

Circular Economy and Sustainable Development Goals: A bibliometric analysis of scientific production

Economia Circular e Objetivos do Desenvolvimento Sustentável: Uma análise bibliométrica da produção científica

Economía Circular y Objetivos de Desarrollo Sostenible: Un análisis bibliométrico de la producción científica

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Resumo: Este estudo tem como objetivo analisar a produção científica relacionada à Economia Circular (EC) e aos Objetivos de Desenvolvimento Sustentável (ODS), no período de 2015 a 2022. Para isso, realizou-se uma análise bibliométrica com base em 336 artigos indexados na base Web of Science, utilizando os termos “Circular Economy” e “Sustainable Development Goals”. A partir dos dados coletados, foram aplicadas técnicas de mapeamento científico por meio do software VOSviewer, permitindo a visualização de redes de cocitação, coautoria e coocorrência de palavras-chave. Os resultados revelam um crescimento expressivo das publicações a partir de 2019, com destaque para periódicos de alto impacto, como *Sustainability* e *Journal of Cleaner Production*. Observou-se que países como Índia, China e Brasil vêm ampliando sua participação nas pesquisas sobre EC e ODS. Além disso, identificaram-se os artigos mais citados, os autores com maior número de publicações e os principais agrupamentos temáticos da área. O estudo contribui para a compreensão das principais tendências da literatura e para a identificação de lacunas e oportunidades de pesquisa, especialmente no contexto de economias emergentes. Conclui-se que a EC tem se consolidado como um importante instrumento para o alcance dos ODS, especialmente nas dimensões ambiental e econômica da sustentabilidade.

Palavras-Chave: Economia Circular. Objetivos do Desenvolvimento Sustentável. Bibliométrica.

Abstract: This study aims to analyze the scientific production related to the Circular Economy (CE) and the Sustainable Development Goals (SDGs) between 2015 and 2022. A bibliometric analysis was conducted using 336 articles indexed in the Web of Science database, based on the terms “Circular Economy” and “Sustainable Development Goals.” The data were analyzed using the VOSviewer software to map co-citation, co-authorship, and keyword co-occurrence

networks. The results show a significant growth in publications from 2019 onward, particularly in high-impact journals such as *Sustainability* and *Journal of Cleaner Production*. Countries such as India, China, and Brazil have shown increasing involvement in research on CE and SDGs. The study also highlights the most cited articles, the most prolific authors, and the main thematic clusters within the field. This work contributes to a better understanding of the main research trends, identifies gaps and opportunities for future studies, and reinforces the relevance of CE as a key strategy to achieve the SDGs, especially regarding the environmental and economic dimensions of sustainability.

Keywords: Circular Economy. Sustainable Development Goals. Bibliometrics.

Resumen: Este estudio tiene como objetivo analizar la producción científica relacionada con la Economía Circular (EC) y los Objetivos de Desarrollo Sostenible (ODS) entre 2015 y 2022. Se realizó un análisis bibliométrico con base en 336 artículos indexados en la base de datos *Web of Science*, utilizando los términos “Circular Economy” y “Sustainable Development Goals”. Los datos fueron analizados mediante el software *VOSviewer*, lo que permitió mapear redes de citación, coautoría y coocurrencia de palabras clave. Los resultados muestran un crecimiento significativo de las publicaciones a partir de 2019, con énfasis en revistas de alto impacto como *Sustainability* y *Journal of Cleaner Production*. Países como India, China y Brasil han ampliado su participación en las investigaciones sobre EC y ODS. El estudio también identifica los artículos más citados, los autores más productivos y los principales temas abordados en el área. Esta investigación contribuye a comprender las principales tendencias de la literatura, señalar vacíos y oportunidades para futuras investigaciones y reforzar la EC como una estrategia clave para alcanzar los ODS, especialmente en las dimensiones ambiental y económica de la sostenibilidad.

Palabras Clave: Economía Circular. Objetivos de Desarrollo Sostenible. Bibliometría.

Introduction

The linear model of production, consumption, and disposal has proven to be unsustainable in the face of the growing scarcity of natural resources and the worsening environmental crisis. In this context, the Circular Economy (CE) emerges as an alternative approach, based on closing material and energy loops and inspired by natural processes. This perspective seeks to keep products, components, and materials in use for as long as possible, promoting waste reduction and more efficient use of resources..

Furthermore, the Circular Economy (CE) proposes the decoupling of economic growth from the consumption of finite resources by encouraging more sustainable and innovative practices (MacArthur Foundation, 2021; OECD, 2020). In this way, it has been consolidating as a relevant pathway toward achieving sustainable development, by promoting a restructuring of production and consumption patterns and contributing to the mitigation of environmental impacts, as well as to the generation of economic value in a sustainable manner.

This approach also promotes energy efficiency and the sustainable conversion of waste, generating both environmental and economic benefits. By encouraging reuse, recycling, and technological innovation, it contributes to reducing emissions and improving the management of critical resources, especially in sectors with high consumption of energy and raw materials (Elroi, Zbigniew, Agnieszka & Piotr, 2023).

