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Mapping the Field: A Bibliometric Analysis of Green Innovation

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Abstract: The topic of green innovation (GI) has increasingly attained organizational relevance due to its contribution to the satisfaction of environmental needs while concurrently enabling companies to differentiate themselves from their competitors, and hence attain sustainable competitive advantages. In this context, we conducted a detailed analysis of 618 papers on green innovation from the Web of Science (WoS) database for the 1971–2015 period. This paper develops a bibliometric analysis with the aim of assessing the key papers in the field and identifying the most substantive contributions to the literature. This study presents the following findings: (i) the chronological development of the discipline; (ii) the research trends and popular issues in this field; (iii) the antecedent variables acting as key drivers of GI in these studies; and (iv) the main outcomes of GI. Therefore, this paper provides the past, the present and the potential future of this specific topic and serves as an orientation and guide for researchers who are new to the topic of GI; it also enhances their knowledge concerning which journals, authors and articles they may consult while creating their theoretical framework or designing future research models.

Keywords: green innovation; sustainability; bibliometric analysis; Web of Science

1. Introduction

In recent years, the growing global concern about environmental issues, the strict regulations on international conventions for sustainability and environmental protection, and an increase in the number of pro-environmental consumers have led industries to dedicate significant efforts to developing green practices. Until a few years ago, however, the academic community had paid little attention to the organization's role in protecting the environment.

In this way, and despite many researchers' recent attempts to understand and explain this topic, the green innovation (GI) construct remains open to interpretation regarding even its most necessary aspects, including the definitions or types of innovation and measurement. This ambiguity has led to a significant escalation in the number of working papers, conference sessions and workshops on GI throughout the world. Special Issues focused on GI are starting to appear in academic books and journals. The wide variety of studies contributes to the vitality and affluence of research on GI but also creates some confusion regarding the construct's meaning and utility. Several studies provide insights with a literature review of GI (e.g., [1,2]), but the field of GI is beginning to split into distinct branches because of researchers' different foci of study.

Recently, some studies have applied the bibliometric methodology to the field of eco-innovation (e.g., [3]). Yet, these studies only rely on the use of such a methodology to complement a theoretical

article, with graphs and tables showing the distribution of papers per year or a group of journals involving a certain degree of specialization on the topic.

By contrast, this research applies bibliometric techniques to explore the way in which scholarly literature on GI is being developed. The bibliometric methodology makes it possible to give shape, structure and direction to the research domain as it develops and advances. Therefore, this study analyzes the chronological development of the discipline, the research trends and popular issues in the field of this study, the antecedent variables acting as key drivers, and the main outcomes of GI.

To do so, this article uses the Web of Science database (WoS), which lists up to 2350 publications until the end of 2015. This study focuses exclusively on analyzing the publications related to the topic of green innovation in the business economics research area from 1971 to 2015 in order to assess their scholarly impact. This period of time comprises 618 publications devoted to investigating GI.

Hence, the main aim of this study is to use the bibliometric methodology in the GI field to identify and analyze the critical literature on this topic, based on the publication impact on the scholarly community to know the past, the present, and the future of this field of research. To learn about this field's past, the study shows the stages through which the discipline has been reflected. The analysis of the most cited studies brings to light the most important concerns or debates that shape this topic. Finally, after reviewing the latest empirical papers in the area, this study may offer insights concerning the best way to face future research gaps. This study could guide researchers through the concept of GI because it shows the literature that has to be included in further analyses. Furthermore, this study might serve as a point of reference and a preliminary approach for new researchers seeking to familiarize themselves with the GI literature and trends.

The structure of this study is as follows: The second section presents a review of the GI literature to show the impact of this topic on the management field and delineate its domain. In the third section, the study describes the methodology. The fourth section presents the results of the bibliometric analysis. Finally, the fifth section provides conclusions, limitations and possible avenues for future study.

2. A Review of the Green Innovation Concept

In general, different terms are used to explain the type of innovation aimed at minimizing the negative effect that organisations can have on the environment, such as "eco", "sustainable", "environmental" and "green" [4], with several differentiations and similarities between them. Subsequently, we briefly review some of the most accurate definitions in this regard.

According to Kemp and Pearson [5], the term "eco-innovation" consists of constructing, assimilating or exploiting a product, production process, service, or managerial method that is novel to the organization that is developing or adopting it. It must also result (throughout its life cycle) in a reduction of environmental risk, pollution, and other negative impacts of the use of resources (including energy use) compared with relevant alternatives. "Environmental innovation" comprises a set of techniques, systems, products and/or new or modified processes that serve to prevent or reduce environmental damage [6]. Finally, "sustainable innovation" is defined as "the integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and well-being of all people" [7] (p. 30).

