., Govindan, K., Iranmanesh, M., Shaharudin, M. R., & Chong, Y. S. (2015). Green innovation adoption in automotive supply chain: the Malaysian case. <i>Journal of Cleaner Production</i>	11.072	342	2015	352. 011072
5	Borghesi, S., Cainelli, G., & Mazzanti, M. (2015). Linking emission trading to environmental innovation: evidence from the Italian manufacturing industry. <i>Research Policy</i>	9.473	336	2015	346. 009473
6	Cai, W. G., & Zhou, X. L. (2014). On the drivers of eco-innovation: empirical evidence from China. <i>Journal of Cleaner Production</i>	11.072	321	2014	326. 011072
7	Hojnik, J., & Ruzzier, M. (2016). The driving forces of process eco-innovation and its impact on performance: Insights from Slovenia. <i>Journal of cleaner production</i>	11.072	254	2016	269. 011072
8	Aboelmaged, M., & Hashem, G. (2019). Absorptive capacity and green innovation adoption in SMEs: The mediating effects of sustainable organisational capabilities. <i>Journal of cleaner production</i>	11.072	236	2019	266. 011072
9	Antonioli, D., Mancinelli, S., & Mazzanti, M. (2013). Is environmental innovation embedded within high-performance organisational changes? The role of human resource management and complementarity in green business strategies. <i>Research Policy</i>	9.473	265	2013	265. 009473
10	Asadi, S., Pourhashemi, S. O., Nilashi, M., Abdullah, R., Samad, S., Yadegaridehkordi, E., ... & Razali, N. S. (2020). Investigating influence of green innovation on sustainability performance: A case on Malaysian hotel industry. <i>Journal of cleaner production</i>	11.072	209	2020	244. 011072

11	Huang, Y. C., Ding, H. B., & Kao, M. R. (2009). Salient stakeholder voices: Family business and green innovation adoption. <i>Journal of Management & Organization</i>	3.64	211	2009	191.00364
12	Ghisetti, C., Mancinelli, S., Mazzanti, M., & Zoli, M. (2017). Financial barriers and environmental innovations: evidence from EU manufacturing firms. <i>Climate Policy</i>	6.056	167	2017	187.006056
13	Marin, G., Marzucchi, A., & Zoboli, R. (2015). SMEs and barriers to Eco-innovation in the EU: exploring different firm profiles. <i>Journal of Evolutionary Economics</i>	1.962	153	2015	163.001962
14	Ghisetti, C. (2017). Demand-pull and environmental innovations: Estimating the effects of innovative public procurement. <i>Technological Forecasting and Social Change</i>	10.884	124	2017	144.010884
15	Hojnik, J., Ruzzier, M., & Manolova, T. S. (2018). Internationalization and economic performance: The mediating role of eco-innovation. <i>Journal of Cleaner Production</i>	11.072	113	2018	138.011072
16	Rothenberg, S., & Zyglidopoulos, S. C. (2007). Determinants of environmental innovation adoption in the printing industry: the importance of task environment. <i>Business Strategy and the Environment</i>	10.801	165	2007	135.010801
17	Triguero, Á., Cuerva, M. C., & Sáez - Martínez, F. J. (2022). Closing the loop through eco - innovation by European firms: Circular economy for sustainable development. <i>Business Strategy and the Environment</i>	10.801	69	2022	114.010801
18	Pace, L. A. (2016). How do tourism firms innovate for sustainable energy consumption? A capabilities perspective on the adoption of energy efficiency in tourism accommodation establishments. <i>Journal of Cleaner Production</i>	11.072	95	2016	110.011072
19	Zailani, S., Iranmanesh, M., Nikbin, D., & Jumadi, H. B. (2014). Determinants and environmental outcome of green technology innovation adoption in the transportation industry in Malaysia. <i>Asian Journal of technology innovation</i>	1.769	94	2014	99.001769
20	Ali, S., Yan, Q., Dilanchiev, A., Irfan, M., & Fahad, S. (2023). Modeling the economic viability and performance of solar home systems: a roadmap towards clean energy for environmental sustainability. <i>Environmental Science and Pollution Research</i>	5.19	42	2023	92.00519

