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Circular economy: a systematic and bibliometric review

Economía circular: una revisión bibliométrica y sistemática

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ABSTRACT

The circular economy is a strategy to optimize waste management and recycling and achieve sustainability models. This research aimed to conduct a systematic bibliometric review of the circular economy. A descriptive approach was used to analyze the data obtained from the Scopus database. The results show a moderate positive increase of R2 0.6936 in scientific production, with more publications in 2022. The United Kingdom leads in this type of publication, and the most cited article is by authors Murray A., Skene K., and Haynes K.; forty-three authors are estimated to be the most prolific. According to Bradford's law, the most relevant journal is the Journal of Cleaner Production. The authors Jaca C., Prieto-Sandoval V., Ormazabal M., Baumgartner R. J., and Vermeulen W. J. V. worked together in four research. The most prominent keywords are circular economy, environmental economics, economic sciences, and eco-design. In conclusion, the circular economy is an innovative alternative that contributes to the sustainability of production processes and the redesign of more environmentally friendly products.

Keywords: circular economy, green economy, recycling, sustainability.

JEL Classification: Q2, Q5, Q54, Q57

RESUMEN

La economía circular se presenta como una estrategia que permite optimizar la gestión de residuos y reciclaje, y alcanzar modelos de sostenibilidad. El objetivo de esta investigación tuvo como propósito realizar una revisión bibliométrica y sistemática de la Economía Circular; se utilizó un enfoque descriptivo para analizar los datos obtenidos de la base de datos de Scopus. Los resultados muestran un incremento moderado positivo R2 0.6936 en la producción científica, con un mayor número de publicaciones en 2022. El Reino Unido lidera en este tipo de publicaciones y el artículo más citado es el de los autores Murray A., Skene K., Haynes K. y se estima que 43 autores son los más prolíferos. La revista más relevante según la ley de Bradford es Journal Of Cleaner Production y los autores Jaca C., Prieto V., Ormazabal M., Baumgartner R. y Vermeulen W. trabajaron juntos en 4 investigaciones. Las palabras clave más destacadas son Economía Circular, economía ambiental, ciencias económicas y ecodiseño. En conclusión, la Economía Circular se presenta como una alternativa innovadora que contribuye a la sostenibilidad de los procesos productivos y al rediseño de productos más amigables con el medio ambiente.

Palabras clave: economía circular, economía verde, reciclaje, sostenibilidad.

Clasificación JEL: Q2, Q5, Q54, Q57

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INTRODUCTION

Currently, the main demands of social responsibility in the market require companies to change or design production processes that ensure respect for the environment and, in this context, the Circular Economy (CE) represents a change in production processes and optimal processing and reuse of waste and residues in their different stages and thus achieve mitigation of the negative effects on the environment (Cardozo et al., 2023; Melo & Souza, 2022). The CE model is structured among the following processes: recycling, reuse, recovery, reduction, repair, remanufacturing, redesign,

redistribution, and rethinking; each of them is designed to minimize the environmental impact of a company's production processes (Matiacevich et al., 2022).

In this order of ideas, CE proposes the change of processes in a linear way to achieve a practical solution and the reuse of resources in order to build profitable sustainability models for companies, which also generate the involvement of the different roles of economic agents and establish environmentally friendly processes and the correct use of resources to contribute to the reduction of greenhouse gases and mitigation of climate change (Colla et al., 2022; García & González, 2022). According to Reyes Pulido et al. (2022), the importance of implementing CE is in the optimal management of waste, residues, and reuse in the different stages that, in turn, allow the creation, optimization, and improvement of environmentally friendly products; this allows the company to build functional advantages and cost reduction. Therefore, by implementing business strategies that promote CE, the reuse and preservation of the natural capital of renewable resources is facilitated; leading to an optimization in the use of limited inventories and greater efficiency in the production system without generating external negative impacts that affect the company (Balboa & Domínguez, 2014; González & Vargas, 2017).

The circular system adapts to a society with a progressive trend, which demands and is concerned about the correct management of resources; it provides strategic solutions for friendly, sustainable, and respectful processes of environmental resources, as opposed to traditional processes, predatory and unconscious exploiters of resources (Almeida & Diaz, 2020). Circularity appears as a competitive advantage to adapt the company to international business regulations and different governmental laws to develop value propositions and, thus, achieve sustainability of resources, generating employment and achieving differentiation from competitors (Diaz et al., 2020).

