# Mapping the knowledge of green innovation: a systematic literature review

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## Abstract

**Purpose** – Green innovations (GI) is an emerging field that presents an opportunity to thrive in the competitive market. Nevertheless, in the field of green innovation, there is no clear and complete picture. To fill this gap the current study was conducted with the following objectives. (1) To identify existing knowledge on green innovation and offer bibliographic insights through a systematic literature review (SLR), (2) To comprehend the areas in which research is lacking within the territory of green innovation.

**Design/methodology/approach** – The SLR methodology was employed in this study, following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines. A total of 381 articles published between 2015 and 2023 were extracted from Lens org. database for review. Additionally, a bibliometric analysis was conducted to fulfill the research objectives.

**Findings** – The findings revealed that the field of green innovation lacks sufficient scholarly attention, despite being an emerging area. As a result, several gaps have been identified, encompassing various aspects of green innovation. These gaps include areas such as green innovation behavior, green finance, barriers to green innovation, green product innovation, green technological innovation and more.

**Originality/value** – This study adds to the existing body of knowledge on green innovation by addressing identified knowledge gaps. In particular, this knowledge contributes to future researchers aiming to design and conduct studies that target these identified research gaps.

**Keywords** Green innovation, Knowledge mapping, Research gaps, Systematic literature review

**Paper type** Literature review

## 1. Introduction

Today, individuals are placing greater emphasis on adopting environmentally friendly practices compared to earlier decades (Rupasinghe *et al.*, 2023). This shift is mainly attributed to the escalating environmental degradation, which poses a significant threat to human survival. Especially, organizations are trying to reduce detrimental effects on the



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environment because of the pressure from their stakeholders. These organizations are proactively seeking and transitioning towards products with reduced pollutants and extended lifetimes (Chen, 2008). Consequently, organizations view green innovation as both a market competitiveness opportunity and a strategic approach for achieving environmental protection and economic growth.

Green innovation is defined as the hardware or software innovation related to green products or processes (Chen *et al.*, 2006) and it consists of technical improvements or new administrative practices (Huang *et al.*, 2009; Rennings, 2000). Castellacci and Lie (2017) defined green innovation or eco-innovation as a process that donates to the creation of new production and technologies with the aim of reducing environmental risks, like pollution and negative consequences of resource exploitation (e.g. energy). Green innovation has been divided into product, process innovation (Tang *et al.*, 2018), and managerial innovation (Chen, 2008).

The Innovation process courses firms to build up cost efficiency and organizational flexibility, resource efficiency and as a result reduces pollution rates, increases recycling, saves energy and achieves competitive advantages (Takalo *et al.*, 2021). Green innovation has resulted in gaining competitive advantages in different aspects through product differentiation, cost reduction and product customization (Rupasinghe *et al.*, 2023). Further, through green innovations, ecological reputation is enhanced by upgrading positive performance in an organization, improving the quality of service provision and producing eco-friendly products or services (green product design) (Takalo *et al.*, 2021).

Some scholars have tried to add knowledge on green innovation in different aspects (e.g. Khan *et al.*, 2021a, b; Takalo *et al.*, 2021; Tietze *et al.*, 2011; Khanra *et al.*, 2021; Rupasinghe *et al.*, 2023). But still don't have enough research to understand the existing knowledge on green innovation. To fill this gap, the present study was designed with two research objectives; To identify existing knowledge on green innovation and offer bibliographic insights through a systematic literature review (SLR), (b) To comprehend the areas where in which research is lacking within the territory of green innovation.

This study is organized into six sections: Section one provides a preliminary introduction to the subject matter. Section two explores the adapted method and methodology. Section three presents the findings and discussion, section four presents the conclusion. Section five discusses potential directions for future research endeavors, along with any encountered limitations and section six compiles the references used in this study and illustrates the references.

## 2. Adapted methodology for the study

Present literature review is based on a bibliometric analysis of Biblioshiny and VOSviewer software and it provides a clear knowledge map of a specific theme. A seven-step process was developed to explore the green innovation journal articles and present the results. The quality and reproducibility of the present study were assured by the use of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol (Moher *et al.*, 2009).

As the first step, in June 2023 analyzed the literature on green innovation to understand the updated overview of the research topic and to know common keywords used in the field. Articles were found using an advanced search of "green innovation" as the keyword in the titles in Lens.org. database published from 2015 to 2023. Accordingly; "green innovation", and "sustainable development" were found to be the most used keywords indicated in the literature on green innovation. It implied the increasing trend of using these key wards. It was decided to use "green innovation" as the key ward to make sure the highly related article in the field.

In the second step, inclusion criteria were defined before starting the data collection process. The inclusion criteria of article selection and analysis methods are more objective methods in a SLR. In terms of the article selection process PRISMA flow diagram was recommended for SLRs (Liberati *et al.*, 2009; Priyashantha *et al.*, 2022). It consists of three steps: "identification, screening, and included" which is Figure 1 presents how these steps were followed in this study. The identification stage contains determining the search terms, data extraction method and database. The key search term was "green innovation". Since this article focuses on green innovation researchers did not consider other similar terms as search criteria. At the screening stage, the inclusion criteria were applied to include the articles (see Table 1). The inclusion criteria were the "publications as articles" published in "English" in "Journals" publications with the keyword "green innovation" from "2015 to 2023 under Emerald, Wiley, Elsevier B. V. publisher". 2015 was selected because rapidly increasing the publication relate to green innovation and people have more talked about the green innovation After 2015, because of its extensive and crucial applications along with the environmental awareness (Takalo *et al.*, 2021). A summary of the search process is presented in Table 2. Journal articles were selected since they are recommended for SLRs and ensure