The term "environmental innovation" emerges as the predominant term. It is frequently replaced by "eco-innovation", which has been the most commonly used term in this regard for the past decade [3]. However, this study focuses on the term "green innovation", which is the least developed because of the scarcity of clear and precise definitions in the literature. Thus, a clarification of this concept is essential [3]. According to Schiederig [8], the increase in the use of the different terms depends on the aspects of different definitions (i.e., innovation object, market orientation, phase, impulse or level).

Although several authors, including ([9,10]), have already defined green innovation, a clarification of the concept is necessary for the purposes of this study.

We initially define the concept of green innovation (GI) as a type of innovation whose main objective is to mitigate or avoid environmental damage while protecting the environment and enabling companies to satisfy new consumer demands, create value, and increase yields.

Some previous references to the concept can be found in the literature. Authors such as [8,11] suggest that green innovation may increase firms' productivity and maximize their use of resources. The firms become more competitive as a result of the gain in and sustainment of competitive advantages rooted in the corporate image improvement and the development of new markets, while satisfying the requirement of environmental protection [12,13]; this has generated a growing flow of research on this particular topic, and it marks the first time a clear concept of GI has appeared. Chen [10] (p. 332) define "green innovation" as "hardware or software innovation that is related to green products or processes, including the innovation in technologies that are involved in energy-saving, pollution-prevention, waste recycling, green product designs, or corporate environmental management". In their efforts to carry out environmental actions, companies might develop new products, processes, and/or managerial innovations that are designed to increase companies' levels of efficiency and/or effectiveness [14]. These authors also suggest that GI is involved in waste recycling, green product designs, energy saving, pollution prevention and corporate environmental management.

Chang [13] (p. 363) states that green innovation "can enhance the performance of environmental management to satisfy the requirements of environmental protection. A company devoted to developing green innovation can not only meet the environmental regulations but also build up barriers to other competitors." Leenders and Chandra [15] argue that green innovation is a product or process innovation that includes the development of new technologies focused on pollution prevention, waste recycling, energy saving and eco-efficient design. Recently, Hashim [4] posited that this kind of innovation seeks to reduce the impact of the firm's activity on the environment by including transformations in corporate strategies, product-designing methods, production processes, resource consumption, and waste-disposal procedures.

Thus, GI is sustained to exert a positive effect on competitive advantage (e.g., [8,9]). If companies are ready to carry out GI, they might reap the advantages of differentiation and challenge existing competitive rules. GI has become a core strategic concern for firms, which may be described as a combination of abilities and knowledge that makes it possible to generate commercial innovations without harming the environment [16]. Hence, companies would commercialize sustainable products (protection of the environment in the design and packaging of products), which might increase the differentiation advantages ([9,11]). Moreover, the adoption of proactive, environment-oriented, managerial strategies will allow firms to avoid facing sanctions or protests by environmentalists [17]. The pioneers in implementing GI can sell green products and services at higher prices, enjoy higher profits, improve their corporate image, sell their innovative environmental technologies and even create new markets ([8,18]) that address the needs of the most demanding customers. In this way, GI increases companies' productivity and efficiency in assigning resources, along with their environmental management performance in order to meet the requirements of environmental protection [12] that simultaneously create barriers to competitors [19].

Next, Table 1 shows the green innovation definition approach.

Table 1. Green innovation definition focus.

Author	Focus
[20]	Continuous innovation, new market opportunities, wealth creation.
[11]	Quality of life, very profitable, not only in terms of efficiency.
[8]	Corporate image, successful companies.
[21]	Environmental burden.
[22]	Concerns not only the process but also the product.
[12]	Environmental management, requirement of environmental protection.
[9]	Hardware or software innovation, green products or processes, innovation in technologies, energy saving, pollution prevention, waste recycling, green product designs, corporate environmental management.
[23]	Great effort in environmental management, avoiding the trouble of protests or punishment about environmental protection, corporate images, develop new markets, competitive advantages.
[13]	Satisfy the requirements of environmental protection, devoted to developing green innovation, environmental regulations, barriers to other competitors.
[1]	Enhance product value, offset the costs of environmental investments.
[24]	Minimization of environmental impacts, management innovation, process innovation, product innovation, technological innovation.
[10]	Technological improvements, save energy, prevent pollution, waste recycling, green product design, corporate environmental management.
[15]	Development of new technologies, energy saving, pollution prevention, waste recycling, eco-efficient design.
[4]	Type of innovation reduced impact on the environment.
[16]	Strategic need for firms, great opportunity to prevent buyers' harming the environment.
[25]	Mitigate or avoid environmental damage, responsible and optimal use of available resources.