In this sense, it goes beyond environmental management and is configured as a regenerative development model with the potential to strengthen a more resilient economy. Additionally, the CE aligns with the pillars of the Sustainable Development Goals (SDGs), particularly those related to inclusive economic growth, resource efficiency, and the transition to a low-carbon economy (Binsuwadan, Yousif, Abdulrahim & Alofaysan, 2023). The study by Schroeder, Anggraeni, and

Weber (2019) analyzed this relationship and identified greater convergence with SDGs 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), 12 (Responsible Consumption and Production), and 15 (Terrestrial life), highlighting its potential as a strategy for sustainable development.

In this context, discussions on this model have intensified in different countries over the past decade (Farias, Pinto, de Sousa Araújo, de Menezes & de Andrade, 2021). However, the broad scope and conceptual fragmentation of the field result in multiple terms, approaches, and applications, making theoretical consolidation and scientific advancement more difficult, as well as potentially compromising the methodological rigor of studies (Korhonen, Honkasalo & Seppälä, 2018; Konietzko, Baldassarre, Brown, Bocken & Hultink, 2020).

According to Ritzen and Sandström (2017), there is no single consensus on how to approach the application of this concept due to its wide scope. This complexity involves, among other aspects, the principles of the 3Rs — reduction, reuse, and recycling of materials — and different interpretations of how they should be operationalized. In this scenario, although the Circular Economy is understood as a means to achieve sustainability (Linder & Williander, 2017), its implementation involves multiple dimensions and challenges. These challenges are distributed across governmental, business, and civil society spheres (Kirchherr, Reike & Hekkert, 2017), highlighting conceptual and practical gaps that still hinder its consolidation in an integrated manner.

Given the complexity of the sustainability field, within which the Circular Economy is situated — characterized by multiple definitions and approaches — bibliometric studies contribute to understanding the area by enabling the analysis of scientific production and the identification of emerging themes. In this context, previous research has explored different interfaces of the Circular Economy, such as its relationship with sustainable consumption (Queiroga, Oliveira & Elf, 2021), Industry 4.0 (Silva et al., 2022), production frameworks (Cajuela & Padua, 2024), and the Sustainable Development Goals (Schroeder et al., 2019). However, due to the dynamic nature of the field, updated analyses are still necessary.

Given this, the general objective of this study is to analyze how scientific production on Circular Economy (CE) relates to the Sustainable Development Goals (SDGs) in the period from 2015 to 2022. To achieve this objective, a methodological protocol was adopted for the collection and organization of bibliometric data, followed by the application of specialized software for processing and analyzing the articles, such as VOSviewer, which made it possible to map the scientific production on the topic.

Theoretical elements of the research

Sustainable development goals and Circular economy

The introduction of the concept of Circular Economy is attributed to Pearce and Turner (1990) and is closely linked to the concept of sustainability (Geissdoerfer, Savaget, Bocken & Hultink, 2017), as it seeks economic development with reduced environmental impacts (Yuan, Bi & Moriguchi, 2006). According to Haas, Krausmann, Wiedenhofer, and Heinz (2015), CE is a simple yet compelling strategy that aims to reduce both the input of virgin materials and the generation of waste by closing economic and ecological loops of resource flows. The idea of a Circular Economy highlights the need to extend the value and utility of products, as well as to treat production and consumption outputs as secondary resources (Mayer et al., 2019).

Pomponi and Moncaster (2017) emphasize that the main innovation within the concept of Circular Economy lies in decoupling resource depletion from the growth of resource consumption. This would enable increasing economic development and profitability without placing growing pressure on the environment. In line with this, Kirchherr et al. (2017) analyzed 114 definitions of Circular Economy and concluded that it is most frequently described as a combination of reduction, reuse, and recycling activities. Furthermore, the authors concluded that the studies analyzed rarely focus on the systemic change that EC requires.

According to Schroeder et al. (2019), the Circular Economy is defined through specific actions and practices such as eco-design, reuse, refurbishment, remanufacturing, repair, product sharing, and industrial symbiosis. The same authors point out that there are conceptual overlaps between these different practices, principles, or concepts, with other approaches such as cleaner production and Industrial Ecology. Therefore, the Circular Economy (CE) is linked to the Sustainable Development Goals (SDGs), highlighting its potential to contribute to reducing resource use, minimizing waste, and increasing the efficiency of production systems, especially in objectives related to responsible production and consumption and the sustainable use of natural resources (Korhonen et al., 2018).

However, authors such as Ghisellini, Cialani, and Ulgiati (2016), Geissdoerfer et al. (2017), and Murray, Skene, and Haynes (2017) emphasize that this contribution occurs only partially, as CE presents important limitations, particularly regarding the incorporation of the social dimension and the physical constraints of ecological systems. Thus, although CE is often associated with sustainable development, its articulation with the SDGs still faces conceptual and structural challenges that hinder full integration across its multiple dimensions.

Related studies

Regarding studies involving Circular Economy and using bibliometric methodology, the research by Queiroga et al. (2021) stands out. This study investigated academic production from 2011 to 2021 using the Web of Science database, focusing on the themes of Circular Economy and Sustainable Consumption. The study found 93 articles, with the largest number dating back to 2016. Furthermore, research peaked in 2020 with 31 studies. Furthermore, in 2020, research reached its peak with 31 studies..

