Management Perspective of "Green Strategies" Research—Scientometric Analysis

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Abstract This study provides insight into research on green strategy in the disciplines of management, business, and economics. The dataset of 544 bibliographic references was extracted from the Web of Science database. The main findings of the study indicate that the research on green strategies related to the management perspective is continuously increasing; however, the growth is not yet exponential and further research is needed. In terms of collaboration between authors, institutions, and countries, the results show that the development of research networks between different authors, institutions, or countries is still in its infancy. Analysis of the co-occurrence of keywords shows the evolution of research interests from more general to more focus. Green innovation is one of the emerging hotspots in the research field. The analysis of document co-citations sheds light on the major specialties in green strategies research. The main contribution of this study is in concisely summarizing the intellectual base (most cited articles) and research frontiers (citing articles), and providing insights useful to researchers, practitioners, and policymakers.

Keywords Environmental management · Green strategy · Management discipline · CiteSpace · Scientometric analysis

1 Introduction

Carbon emissions have been frequently recognized as one of the major cause of environmental degradation. Production-related carbon emissions account for up to one-third of total carbon emissions. Not surprisingly, an increasing number of stakeholders, such as governments, local communities, industry or trade associations, and especially consumers, are expressing concern about companies' environmental performance. As a result, the governments have applied regulatory and legislative pressure to prevent or control long-term environmental degradation. More and more companies, such as multinational corporations and companies in the construction

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sector, to name a few [1], are already required to actively and effectively implement "green" or "environmental management" strategies to meet the regulatory frameworks of their respective markets. Increasingly, companies view environmental issues as a strategic imperative to reduce the cost of scarce natural resources or as a strategic opportunity to gain competitive advantage [2]. Accordingly, academic research on how contemporary businesses become green (or carbon neutral) has been recognized as important to stainable development.

Green or environmental issues have been considered from different perspectives. Currently, the number of publications dealing with environmental protection, resource conservation, carbon reduction, clean production, recycling, or waste management seems to be growing exponentially and gaining interdisciplinary attention. Addressing the management, business, and economic contribution to environmental management may be the most urgent task to enable companies and other stakeholders to better understand these issues and more effectively implement green or environmental management strategies at the company level [3].

Green strategies have not only been frequently called for, but they have also been difficult to define, pursue, and implement. The proverbial phrase that "going green" is easier said than done is true in both academic and practical senses. Improving the management capacity of companies to successfully develop green strategies and effectively implement them is increasingly recognized as important to the future viability of any business. Despite the expansion of environment-related literature, there are relatively few studies that are focused on the management perspective of green strategy research. This study attempts to uncover the progress of management insights emerging from green strategy research. The purpose of the study is to examine the current state of green strategy research and to assess the patterns of collaboration, intellectual base, and emerging themes of green strategy research using the increasingly popular data-driven scientometric analysis. The concise summary of the most active authors, collaboration patterns, research fronts, and emerging hotspots of green strategies research is primarily intended for researchers, practitioners, and policymakers who can benefit from a better understanding of the diversification of the topics studied and their development trends or interrelationships.

The remainder of the paper is organized as follows: Sect. 2 provides an overview of the meaning and definitions of "green" and "environmental management" strategies. Section 3 outlines the scientometric approach and describes the protocol for retrieving and analyzing the dataset of bibliographic records. The results are presented and discussed in Sect. 4. Section 5 summarizes the main conclusions, limitations, and further research implications of the study.

2 Previous Research

2.1 Environmental Management

The increased environmental consciousness of governments, consumers, and local communities is an open call for designing and implement better environmental management strategies. Reducing the company's negative impact or increasing its positive impact on the environment is becoming a strategic priority for more and more companies. In part, this strategic priority is driven by government regulations, customer safety concerns, local community environmental concerns, and in part by sound business decisions. As a result, over the past few decades, the literature on environmental management or green strategies has gradually expanded.

The first mentions of the environmental management date back to Welles' analysis of environmental management strategies amid multinational corporations [1]. One study stated that the focus of environmental management should be to "prevent negative environmental impacts and improve environmental performance by institutionalizing various environmental programs and practices, such as establishing environmentally related performance measures and developing green technologies, processes, and products" [4]. Porter [5] made an important conceptual contribution to this field by suggesting that environmental management should be used to provide sustainable competitive advantages to firms. Pettula [6] suggested that avoiding environmental risks/crises, reducing costs, and achieving differentiation by exceeding environmental and industry regulations and standards are the three main approaches to corporate environmental management strategies.