For Pearce & Turner (1989), CE is called "natural resource and environmental economics". Over the years, this term has become more important, not only in academia but also in the business, social, economic, and political sectors (cited by González & Pomar, 2021). Due to the damage caused to the environment by the excessive use of natural resources -derived from the mass production of consumer products- it is necessary to have a mechanism to address the issue of waste pollution and mitigate such damage (Córdova et al., 2021).

In this sense, CE is a current that postulates the idea that resources can be used responsibly and that they are not infinite and, therefore, it is necessary to create a collective awareness of the importance of a socially responsible company with the environment and thus make intelligent use of them (Gutiérrez, 2022). Eliminating waste is a practice that CE invites to do as a form of corporate social responsibility, thus inviting the use of materials in an intelligent way, which provides a competitive advantage for different industries (Porcelli & Martinez, 2018). Of course, CE in the last decade is an alternative model that moves to a green economy; which means a more efficient, rational, and balanced use of resources, where the most important thing should be the common good and respect for the environment, which is the bet of the objectives set out in the 2030 agenda (Moscoso, et al., 2019).

For the agricultural sector, this theory is of great importance because, given the growth of the world population and the need to produce food massively, it can make this sector one of those that produce the most waste and, therefore, one of those that pollute water sources, soils and the atmosphere the most (Cervantes, 2021). In this sense, the CE seeks that the agricultural sector closes this circle of linear production and migrate to the new model, in favor of a higher yield in its operations (Ramírez, 2022). Therefore, this concept is correlated with sustainability, and its objective is that materials and products remain in the market for as long as possible, causing the reduction of pollution-causing waste (Melgarejo & Fernandez, 2019). For the Peruvian agroindustrial sector this is a matter of vital importance, since it has discovered that having a good use of waste represents a better acceptance in its national and international market, being, then, a matter of good image (Hernández & Yagui, 2021).

For the coffee sector, as one of the sectors that produces the most waste (given that every two-thirds of its production is converted into waste), it is imperative to apply CE, given this context where the demand for energy at a global level is increasing every day and where energy is migrating from production based on fuels derived from fossil fuels to biofuels; coffee pulp is an opportunity for this sector to practice CE and obtain greater profitability (Gutiérrez et al., 2021).

For companies in the textile sector, CE is an alternative that -given the world crisis of global warming- should be focused on, from a production conducive to the mitigation of climate effects, which also becomes a competitive advantage since new customers prefer to consume garments that come from factories where CE is an adopted practice (Sarmiento et al., 2022). In relation to the above, the purpose of this paper was to conduct a bibliometric analysis of research on CE.

METHODOLOGY

In this study, a bibliometric analysis was used as a technique to measure the scientific activity and impact of CE (Licea de Arenas & Santillán, 2002). A descriptive approach was used to identify the fundamental characteristics of this object of study (Hernández & Fernández, 2014, p. 92). The information was collected using the Scopus database, which provides summaries and citations of peer-reviewed literature in various fields of science, technology, medicine, social sciences, arts, and humanities, being a comprehensive tool for global research (Elsevier, n.d.).

To perform the search, the fields "Article title" and "Search documents" were selected; the keyword "circular economy" was used. No time parameter restrictions were applied; data extraction was performed on May 7, 2023. The search was limited to the subject area of "business, management and accounting", "BUSI" and "economics, econometrics and finance" ("ECON"), document type articles ("ar"), in its final stage ("final"), and open access "j" journals ("all"). Boolean operators were used to improve the precision of the search results (Villegas, 2003).

The resulting search equation was: TITLE ("circular economy") AND (LIMIT-TO SUBJAREA, "BUSI") OR (LIMIT-TO SUBJAREA, "ECON") AND (LIMIT-TO DOCTYPE, "ar") AND (LIMIT-TO PUBSTAGE, "final") AND (LIMIT-TO SRCTYPE, "j") AND (LIMIT-TO (LANGUAGE, "English") OR LIMIT-TO (LANGUAGE, "Spanish") AND (LIMIT-TO OA, "all").

