

Green Supply Chain Management and Innovation: convergence and future directions

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Abstract

This paper aims to investigate the main associations between research regarding innovation and green supply chain management. For this the study sought to (1) present the most cited authors in the area; (2) demonstrate the main localities that develop research with this focus; (3) list the main journals where such studies and authors published their research. The methodology used was a bibliometric survey using the Scopus database as the data source. The VOSviewer® software was used to perform the analysis of the database from the respective DOI's of each article. As results of the research, it is possible to demonstrate the existence of an agglomeration of countries that are interrelated in the development of research on these themes, especially China, the United States and the United Kingdom as the main foundations of this center. Besides, Zhu, Q. is the author with more prominence and the paper of Chiou (2011) is the one that received the largest quantity of citations according to the studied base.

Introduction

The search for growth and acceleration of industrial development means that countries have major conflicts between energy consumption and environmental protection. Enterprise supply chains suffer, and will still suffer, more pressure on natural resources and a resulting demand to utilize more green energy. Companies will experience increasing pressure from stakeholders to reduce the environmental impact of their activities (Jensen, Munksgaard & Arlbjørn, 2013). In addition, companies use this scenario to pressure their suppliers to adhere to such practices (Laari, Töyli & Ojala, 2017).

Restricted by environmental protection policies and motivated by high consumer demand for green products, manufacturers begin by engaging in green activities to improve the energy efficiency of products (Zhang & Zhang & Tang, 2016).

In this process of engagement and minimization of environmental impact, designing and producing ecologically correct products, several methodologies are used to quantify the environmental impact in the supply chain and to identify opportunities to implement improvements. To that end, Green Supply Chain Management stands out (Zhang; Zhang & Tang, 2016; Sehnema et al., 2015). Green Supply Chain Management can be seen as environmental management activities associated with sustainable technological innovation (Song & Gao, 2018; Zhu et al., 2012).

In this scenario, this work has the following question: Where are the main research related to Green Supply Chain Management associated with innovation, who are the main authors working on this association of themes and what are the main journals) that such research is published? The main objective of the research is to investigate the main associations between innovation studies and the green supply chain. As specific objectives are listed: (1) present the most cited authors in the main works of the area; (2) demonstrate the main localities that develop research with this focus; (3) list the main journals where such studies and authors published their research.

Such research is justified by demonstrating the direction of scientific research within the area, demonstrating where there is convergence for innovation in actions related to Green Supply Chain Management. This guidance may demonstrate possible existing and unexplored gaps so that researchers can direct future research or check gaps to be filled by the development of new processes.

Theoretical Background

Green Supply Chain Management

Green Supply Chain Management (GSCM) is an evolution of supply chain management with the aim of minimizing environmental impacts and increasing resource efficiency through all phases of the supply chain, starting with product acquisition until its final disposal after use (Song & Gao, 2018; Stefanelli, Jabbour & Jabbour, 2014; Mathiyazhagan, Govindan & Haq, 2013).

The GSCM's goal is to incorporate environmentally conscious principles into all phases of supply chain management (Zhu et al., 2012). Hafezalkotob (2017) and Fu, Chen & Hu (2017) point out in their studies several issues related to competition and cooperation based on green supply chain and development of green technologies. Legislation in each country and on the theme is highlighted, which makes the management of the green supply chain an important driver of sustainable public policies.

In addition, Song & Gao (2018) point out that green supply chains differ from supply chains in general, because green supply chain coordination objects not only include manufacturers and retailers in traditional supply chains, but also include consumers.

In this context, Dai, Zang & Tang (2017) argue that more and more manufacturers are joining the ecological supply chains and contributing to the rapid growth of the green market, this is due to the increase of green consumers, caused by the growing awareness environmental.

In addition to the environmental gain, there is prominence in the literature for gains related to the organization's brand. Ghosh and Shah (2015) demonstrate this by stating that companies have their name associated with green initiatives and that consumers tend to make choices prioritizing such entrepreneurial initiatives. In addition, the authors argue that large retailers now have bargaining power by selecting products that adhere to this green chain, further bringing to their business this gain related to the brand and marketing of products from a green supply chain.