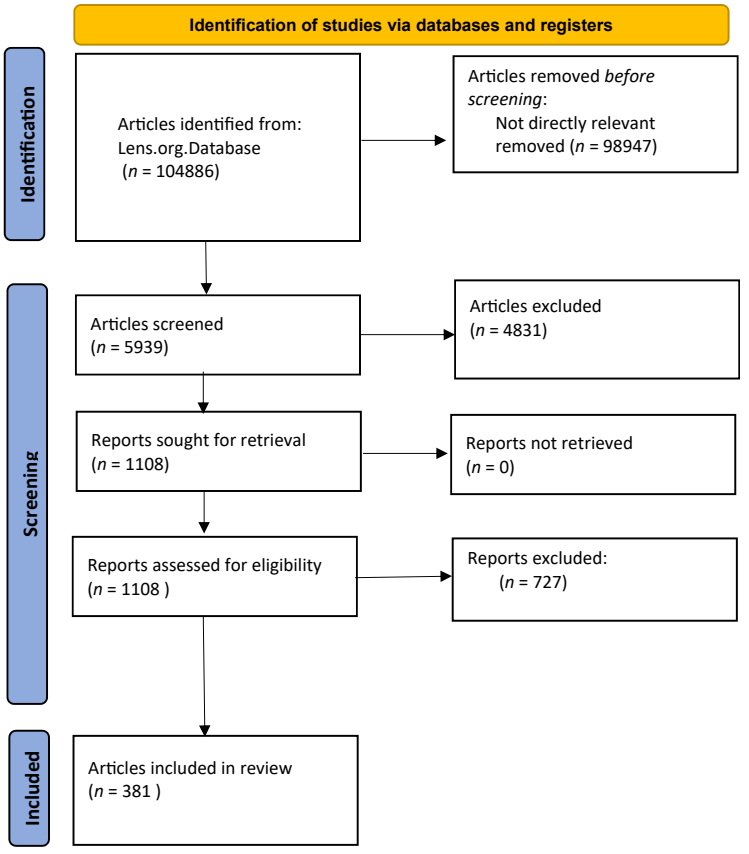


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**Figure 1.**
Prisma article selection flow diagram

methodological quality to derive relevant findings that satisfy internal validity (Priyashantha *et al.*, 2022).

After defining the boundaries of the study, in step three, it involved to the data collection on June 31 2023 at Lens.org. database. It generated 104,886 articles at the first stage. At the identification stage, out of the 104,886 articles, 98,947 were rejected because those are not directly relevant to the study.

In the fourth step, the remaining articles (5,939) were assessed against the inclusion criteria. It includes articles satisfying the inclusion criteria (refer Table 1) "published as articles" published in "English" "journals" from "2015 to 2023" published as Emerald, Wiley, Elsevier B V publication. This screening was done through Lens.org. automation with the database's limiting options; published as, language, publication type, publications with the keyword "green innovation in title, publication date and publisher. At this point, 2,486 articles were excluded because they did not meet the inclusion above criterion. The other publication types (e.g. conference proceedings, books, book chapters, reports, editorial notes dissertations) non-English articles, articles published out of the considered year range and articles published under other publishers were excluded. Then, the full versions of the screened articles were saved for the next stage of screening; the eligibility assessment.

In the fifth step, the remaining articles' complete versions were downloaded and manually screened. At the manual screening, the study authors independently reviewed each abstract of the downloaded article and assessed them against the inclusion criteria. After removing unnecessary articles, the study authors manually and independently examined the remaining articles for the exclusion criteria. As the exclusion criteria, methodological eligibility and field

**Table 1.** Article inclusion criteria

| Inclusion criterion | Focus on |
|---|---|
| 1 | Publications as articles |
| 2 | The articles in the English language |
| 3 | Published in journal |
| 4 | Publications with the keyword "green innovation" |
| 5 | Publications from 2015 to 2023 |
| 6 | Publisher "Emerald, Wiley, Elsevier B V" |

**Source(s):** Table by authors

**Table 2.** Leng.org database search summary

| Keywords | Field | Published in | Language | Time | Publisher | Type of publication | No.of paper |
|---|---|---|---|---|---|---|---|
| "Green innovation" | all | all | English | all | all | all | 5,939 |
| "Green innovation" | title | all | English | all | all | all | 4,008 |
| "Green innovation" | title | Journal | English | all | all | all | 3,450 |
| "green innovation" | title | Journal | English | 2015–2023 | all | all | 3,100 |
| "Green innovation" | title | Journal | English | 2015–2023 | "Emerald, Wiley, Elsevier B V" | all | 1,192 |
| "Green innovation" | title | Journal | English | 2015–2023 | "Emerald, Wiley, Elsevier B V" | article | 1,108 |

**Source(s):** Table by authors

of study were evaluated. The eligibility assessment guarantees that articles of high methodological quality are included (Meline, 2006). The eligibility check revealed 727 "methodology not clear" and "field of study not relevant" articles. As a consequence of it, those articles were rejected. Finally, 381 articles were retained for review as shown in Figure 1.

In the sixth step, bibliometric analysis was done with selected 381 papers. Bibliometric analysis is a scientific technique for examining scientific activity in a study (Paule-Vianez *et al.*, 2020; Priyashantha *et al.*, 2022). It includes two types of analysis; (1) evaluation, performance and scientific productivity analysis, and (2) scientific maps (Cobo *et al.*, 2012). Based on different information like keywords, citations in the article bibliometric networks can be created. Keyword analysis is the most widely used unit of analysis for such bibliometric networks and many links can be seen with the co-occurrence relationship of the keywords in an article (Aparicio *et al.*, 2019). VOS viewer is used to generate different maps based on bibliometric relationships, such as keyword co-occurrence networks, co-citation networks of authors or journals.