A total of 618 scientific articles associated with the topic were obtained. The data were exported from Scopus in "CVS" and plain text ("RIS") formats for subsequent processing in Microsoft® Excel ®, for Microsoft 365 Education and VOSviewer version 1.6.19, a specialized tool for establishing and representing bibliometric networks (Orduña-Malea & Costas, 2021).

The results were classified according to bibliometric indicators that measure scientific production, for which: annual scientific production using the law of exponential growth of science, proposed by de Solla (1976); scientific production by country; most cited and relevant articles; most prolific authors estimated according to Lotka's Law (Urbizagastegui, 1999); scientific journals with the greatest impact by applying Bradford's Law (Urbizagastegui, 1996); and the evaluation of co-authorship networks and co-occurrence of keywords, using the analysis of fragmentation and visualizations of temporal and thematic trends known as Zipf's Law (Perianes et al., 2016).

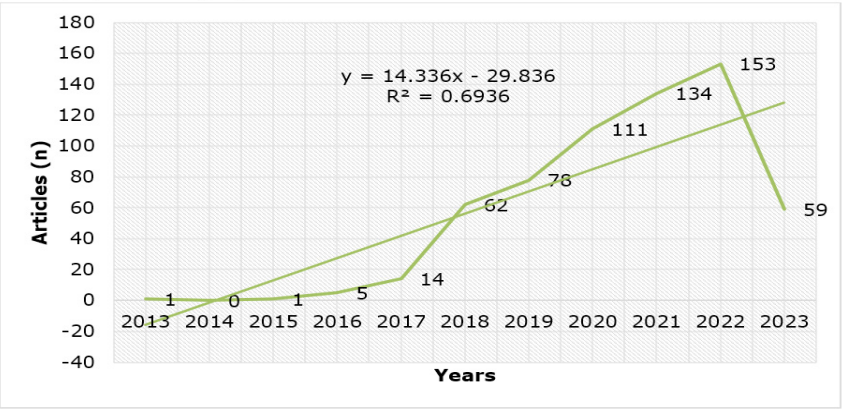
Finally, the most significant results on CE are discussed and the corresponding conclusions are presented.

RESULTS

Scientific production per year

The topic of CE has become an area of great interest for scientific research in recent years, as illustrated in Figure 1, which shows an exponential increase in scientific production in this field between 2013 and 2023. The coefficient of determination, which indicates the strength of the relationship between time and number of publications, is moderately positive (R2: 0.6936). Moreover, a maximum peak can be observed in the year 2022, suggesting a great interest in this topic.

Figure 1.
Scientific production per year

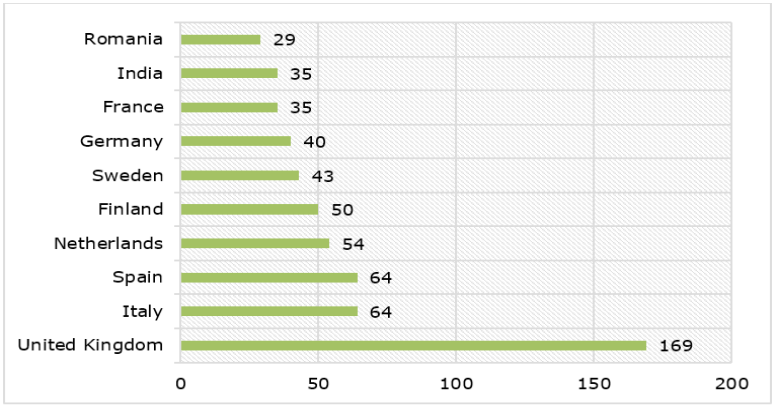


Source: own elaboration, based on data obtained from the Scopus 2023 database.

Scientific production by country

Figure 2 shows that the country with the highest scientific production in CE is the United Kingdom, which contributed 169 articles, representing 28% of the total number of publications analyzed. This indicates a high concentration of scientific production in that country. On the other hand, Italy and Spain also made a significant contribution, with 64 articles each.

Figure 2.
Scientific production by country



Source: own elaboration, based on data obtained from the Scopus 2023 database.