Previous literature reviews of environmental management strategies offer at least two major typologies or taxonomies of environmental management strategies [3]. One critical review of corporate responses to the natural environment found that typical responses can be categorized along the stages of "Non-Compliance, Compliance, Compliance Plus, Commercial and Environmental Excellence, Leading Edge" [7]. Another study found that the maturity level of a company's environmental management strategy can be categorized as at the stage of beginners, fire fighters, concerned citizens, pragmatists, and proactivist [8]. However, the typologies and taxonomies of the environmental management strategies are still perceived as conceptually underdeveloped and empirically under-researched [9].

2.2 Green Strategies

The terms "green strategy" or "environmental management strategies" are frequently used interchangeably in the existing literature. Green strategies have been intensively discussed from the perspective of different disciplines and fields, which is why the term has a different meaning in chemistry or medicine than in business or management research. For example, in business, green strategies mean "aligning

a company's environmental performance with stakeholder expectations as well as constituting a significant new source of competitive advantage such as lower costs and expanded market share" [4]. Olson suggested three guiding principles of green strategic positioning include creating green culture and awareness among managers and employees, integrating green decision-making in initiatives and transformation across the entire company (from operating, technology, marketing, green product and services, green processes and facilities, green performance rewards, green technology information, and other supporting infrastructure) [10].

Despite the increasing attention and popularity of the trend to make everything greener, there is relatively little research that consolidates the current state of research on green strategies from a management perspective and provides insights. The ability of managers to effectively design, integrate, or coordinate green strategies appears to be critical to a sustainable future. However, practitioners or policymakers studying how to effectively implement, coordinate, or promote green strategies are also very interested in new insights from academia. Previous researches have been already making the systematic literature overviews of the carbon emissions [11], green human resource management [12], green marketing [13], green innovation [14], green technology [15], or green business models [16]. Although each of these literature reviews is closely connected to the company level strategies, the entirety of strategic perspective appears to be neglected. Therefore, consolidating, summarizing, and visualizing the research field of green strategies could be useful to understand the contribution of the management literature to the urgent green transformation.

3 Methodology

3.1 Data Collection

Recently, scientometric analysis has become a popular approach for visualizing, analyzing, and synthesizing the evolutionary pathways of a particular field of study. Apparently, it has not been used to analyze progress in the green or environmental management strategies. To this end, the data collection, scientometric instrument selection, metrics, analysis, and visualization techniques are briefly explained.

The data collection is based on the Thomas Reuters bibliographic database Web of Science (All selections), which is recognized as a reliable source of bibliographic data for the respected journal articles [11, 17]. The time period for retrieving the articles was "1955–2022." To focus the search on the most relevant publications, the retrieval of articles was based on the following criteria: Topic = "green* strategy*" or "environmental strategy*"; and Document type = Article; and Language = English; and WoS subject category = Business, Management; Economics, Business Finance, Operations Research, Management Science. Although the inclusion of subject categories as part of the retrieval strategy could exclude influential articles from other disciplines, it was chosen to ensure that records were collected from a management