Working the green supply chain is a potentially effective mechanism for improving the company's track record in corporate social responsibility, improving reputation, reducing waste, and focusing on environmental regulations (Laari, Töyli & Ojala, 2017; Simpson et al., 2007). In this context, some manufacturers will require the implementation of internal GSCM activities as an extension to their external supply chain partners (Zhu et al., 2013). On the other hand, this type of approach, considered coercive, shows that many suppliers are likely to comply, but only to respond in a reactive way to minimum requirements (Tachizawa & Wong 2015).

The opposite is also observed by Laari, Töyli & Ojala, (2017) who showed in their results that curiously there are companies that claim to be competing with small environmental

impacts but do not collaborate or monitor their suppliers environmentally. These companies can focus more on implementing internal activities, rather than enhancing environmental sustainability upstream in the supply chain.

Green Supply Chain Innovation

Green innovation is the main driver of sustainable development, which seeks to reduce the negative environmental impacts caused at each stage of a product's life cycle (Wu, 2013; Dangelico & Pujari, 2010).

Dai, Zang & Tang (2017) comment that research on R & D cooperation in the context of green supply chains has not received sufficient attention. While a small fraction of previous research into R & D alliances takes into account the impact of technological capability differences on companies, R & D cooperation in a green market where external environmental awareness and subsidy factors coexist governmental organizations can interactively impact corporate decision-making.

Efforts related to reducing or reducing an impact on the environment, the creation of a sustainable energy supply and social welfare, such as job creation are related to environmental innovations (Hafezalkotob, 2017).

Min & Kim (2012) point out that great strides have been made to incorporate ethical and environmental responsibilities into the core culture of the business world. With the greatest attention given to these responsibilities, a growing number of companies have exploited this niche and using these initiatives as competitive strategic weapons.

Thus innovation to a higher green level is the top priority for the GSCM. Innovation in green products can not only improve the environment, but also increase the competitive advantage of the manufacturer (Yang & Xiao, 2017; Basiri & Heydari, 2017). Green innovation also depends on the effective integration of resources and capabilities of supply chain partners and manufacturers (Wu, 2013).

Song & Gao (2018) demonstrate that innovation in the management of the green supply chain brings results felt by the consumer who already has sensitivity to the green product. This directly affects the level of product ecology and the size of sales, which in turn affects the profitability of manufacturers and retailers.

In this context, the studies Laari, Töyli & Ojala (2017) show that in commerce, companies that seek cost leadership and / or hybrid strategies are more likely to combine high environmental collaboration and high environmental monitoring, aiming at this sensitivity that results in increased profitability. Vachon & Klassen (2008) point out that meeting consumer demand for green products is one of the main objectives of green supply chain participants implementing green innovations.

Liu and Yi (2017) demonstrate how using Big Data can be useful as an innovation for the green supply chain. The results of the studies demonstrate how to use advertising as a way of gain related to the use of the green supply chain associated with exposure to its customers. This demand, according to Howes et al. (2013) and Fu, Chen & Hu (2017) makes most of the innovations in production processes and product characteristics come not only from government regulations but also from market demands.

Methodology

This paper was developed using the Scopus database covering the period from January 2007 to October 2018, in order to verify the structure of cooperation among authors and institutions, the incoming authors and the categories of production and continuity, the regularity of publication and the distribution of their publications over time.

The search keywords were "Green Supply Chain Management", "Green Supply Chain" and "Innovation". Of these, the results were limited to full text, type of publication - academic journal, type of document - "article" or "review", English language, being that 75 scientific articles that composed the analyzed sample were left. Of these 75 articles, 11 could not be analyzed by the software because they did not have the DOI (Digital Object Identifier), a requirement chosen to run the data because it has greater capacity to capture information from the articles (see Figure 1).