As further results, Queiroga et al. (2021) conclude that the Circular Economy gains importance as an alternative source that drives sustainable development. To achieve this transition, actors such as governments, companies, and civil society must be engaged in joint actions. However, it is important to note the difficulty of shifting the economic model, as it requires breaking away from entrenched consumption habits. In addition, there is a need to develop new, attractive business models that must be economically viable for both companies and consumers.

On the other hand, the study by Silva et al. (2022) aimed to analyze the integration between Industry 4.0 and the Circular Economy, focusing on the consolidation of the concept of remanufacturing 4.0. Methodologically, the authors conducted a bibliometric study using databases such as Scopus and Web of Science, employing VOSviewer software for keyword co-occurrence analysis and mapping of relationships between themes. Mainly, they identified a significant growth in publications in the area, especially from 2018 onwards, and highlighted that technologies such as the Internet of Things, Big Data, and additive manufacturing are central to this integration process, demonstrating a strong relationship between digitalization and circular practices.

Therefore, the study by Cajuela and Pádua (2024) aimed to identify the state of the art regarding frameworks, methods, and steps used in the implementation of the Circular Economy in organizations. To this end, a bibliometric approach was adopted using the Web of Science database, with the support of software such as VOSviewer and HistCite for the analysis of scientific production. The results indicate a significant growth in publications in recent years, with a predominance of recent studies, in addition to revealing a dispersion of knowledge and low density of cooperation between authors and countries. The work also highlights the relevance of frameworks as instruments to support the transition from linear to circular models, while also highlighting theoretical gaps and opportunities for the advancement of the area.

In another study, Schroeder et al. (2019) identified the relationship between circular economy (CE) practices and the implementation of the Sustainable Development Goals (SDGs). The authors identified that, to advance the practice of Circular Economy for the SDGs, more efforts are needed in skills training, capacity-building programs, technology development, and participation in multiple partnerships. Furthermore, there should be engagement from companies throughout global supply chains, as well as the establishment of synergies with SDG 4 (Quality Education) for the development of skills and capacities necessary to scale up and replicate CE practices.

Overall, the studies highlight the recent growth and diversification of approaches to Circular Economy, emphasizing its connection with themes such as sustainable consumption, Industry 4.0, organizational frameworks, and the Sustainable Development Goals (SDGs). Despite these advances, gaps remain, particularly regarding knowledge dispersion, the need for greater integration among stakeholders, and the difficulty of practically consolidating the circular model. In this context, developing updated analyses becomes relevant to better understand how scientific production has evolved and how Circular Economy has been linked to the SDGs, thereby contributing to both the theoretical and empirical advancement of the area.

Methodological elements of the research

To achieve the proposed objective, the study was conducted using the Web of Science (WoS) database with the following descriptors: (“*development sustainable goals*” AND “*circular economy*”) in the “abstract” field, and restricted to the document type “article,” which resulted in a total of 336 records. It is worth noting that the asterisk (*) in the descriptors was used to include expressions containing variations of the specified terms.

The Web of Science database was selected due to its recognition, quality, and scope. It is a well-established and widely used database in bibliometric studies within the fields of Management and Organization, being adopted in approximately 70% of the studies analyzed in this area (Zupic & Čater, 2015). Furthermore, it stands out for its high quality and rigor in journal indexing (Liu, Lu, Lu, & Lin, 2013).

The bibliometric analysis considered articles identified on the topic between 2015 and September 2022. The initial delimitation in 2015 is justified by the fact that it was the year in which the 2030 Agenda was established by the United Nations, defining the 17 Sustainable Development Goals (SDGs). Bibliometrics is characterized by the application of statistical and mathematical methods aimed at describing and quantifying scientific production in a given field of knowledge (Silva & Niyama, 2019).

In this sense, it allows for the analysis of the dynamics of knowledge production and dissemination, as well as the identification of patterns and characteristics of scientific communication

(Araújo, 2006). For the operationalization of the analysis, the variables presented in Table 1 were considered. These variables were extracted from the Web of Science database and subsequently quantified, analyzed, and mapped.