3. Method

3.1. Technical Support and Tools

In order to develop the objectives that we have explained in the introduction, we use Bibliometric analysis. This technique was introduced by Garfield [26], who claimed that it collects a set of mathematical methods and statistics used to analyze and measure publications (i.e., articles, books, and book chapters, among others). It consists in applying statistical methods to establish qualitative and quantitative changes within a given scientific research topic to detect the profile of publications on the topic and to pinpoint trends within a discipline ([27–29]).

Bibliometric analyses examine bibliographical material that is useful in order to exploit, organize and analyze the information in a particular field [30] for experts seeking to assess scientific activity [31]. It represents an innovative methodology with respect to traditional theoretical framework building [32]. Hence, bibliometric analyses will make it possible to know the past, understand the advances of the investigations and enhance future research. Moreover, the research trends and popular issues in the study fields may be identified by employing such a method. The resulting information is also useful in decision making [33].

Finally, to illustrate our study we use two software tools. *Bibexcel* is frequently used to perform bibliometric and network analysis and *Pajek* used for the analysis and visualization of large networks [34].

3.2. Database Choice

The first step of a bibliometric analysis is to identify the databases that would be useful for the purpose of the research. Bibliometric analysis is limited by the information available. Therefore, the information sources must be reliable and suitable to perform the analysis and to make the best decisions [35], hence the importance of choosing an appropriate database. The ISI, Scopus and Google Scholar databases are available and up-to-date, and therefore their use in the literature is very prevalent.

This study uses the Thomson Reuters Web of Science database (WoS) (formerly the ISI Web of Knowledge), which is an online scientific information supporter. This database gives scholars access to material available from scientific journals, books, and other academic papers in all scientific fields. All journals in the WoS have an impact factor in the Journal Citation Report (JCR), which makes it possible to classify journals as top-tier or lower-tier journals. The bibliometric analysis of studies within the WoS provides data on output, collaboration, dissemination, and impact [27].

3.3. Indicators

After choosing the database, the second step is to select the indicators to evaluate the sample obtained. Few studies provide a description of the methodology that should be applied for a bibliometric analysis (the appropriate indicators, their measurement and their graph representation or their interpretation) [36]. As a result, the literature presents different types of bibliometric indicators [33,37]. According to [33], there are three types of bibliometric indicators: (i) quantity (to measure the productivity); (ii) quality (to measure the impact); and (iii) structural (to measure the connections) indicators.

3.4. Codification Process

This study examines the research area of business economics, which comprises more studies on green innovation than other areas (618 research studies). Our analysis was performed in January 2016 using the WoS database. This study analyzes scientific studies for the period 1971–2015. The starting year is 1971, and the date of publication of the first study on GI is listed in the WoS.

This bibliometric analysis includes the most common knowledge areas, the most prolific authors, the journals with the most publications, the most productive countries and the most cited studies. The search term used is "green innovation", and the results were filtered according to the indicators used. The WoS webpage allows filtering the results and collecting the publications using the keyword "green innovation" in the titles, abstract, and/or keywords.

4. Results

This section presents the results of the bibliometric analysis of GI. Given that the aim of this study is to gain an overall perspective of the development of research on GI, the analysis is not limited to any specific language, document type, or country. This study examines research works published between 1971 and 2015. The study titled *Elements of Induced Innovation–Historical Perspective for Green Revolution* by Yujiero Hayami [38] was the first document to be published on the topic that is listed in the WoS.

The 618 studies on green innovation in the business economics field are made up of 383 articles, 200 proceedings papers, 14 reviews, two editorial materials, three book reviews and one note, one reprint, and one discussion.

The bibliometric variables applied in this study are as follows:

- The number of publications on GI per year between 1971 and 2015.
- The most cited papers published on GI.
- The most frequent trends and topic words.
- The number of empirical studies that assess GI variable, as well as the drivers and outcomes variables of GI.

4.1. Evolution of Publications and Citations Structure

Figure 1 shows the accumulation of the number of studies published about GI since 1971 and reveals three stages in the publication trend. The first stage corresponds to the period between 1971 and 1999, when the volume of studies was less than 20 studies per year. The second stage covers the period from 2000 to 2007, when research grows moderately. The annual volume was 19 studies. Finally, during the third stage, from 2008 to 2015, the number of publications has increased considerably. The annual volume for this period is between 60 and 90 studies, the record number being 92 in 2015. Figure 1 also reveals the number of citations per year that these studies have obtained.