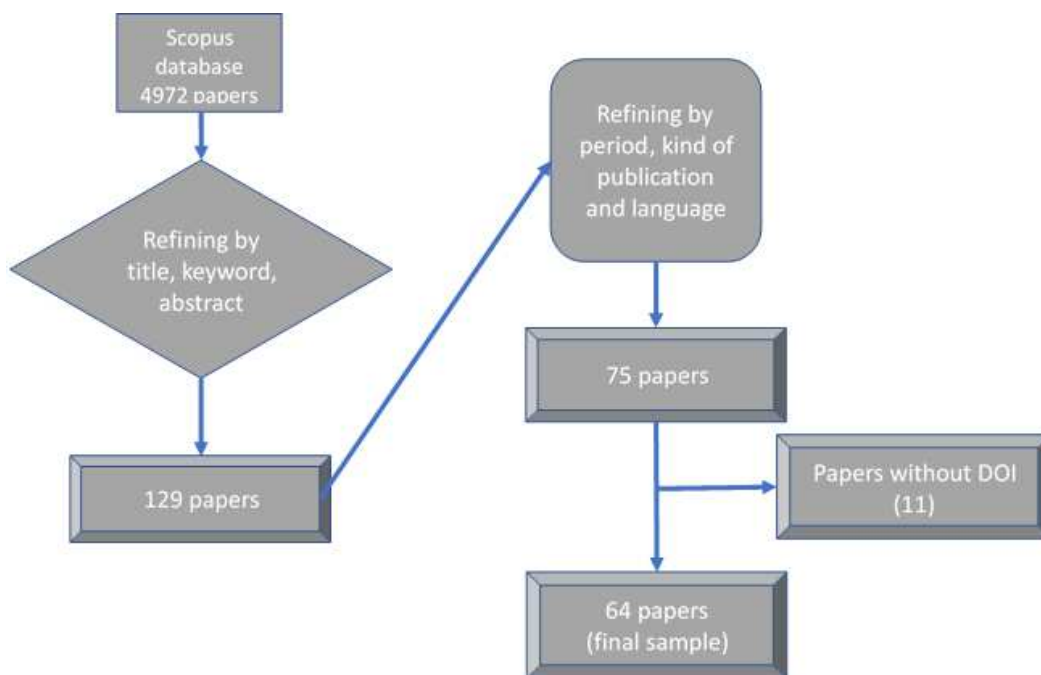


Figure 1 – Search Framework

The justification for choosing the above database takes into account the availability of access offered by the educational institution to which the researchers are associated. In addition, this database was chosen because it covers a significant number of journals, indexed by the main publishers of the academic field, such as: Elsevier, Emerald, Springer, Inderscience Enterprises, IAEME Publication, Taylor and Francis Ltd., MDPI AG, Academic Press, Institute of Electrical and Electronics Engineers Inc., Prague Development Center, Brazilian Institute for Information in Science and Technology, Routledge, Econjournals, Medwell Journals, Academic Journals Inc., International Information Institute Ltd., John Wiley and Sons Ltd, IGI Global, Wiley-Blackwell, Mohammed Premier University, Italian Association of Chemical Engineering - AIDIC, Journal of Chemical and Pharmaceutical Research,

Among the revisions already carried out under a group of approximate keywords, none that focused on this theme (GSCM) associated with innovation was found.

A three-stage process was used for this review, modified from methods employed by Tranfield et al. (2003), Seuring and Müller (2008) and Igarashi, Boer and Fet (2013):

1. Material collection: the material to be collected is defined and delimited.
2. Category selection: general aspects, for example, database, year of publication, type of research, main authors involved, main periodicals, among other relevant information.
3. Classification and evaluation of the material: the material is analyzed according to the categories defined in stage 2.

For the analysis of the data, the periodical in which the authors were published and the institutions to which they were linked at the time of publication was observed. In addition, the main countries of origin of the published works were analyzed. With the articles selected in this first stage, the data will be tabulated and the analyzes will be carried out to identify links between researchers.

The results are presented quantitatively, demonstrating the volume of articles, researchers and authors present. The analyzed aspects were: a) quantity of articles published by authors and in which periodicals; b) distribution of researchers according to categories of production and continuity and co-authoring related to each category of production and continuity; c) affiliation institutions; d) authors and periodicals that published on the subject Green Supply Chain Management associated with innovation. This categorization was modified from Sehnema et al. (2015).