Most cited and relevant articles

The most relevant and highly cited article is entitled "The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context" by Murray A., Skene K. & Haynes K. (2017), with 1248 citations. In it, CE is addressed as a sustainable strategy to drive economic development. The second article, "Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications", by authors Genovese A., Acquaye A., Figueroa A. & Koh S. (2017), has 702 citations and highlights the importance of CE and the impetus it generates to transform processes and products that are environmentally friendly. The third most cited and relevant article is "Circular economy - From review of theories and practices to development of implementation tolos", written by Kalmykova Y., Sadagopan M. & Rosado L. (2018), with 645 citations. In it, an overview of the literature on theoretical approaches, strategies and cases of CE implementation is presented. Table 1 shows the 10 most cited and relevant articles, highlighting these 3 as the most important.

Table 1.
Most cited and relevant articles

Article name	Authors	Year	Citation	Reference
The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context	Murray A.; Skene K.; Haynes K.	2017	1,248	(Murray *et al.*, 2017)
Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications	Genovese A.; Acquaye A.; Figueroa A.; Koh S.	2017	702	(Genovese *et al.*, 2017)
Circular economy - From review of theories and practices to development of implementation tools	Kalmykova Y.; Sadagopan M.; Rosado L.	2018	645	(Kalmykova *et al.*, 2018)
The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options	Reike D.; Vermeulen W.; Witjes S.	2018	626	(Reike *et al.*, 2018)
Barriers to the Circular Economy: Evidence from the European Union (EU)	Kirchherr J.; Piscicelli L.; Bour R.; Kostense E.; Muller J.; Huibrechtse A.; Hekkert M.	2018	610	(Kirchherr *et al.*, 2018)

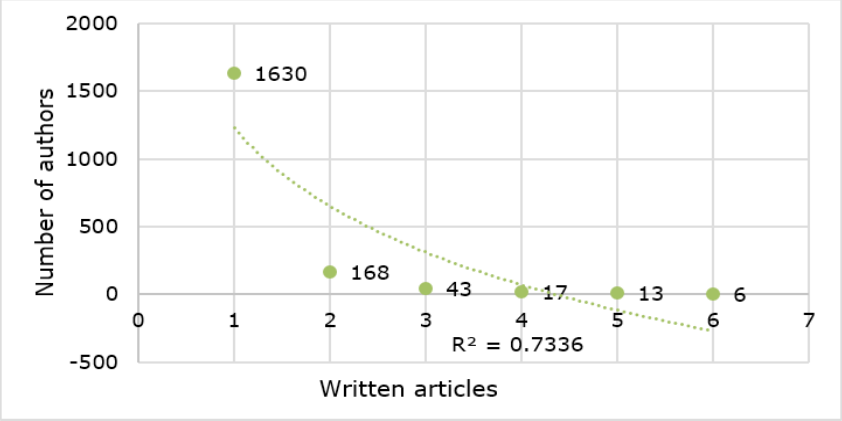
Circular economy as an essentially contested concept	Korhonen J.; Nuur C.; Feldmann A.; Birkie S.	2018	589	(Korhonen *et al.*, 2018)
Towards a consensus on the circular economy	Prieto V.; Jaca C.; Ormazabal M.;	2018	478	(Prieto-Sandoval *et al.*, 2018)
Business models and supply chains for the circular economy	Geissdoerfer M.; Morioka S.; de Carvalho M; Evans S.	2018	476	(Geissdoerfer *et al.*, 2018)
Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy	de Jesus A.; Mendonça S.	2018	421	(Jesus & Mendonça, 2018)
Circular economy for the built environment: A research framework	Pomponi F.; Moncaster A.	2017	420	(Pomponi & Moncaster, 2017)

Source: own elaboration, based on data obtained from the Scopus 2023 database.

Analysis of the most prolific authors

Figure 3 shows the frequency distribution of events describing the number of scientific publications produced by different authors, with a coefficient of determination R2 of 0.7336, indicating a moderate positive trend. According to Lotka's Law, it is inferred that a small group of prolific authors is responsible for most of the knowledge generation. In this study, it has been identified that this group is composed of 43 authors, equivalent to the square root of 1877, who have published papers on the subject in question.

Figure 3.
Analysis of the most prolific authors



Source: own elaboration, based on data obtained from the Scopus 2023 database.

Analysis of scientific journals

Table 2 shows the results of Bradford's Law analysis, which indicates that the most prolific journal on the subject of CE is Journal Of Cleaner Production, located in the middle zone of the top 10 journals. This journal has a cumulative frequency of 163 in zone 1, ranging from 163 to 76. It is relevant to note that the journal Resources, Conservation And Recycling is also in zone 1 with a frequency of 76.