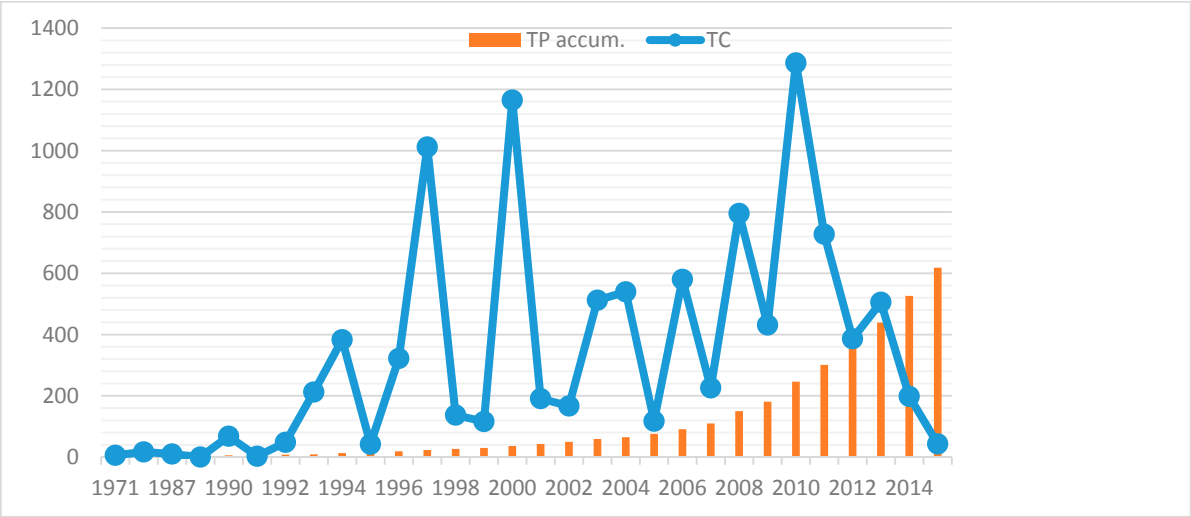

Figure 1. Total publications (accumulated) and total citations on green innovation (GI) between 1971 and 2015.

Table 2 presents the annual number of citations of GI studies. The results show that, over the past few years, the increase in citations has been significant, reaching a record of 1282 citations in 2010. The high number of citations corresponding to 1997 (1012) is due to the publication of *A Resource-Based Perspective on Corporate Environmental Performance and Profitability* by Russo and Fouts [39], which has received 943 citations. This is the article on GI with the highest number of citations. Similarly, out of the 1165 citations from 2000, 582 citations belong to a single article: *Why Companies Go Green: A Model of Ecological Responsiveness*, written by Bansal and Roth [40].

Table 2 also provides the results for the number of articles that have 100 or more, 50 or more, and 20 or more citations. The results show that only 16.16% of the studies obtain more than 100 citations, 25.38% obtain more than 50, 61.50% more than 20, almost 57.59% more than 10, 65.40% more than five citations, and the rest of the studies have received more than one citation.

In the past few decades, we observe a significant increase in the number of publications. Information and communication technologies (ICTs) might have enabled this increase, as they have facilitated the introduction of bibliographic reference tools and online databases (e.g., Scopus and WoS).

Table 2. General citation structure of GI literature according to (Web of Science) WoS.

Year	Total Studies	Total Citations	>100	>50	>20	>10	>5	>1
1971	1	6	0	0	0	0	1	0
1981	2	17	0	0	0	1	0	1
1987	1	10	0	0	0	1	0	0
1989	1	0	0	0	0	0	0	0
1990	1	68	0	1	0	0	0	0
1991	1	3	0	0	0	0	0	1
1992	1	48	0	0	1	0	0	0
1993	1	212	1	0	0	0	0	0
1994	4	383	1	0	1	0	0	2
1995	2	42	0	0	1	1	0	0
1996	4	322	1	2	0	0	0	1
1997	4	1012	1	0	0	1	1	0
1998	4	137	0	1	1	1	1	0
1999	3	116	0	1	1	0	0	0
2000	6	1165	2	0	1	0	0	0
2001	7	191	1	0	1	3	2	0
2002	7	167	0	1	4	1	1	0
2003	9	512	1	3	3	0	1	0
2004	6	539	1	0	3	1	0	0
2005	11	117	0	1	0	1	1	1
2006	15	580	2	1	3	1	1	1
2007	19	226	1	0	1	3	1	2
2008	40	795	1	7	2	5	3	2
2009	31	431	0	2	7	3	4	2
2010	65	1286	4	4	7	3	6	7
2011	55	727	0	2	13	10	10	1
2012	61	386	0	0	4	10	11	15
2013	77	505	0	0	7	12	19	20
2014	87	198	0	0	2	0	4	10
2015	92	43	0	0	0	1	0	21
Total	618	10,244	17	26	63	59	67	87
Percentage	100	100	16.60	25.38	61.50	57.59	65.40	84.93

4.2. The Most Cited Publications

This section presents the 20 most cited studies found in the WoS (Table 3). Publications were collected using the search string "green innovation" in the abstract, keywords, and/or title, including all studies published in the business economics discipline.