It is important to note that VosViewer (software used to categorize the papers) performs categorical separation as follows:

- Co-authoring analysis: the relation of the number of items is determined by the number of documents in co-authorship. This category is subdivided between authors and organizations to which they are linked.
- Citation analysis: the relation of the number of items is determined by the number of times each author cited another author. This category is subdivided into documents (articles), authors, sources and organizations to which they are linked.
- Analysis of bibliographic connections: the relationship between items is based on the number of references they share. This category, like the previous one, is subdivided into documents (articles), authors, sources and organizations to which they are linked.
- Cocitation analysis: The relationship between items is determined based on the number of times they are cited together (which are co-authors). This category is subdivided in cited references, quoted authors and cited sources.

Results and discussions

Initially, this section shows the articles with the highest number of citations, links verified in the Vosviewer software, the authors with the largest number of articles and citations and the journals with the largest number of articles and citations.

Among the 64 articles analyzed in this study, Chiu (2011), Zhu (2007), Yang (2010), Zhu (2012b) and Tseng (2013) are highlighted in relation to the number of citations, as shown

in Table 1 - ranging from 214 citations to Chiou (2011) to 107 citations to Tseng (2013), which highlights the relevance of such works in the academic community.

Paper	N° of citations	N° of links
Chiou (2011)	214	7
Zhu (2007)	182	1
Yang (2010)	144	0
Zhu (2012b)	115	3
Tseng (2013)	107	0

Table 1 – More cited papers

By analyzing the number of connections (links) verified in Vosviewer software, the papers of Chiou (2011), Song (2017), Wu (2013), Zhu (2012b) and Dai (2015) are emphasized, as shown in Table 2 - varying among 7 links for Chiou (2011) up to 2 links for Dai (2015). Such links are brought as output in Vosviewer software and show the intensity of the article's relationship.

Paper	N° of links	N° of citations
Chiou (2011)	7	214
Song (2017)	4	2
Wu (2013)	3	44
Zhu (2012b)	3	115
Dai (2015)	2	19

Table 2 – Papers with more links

Table 3 shows the authors with the highest number of articles and citations. Emphasis is given to the importance of Qinghua Zhu (China), Kee-hung Lai (China) and Joseph Sarkis (USA). Zhu appears in 5 articles with a total of 454 citations; Lai consists of 3 articles, with 327 citations; and Sarkis is also in 3 articles, summing 330 quotes. They are relevant authors in the subject studied and this is noticed both by the strong publication and by the impact of citations in the academic community.

Author	N° of papers	N° of citations
Zhu, Q.	5	454
Lai, K. H.	3	327
Sarkis, J.	3	330

Table 3 – Authors with more papers and citations

Another way to highlight the relevance of authors and papers is through the output of VOSviewer® software, which brings the network of work relationships. Figure 2 makes clear, for example, the network of Zhu's articles in the scenario of relation with other works, thus corroborating their relevance not only quantitatively (in number of articles and citations).