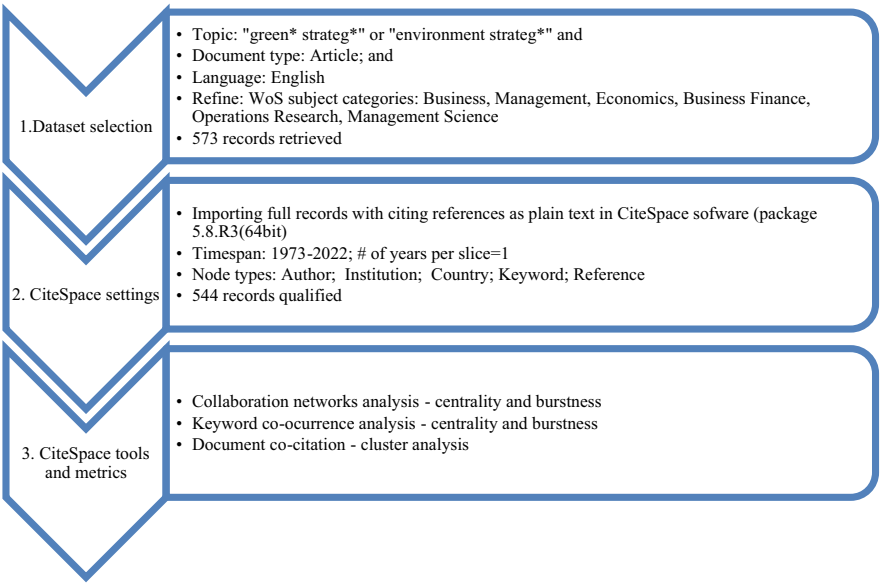

Fig. 1 Research design

perspective and were primarily relevant to the management discipline. A total of 573 records were selected. After filtering the dataset for duplicates or invalid records, the remaining 544 records qualified for further analysis. The research design is shown in Fig. 1.

3.2 Scientometric Techniques, Visualization, and Analytical Metrics

The collaboration analysis was used to identify the most productive authors, institutions, and countries in the green, and environmental management strategy field. The analysis of the keyword co-occurrence is used to analyze the development trends in research. Co-citation analysis is defined as the frequency with which two items of earlier literature are cited together in later literature [18, 19]. Document co-citation is used to gain insight into the knowledge domains of the green strategy field, emerging trends and the most cited, novel, or influential references.

The analysis and visualization are based on CiteSpace (package 5.8.R3. 64bit). CiteSpace is an open-access software and is frequently used in sustainability, carbon emissions, and other expanding green research areas [11, 17]. The analysis was based on the default settings and the time span of the analysis was set as "1973–2022, # of years per slice = 1." Nodes and links are the main building blocks of scientometric visualizations. Links indicate the relationship (frequency, co-occurrence, co-citation)

between two nodes, calculated based on the number of articles in which the keywords or references appeared simultaneously. The thicker the links, the stronger the relationship between the nodes. In the collaboration network analysis, the nodes represent either authors, institutions, or countries. In the co-occurrence analysis, the nodes stand for keywords. In the co-citation analysis, references are used as the node type. The size of the node reflects the frequency or citation history of the node, depending on the type of analysis and visualization.

Structural metrics available in CiteSpace that are primarily used for co-citation analysis include betweenness centrality, modularity, and silhouette metrics. Betweenness centrality (BC) measures the extent to which a node is the shortest path between two other nodes [18]. Nodes with a BC value greater than 0.1 denote articles that may lead to breakthrough discoveries [20] and initiate important evolutionary turning points in a research area. Nodes with high betweenness centrality are indicated by the purple outline of the node [19]. The modularity score measures the extent to which a network can be divided into independent clusters. A modularity score ranges from 0 to 1, and a score above 0.7 ($Q \geq 0.7$) indicates clear boundaries between clusters and a well-structured network [18]. The silhouette values estimate the uncertainty in describing the true nature of a cluster. It ranges from -1 to 1. The value of 1 represents the perfect separation of clusters. The silhouette values between 0.5 and 0.7 are considered reasonably reliable, while the silhouette value between 0.7 and 0.9 indicates high reliability and homogeneity of the cluster [18].

Temporal and hybrid metrics include identifying the duration and strength of citation bursts and the novelty (or sigma) score. Citation bursts refer to sudden changes in the number of citations in a given time period. They are useful for identifying emerging trends in a research area. The strength of citation bursts indicates references that have a significant impact on the research area. The duration of citation bursts is useful for understanding changes in researched topics over time and current hotspots in the research area [21]. When citation bursts are detected, it is indicated by a red outline above the node. The novelty score (sigma) measures whether the scientific publication is likely to represent a new idea and is calculated by combining the BC and citation bursts scores [21].

4 Results with Discussion

The first relevant contribution to green or environmental management strategies can be traced back to 1973 [1]. As shown in Fig. 2, the number of publications and citations in the field of green strategies research is still in the early stages of development, with less than 100 publications per year. However, the number of publications and citations is gradually and steadily increasing.