The most cited article, with almost 950 citations, is *A Resource-Based Perspective on Corporate Environmental Performance and Profitability*, written by Russo and Fouts [39], whose authors argue that there is a positive relationship between environmental performance and economic performance and that industry growth moderates this link. They carry out a longitudinal analysis to test their hypotheses on a sample of 243 companies. Their results reveal that being green pays off and that the link between environmental performance and economic performance boosts higher-growth industries. In second place, Bansal and Roth [40] *Why Companies Go Green: A Model of Ecological Responsiveness*, has been cited 582 times. This study sought to disentangle the motivations and contextual factors underlying corporate ecological responsiveness. The authors gathered qualitative data from 53 companies in the UK and Japan. Their results revealed three main motivations (competitiveness, legitimation, and ecological responsibility), influenced by three contextual conditions (field cohesion, issue salience, and individual concern). A study by Zhu and Sarkis [41] appears in third place with 393 citations. In this work, the authors investigate how two principal managerial operations philosophies—quality management and just-in-time (or lean) manufacturing—influence the relationship between green supply chain management practices and business performance. The first two works were published in the *Academy of Management Journal*, one of the most prestigious research journals in the field of

management. Most studies on this list are from the 1990s and 2000s, although some recent studies also make an appearance.

Table 3. The 20 most cited studies on GI.

Rank	TC	Title	Author	Journal
1	943	A resource-based perspective on corporate environmental performance and profitability	[39]	*Academy of Management Journal*
2	582	Why companies go green: A model of ecological responsiveness	[40]	*Academy of Management Journal*
3	393	Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises	[41]	*Journal of Operations Management*
4	341	It's not easy being green	[20]	*Harvard Business Review*
5	233	Extending green practices across the supply chain—The impact of upstream and downstream integration	[42]	*International Journal of Operations and Production Management*
6	206	The adoption of agricultural innovations—A review	[43]	*Technological Forecasting and Social Change*
7	126	The influence of green innovation performance on corporate advantage in Taiwan	[9]	*Journal of Business Ethics*
8	107	Information systems innovation for environmental sustainability	[44]	*MIS Quarterly*
9	99	Design for the environment: A quality-based model for green product development	[45]	*Management Science*
10	92	Use the supply relationship to develop lean and green suppliers	[46]	*Supply Chain Management—An International Journal*
11	90	Green and competitive—Influences on environmental new product development performance	[47]	*Journal of Business Ethics*
12	88	Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives	[48]	*Supply Chain Management—An International Journal*
13	85	The driver of green innovation and green image—Green core competence	[23]	*Journal of Business Ethics*
14	79	Managing 'green' product innovation in small firms	[22]	*R&D Management*
15	75	The Drivers of Green Brand Equity: Green Brand Image, Green Satisfaction, and Green Trust	[49]	*Journal of Business Ethics*
16	69	Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability	[50]	*Journal of Business Ethics*
17	59	The effects of customer benefit and regulation on environmental product innovation. Empirical evidence from appliance manufacturers in Germany	[51]	*Ecological Economics*
18	56	The positive effect of green intellectual capital on competitive advantages of firms	[52]	*Journal of Business Ethics*
19	53	The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan	[53]	*Transportation Research Part E—Logistics and Transportation Review*
20	48	Why and how to adopt green management into business organisations?: The case study of Korean SMEs in manufacturing industry	[54]	*Management Decision*

4.3. Large Networks

Based on Pajek tools for the visualization of large networks, as shown in Figure 2, which includes the most frequent topics addressed within this field, we can observe that there exist some certainly large nodes that represent the main terms or topics that shape this field: innovation, sustainability, sustainable development, environmental, and GI.