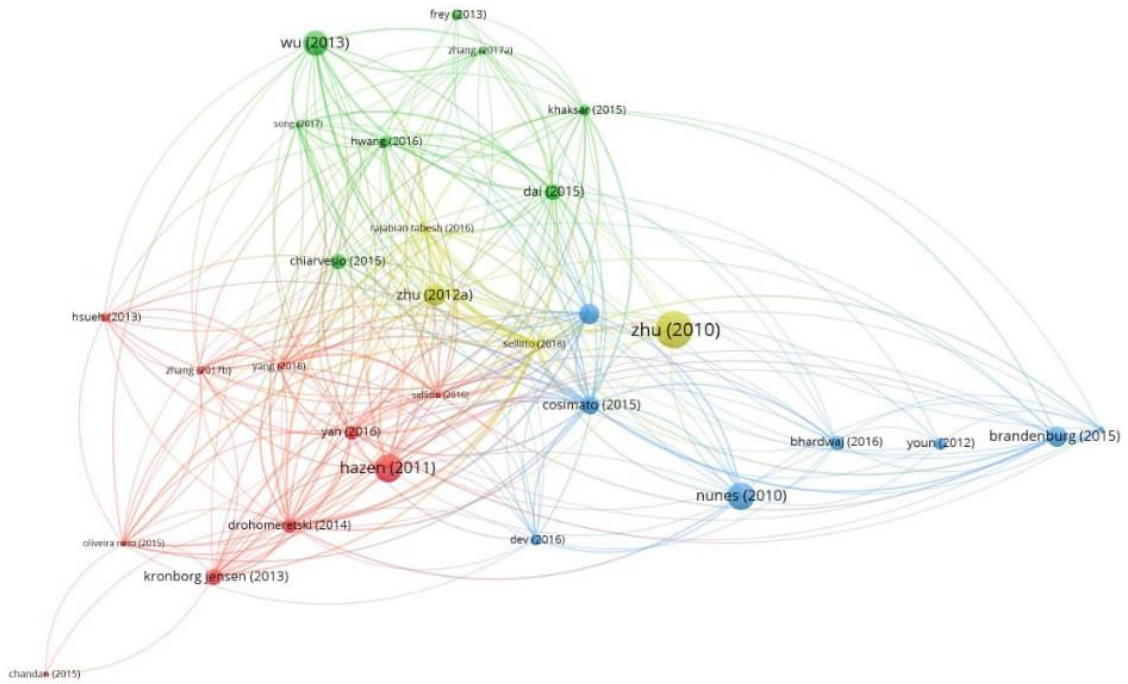


Figure 2 – Network of analyzed papers

Analyzing the main journals regarding the number of articles in the analyzed database (Table 4), we have: Journal of Cleaner Production (6 articles), Sustainability (4 articles) and Benchmarking: an International Journal (4 articles). They are relevant journals in the area and this can be evidenced by the impact factor of each: Journal of Cleaner Production (5,651), Sustainability (2,075) and Benchmarking: an International Journal (1,97).

Journal	Nº of papers
Journal of Cleaner Production	6
Sustainability	4
Benchmarking: an International Journal	4

Table 4 – Journals with more papers in the analyzed database

Based on the analysis of the number of citations, the journals that stand out in this category are: Transportation Research Part E (214 citations), Journal of Environmental Management (197 citations) and Journal of Cleaner Production (174 citations).

Journal	Nº of citations
Transportation Research Part E	214
Journal of Environmental Management	197
Journal of Cleaner Production	174

Table 5 – Journals with more citations in the analyzed database

This fact can still be observed in Figure 3 which brings a software output portraying such journals and others that make up a large part of the citations contained in the analyzed papers.