The study's first goal was to identify existing knowledge on green innovation; hence, this keyword co-occurrence analysis was used to achieve that. The keyword density visualization is a variation of keyword co-occurrence network visualization. It was used to accomplish the study's second objective: to comprehend the areas in which research is lacking within the territory of green innovation. VOS viewer presents distinct and rich graphs as compared to other visualization software, and cause to explain effectively and analyze the results of bibliometrics (He *et al.*, 2020). Biblioshiny of R software was also used to generate "basic information about the article set", "year-by-year article publishes" and "average citations received".

In the seventh step, the selected studies (N = 381) of this review were critically analyzed with a focus on better understanding the critical thematic area to discuss in future research. To create this diverse set of studies, thoroughly review articles in line with the recently published SLR studies (Seth *et al.*, 2020; Khan *et al.*, 2021a, b). To ensure an unbiased narration of the selected literature, the three authors engaged to review the articles against the identified themes in the literature.

### *2.1 Assessment of article risk of bias*

According to Kitchenham and Charters (2007), researcher bias in the article selection and analysis of articles can undermine the quality of a review article. The selection bias can be escaped by following a systematic, review protocol and objective article selection procedure (Priyashantha *et al.*, 2022). Furthermore, as outlined by Xiao and Watson (2019), the potential for analysis bias was avoided and addressed through a preliminary protocol design that predetermined the analysis methods (Priyashantha *et al.*, 2022). Current study, to reduce the potential for bias, first, inclusion criteria were clearly described in detail to avoid inconsistent application in study selection, and the inclusion criteria are documented in Table 1. Second, track the resulting flow of studies through the PRISMA diagram.

## 3. Findings and discussion

### *3.1 Article characteristics*

Table 3 depicts the main information of the articles considered in the review. There were 381 articles published from 2015 to 2023 in 94 journals by 933 authors. The annual growth rate is 37.03, and the total number of references considered for the review was 13,735. Further, the total number of keywords included in the review was 67.

Figure 2 shows the annual scientific production, showing a gradual increase. It also depicts that the majority of studies were completed in 2020. It indicates the popularity of the field of green innovation is gradually increasing among scholars. After 2020, schoolers have been more focused on green innovation. Nevertheless, some scholars (Takalo *et al.*, 2021; Li *et al.*, 2022) found that after 2015, some others (Díaz-García *et al.*, 2015) found that after 2010, green innovation was popular among researchers.

The most relevant sources of the articles published are shown in Figure 3. It shows the 20 journals which published the highest number of articles. Accordingly, the *Journal of Cleaner Production* (66 articles), *SRN Electronic Journal* (44 articles), and *Journal of Business Strategy and the Environment* (43 articles) are first, second and third, respectively, in green innovation article publications. Takalo *et al.* (2021) and Li *et al.* (2022) also have similar findings that the *Journal of Cleaner Production*, and *Business Strategy and the Environment* are the journals with the most publications in their study. Besides that, the *Journal of Technological Forecasting and Social Change* and the *Journal of Energy Economics* have published 22 and 16 articles, respectively. Eleven articles each have been published by the *Journal of Corporate Social Responsibility* and *Environmental Management* and the *Journal of Environmental Management*. *The Journal of the European Journal of Innovation Management* and *the International Journal of finance research letters* have published eight articles each. The *Journal of Technology in Society and Resources Policy* has published seven and six articles,

| Description | Results |
|---|---|
| Timespan | 2015:2023 |
| Sources (journals) | 94 |
| Annual growth rate % | 37.03 |
| Document average age | 1.72 |
| References | 13,735 |
| Author's keywords | 67 |
| Authors | 933 |
| Journal article | 381 |

**Source(s):** Table by authors

**Table 3.**
Main information about data

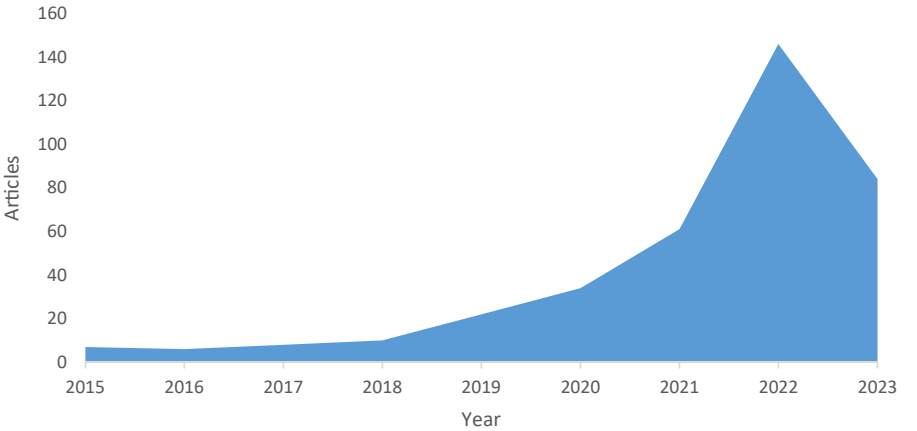


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**Figure 2.**
Annual scientific production