21	Hazarika, N., & Zhang, X. (2019). Factors that drive and sustain eco-innovation in the construction industry: The case of Hong Kong. <i>Journal of cleaner Production</i>	11.072	61	2019	91. 011072
22	Jun, W., Ali, W., Bhutto, M. Y., Hussain, H., & Khan, N. A. (2019). Examining the determinants of green innovation adoption in SMEs: A PLS-SEM approach. <i>European Journal of Innovation Management</i>	4.75	61	2019	91. 00475
23	Yu, D., Tao, S., Hanan, A., Ong, T. S., Latif, B., & Ali, M. (2022). Fostering green innovation adoption through green dynamic capability: The moderating role of environmental dynamism and big data analytic capability. <i>International Journal of Environmental Research and Public Health</i>	4.614	44	2022	89. 004614
24	El-Kassar, A. N., & Singh, S. K. (2019). Green innovation and organizational performance: The influence of big data and the moderating role of management commitment and HR practices. <i>Technological forecasting and social change</i>	10.884	58	2019	88. 010884
25	Long, S., & Liao, Z. (2022). Green relational capital, integration capabilities and environmental innovation adoption: The moderating role of normative pressures. <i>Sustainable Development</i> .	8.562	43	2022	88. 008562
26	Raza, Z. (2020). Effects of regulation-driven green innovations on short sea shipping's environmental and economic performance. <i>Transportation Research Part D: Transport and Environment</i>	7.041	53	2020	88. 007041
27	Del Río, P., Carrillo-Hermosilla, J., Könnölä, T., & Bleda, M. (2016). Resources, capabilities and competences for eco-innovation. <i>Technological and Economic Development of Economy</i>	5.656	73	2016	88. 005656
28	Polas, M. R. H., Kabir, A. I., Sohel-Uz-Zaman, A. S. M., Karim, R., & Tabash, M. I. (2022). Blockchain Technology as a Game Changer for Green Innovation: Green Entrepreneurship as a Roadmap to Green Economic Sustainability in Peru. <i>Journal of Open Innovation: Technology, Market, and Complexity</i>	0.588	42	2022	87. 000588
29	Gilli, M., Mancinelli, S., & Mazzanti, M. (2014). Innovation complementarity and environmental productivity effects: Reality or delusion? Evidence from the EU. <i>Ecological Economics</i>	6.536	80	2014	85. 006536

30	Zhao, Y., Zhao, Z., Qian, Z., Zheng, L., Fan, S., & Zuo, S. (2023). Is cooperative green innovation better for carbon reduction? Evidence from China. <i>Journal of Cleaner Production</i>	11.072	34	2023	84. 011072
31	Ali, W., Wen, J., Hussain, H., Khan, N. A., Younas, M. W., & Jamil, I. (2021). Does green intellectual capital matter for green innovation adoption? Evidence from the manufacturing SMEs of Pakistan. <i>Journal of Intellectual Capital</i>	6.371	43	2021	83. 006371
32	Ben Amara, D., & Chen, H. (2022). Driving factors for eco-innovation orientation: Meeting sustainable growth in Tunisian agribusiness. <i>International Entrepreneurship and Management Journal</i>	1.578	36	2022	81. 001578
33	Zhang, S., Yu, Y., Zhu, Q., Qiu, C. M., & Tian, A. (2020). Green innovation mode under carbon tax and innovation subsidy: an evolutionary game analysis for portfolio policies. <i>Sustainability</i>	3.889	45	2020	80. 003889
34	Zhou, Y., Hong, J., Zhu, K., Yang, Y., & Zhao, D. (2018). Dynamic capability matters: Uncovering its fundamental role in decision making of environmental innovation. <i>Journal of Cleaner Production</i>	11.072	54	2018	79. 011072
35	Bhatia, M. S. (2021). Green process innovation and operational performance: The role of proactive environment strategy, technological capabilities, and organizational learning. <i>Business Strategy and the Environment</i>	10.801	39	2021	79. 010801
36	González, M., & León, C. J. (2001). The adoption of environmental innovations in the hotel industry of Gran Canaria. <i>Tourism economics</i>	4.582	135	2001	75. 004582
37	Costa, J. (2021). Carrots or sticks: Which policies matter the most in sustainable resource management?. <i>Resources</i>	0	35	2021	75
38	Ullah, S., Khan, F. U., & Ahmad, N. (2022). Promoting sustainability through green innovation adoption: a case of manufacturing industry. <i>Environmental Science and Pollution Research</i>	5.19	29	2022	74. 00519
39	Burki, U., Ersoy, P., & Najam, U. (2019). Top management, green innovations, and the mediating effect of customer cooperation in green supply chains. <i>Sustainability</i>	3.889	44	2019	74. 003889
40	Fahad, S., Alnori, F., Su, F., & Deng, J. (2022). Adoption of green innovation practices in SMEs sector: evidence from an emerging economy. <i>Economic Research-Ekonomska Istraživanja</i>	0.565	29	2022	74. 000565