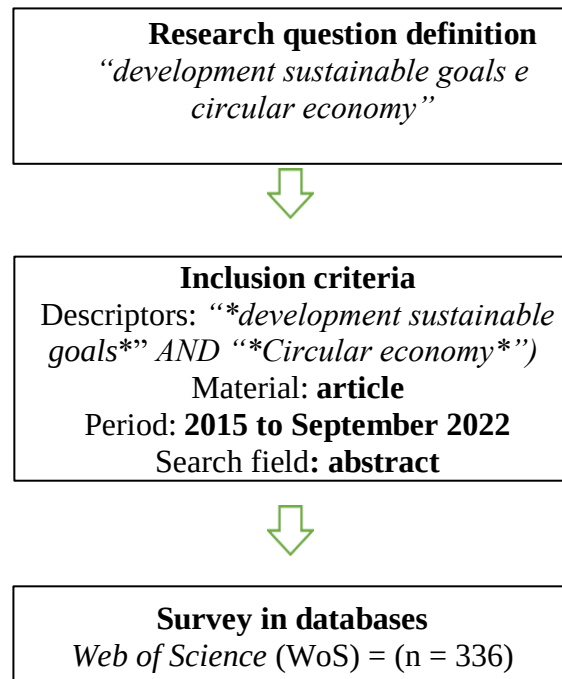
Table 1 - **Variables for analysis**

Variable	Reference
Journals with the highest number of publications	(Nunes, Mota, Cabral & Santos, 2020)
Number of articles per year	(Peixe, Rosa Filho & Passos, 2018; Silva et al., 2021)
Classification of most cited articles	(Lacruz, Américo & Carniel, 2017)
Number of articles per authorship	(Lacruz et al. 2017; Peixe et al., 2018; Silva et al., 2021)
Article co-citation network	(Van Oorschot, Hofman, & Halman, 2018)
Cooperation network between countries and institutions	(Van Eck & Waltman, 2010)
Keyword co-occurrence	(Farias <i>et al.</i> , 2021)

Source: adapted by the authors based on Silva et al. (2021).

Figure 1 shows the procedure adapted by the researchers.

Figure 1 - **Bibliometric procedure**





Bibliometric analysis
Use of variables as described in Table 1

Source: produced by the authors (2022).

For data analysis, VOSviewer version 1.6.18 was used, which is a text mining software that creates network maps in order to explore bibliometrics visually (Van Eck & Waltman, 2010). In addition to the study's temporal delimitation, it is important to justify that data collection occurred only in the Web of Science, because the VOSviewer software itself, which performs bibliometric mapping, limits the use of files containing information from databases such as Web of Science and Scopus, but not yet consolidated (Van Eck & Waltman, 2010).

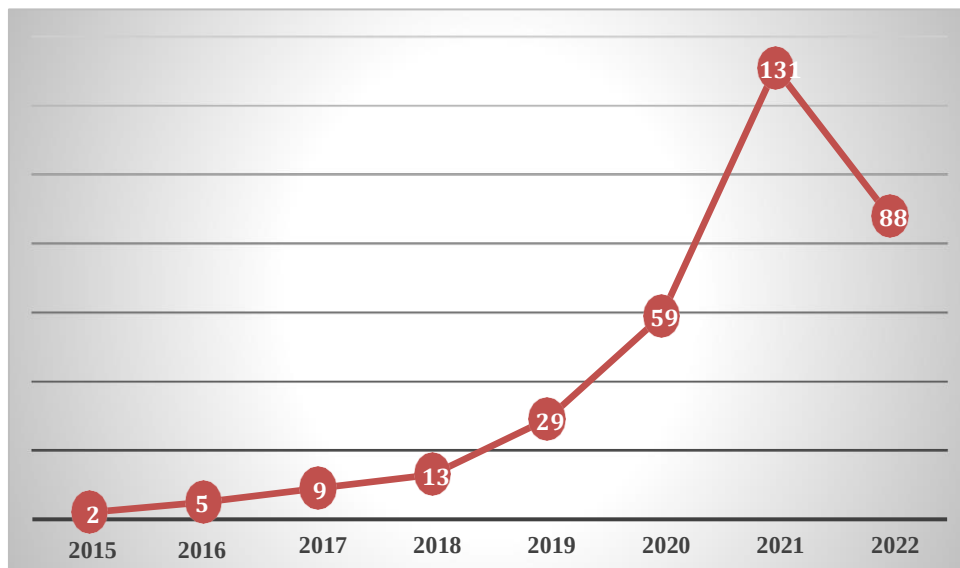
Results and discussion

This section will present the results of bibliometric analyses performed directly on the Web of Science and, subsequently, the mappings obtained from the sample analysis in VOSviewer.

Evolution in studies in the subject area

Considering Figure 2, when analyzing the 336 publications, it is possible to observe a considerable growth over the years, especially in 2021, as well as a growth trend in 2022, with 131 and 88 studies published, respectively.

Figure 2 - Publications per year



Source: Research results (2022).

The growth in publications throughout the analyzed period can be interpreted in light of the consolidation of the 2030 Agenda, established in 2015, which contributed to boosting research focused on sustainability in different areas. This behavior suggests an initial period of maturation of the topic, followed by a phase of expansion, as the Circular Economy becomes more frequently associated with the Sustainable Development Goals (SDGs).

This movement is consistent with what Schroeder, Anggraeni, and Weber (2019) pointed out, highlighting the convergence between these agendas, indicating that the increase in scientific production reflects not only academic interest but also institutional and political demands for sustainable solutions.

Furthermore, previous studies converge with this growth trend. Navarro, Ferreira, Sugahara, and Conti (2021), in conducting a bibliometric analysis of scientific production on Circular Economy from 2016 to 2020 using the SciELO, Scopus, and BDTD databases, also identified a significant increase in publications, particularly in recent years, with a predominance of international studies.

Regarding the dissemination of this scientific production, the journals that have published the most on the topic stand out, namely: *Sustainability*, with 59 articles (9.2% of the sample), *Journal of Cleaner Production*, with 33 publications, and *Energies*, with 13. There is partial alignment with the findings of Farias et al. (2021), who, when analyzing international scientific production on Circular Economy over the past decade, identified the *Journal of Cleaner Production* as the most prominent journal in terms of publication volume.

