



## A Look the Latest 17 Years of the Circular Economy: Retrospectives and Perspectives

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# A LOOK THE LATEST 17 YEARS OF THE CIRCULAR ECONOMY: RETROSPECTIVES AND PERSPECTIVES.

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**Abstract.** This paper emphasizes the scientific and research density of the interconnected circular economy, establishing a robust framework for understanding and promoting the interconnection of related concepts and practices over its timeline. Utilizing content analysis and meta-analysis over the past 17 years, it explores the evolution of the circular economy, offering insights into temporality and future research trends. Employing a systematic literature review (SLR) approach based on a PRISMA research protocol, articles from Scopus and Web of Science (WoS) databases were retrieved. The Science Mapping Analysis Software (SciMAT) and Biblioshiny tools were then used to visualize and assess the development and density of scientific contributions. This study illuminates the potential benefits and challenges of the circular economy, identifies key constructs related to its implementation, and evaluates the density and centrality of themes. SLR results highlighted Yong Geng as the author, the Journal of Cleaner Production as the journal, China as the country, and the Delft University of Technology as the institution. Bibliometric analysis demonstrated a significant shift in EC themes, transitioning from "Recycling" to "Circular Economy" as the central theme. It also showed a conceptual expansion, including Chemical Substance, Technology, and Urban Development. The findings of this research confirm conclusions from previous studies and provide a comprehensive and updated view of emerging trends in the Circular Economy. However, it is limited to Scopus and WoS databases, focusing on the interconnected circular economy in general.

**Keywords:** Circular Economy; SciMAT; Biblioshiny; Literature Review.

## 1 Introduction

The exhaustion of natural resources and environmental deterioration have highlighted the need to reformulate the conventional linear model of production and consumption, known as "extract-produce-discard" [1]. In this sense, the Circular Economy (CE) emerges as a transformative approach that aims to integrate economic, social, environmental, and technological aspects positively [2][3].

This concept seeks to completely redesign industrial and consumer systems to reduce waste, preserve finite natural resources, and minimize environmental impact. The most widely recognized definition in this context conceptualizes the CE as "an industrial economy that is intentionally restorative or regenerative by design [4]."

From this perspective, companies must develop production models based on the 10R philosophy (reduce, reuse, refuse, rethink, redistribute, repair, restore, reuse, recycle and recover) [5]. However, the advancement of the CE has been predominantly expert-led, leaving a considerable gap in empirical evidence [6]. Issues regarding the sustainability of the concept in terms of social inclusion and climate change mitigation have also been raised by other authors [7]. This lack of theoretical development has yet to define practical consequences for sustainability, creating some ambiguity regarding the principles of the CE [8].

The main objective of this research was to evaluate the level of scientific and theoretical advancement of the concept of CE through the production of research articles, authors, journals, institutions, and countries, aiming to outline directions for current and future research. Thus, to achieve this goal, this study carries out a comprehensive mapping of the concept of CE using bibliometric methodology through the Scimat and Biblioshiny software, highlighting current knowledge and future research trends.

Thus, this review article explores the following questions: (i) What is the direction of publications related to the CE? (ii) What are the predominant thematic areas in the CE? (iii) Which collaborators stand out the most (authors, journals, countries, and institutions)? (iv) What topics are priorities in CE research?

## 2 Methods

A bibliometric analysis and a systematic literature review (SLR) were performed to evaluate the academic production of CE. The type of research involved the quantitative analysis of the publications through the bibliometric study that identifies patterns, trends, and relationships [9]. It involved a qualitative analysis through the SLR referring to previously published bibliometric research on the subject for comparison with the results found. The Scopus and Web of Science (WoS) databases were used to search for the records of both studies due to the reliability of their data and the multidisciplinary approach. The instruments used for the bibliometric analysis were SciMAT and Biblioshiny, which allow systematic navigation and the extraction of significant information. The need for a comprehensive analysis motivated the decision to use both tools. For SLR, we followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), outlining a transparent and rigorous four-phase process [10]. The search procedure involved two steps. The first stage aimed to identify articles that contain bibliometric research in their scope. The keywords selected for the search sequence were

"Circular Economy" and "Bibliometrics", resulting in 47 articles in Scopus and 26 in Web of Science. The search was limited to articles in English with open access.

After applying the filters, 27 documents were obtained from the Scopus database and 14 from the WoS database. The titles and abstracts were revised, keeping those in which CE remained the central theme and excluding others. Duplicates were removed between the two databases, resulting in 8 articles for bibliometric analysis of the literature on the subject. In the second stage of the research, I focus on retrieving articles intended for bibliometric analysis, aiming to incorporate them into the SciMAT and Biblioshiny software [11][12]. In this sense, the search approach was expanded, using the keyword 'Circular Economy' as a starting point. This more comprehensive approach aimed to encompass various relevant articles to enrich the analysis. Initially, the search yielded 26,235 documents. The search was limited to the articles, specifically the 2,000 most recent and the 2,000 most cited in each database, as these were the export limits, resulting in a final sample of 8,000 documents.