At least three phases of development in green strategy research can be identified. The period from 1973 to 2009 appears static and marks the beginnings of green strategy research. In 2010 to 2018, the number of publications per year began to

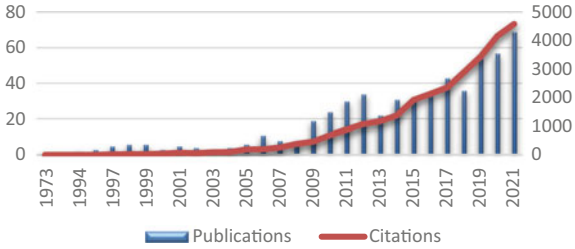

Fig. 2 Distribution of publications and citations from 1973 to 2022

grow gradually (no more than 50 publications per year). Only recently, from 2019 to 2021, has the growth of publications accelerated.

4.1 Collaboration Network

The author's collaboration network included 488 nodes and 252 collaboration links, indicating underdeveloped collaborations among green strategy research authors. Sanjay Sharma is the only collaborator who received citation bursts between 1995 and 2005. The top 6 authors with 3–5 collaborations were as follows Concepción Garcés Ayerbe (University of Zaragoza), Antonio Rueda Manzanares (University of Granada), Juan Alberto Aragon-Correa (University of Granada), Sanjay Sharma (Faculty of Commerce, Halifax), Frank Figge (ESCP Business School, Paris). The analysis of collaboration patterns confirmed that collaboration between institutions is still modest. Only three institutions were detected in the citation bursts: the University of Granada, Hong Kong Polytech University and Xiamen University. The analysis of the cooperation network at the country level is shown in Fig. 3.

The U.S., Spain, China, England, Canada, and Australia contribute the most to the total output, as you can see from the size of the nodes. However, eight nodes are outlined in red, indicating a sudden surge of interest in the green strategy in these countries. Analysis of citation bursts shows that the U.S., Canada, and Australia record citation bursts beginning between 1994 and 1998. England and Spain record

Fig. 3 A visualization of the country collaboration network

citation bursts between 2000 and 2007, while citation bursts beginning between 2010 and 2017 indicate the increasing importance of the Netherlands, Canada, China, and Pakistan in the research field. The strong influence on green strategy research is also confirmed by the high centrality scores (indicated by the purple border around the node). England (BC = 0.25); USA (BC = 0.23), France (BC = 0.11), Canada and China (BC = 0.1) establish themselves as the most influential countries in green strategy research.

Not surprisingly, the pattern of collaboration is underdeveloped given the infancy stage of the research field. In general, the authors, institutions, and countries that are currently prominent provide the breeding ground for future collaborations. It is worth noting that collaboration patterns could reflect the number of research institutions, the availability of research funding, and the strategic priority of greening for a particular institution or country. Thus, given the regulatory pressures, especially in countries facing large carbon emissions, it is reasonable to expect that collaborations will increase greatly in the future.

4.2 Keyword Network Analysis and Citation Burst

After analyzing the coincidence of keywords, the management perspective of green strategy research evolves around the search for conceptual or theoretical frameworks (such as the resource-based view of the firm), gaining competitive advantage through sustainable development, corporate social responsibility, exploring the determinants of green strategies or their impact on environmental, financial, or overall business performance. Looking at the centrality of the keywords (see Table 1), it can be seen that model, green strategy, impact, performance, or environmental management play the most influential and important role, which is not surprising given the stage of development of the research.

As noticeable in Table 1, environmental management and innovation have seen the largest increase in citations, as indicated by the strength of the citation bursts. However, considering the onset of the citation bursts, the occurring keywords can be divided into three main categories. The first category includes the keywords that were particularly frequently cited from 2005 to 2008, such as environmental management, natural environment, corporate strategy, commitment. These keywords mark the increased attention being paid to the relationship between corporate strategy and the natural environment. From 2011, academic attention has been drawn to the more specific subsystems of corporate strategies in terms of industry, stakeholder pressure, corporate operations, or other corporate systems. Finally, as of 2019, the proactive design of environmental strategy and, in particular, innovations related to the diversified strategic green initiatives (from organization green awareness and culture to the green business model, supply chain management, reporting, and rewarding systems) are the latest hotspots of green strategy research.