41	Pellegrini, C., Annunziata, E., Rizzi, F., & Frey, M. (2019). The role of networks and sustainable intrapreneurship as interactive drivers catalyzing the adoption of sustainable innovation. <i>Corporate Social Responsibility and Environmental Management</i>	8.464	43	2019	73. 008464
42	Shahzad, M., Qu, Y., Rehman, S. U., & Zafar, A. U. (2022). Adoption of green innovation technology to accelerate sustainable development among manufacturing industry. <i>Journal of Innovation & Knowledge</i>	11.219	21	2022	66. 011219
43	Han, M. S., & Chen, W. (2021). Determinants of eco-innovation adoption of small and medium enterprises: An empirical analysis in Myanmar. <i>Technological Forecasting and Social Change</i>	10.884	26	2021	66. 010884
44	Pancino, B., Blasi, E., Rappoldt, A., Pascucci, S., Ruini, L., & Ronchi, C. (2019). Partnering for sustainability in agri-food supply chains: the case of Barilla Sustainable Farming in the Po Valley. <i>Agricultural and Food Economics</i>	2.87	34	2019	64. 00287
45	Simms, C., Trott, P., van den Hende, E., & Hultink, E. J. (2020). Barriers to the adoption of waste-reducing eco-innovations in the packaged food sector: A study in the UK and the Netherlands. <i>Journal of Cleaner Production</i>	11.072	28	2020	63. 011072
46	Simms, C., Trott, P., van den Hende, E., & Hultink, E. J. (2020). Barriers to the adoption of waste-reducing eco-innovations in the packaged food sector: A study in the UK and the Netherlands. <i>Journal of Cleaner Production</i>	11.072	28	2020	63. 011072
47	Hartmann, J., Inkpen, A., & Ramaswamy, K. (2022). An FsQCA exploration of multiple paths to ecological innovation adoption in European transportation. <i>Journal of World Business</i>	8.635	18	2022	63. 008635
48	Poussing, N. (2019). Does corporate social responsibility encourage sustainable innovation adoption? Empirical evidence from Luxembourg. <i>Corporate Social Responsibility and Environmental Management</i>	8.464	33	2019	63. 008464
49	Gauthier, J., & Wooldridge, B. (2012). Influences on sustainable innovation adoption: evidence from leadership in energy and environmental design. <i>Business Strategy and the Environment</i>	10.801	67	2012	62. 010801

50	Nasiri, M., Saunila, M., Rantala, T., & Ukko, J. (2022). Sustainable innovation among small businesses: The role of digital orientation, the external environment, and company characteristics. <i>Sustainable Development</i>	8.562	17	2022	62. 008562
51	Carfora, A., Scandurra, G., & Thomas, A. (2021). Determinants of environmental innovations supporting small - and medium - sized enterprises sustainable development. <i>Business Strategy and the Environment</i>	10.801	21	2021	61. 010801
52	Huang, Y. F., Chen, A. P. S., Do, M. H., & Chung, J. C. (2022). Assessing the Barriers of Green Innovation Implementation: Evidence from the Vietnamese Manufacturing Sector. <i>Sustainability</i>	3.889	15	2022	60. 003889
53	Ullah, S., Ahmad, N., Khan, F. U., Badulescu, A., & Badulescu, D. (2021). Mapping interactions among green innovations barriers in manufacturing industry using hybrid methodology: insights from a developing country. <i>International Journal of Environmental Research and Public Health</i>	4.614	19	2021	59. 004614
54	Thomas, A., Scandurra, G., & Carfora, A. (2022). Adoption of green innovations by SMEs: An investigation about the influence of stakeholders. <i>European Journal of Innovation Management</i>	4.75	13	2022	58. 00475
55	Bell, C., & Ruhanen, L. (2016). The diffusion and adoption of eco-innovations amongst tourism businesses: the role of the social system. <i>Tourism Recreation Research</i>	0.877	42	2016	57. 000877
56	Ali, A., Jiang, X., & Ali, A. (2022). Social ties, absorptive capacity, and the adoption of green innovation: a social capital perspective. <i>International Journal of Manpower</i>	3.295	8	2022	53. 003295