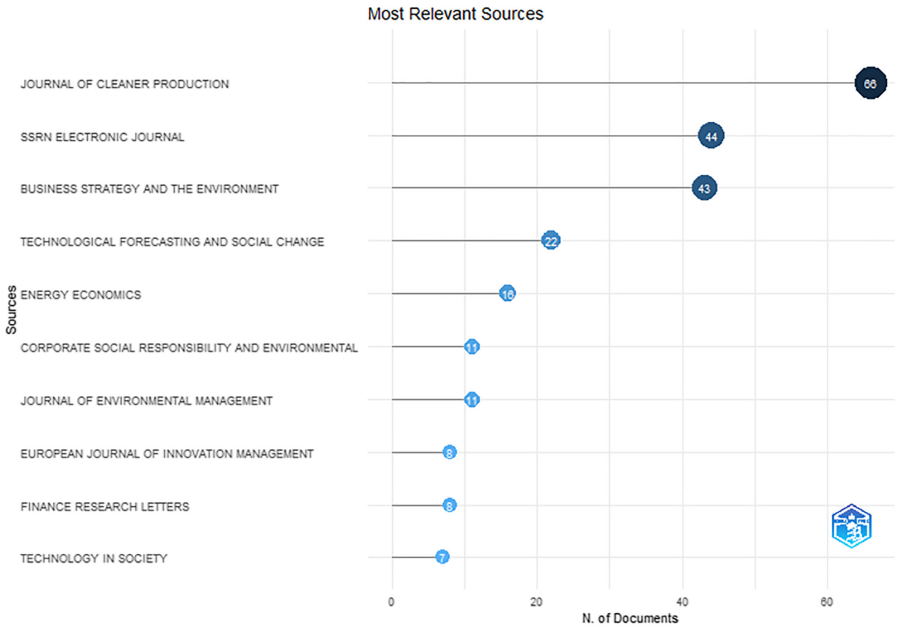


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**Figure 3.**
Most relevant sources

respectively. *Journal of Energy Policy, Journal of Heliyon, Journal of Managerial and Decision Economics, Journal of Renewable Energy,* and *Journal of Sustainable Development* have published five articles each. The rest of the journals listed in Figure 3 have published four articles each.

### *3.2 Results of studies*

This section reports the findings complying with the research objectives. The findings were developed using keyword co-occurrence analysis and co-citation analysis. The keyword co-occurrence network visualization and co-citation analysis network addressed the first objective: To find the current knowledge on green innovation and provide bibliographic information through a SLR, The keyword co-occurrence density visualization addressed the second objective, finding the areas where green innovation empirical research is lacking.

*3.2.1 The current knowledge in green innovation.* Using the minimum keyword occurrences functionality of VOSviewer software, for each of the 67 keywords, the total strength of the co-occurrence link with other keywords was calculated. 67 keywords were discovered frequently in the studies. It shows gradually increasing the keyword occurring times, starting with one until the threshold keyword level reaches a level that covers more keywords (Table 4). The line thickness in the figure denotes the strength of the relationship between the keywords. The size of the node denotes the frequency of occurrences. Higher frequency denotes higher the size of the nodes. Thus, "green innovation" can be said it frequently occur in studies. It means this area has been widely researched. Table 4 shows gradually increasing keyword occurring times and "green innovation", "green technology innovation", "innovation", and "innovation performance" are the most used keywords in this study. It implies that these are the area that has some extent touched by the scholars. Takalo

| Keyword | Occurrences |
|---|---|
| Green innovation | 7 |
| China | 3 |
| Green technology innovation | 2 |
| Innovation | 2 |
| Innovation performance | 2 |
| Sustainable development | 2 |
| Environmental regulation | 2 |
| Environmental performance | 2 |
| Environmental regulation | 1 |
| Human resource practices | 1 |
| Management commitment | 1 |
| Organizational performance | 1 |
| Process innovation | 1 |
| Product innovation | 1 |
| Caribbean | 1 |
| Hurricanes | 1 |
| Natural disasters | 1 |
| Small island developing states (sids) | 1 |
| Cleaner production | 1 |
| Corporate financial performance | 1 |
| Corporate value | 1 |
| Emerging markets | 1 |
| Environmental innovation | 1 |
| Environmental management | 1 |
| Environmental policy stringency | 1 |
| Environmental responsibility | 1 |
| Evolutionary game model | 1 |
| Green bonds | 1 |
| Green exploratory innovation | 1 |
| Green finance | 1 |
| Green innovation behavior | 1 |
| Green innovation performance | 1 |
| Green product innovation | 1 |
| Green technological innovation | 1 |
| Green technology trading market | 1 |
| Heterogeneity | 1 |
| Heterogeneous environmental regulation | 1 |
| Incentive and penalty | 1 |
| Industry | 1 |
| International collaboration | 1 |
| Manufacturing companies | 1 |
| Market-based environmental regulation | 1 |
| Moderating effect | 1 |
| Open innovation | 1 |
| Patents | 1 |
| Perceived health | 1 |
| Temperature change | 1 |
| Transformation rate of innovation achievement | 1 |
| Carbon neutrality | 1 |
| Co(2) emissions | 1 |
| Composite risk index | 1 |
| Digital finance | 1 |
| Digital transformation | 1 |
| Environmental policies | 1 |

**Table: 4.**
The keywords with a minimum of one occurrence

(*continued*)

| Keyword | Occurrences |
|---|---|
| Environmental policy | 1 |
| Environmental regulations | 1 |
| Financing constraints | 1 |
| Green technology innovation | 1 |
| Influencing mechanism analysis | 1 |
| International trade | 1 |
| Manufacturing | 1 |
| Public participation | 1 |
| Regional green innovation | 1 |
| Renewable energy | 1 |
| Threshold effect | 1 |
| Board internationalization | 1 |
| Foreign directors | 1 |

**Source(s):** Table by authors

**Table: 4.**

*et al.* (2021) have found that "Green innovation", "Innovation", and "Sustainable development" are the most used keywords in their study. Accordingly, it is clear that "Green innovation", and "Innovation" are the most popular keywords in the area. Nonetheless, it is not saying there is enough research in these areas because the map of keyword co-occurrence density visualization (Figure 7) does not show keywords in the red area. If it shows keywords in the red area we can say there is enough research related to those keywords. Thus, more research can focus on infrequently investigated areas shown in Table 4.