The concentration of publications in journals such as *Sustainability* and *Journal of Cleaner Production* indicates that scientific production on Circular Economy and SDGs is strongly embedded in the field of environmental sciences and sustainability. These journals are recognized for addressing interdisciplinary topics related to resource management, sustainable innovation, and environmental policies, which contributes to consolidating them as key channels for knowledge dissemination in this field. This result suggests that, although Circular Economy encompasses multiple dimensions, its approach remains predominantly associated with environmental and production-oriented perspectives.

Additionally, co-citation analysis reinforces the relevance of these journals within the intellectual structure of the field. In this regard, similarities can be observed with the co-citation results presented by Farias et al. (2021). Among the journals with between 66 and 484 citations identified in the study, high-impact journals were highlighted, such as *Journal of Cleaner Production* (5,651), *Journal of Industrial Ecology* (4,356), *Resources, Conservation and Recycling* (5,120), *Waste Management & Research* (1,955), and *Sustainability* (2,075). Thus, it can be observed that three of the five most co-cited journals are also prominent in the present study.

Concerning the most cited articles, Table 2 presents two classifications: total citations and average annual citations. The study by Schroeder et al. (2019), titled “The Relevance of Circular Economy Practices to the Sustainable Development Goals,” stands out as the most cited, with 335 citations, and also presents the second-highest annual average (88.75), highlighting its relevance in linking Circular Economy and SDGs. Next, the article by Singh and Ordonez (2016), titled “Resource recovery from post-consumer waste: important lessons for the upcoming circular economy,” ranks second in absolute terms with 198 citations, although it shows lower prominence when considering the annual average (7th position).

The study by Ibn-Mohammed et al. (2021), titled “A critical analysis of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy

strategies,” appears as the third most cited (191 citations) and has the highest annual average (95.5). This can be explained by the surge in scientific production during the COVID-19 pandemic, especially in studies linking sustainability and global crises.

Subsequently, the works of Martins, Felgueiras, and Caetano, titled “Analysis of Fossil Fuel Energy Consumption and Environmental Impacts in European Countries,” stand out with 188 citations and an annual average of 47. This is followed by the study by De los Rios and Charnley, titled “Skills and capabilities for a sustainable and circular economy: The changing role of design,” which recorded 167 citations and an average of 83. These results highlight the thematic diversity of the most influential studies, covering aspects ranging from energy and environmental issues to the role of skills and design in the Circular Economy.

Table 2 - **Most cited articles and those with the highest average annualized citations**

Authors	Citations	
	Total	Average
Schroeder, P; Anggraeni, K and Weber, U	335 1°	88.75 2°
Singh, J and Ordonez, I	198 2°	28.29 7°
Ibn-Mohammed, T; Mustapha, KB; (...); Koh, SCL	191 3°	95.5 1°
Martins, F; Felgueiras, C; (...); Caetano, N	188 4°	47 3°
De los Rios, IC and Charnley, FJS	167 5°	27.83 8°

Source: Research results (2022).

The prominence of certain studies among the most cited can be explained by their ability to integrate different agendas and provide relevant conceptual or applied contributions. The work by Schroeder et al. (2019), for example, gains visibility by establishing direct connections between Circular Economy and the SDGs, linking two widely discussed agendas in the field of sustainability. Moreover, studies with a broader scope or practical implications tend to receive a higher number of citations, as they serve as both theoretical foundations and guiding references for subsequent research. This behavior is consistent with the literature, which indicates that works synthesizing concepts or connecting different areas tend to become key references in the field (Geissdoerfer et al., 2017; Ghisellini et al., 2016).

Continuing the analysis of scientific production, the authors with the highest number of publications stand out. In this regard, the most prominent is Kumar S, with four publications, either individually or in collaboration. The authors Belmonte-Ureña LJ, Czajkowski A, Goel G, Kumar M, Łażniewska-Piekarczyk B, Pikon K, Poranek N, Raut RD, Rodríguez-Antón JM, and Zorpas AA follow, each with three publications.

These findings partially diverge from the results of Oliveira, Silva, and Moreira (2020), who identified a greater concentration of publications among authors such as Yong Geng (19 works), followed by Mari Lundström (13), Mario Pagliaro (10), and Luca Fraccascia (10), indicating differences in sample composition and the time frame adopted.

It should also be noted that the studies by Kumar S, the author with the most publications, took place between 2021 and 2022, with the latter year standing out as it saw three of the four studies published. These studies address different perspectives of the Circular Economy, including wastewater treatment, supply chain performance, sustainable innovation, and product development. Among them are: *Industrial wastewater treatment: current trends, bottlenecks, and best practices* (2021); *Supply chain firm performance in circular economy and digital era to achieve sustainable development goals* (2022); *Eco-innovations and sustainability in solid waste management: An Indian upfront in technological, organizational, start-ups and financial framework* (2022); and *Green product innovation: A means towards achieving global sustainable product within biodegradable plastic industry* (2022).