Table 2.
Analysis of scientific journals

Journal	Range	Frequency	Cumulative Frequency	Zone
Journal Of Cleaner Production	1	163	163	Zone 1
Resources, Conservation And Recycling	2	76	239	Zone 1
Business Strategy and The Environment	3	45	284	Zone 2
Ecological Economics	4	15	299	Zone 2
Technological Forecasting and Social Change	5	12	311	Zone 2

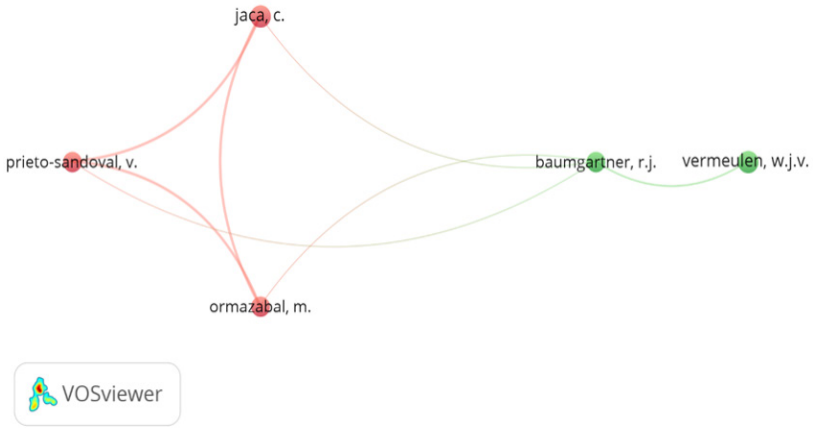
Amfiteatru Economic	6	11	322	Zone 2
Journal Of Business Research	7	10	332	Zone 2
International Journal of Mathematical, Engineering And	8	9	341	Zone 2
Management Sciences	9	7	348	Zone 2
Cleaner And Responsible Consumption	10	7	355	Zone 2

Source: own elaboration, based on data obtained from the Scopus 2023 database.

Co-authorship Network Analysis

Figure 4 shows that authors Jaca. C., Prieto, V., Ormazabal, M., Baumgartner, R., and Vermeulen, W. collaborated on 4 CD-related research projects during the period analyzed, which is reflected in the cluster and co-authorship network.

Figure 4.
Co-authorship analysis

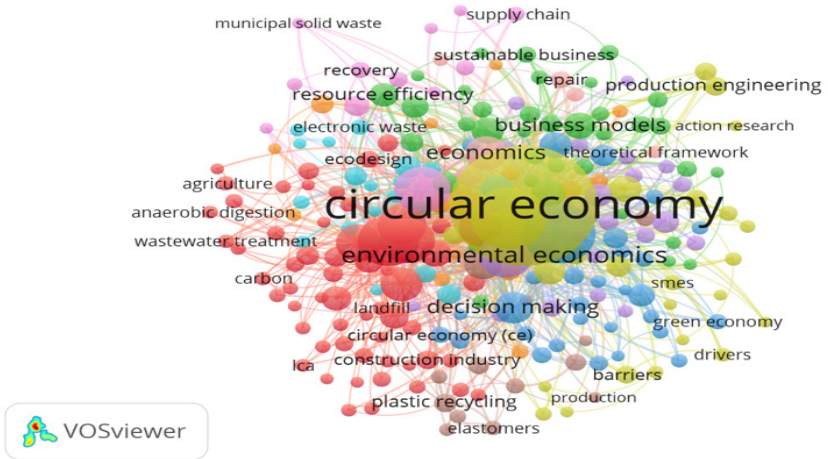


Source: Co-authored network.
Figure developed with VOSviewer software version 1.6.19, with data obtained from Scopus 2023.

Keyword co-occurrence and trend analysis

Figure 5 shows the most commonly used keywords in the scientific production on circular economy, among which are: circular economy, environmental economics, economics, ecodesign, business models, action research, action research, recovery, sustainable business, supply chain, green economy, production engineering, decision making, plastic recycling, SME, barriers, construction industry, and production.