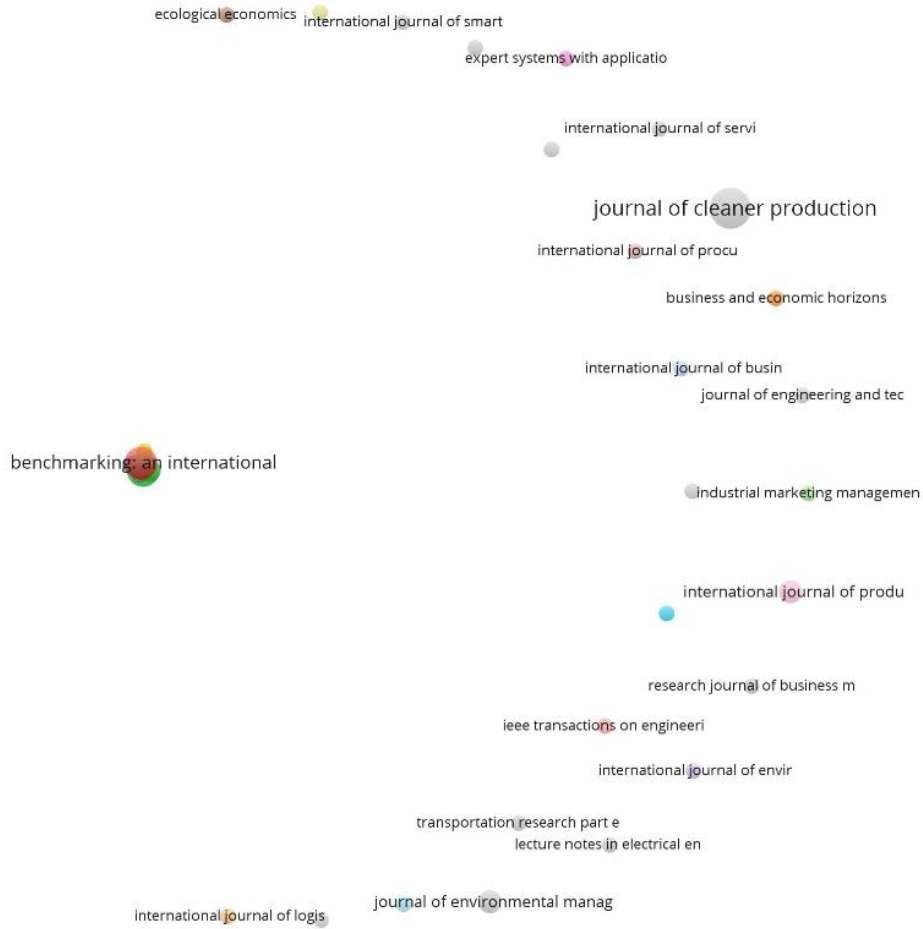


Figure 3 – Journal of analyzed papers

In observing Figure 3, it is possible to note the non-connection between the majority of journals, however, it is important to highlight a strong connection detected by the software among journals that were not the most cited. Figure 4 is an approximate cross-section of Figure 3, where several journals are agglomerated and have several links to each other.

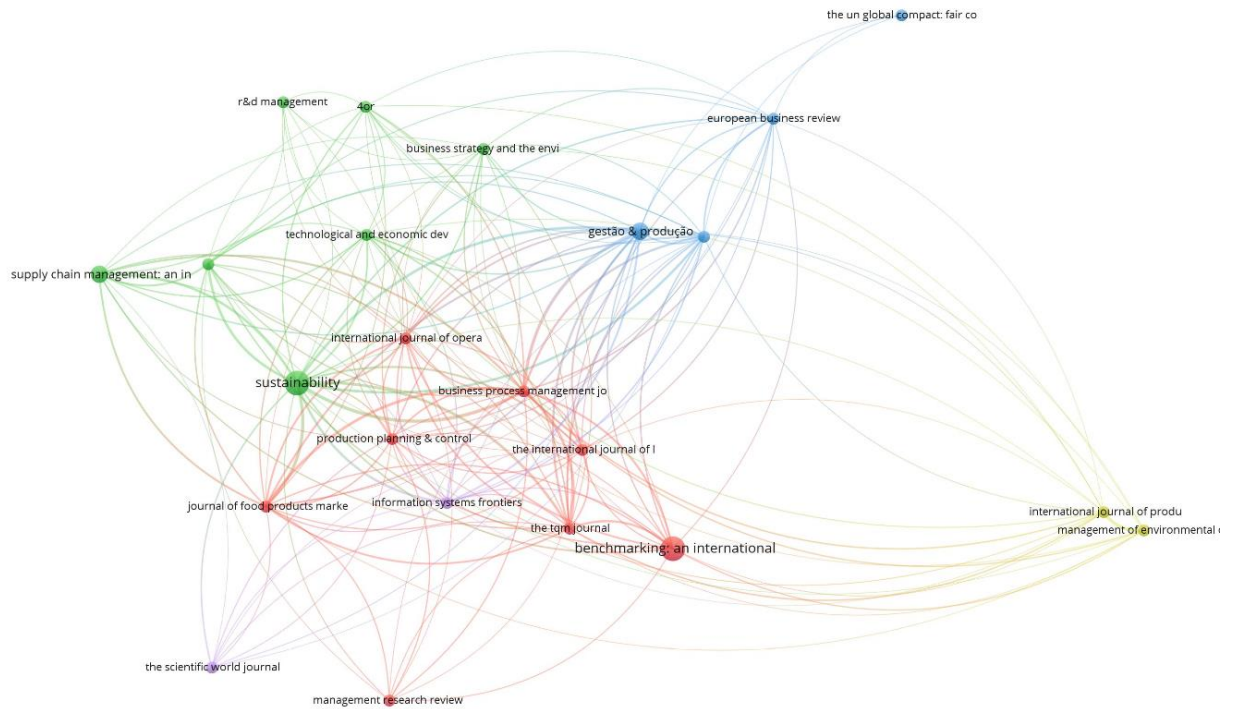


Figure 4 – Links among journals of analyzed papers

Finally, this database allowed to analyze the origin of the publications. For this analysis the country of origin and its links were verified, through the authors, and the relevance in the academic scenario of these papers. In this way, Figure 5 shows the links among the articles and their respective origins.