Regarding institutional affiliation and geographical distribution of publications, the *National Institute of Industrial Engineering* (NITIE), located in Mumbai, India, stands out as predominant, accounting for seven affiliations in the sample. In terms of production by country, there is a greater concentration in European nations, such as Spain (43), Italy (39), and England (34). However, emerging countries such as China (30) and India (26) also have significant participation. Brazil, in turn, has 17 publications, and the main researchers with 2 studies are: Almeida, Cecilia M. V. B.; Agostinho, Feni; and Giannetti, Biagio F. (Universidade Paulista).

In this context, the increase in studies in countries such as China, India, and Brazil may be associated with structural and institutional factors. In China's case, the adoption of public policies focused on Circular Economy has driven both practice and academic research in the field. Meanwhile, India and Brazil, as emerging economies, face challenges related to resource management, urban growth, and environmental impacts, which may stimulate scientific production aimed at sustainable solutions. This pattern is also observed in studies such as Cajuela and Pádua (2024), which identify growth in research on CE and SDGs in developing countries, suggesting that scientific production follows the socioeconomic and environmental demands of these nations.

Mapping the structure of the research field

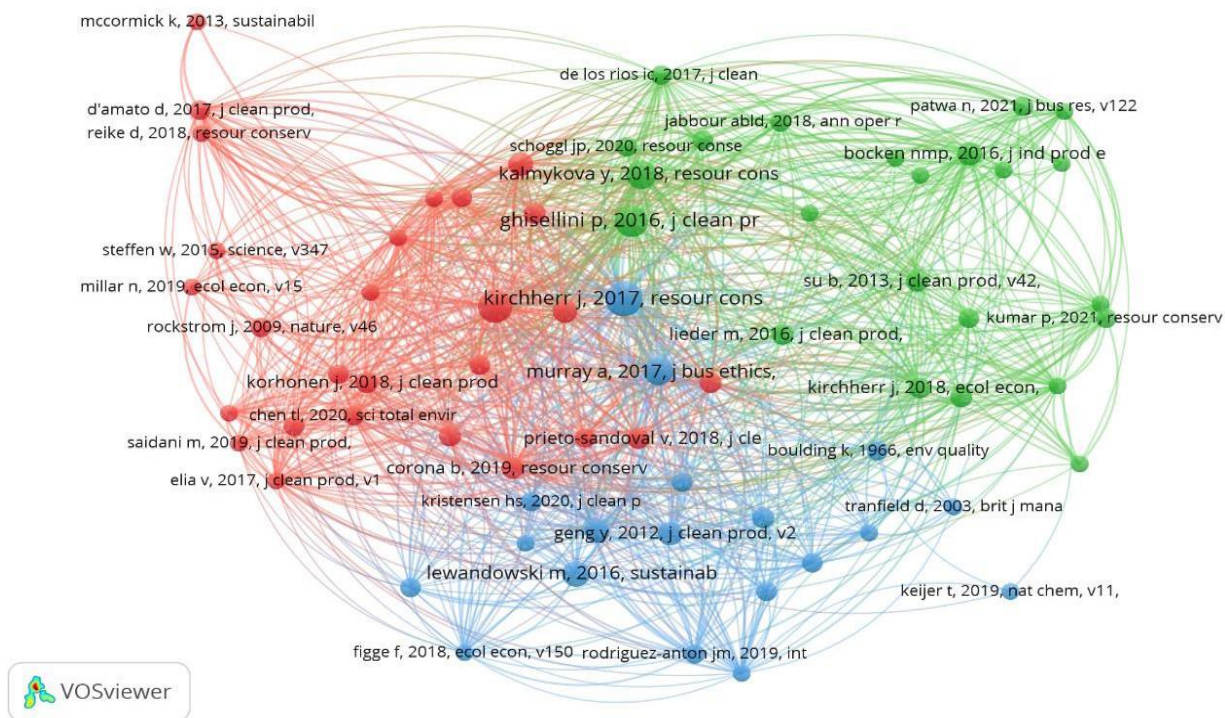
The second stage was carried out using VOSviewer, making it possible to project certain mappings. Thus, according to van Oorschot et al. (2018), this type of analysis makes it possible to identify the main references by area or subject studied, as well as the most influential fields of study, subjects and authors, in addition to the main interrelationships (Zupic & Čater, 2015). It is worth noting that mapping allows for the identification and listing of the studies that have received the highest number of citations and/or the authors who have published the most, thus demonstrating the scientific recognition of both the studies and the authors (Silva et al., 2021).

In order to analyze the existence of interactions among authors, co-authorship analyses were conducted based on publications by country and by institution. According to Zupic and Čater (2015), this type of mapping presents the set of institutions and countries that form a kind of scientific network through collaborations, thereby illustrating the research field of a given topic. Figure 3 shows a total of 2302 citations in the sample articles, with 336 items and 1517 links. It is important to note that the size of each circle is proportional to the number of citations, and each color represents a cluster, indicating groupings and networks of connections.

From Figure 3, the existence of three clusters can be observed, with particular emphasis on the blue circles, which are larger and well centralized. This cluster includes the author Kirchherr et

al. (2017), whose study “*Conceptualizing the circular economy: An analysis of 114 definitions*” has the highest number of citations (13) and the greatest number of links (179). In the red cluster, the highlight is Geissdoerfer et al. (2017), with the study “*The Circular Economy – A new sustainability paradigm?*”, which has 11 citations and 142 co-citation links.