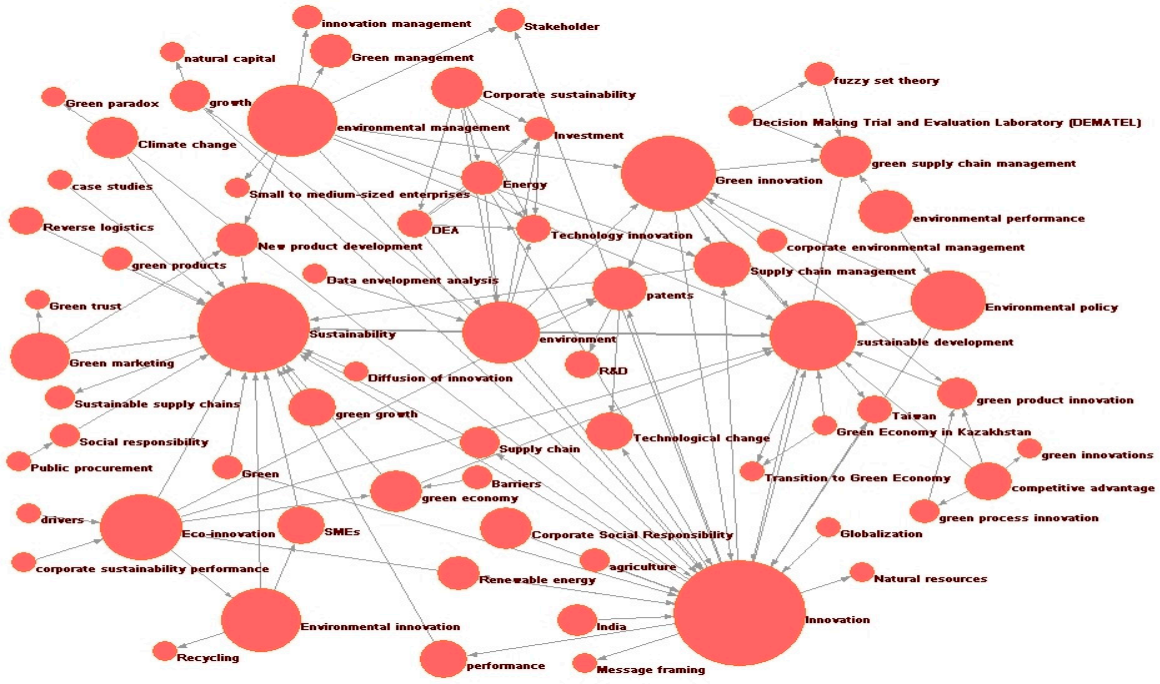

Figure 2. Most frequent topic words.

Innovation is the term most used, since it is the key concept from which most researchers within the topic of GI begin their work. The subsequent most highlighted nodes are sustainability, sustainable development, and GI. Likewise, innovation processes toward sustainable development have received increased attention during the last decades. Nonetheless, these terms have continued being adapted because clear definitions to describe these topics did not exist.

We may also pay attention to some topics that are arising and increasingly attaining more attention, although the size of their nodes is not yet that large. This is the case of topics such as green marketing, green supply chain management, corporate sustainability, energy, and climate change.

4.4. Green Innovation Variable

Finally, this section presents a list of empirical studies that use the GI variable in their models (Table 4). This list provides the variables most commonly related to GI and suggests where to find a theoretical or empirical gap in this research field. Nevertheless, an important proportion of the most cited articles in this field involve theoretical works aimed at the conceptualization and development of GI. In this sense, only 14 studies make empirical use of the GI variable. This may be because research in GI is still in its initial stages or because there are different and interchangeable terms to refer to the same topic. Table 4 provides the authors' names, the journal's title and the variables used in each study. We assess and distinguish between the types of variables to acknowledge which role is associated with GI: GI drivers (modeling GI as a dependent variable), outcomes of GI (modeling GI as an independent variable), and the mediating or control variable. We did not find moderating variables in these works.

Table 4. Selected empirical research on GI.

Author	Journal	Trends in Research	Drivers of GI	Outcomes of GI	Mediating or Control Variables
[9]	*Journal of Business Ethics*	Performance		Corporate competitive advantage	
[10]	*Organization and Environmental*	Performance/drivers	Environmental regulations, environmental normative levels	Financial performance	
[1]	*Management Decision*	Drivers	Environmental leadership, environmental culture, environmental capability, environmental request of investors and clients, environmental regulations		
[55]	*Corporate Social Responsibility and Environmental Management*	Drivers	Foreign customers, stockholders, foreign investors, regulatory stakeholders, community stakeholders		Industrial type, firm size
[56]	*Supply Chain Management: An International Journal*	Process/drivers	Green supply chain integration		Environmental uncertainty/firm size
[57]	*Management Decision*	Drivers	Green organisational identify		Environmental commitment, environmental organizational legitimacy
[58]	*Energy Journal*	Context	Energy prices		
[16]	*Journal of Knowledge Management*	Drivers/performance	Information technology, relationship learning	Customer capital	
[59]	*Business Strategy and the Environment*	Drivers	green requirements, knowledge sharing		
[23]	*Journal of Business Ethics*	Drivers/performance	Green core competences	Green image	
[53]	*Transportation Research Part E*	Drivers/performance/process	Greening the supply	Environmental performance, competitive advantage	
[13]	*Journal of Business Ethics*	Drivers/performance	Corporate environmental ethics	Competitive advantages	
[60]	*Asian Journal of Technology Innovation*	Drivers/performance/process	Organizational support, quality of human resources, customer pressure, government support, environmental uncertainty	Environmental outcome	