Table 1 Top keywords (by centrality, strength, and duration of citation bursts)

Keyword	Centrality	Keyword	Strength of bursts	Duration of bursts
Model	0.15	Environmental management	6.49	2005–2013
Performance	0.14	Natural environment	4.84	2007–2012
Green	0.12	Corporate strategy	3.12	2007–2011
Impact	0.1	Commitment	3.35	2008–2013
Strategy	0.1	Technology	3.4	2011–2012
Environmental management	0.1	Operation	3.21	2012–2014
Management	0.08	System	2.83	2012–2015
Sustainability	0.08	Corporate	4.84	2013–2016
Environmental strategy	0.07	Pressure	2.98	2015–2019
Corporate social responsibility	0.07	Perspective	3.02	2017–2018
Firm	0.07	Moderating role	4.83	2018–2022
Perspective	0.07	Proactive environmental strategy	3.51	2019–2022
Sustainable development	0.07	Green innovation	3.54	2020–2022
Determinant	0.06	Innovation	6.15	2021–2022

4.3 Document Co-citation Analysis

The document co-citation network consists of references cited by the 544 bibliographic records in the dataset. Each node represents a cited document and the links between them indicate the co-citation relationship between two articles. The size of the node represents the frequency of co-citations of that article. Cluster analysis tools are used to divide the research area into distinct and meaningful research subtopics or specialties. CiteSpace found a total of 16 meaningful clusters of co-cited references. According to the modularity score ($M = 0.89$) and the silhouette index ($S = 0.94$), the partitioning of the network and the homogeneity of the clusters are reliable and indicate well-structured clusters with clear boundaries between them. The visualization of the clusters' timeline shows the progress of the research topics over time. In addition, the impact and influence or dynamics of each cluster are shown by the larger nodes with red or purple borders. As shown in Fig. 4, the research topics such as #1 (inspiring employees) and #10 (analyzing green human resource management) were developed recently and reflect the shift of research in green strategy to promoting employee or manager engagement for changes in company operations or

behaviors. Cluster #17 (green patents) reflects the interest in green businesses and patents as the most radical form of protecting differentiation from competitors or the growth of patent-based technologies important to green manufacturing. Second, clusters #6 (fostering green management decisions), #3 (managing carbon aspiration), and #12 (life cycle assessment) reflect a shift in research toward measuring and documenting corporate carbon emissions, while cluster #8 indicates a shift toward broader value chains and monitoring the impact of reducing carbon emissions not only through corporate operations but also through corporate purchasing. Third, several clusters focus on identifying the conceptual or theoretical framework, particularly the resource-based or stakeholder view of the firm (#0), or on introducing more specific strategic issues such as low carbon as a risk and cost reduction strategy (#2), while others focus on analyzing the competitive advantages of differentiation through greening products or on corporate-level strategies. Moreover, the causal relationships between the predictors and the effects of green strategies in terms of industry, company size, and national context have been the distinctive features of green strategy research since the field's inception. Finally, it is worth noting that several clusters (#0; #1; #2; #3; #5; #6; #7) have a larger number of nodes outlined in red or purple, indicating influential, dynamic, novel, and important research findings emerging from the co-cited references in the aforementioned clusters. In contrast, several topics have not yet achieved citation bursts or high influence in this area (#12, #13) and could indicate a gap in the research worthy of further exploration.

Clustering the research field is useful to identify the intellectual base (cited articles) as well as the research fronts (citing articles) [21]. Table 2 provides information