Further, seven clusters can be identified in the study. These seven clusters denote the nodes in Figure 4 in different colors: red, green, blue, yellow, light green, light blue, purple and orange. Different clusters describe how investigations have differed in different areas of investigations. These findings related to each theme are explained below. keywords in clusters one and five are trending areas in 2023.

Cluster 1 – Blue: The keywords green innovation, co(2) emissions, digital transformation, environmental regulation, China and manufacturing fell into this cluster.

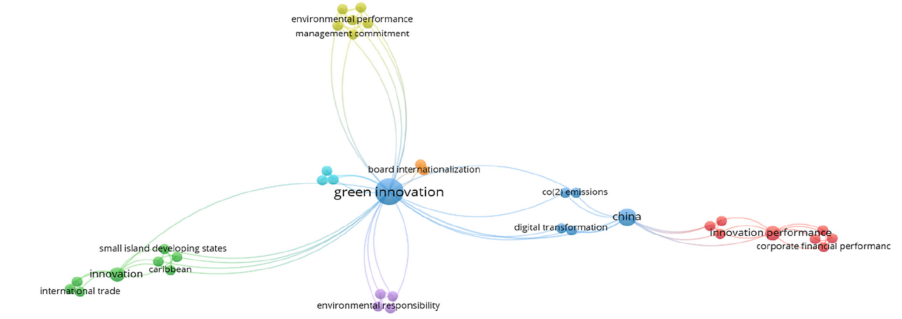


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**Figure 4.**
The keyword co-occurrence network visualization

Cluster 2 – red: corporate financial performance, corporate value, emerging market, environmental innovation, environmental management.

Cluster 3 – red: environmental policies, Caribbean included in this cluster.

Cluster 4 – green: Hurricane, environmental policies, innovation, international trade, natural disaster, renewable energy, small island development are included in this cluster.

Cluster 5 – light green: environmental performance, human resources practices, management commitment, organizational performance and process innovations fell into this cluster.

Cluster 6 – purple: environmental responsibility, green exploratory innovation and temperature change fell into this cluster.

Cluster 7 – light blue: carbon neutrality, environmental policy and composite risk index included in this cluster.

Citation analysis searches to assess the academic acceptability of research by including the frequency with which studies have been cited in various publications (Khanra *et al.*, 2020). A co-citation link is a link between two items that are both cited by the same document (Guleria and Kaur, 2021). Using cited documents as the unit of analysis, a co-citation analysis was conducted. The minimum number of documents for a cited article was considered three (Figure 5). Of the total 381 cited documents, 265 met the threshold. For each of the 265 cited documents, the total strength of the co-citation links was calculated. According to Figure 5, a

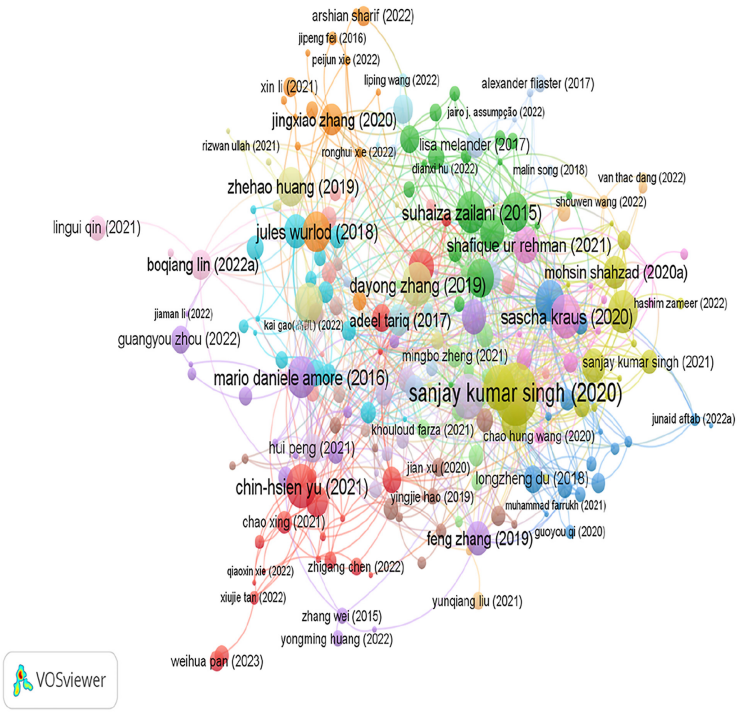


**Figure 5.**
Co-citation analysis based on the documents

**Source(s):** Figure by authors

higher number of co-citations reflect that there is more shared data, and nearer proximity and fewer co-citations reflect that the manuscripts have less data in common (Lamba *et al.*, 2022).