Figure 5 – Country (origin) of analyzed papers

Figure 5 shows the existence of a nucleus of research that relates studies about the green supply chain and innovation with strong connection between some countries (Figure 6). From this analysis one can determine the countries that are central to these surveys.

Thus, countries such as China, the United Kingdom, the United States, Morocco, France, Denmark, Hong Kong, Australia, Taiwan, the Philippines, Japan and South Korea stand out because of the amount of research published on the subject and because they have links between their studies and research on innovation and green supply chain.

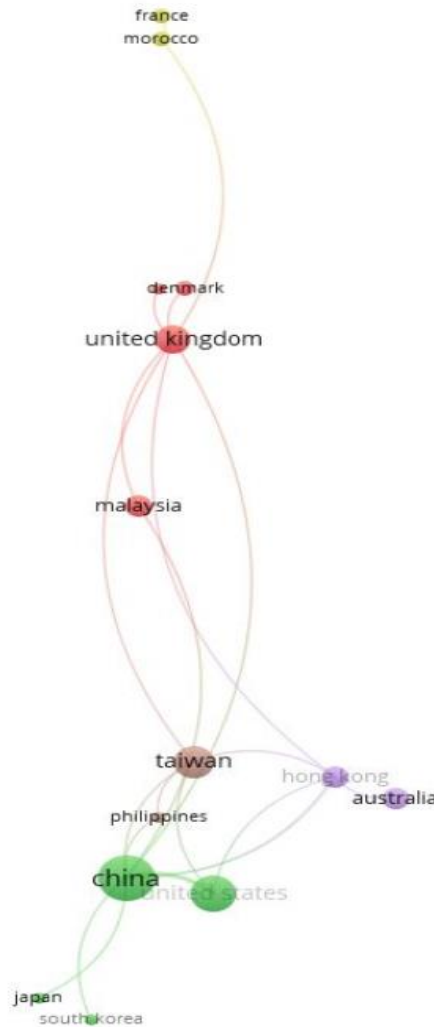


Figure 6 – Main countries (origin) of analyzed papers

Final remarks

The main objectives of the present study were: (1) to present the most cited authors in the main papers associating the themes of innovation and the green supply chain; (2) demonstrate the main localities that develop research with this focus and (3) list the main journals where such studies and authors published their research.

It was possible to identify the main associations between authors, respective works with the highest number of citations and authors that stand out in this research area. In addition,

it was possible to identify the main research centers that develop studies associating the approach of innovation to the green supply chain.

Relevant fact of this study was to demonstrate that there is a periphery that also develops research that associates the themes. The relevance of this finding can be highlighted by demonstrating the possibility of forming research partnerships and future cooperation networks for such studies, since for scientific research the union of study centers already consolidated with other centers of lesser importance can transform the reality of research developed in these peripheral points.

It should be emphasized that studies that associate the themes of innovation and the green supply chain show great acceptance within the academic community, since reference periodicals, with great impact factor, show interest in this type of research when analyzing the quantity of articles published by them.

The present research also highlights the limitation on a greater deepening and discrimination of other networks when having been carried out on a database only, the Scopus. In addition, another limitation was related to the use of DOI to form the basis of analysis. This limitation was verified, therefore, it was not all the articles that had this record. In spite of the limitation, it is important to highlight that the main journals are indexed by Scopus, which guarantees the guarantee a relevance for such research, even knowing this limitation.

As suggestions for future research, a new analysis focusing on more databases and a confrontation with this current research, would try to find new researchers and research relevant to the context, as well as to demonstrate if there are other journals that were not cited by (2) a more qualitative look at the major research center, when the main countries and the periphery of studies related to the theme of this research are observed. An attempt to find out the reasons for forming a (perhaps unintentional) association of countries that research on the themes and possibilities of forming a network of study cooperation associating countries that are at the periphery of these researches.

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