Figure 3 - Co-citation mapping of references



Source: Research results (2022).

Next, Ghisellini et al. (2016), with the study “*A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems*”, appears in the green cluster, with 10 citations and 142 links. It is worth noting that in the study by Farias et al. (2021), this was precisely the most prominent and most cited work. Also worthy of attention is the number of citations and networks of researchers Kalmykova, Sadagopan and Rosado (2018), in the green cluster, with the study “*Circular economy – From review of theories and practices to development of implementation tools*”.

Another highlight in the blue cluster, with 8 citations and 141 links, is the study “*The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context*” by Murray, Skene, and Haynes (2017). In this study, the authors emphasize the importance of China in Circular Economy (CE) research, stating that the set of ideas on the topic not only originated in the Asian country, but was also initially adopted by it in the 1990s as a foundation for its economic development. This approach helped disseminate the concept among policymakers and non-governmental organizations (NGOs) in the West (Murray et al., 2017).

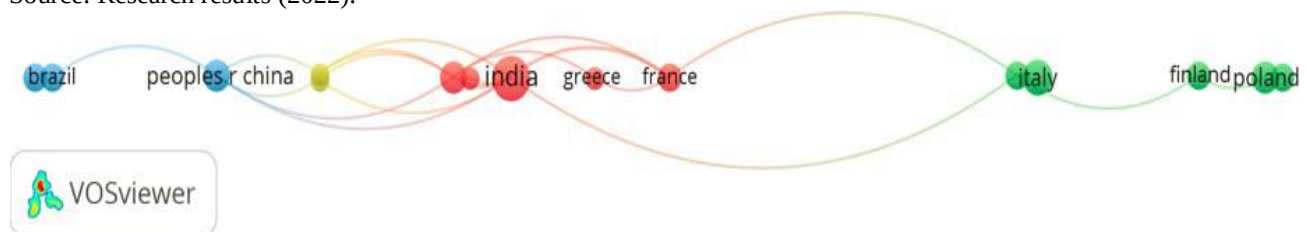
Regarding the analysis of co-authorship mapping in publications by country, as shown in Figure 4 below, it is possible to see the existence of 4 clusters, with the most extensive networks being in red (1), which includes India (8 documents) and has a strong relationship with England (4

documents), as well as France and Greece, with 3 and 2 documents, respectively. In the green cluster (2), Italy stands out with 5 documents and its direct relationship with Finland and Poland. Regarding the blue cluster, it is worth highlighting China and its network of interaction with Brazil and two European countries, Australia and Germany.

In their analysis, Farias et al. (2021) pointed out that in the main studies analyzed, none of them specifically addresses EC in emerging economies — except for China —, maintaining a focus on European Union countries. However, the present study quantitatively demonstrates the growth of collaboration networks in India and Brazil concerning Circular Economy and SDGs. In this context, Figure 4 below illustrates these findings.

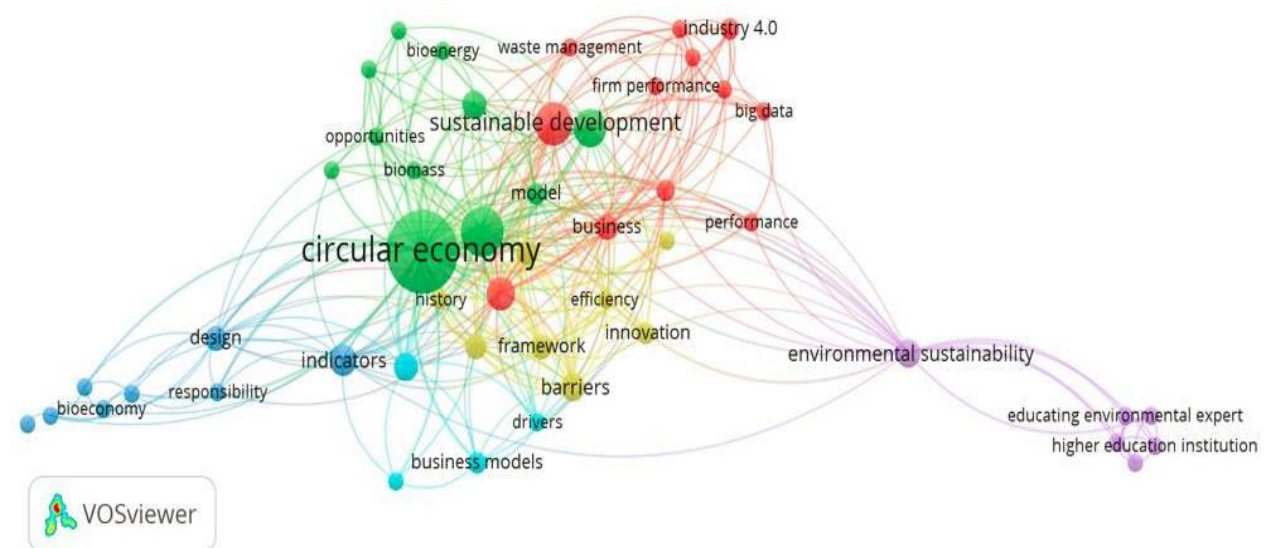
Figure 4 - Co-authorship mapping in publications by country

Source: Research results (2022).