Figure 6 shows that co-citation analysis was done based on sources and the minimum number of sources for a cited article was considered two. Among the total of 94 journals, cited documents, 36 met the threshold. For each of the 36 sources, the total strength of the citation links with other sources was calculated. The sources with the grated total link strength were selected. Sources and their co-linkages with other sources are shown by the colored circles and lines. Further, the size of the circle represents the citation weight. "Journal of Cleaner Production" in green, has the most citations to its credit and forms a green cluster with co-cited sources like "Sustainable Cities and Society", and "Environmental Impact Assessment Review". In red, "business strategy and the environment" forms linkages with "technological forecasting and social change" and "corporate social responsibility and environmental management". Comparatively, other sources in blue, yellow and purple have fewer citations and weak interlink ages. Table 5 also presents the same information; most highly cited research articles were published in journals. It shows *Journal of Cleaner Production* is the highest-cited journal with 3,927 citations in 66 documents. *Business Strategy and the Environment* journal has 1837 citations in 43 documents. Technological forecasting and social change have 2,395 citations in 22 documents. Takalo *et al.* (2021) also found their study also, *Journal of Cleaner Production, Journal of Business Ethics, Business Strategy,* and *the Environment* are the most cited journals. However, citation analysis measures only the popularity of an article among other articles in a sample and not its importance in a research field (Khanra *et al.*, 2021).

*3.2.2 Areas where green innovation research is lacking.* To achieve the study's second objective; to understand the areas where research is lacking in green innovation, all the keywords were checked to see whether the areas represented by the keywords could create established knowledge. Future researchers should address the areas that are indicated by

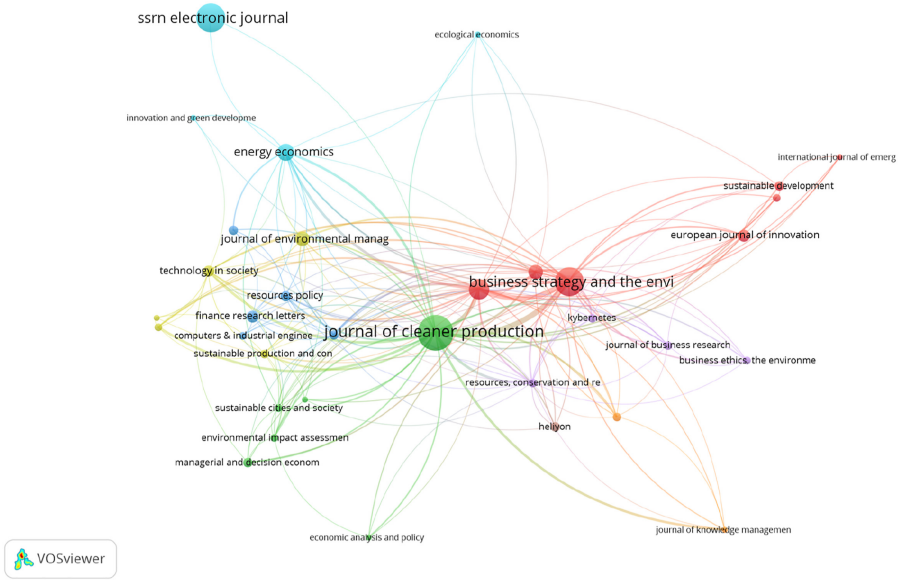


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**Figure 6.**
Co-citation analysis based on the sources

| Source | Documents | Citations |
|---|---|---|
| Journal of cleaner production | 66 | 3,927 |
| Business strategy and the environment | 43 | 1837 |
| Technological forecasting and social change | 22 | 2,395 |
| Corporate social responsibility and environmental management | 11 | 475 |
| Energy economics | 16 | 568 |
| Technology in society | 7 | 328 |
| Resources, conservation and recycling | 4 | 420 |
| Energy policy | 5 | 513 |
| Journal of environmental management | 11 | 355 |
| Journal of open innovation: "technology, market, and complexity" | 3 | 23 |
| Resources policy | 6 | 120 |
| Sustainable production and consumption | 4 | 206 |
| Journal of innovation and knowledge | 4 | 109 |
| Journal of knowledge management | 2 | 164 |
| Kybernetes | 4 | 65 |
| European journal of innovation management | 8 | 127 |
| Journal of business research | 4 | 51 |
| Sustainable cities and society | 3 | 221 |
| Environmental impact assessment review | 3 | 25 |
| Sustainable development | 5 | 201 |
| Business ethics, the environment and responsibility | 3 | 10 |
| Managerial and decision economics | 5 | 30 |
| Helicon | 5 | 19 |
| Renewable energy | 5 | 147 |
| Economic analysis and policy | 2 | 37 |
| Finance research letters | 8 | 112 |
| International journal of innovation science | 3 | 13 |
| Socio-economic planning sciences | 2 | 39 |
| Ecological economics | 2 | 110 |
| International journal of emerging markets | 2 | 4 |
| Computers and industrial engineering | 3 | 55 |
| Journal of manufacturing technology management | 2 | 26 |
| Innovation and green development | 2 | 14 |
| SSRN electronic journal | 44 | 13 |
| Asian economic policy review | 2 | 4 |
| Energy reports | 2 | 1 |

**Source(s):** Table by authors

**Table: 5.**
Highly cited research articles published in journals

keywords that are not enough touch by scholars. To determine this, keyword co-occurrence density visualization using VOSviewer was created (see Figure 7).