Below, Table 5 shows the level of statistical significance of the variables included in the studies enumerated in Table 4. The level of statistical significance (sig.) may appear with "*" whenever it is significant. The number of "*" depends on the *t*-value of the variable in the hypothesis.

In this section, we also group these studies according to the classification that [3] previously used and validated. To do so, we have read the different works and analyzed the variables of these studies. This classification provides the trends in research. The authors cluster the works according to the following categories:

- *Performance*: This category includes articles focusing on the results and outcomes of GI: performance, customer capital, competitive advantage, etc.
- *Drivers*: The main interest of the articles in this category is finding the antecedents of green innovation.
- *Types*: This category is shaped by articles aimed at classifying the different types of green innovation: product, process, managerial, and technological.
- *Process*: This category encompasses all the articles that focus on the process of the development of these types of innovations: green supply chain, green marketing, and green technology innovation.

- *Context*: This category comprises articles that focus on showing the Special Issues occurring in the context of a study such as a specific region or country, transition economies, etc. These works tend to be comparisons.
- *Policy*: This category groups together the articles that focus on policy evaluation, transition management, and the diffusion of GI through policies.

With regard to the classification of trends in this research, "performance" and "drivers" are the most recurrent categories. On the one hand, the independent variables that act as drivers of green innovation in these 14 studies include environmental regulations, environmental normative levels, environmental leadership, environmental culture, environmental capability, environmental request of stakeholders, foreign customers and investors, relationship learning, knowledge sharing, organizational support, and information technology. On the other hand, the main outcomes of green innovation are environmental performance, financial performance, environmental outcome, competitive advantages, green image, and customer capital. Some repeatedly used variables are: factors of environmental uncertainty, performance, and competitive advantage.

This second table allows deeper and more accurate insights into which of the variables are effectively drivers or outcomes of GI.

Given the empirical evidence provided by the literature examined, it has not been demonstrated that regulatory stakeholders, community stakeholders, organizational support, and government support constitute drivers of green innovation, as these relationships are found not to be significant. We may highlight that all the other variables (GI drivers and outcomes) seem to reach satisfactory levels of statistical significance in their links with GI.

Table 5. The level of significance of variables.

Author	GI Drivers	GI Outcomes
[9]		Corporate competitive advantage: +/sig. **
[10]	Environmental regulations: +/sig. ** Environmental normative levels: +/sig. **	Financial performance: +/sig. *
[1]	Environmental leadership: +/ sig. ** Environmental culture: +/ sig. * Environmental capability: +/ sig. * Environmental request of investors and clients: +/ sig. * Environmental regulations: +/ sig. *	
[55]	Foreign customers: +/ sig. * Stockholders: +/ no sig. Foreign investors: +/ sig. * Regulatory stakeholders: +/ no sig. Community stakeholders: +/ no sig.	
[56]	Green supply chain integration: +/sig. ***	
[57]	Green organizational identify: +/sig. **	
[58]	Energy prices: +/sig. **	
[16]	Information technology: +/sig. *** Relationship learning: +/sig. ***	Customer capital: +/sig. ***
[59]	Green requirements: +/sig. * Knowledge sharing: +/sig. ***	
[23]	Green core competences: +/sig. **	Green image: +/sig. **
[53]	Greening the supply: +/sig. ***	Environmental performance: +/sig. *** Competitive advantage: +/sig. ***
[13]	Corporate environmental: +/sig. **	Competitive advantages: +/sig. *
[60]	Organizational support: +/ no sig. Quality of human resources: +/ sig. *** Customer pressure: +/ sig. * Government support: +/ no sig. Environmental uncertainty: +/ sig. ***	Environmental outcome: +/sig. ***

The level of statistical significance (sig.): * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

5. Discussion

This study presents a bibliometric analysis of the literature on green innovation (GI) between 1971 and 2015, according to the publications available in the Web of Science (WoS). Our paper provides a general overview of the recent studies on GI in order to determine the research trends and popular issues, the antecedent variables acting as key drivers, and the main outcomes of GI. Therefore, this

study provides a review of the literature and means to summarize the available research and findings published to date. In brief, this study offers a guide to those who are entering the green innovation field, providing information with regard to the past, the present, and the future of this field in order to build interesting empirical models or develop a worthy literature review.