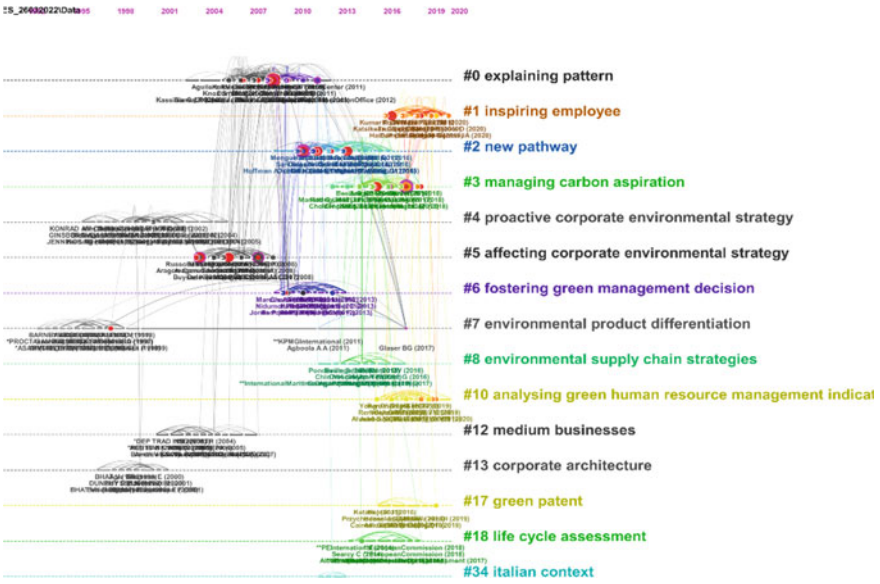

Fig. 4 Timeline view of the clusters in the document co-citation network

about the size of the clusters and metrics that support the homogeneity and reliability of the true nature of the clusters. In addition, Table 2 shows the most frequently cited or important documents and the most active citers of the cited documents. Identifying the intellectual base and research fronts allows the research field to move forward and can be of particular benefit to the research community. Clustering the research field is useful to identify the intellectual base (cited articles) as well as the research fronts (citing articles) [21]. Table 2 provides information about the size of the clusters and metrics that support the homogeneity and reliability of the true nature of the clusters. In addition, Table 2 shows the most frequently cited or important documents and the most active citers of the cited documents. Identifying the intellectual base and research fronts allows the research field to move forward and can be of particular benefit to the research community.

5 Conclusion

This study uncovers the structure of the important and distinctive subtopic of the green strategy research that attracts increased attention of management discipline. Western countries seem to play a leading role in terms of influence on the management perspective of green strategies research, which is not surprising given their total carbon emissions and national targets for reducing it. Although it is still at an early stage of development, a few identifiable subtopics are already visible. In particular, the cluster analysis results show that green strategies are closely related to green innovation, green patents, green human resource management, and new carbon aspiration, to name a few.

However, the results primarily show the management perspective of green management research. Although this limitation was necessary to maintain focus, this approach may miss relevant research from other databases or differently refined datasets. Therefore, further study could include a multi-perspective or multi-discipline approach. Alternatively, further research could be even more focused and examine the contribution of the most prestigious management journals on the green strategy to assess the contribution of high impact factor publications to the structure and development of green strategies from the operational to the corporate level. In addition, it would be interesting to broaden the search string to include all interchangeable terms that map green issues, such as sustainable business strategy, pro-environmental strategy, or eco-efficient strategy.

Table 2 The major clusters of co-cited references

C#	Size	Silhouette	Average year	Label (LLR)	Intellectual base Most important cited documents (by freq, BC; sigma)	Research fronts The most active citing document
0	101	0.89	2007	Explaining pattern	Aragon-Correa et al. (2008), Murillo-Luna et al. (2008), Ambec (2008), Gonzalez-Benito (2006), Clarkson et al. (2011)	de Burgos-Jimenez (2013)
1	90	0.909	2018	Inspiring employee	Hair (2016), Yang (2019), Roscoe (2019), Dumont (2017), Latan (2017)	Shafaei (2020)
2	81	0.93	2012	New pathway	Darnall, (2010), Cronin (2011), Dixon-Fowler (2013), Sarkis (2010), Chan (2012), Delmas (2011); Hart (2011), Torgusa, (2012)	Griffin (2017)
3	61	0.946	2015	Managing carbon aspiration	Leonidou (2017), Alt (2015), Aragon-Correa et al. (2016)	Yang (2019)
4	59	0.993	1999	Proactive corporate environmental strategy	Sharma (2000), Christmann (2000), Bansal (2000), Cordano (2000)	Aragon-Correa, JA (2003)
5	51	0.927	2005	Affecting corporate environmental strategy	Aragon-Correa et al. (2007), Sharma (2005), Bansal (2005), Buysee (2003)	Fraj-Andres (2009)
6	47	0.938	2010	Fostering green management decision	Berrone (2009), Nidumolu (2009), Hahn (2010)	Martinez (2014)
7	41	0.998	1996	Environmental product differentiation	Hart (1997), Glaser (2017)	Reinhardt (1998)

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