The density visualization map usually consists of three colors, red, yellow and green. Keywords in the red areas imply much research has been done related to those keywords. Hence, there is established knowledge related to that area (Priyashantha *et al.*, 2022). According to Figure 7, no red color area and which means there is not a large amount of research related to particular keywords. Furthermore, a keyword in the yellow area, implies a moderate amount of research, whereas keywords falling in the green area show very little research has been done. In that case, moderate and little research does not create established knowledge. Based on this argument, keywords displayed in Table 4, specify insufficient research for established knowledge as they fall into the yellow and green areas in Figure 7. Thus, future researchers need to address further research focusing on those areas. Accordingly, almost all areas should be investigated further; such as innovation, green technology innovation, innovation performance, sustainable development, environmental

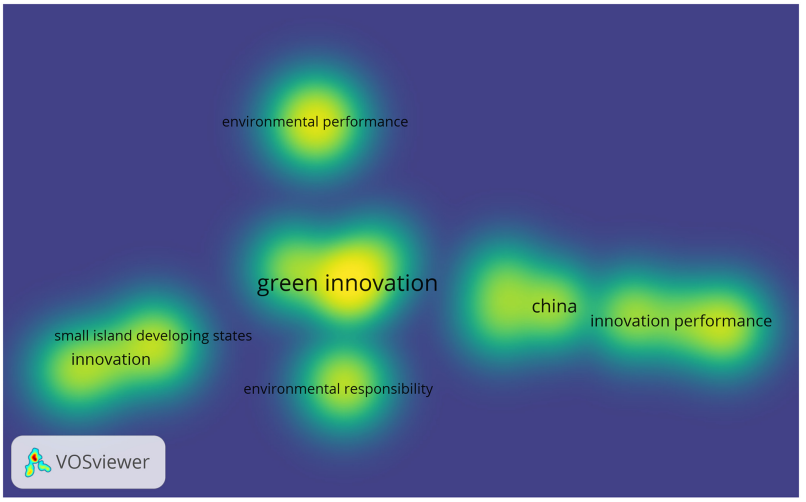


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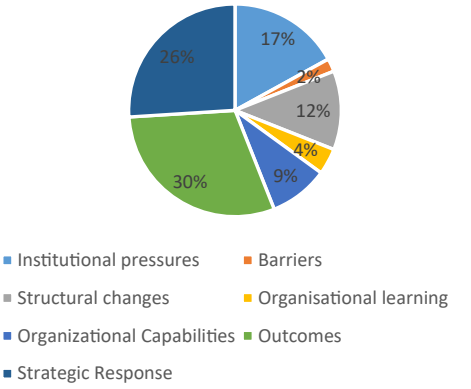
**Figure 7.**
The map of keyword co-occurrence density visualization

regulation and environmental performance should be investigated further. Besides that, barriers to green innovation, green innovation behavior, green finance, green product innovation and green technological innovation can be investigated in the future.

*3.2.3 Theme-based separation of relevant green innovation studies.* Based on the recently published studies by Khan *et al.* (2021a, b) and Seth *et al.* (2020) the themes of the study were divided into seven categories: *institutional pressure* (coercive, normative and internal institutional pressures, and regulatory pressure), *barriers* (internal and external), *structural changes* (green management, green Human Resource Management (HRM) and gender diversity), *organizational learning* (creative thinking and inter-organizational learning, green supplier learning and big data), *organizational capabilities* (green motives, corporate environmental ethics and commitment, environmental management systems R&D strength) *outcomes* (financial performance, firm value, competitive advantage, brand equity, green product success, job satisfaction, energy intensity and emission reduction) and *strategic response* (environmental orientation, environmental ethics, technology implementation and environmental Corporate Social Responsibility (CSR)). Figure 8 presents the theme-based segregation of the relevant green innovation studies, and 30% of the studies among the reviewed articles have discussed the outcomes of green innovation. The second most discussed theme was strategic response (26%), and barriers to green innovation development have been discussed in only 2% of the studies. Accordingly, only 2% of the articles analyzed in this study met this classification (Zhai *et al.*, 2022; Bar, 2015; Yu *et al.*, 2021; Zhang *et al.*, 2020; Schäfer *et al.*, 2022). It implies that barriers to the development of green innovation, don't have enough discussion in the green innovation literature. Further, barriers can be discussed as *internal barriers and external barriers* to the development of green innovation. These barriers need to be empirically examined by future researchers. Organizational learning topics were discussed in only 4% of the articles analyzed (Adomako and Nguyen, 2023; Tuan, 2023; Song and Yu, 2018). Under "organizational learning" need to discuss *creative thinking* and *inter-organizational learning, green supplier learning and big data* in future research. The third lowest discussed area was organizational capabilities (9%).

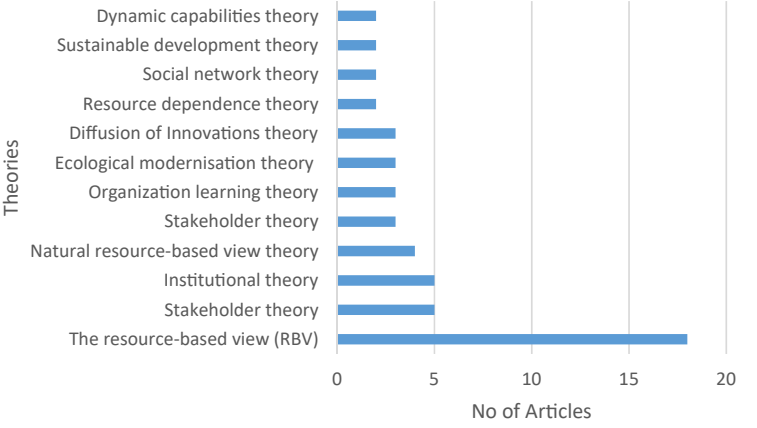



**Source(s):** Figure by authors

**Figure 8.** Theme-based separation of the relevant green innovation studies

Need to more discussion on *green motives, corporate environmental ethics and commitment, environmental management systems and R&D strength* of green innovation. The outcomes of green innovation are the most discussed areas in reviewed articles (Yin and Yu, 2022; Chang, 2018; Xie *et al.*, 2022; Zhao *et al.*, 2021). In the given articles, numerous studies have been conducted to examine financial performance (Xie *et al.*, 2022; Menon *et al.*, 2020; Lin *et al.*, 2019), environmental performance (Singh *et al.*, 2020; Roh *et al.*, 2021), energy intensity (Wurlod and Noailly, 2018) and competitive advantage (Zameer *et al.*, 2022).