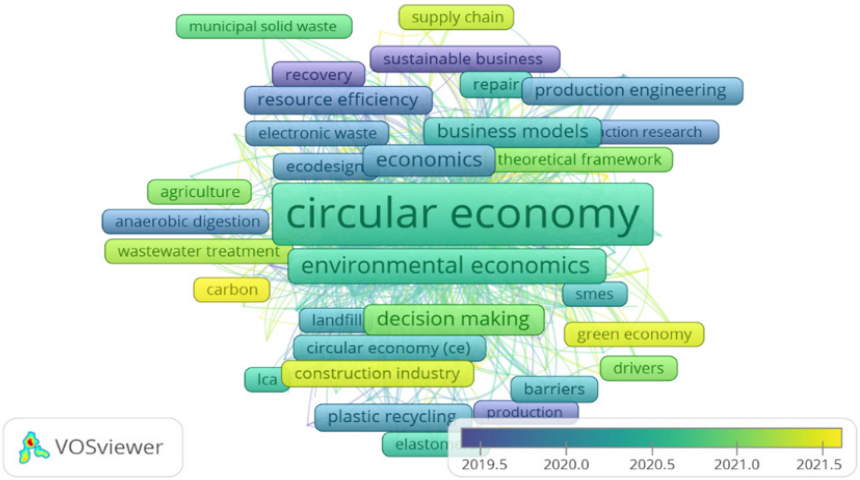
Figure 5.
Cooccurrence of keywords in scientific production



Source: Concurrency network.
Figure developed with VOSviewer software version 1.6.19 with data obtained from Scopus 2023.

Figure 6 shows the trends of the most frequently used words in a given period. In the year 2021, the most frequently used words are "green economy", "coal", "construction industry" and "supply chain". Whereas, in the 2020 period, the most frequent terms were "circular economy", "environmental economics", "business models", "municipal solid waste" and "decision making".

Figure 6.
Cooccurrence of the most trending keywords in recent years



Source: Concurrency network.
Figure developed with VOSviewer software version 1.6.19 with data obtained from Scopus 2023.

DISCUSSION

Through a bibliometric review of the Scopus database, an increase in scientific production has been observed in the year 2022, suggesting a growing interest in the topic of CE. The UK leads the production in the 2013-2023 period, and the most cited article is "The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context", with 1248 citations. The most productive journal on this topic is Journal Of Cleaner Production. In addition, a co-authorship network of 4 collaborations has been identified between the authors Jaca. C., Prieto, V., Ormazabal, M., Baumgartner, R., and Vermeulen, W., who share keywords that vary according to the time period.

Given the importance of CE in business management, this is an issue that organizations should not ignore when considering their corporate strategies. Companies are forced to accelerate their transition from linear production to CE, in which the use of resources is maximized, and waste is minimized or converted into new materials for reuse (Bravo et al., 2021). Recycling is one of the key points to achieving CE and environmental sustainability (Almeida & Diaz, 2020).

Current trends show a global urgency for a more environmentally friendly system to ensure the well-being of all the planet's inhabitants. The importance of CE, despite the efforts of many organizations around the world to promote the issue, some forces oppose such initiatives. Many investigations agree that a greater commitment is needed from governments and civil and social organizations to develop plans that promote the implementation of this economic model (Rodriguez et al., 2021).

The literature review demonstrates that it is possible to be sustainable through a CE. This paradigm has evolved in recent years along with the concept of sustainability and its application in the economy (Prieto et al., 2017). In this sense, it is highlighted that younger generations are more receptive and aware of the need for practices that protect natural resources and promote such an economy (Carrillo & Pomar, 2021).

It is relevant to mention that this study presents a methodological limitation because it focuses only on reviewing open access articles. This could affect the representativeness of the analysis since the information may vary and the database is constantly being updated. It is also important to note that the analysis of scientific production requires the experience and knowledge of experts in the field. Although the Scopus database is one of the main references in scientific production and provides reliable information, it is suggested that other sources and databases be included to obtain a more complete and exhaustive view of the topic addressed. In this way, the analysis could be enriched, and greater precision in the results could be guaranteed.

CONCLUSIONS

This study conducted a bibliometric review demonstrating the importance of CE in the disciplines of administrative sciences and economics. This topic is intrinsically related to corporate responsibility and sustainability and provides an innovative solution to reduce the environmental impact of production processes in a linear fashion. In addition, the study presents a series of findings that can serve as a guide for more comprehensive future research on this topic.

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