Moreover, from a quantitative perspective, the study by Ghisellini et al. (2016) supports the present research, as their review of the last two decades of Circular Economy (CE) literature found that China accounts for a large share of studies, likely due to the significant environmental and social challenges resulting from its rapid economic development. Finally, the co-occurrence of keywords constitutes the last stage of the analysis in this study. This mapping made it possible to identify the main terms present in the literature. In this case, to construct Figure 5, terms from the title, keywords, and abstract fields were considered.

Figure 5 - Keyword co-occurrence mapping



Source: Research results (2022).

Figure 5 presents the mapping of keywords, in which the size of the circles is proportional to the frequency of occurrence of each term. The proximity between words reflects how often they appear together, while the color corresponds to an identified cluster. Out of a total of 440 keywords, six clusters were identified. The size and centrality of the circles belonging to the green cluster indicate the presence of themes related to Circular Economy, sustainability, sustainable cities, bioenergy and food waste. Although the other clusters also include similar terms, this group shows a stronger focus on the environmental dimension of sustainability.

Continuing, the red cluster identifies terms such as: sustainable development, waste management, industry 4.0, supply chain management, resource-based view. In the sugarcane green cluster, terms such as efficiency, innovation, strategies, waste, and framework are found. In both, the social dimension is related to concerns about sustainable development, linking production and consumption in order to foster competitiveness, but with a focus on creating a conservation-oriented society (Farias et al., 2021).

Regarding the light blue and dark blue clusters, the terms China, economics, indicators, and bioeconomy are relevant. In both clusters, the approach to the economic dimension of sustainability is evident. Finally, the lilac cluster presents terms such as: environmental sustainability, educating environmental expert, and higher education institution. The findings are consistent with the literature on the topic, particularly in framing the Circular Economy (CE) as a business model that encompasses economic, environmental, technological, and social aspects (Ghisellini et al., 2016). However, these dimensions are not always addressed jointly or equally, as there is often a prioritization of the environmental perspective, leaving economic and social aspects in a secondary position (Govindan & Hasanagic, 2018).

In turn, the analysis of keywords and thematic clusters indicates a higher concentration of studies related to resource management, energy, and sustainable production, such as SDG 12 (Responsible Consumption and Production), SDG 7 (Affordable and Clean Energy), and SDG 6 (Clean Water and Sanitation). This pattern aligns with the findings of Schroeder et al. (2019), who identify a stronger convergence between Circular Economy and these goals. On the other hand, there is a lower presence of socially oriented SDGs, which may reflect one of the limitations highlighted in the literature, as noted by Korhonen et al. (2018), who emphasize the difficulty of fully incorporating the social dimension into Circular Economy approaches.

Overall, the results indicate that scientific production on Circular Economy and the SDGs has grown consistently, although it still exhibits characteristics of fragmentation and thematic concentration. There is a greater emphasis on environmental and production-related dimensions, particularly SDGs associated with resource use and energy, as well as a significant presence of emerging countries in scientific output. These aspects suggest that, despite progress, the field still faces challenges related to the integration of multiple dimensions of sustainability, especially with regard to incorporating social aspects and consolidating more integrated approaches.

Final considerations

This study aimed to analyze the scientific production regarding the relationship between the Sustainable Development Goals (SDGs) and the Circular Economy (CE), from 2015 to September 2022. To this end, a bibliometric analysis of 336 articles indexed in the Web of Science database was carried out, with the support of the VOSviewer software, considering the terms present in the abstracts

of the publications.

The results show a consistent growth in scientific production throughout the analyzed period, with greater intensity from 2019 onwards, which suggests the consolidation of the theme in the academic field, especially due to the greater articulation between the Circular Economy and the 2030 Agenda. In addition, a thematic concentration on environmental and economic dimensions of sustainability was identified, with less emphasis on social aspects, indicating the existence of gaps in the integrated approach to the SDGs..

Overall, the findings are consistent with the literature in recognizing the Circular Economy as a relevant strategy for sustainable development, particularly with regard to resource efficiency and the reduction of environmental impacts (Ghisellini et al. 2016). However, they also highlight challenges related to the balanced integration of the economic, environmental, and social dimensions, as already pointed out by previous studies.

The main limitation is the exclusive use of the Web of Science database, which may restrict the scope of the results, especially in relation to productions indexed in other relevant databases. Nevertheless, this study is believed to contribute to the advancement of knowledge by mapping trends, identifying gaps, and providing support for future research, with both academic and practical implications.

In this sense, it is recommended that future research broaden the scope of analysis, incorporating other databases and deepening the investigation into the application of the Circular Economy in specific contexts, such as smart cities, industrial sectors, and emerging economies. Furthermore, it is suggested that systematic literature reviews be carried out in order to deepen the theoretical and empirical understanding of the integration between Circular Economy and SDGs.

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