*3.2.4 Theoretical foundations of the relevant green innovation studies.* Figure 9 presents the theoretical foundations of the relevant green Innovation studies, and most studies apply the resource-based view for their studies. The second most applied theories are the stakeholder theory and institutional theory. Four studies apply the natural resource-based view theory. Other theories that apply to three studies include stakeholder theory, organization learning theory, ecological modernization theory and diffusion of innovations theory. The rest of the theories, resource dependence theory, social network theory, theory of sustainable development and dynamic capabilities theory are applied only to the two articles.




**Source(s):** Figure by authors

**Figure 9.** Theoretical foundations of the relevant green innovation studies

It can be seen that, research has been conducted on green innovation from many theoretical perspectives and the application of green innovation varies from different theoretical perspectives. In the study of the performance of green innovation, and the competitive advantage of green innovation, the resource-based view is commonly adopted and its theoretical logic obtains consistent support in describing the performance and the competitive advantage of green innovation (Adomako and Nguyen, 2023; Asiaei *et al.*, 2023; Singh *et al.*, 2020; Simmou *et al.*, 2023; Huang *et al.*, 2016; Negi *et al.*, 2023; Sahoo *et al.*, 2023). Resources are key to the success of green innovation While the lack of resources will limit the practice of green innovation (Li *et al.*, 2022). Thus, the resource-based view is one of the theoretical perspectives preferred by scholars when studying green innovation. Stakeholder theory and Institutional theory are the second most commonly used theoretical perspectives in green innovation studies. According to the Stakeholder theory, government, customers, competitors, employees, etc pay more attention to environmental issues and they put pressure on the performance of organizations in terms of the environment (Singh *et al.*, 2022; Ahmed *et al.*, 2023). In particular, stakeholder pressure will affect the strategic decision-making of the organizations. The institutional theory, under uncertain situations, three different types of external pressures influence for firms' decision-making. Namely, coercive, normative and mimetic pressures (Chu *et al.*, 2018; Qi *et al.*, 2021; Acquah *et al.*, 2023; Negi *et al.*, 2023). Besides, the more commonly adopted resource-based view, the theoretical logic of these two theories, supports to decision making. More than that, other theories will help to see different perspectives of green innovation based on various logical arguments.

## 4. Conclusion

The primary objectives of the present study were two-fold: (1) to identify the existing body of knowledge and (2) to pinpoint areas in which research relating to green innovation is deficient the articles for analysis were sourced from lens.org, with article selection following the PRISMA guidelines. In adherence to the recognized inclusion criteria, a total of 381 articles published between 2015 and 2023 were subjected to review.

To achieve the first objective, the study employed techniques such as keyword co-occurrence network visualization and Co-citation analysis. Accordingly, the keyword "green innovation" displays the highest frequency of occurrence in this study, suggesting that it has been extensively researched. Nevertheless, the keyword co-occurrence density visualization map indicates that no particular area within green innovation has been extensively explored. The level of research activity in "Green innovation" is also observed to be moderate. Thus, It can be concluded that the field of green innovation is still an emerging area. Therefore, future research endeavors could effectively concentrate on these less frequently investigated areas. Further, thematic-based separation analysis concludes that some areas as "barriers to development for green innovation" and "organization learning" do not have enough attention and need more research in the future.

The second objective of the study was to find the areas within green innovation where research is deficient. As explained earlier, the research landscape concerning green innovation remains predominantly unexplored, requiring attention across various aspects such as barriers to green innovation, green innovation behavior, green finance, green product innovation, green technological innovation and etc. These aspects require addressing by future researchers. Further, it is required to do various green innovation research based on different theoretical logical arguments and it will help to paint a complete picture of green innovation in the future.

This analysis has contributed to the understanding of green innovation concepts and their development to the reader. Further, it presented the most relevant journals for literature

review, highly cited research articles published in journals, theoretical foundations of the relevant green innovation studies. It provides recommendations for those interested in entering the field of green innovation, as well as information regarding which journals and articles to refer. It is also suggested that researchers can use this study to construct green innovation concepts using more theoretical integration.

## 5. Directions for future research avenues and limitations

The findings of the present study suggest numerous opportunities for future research agendas. Specifically, these findings indicate potential investigations into areas that have received limited attention, such as, green finance, innovation performance, green innovation behavior, green innovation performance, green product innovation, green process innovation, green technological innovation, digital transformation and etc. Further, the researchers need to conduct research on creative thinking and Inter-organizational learning, green supplier learning, big data, barriers to the development of green innovation, green motives, corporate environmental ethics and commitment, environmental management systems and R&D strength of green innovation.

Among the limitations, two main aspects should be acknowledged. Firstly, the scope of this study has been narrowed only to articles published in journals that are within a single database. Applying additional databases could have led to the discovery of more articles and wider insights into the field of green innovation. That is because in Sri Lanka, the academic community doesn't have access to other popular databases like Scopus, Science Direct etc in this economic crisis period. If more databases had been used, more articles and areas of green innovation could have been found. Because of the selected database, constrained the available analytical options. There was limited analytical option also. If the study targeted more databases, then we have more options for analyzing existing knowledge. Because of that some parts of the analysis (eg: thematic analysis), were performed manually by the researchers. Secondly, although recently published articles have been considered in the analysis, the number of citations is not available for them. Therefore, it is imperative to consider this information in future research.

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