The analysis of the evolution of publications and citations on green innovation allows us to appreciate the evolution of the field. In addition, it enables us to know which have been the years with the highest number of publications and/or citations.

The present study also sheds light on this field's research trends and popular matters. The main issues are GI, sustainability, sustainable development, and environmental. However, we also observe that they are related with recent topics, such as green marketing, green supply chain management, corporate sustainability, energy, and climate change.

The antecedent variables of GI found in this study are: environmental regulations, environmental normative levels, environmental leadership, environmental culture, stakeholder's environmental request, relationship learning, knowledge sharing, environmental capability, and information technology. Therefore, these variables are the ones most used currently.

Finally, the study shows a scarcity of empirical studies that use GI as one of the variables in their research models and hypotheses. Specifically, only 14 empirical studies in the entire WoS employ GI as a research variable. The analysis of empirical studies has allowed us to identify the variables that are used in the models proposed and act as GI drivers and outcomes. On the basis of the conclusions reached by the studies assessed, we can affirm that there is heterogeneity with regard to the variables explored in these works. Therefore, the variables used enable us to have a clear view of the issues addressed in this field, and we can contribute to generating ideas and knowledge for future research.

In this vein, most publications have used the GI variable as a dependent variable, probably because the final objective of the model proposed in most of the studies is to identify the effects of GI on the firms implementing it. The GI variable has also been used as a mediator of a relationship. For instance, in the study by [53], GI positively mediates the relationship between greening the supplier and environmental performance.

Our results also show that research on GI is relatively recent and has its roots in a very particular framework of the literature that is entrenched in the field of environmental management. The topic is of current relevance, and its diffusion takes place mostly in conferences and similar meetings. It seems that publishing studies in a new field is easier because there is still much to discover.

6. Conclusions, Limitations and Future Research

The field of GI has experienced substantial growth since the 1970s, especially in the last few years, which has reflected a noteworthy impact on the literature. In any case, the emergence of an increasingly disaggregated interest is being observed regarding this particular field of knowledge. In conclusion, GI makes up a topic that has been very recently developed and currently entails great relevance both for academics and practitioners. Although GI is mostly used as a dependent variable and the theoretical background surrounding this concept remains under construction, there is a broad heterogeneity with regard to the drivers or antecedent variables of GI. This might be explained by the diversity of scholars approaching this issue (management, economics, engineering, biology, etc.), which in turn reflects the strong interest that this research topic has currently attained.

Nevertheless, the interpretation of the results presented and discussed above is subject to several limitations. First, this research is based on a sample of documents published in the WoS. There are more studies on green innovation published in non-indexed journals that are not accessible through the WoS database. Second, the citation index and the number of publications are frequently used to measure quality and quantity, respectively, despite the actual quality of the document. Podsakoff et al. [61] argued that the number of articles was less significant than the number of citations, as the latter is considered a better approach to a researcher's impact and influence. Nonetheless, the mere fact that an author is considered important or relevant often persuades other authors to cite that particular

author without reading his/her articles or developing a decisive or specific view of their content [62]. Third is the problem of different authors with the same names, which is a general problem in the use of this method. Fourth, four different terms are used interchangeably in the literature to describe innovations that contribute or are intended to reduce the organizations' negative impact on the environment: "green", "environmental", "sustainable", and "eco". This is a serious problem as it results in overlapping definitions riddled with inconsistencies. Fifth, while the results give a picture of the current situation, this situation may change over time, especially for the publications from the past two years that still have to grow considerably in terms of the number of citations. Finally, it should be noted that this study has been developed within a specific field: green innovation. Therefore, researchers should be cautious about generalizing these conclusions.

For future research studies, scholars might consider conducting a bibliometric analysis using other databases (e.g., Google Scholar or Scopus), which would contribute to gathering more information and reaching a better understanding of the topic. Future research could also use a structural indicator, which measures the relationships between publications, authors and areas of knowledge using sociograms.

Finally, further studies could narrow the focus of the bibliometric analysis by studying only GI articles published in English or by comparing the terms "eco", "sustainable", "environmental", and "green" innovations with each other. In addition, it could be interesting to perform an analysis that reflects the current topics in the field and their evolution over time.

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