### 3 Results

With SLR, data were collected to complement the bibliometric analysis, prioritizing information such as author, country, keyword, year of publication, institution, area, citations and predominant journal. Analysis of the articles revealed Yong Geng as the author with the highest number of publications [13; 14; 15; 16], while the Journal of Cleaner Production stands out as the journal with the highest number of publications [13; 15; 16; 17; 18; 19] and most cited [13; 14; 15; 16; 18], and China emerges as the most productive country [13; 14; 15; 16; 20]. The institution with the highest number of publications is Delft University of Technology [2; 4]. 4 keywords with the highest number of citations were identified, "Sustainability" [13; 18; 20], "Recycling", "Business Model", and "Economy" [14; 16; 19]. Considering that other researchers have already explored these findings, the present research aimed a deeper understanding of the evolution of topics related to the Circular Economy over the years since scientific production has experienced notable growth, as evidenced in Figure 1.

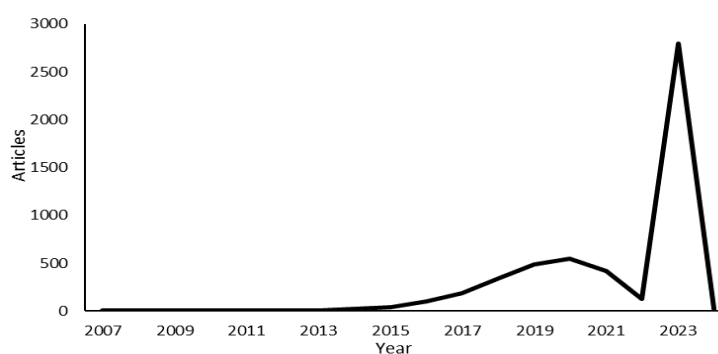


Figure 1 – Annual Scientific Production.

The graph in Figure 1 shows that scientific production on CE was limited, with less than 50 articles per year until 2015. Subsequently, there was a slight growth in 2020, followed by a

decrease until 2022. In 2023, there is a peak production of 2793 articles. To analyze the thematic evolution, we divided the period into three sub-periods: 2007-2015, marking the first growth; 2016-2020, the beginning of the decline; and 2021-2024. Using the Biblioshiny and SciMAT tools, we developed thematic evolution charts. The distinction between these tools lies in the method of keyword clustering: while SciMAT requires manual intervention, Biblioshiny operates automatically, employing Louvain's algorithm. In addition, there are variations in the graphical representation of the charts. In Biblioshiny, the size of the rectangles indicates the frequency of the clusters, while in SciMAT, this frequency is represented by the size of the spheres. The larger the size of these geometric figures, the greater the occurrence of the cluster. Dashed lines in SciMAT illustrate the similarity between the themes, while in Biblioshiny, they are highlighted by similar colours. The correlation between the themes is revealed by wavy lines in Biblioshiny and by continuous lines in SciMAT. In both cases, the thickness of the lines indicates the intensity of the correlation between the themes [21; 22]. The visual representation of the results of this thematic evolution is presented in Figure 3 for comparison purposes.

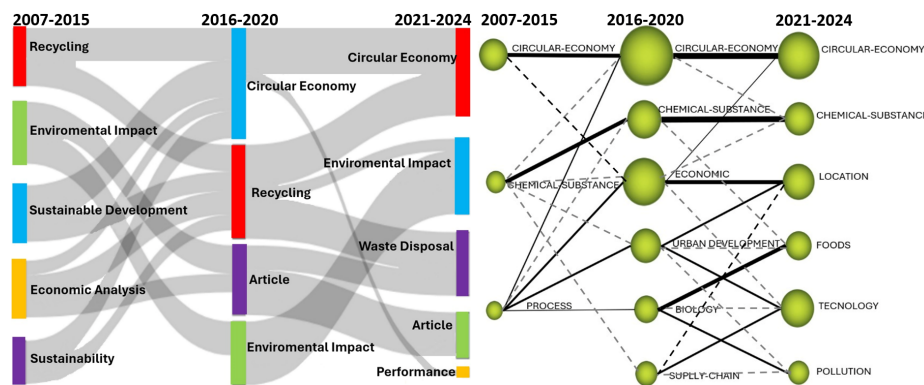


Figure 2 – Thematic Evolution Biblioshiny and SciMAT.

In Biblioshiny, the most significant topic in the first period is "Recycling", with 437 occurrences. This theme unfolds in "Circular Economy" and "Recycling", suggesting that some authors are beginning to address recycling as a component of CE. In the following period, the most prominent theme is the "Circular Economy", with 3453 occurrences. This topic has broken down into "Circular Economy" and "Performance", indicating a connection between these topics; a more comprehensive analysis reveals that the most studied topics are "Sustainability", "Recycling", and "Environmental Impacts". In SciMAT, although there is a greater diversification of themes, "Chemical Substance", "Technology", and "Urban Development" stand out. In addition, it is observed that the cluster "Localization" is relevant, suggesting a concentration of regionalized studies. To analyze the themes identified in SciMAT, we used the Strategic Diagram and the Thematic Network of Clusters. In the Strategic Diagram, we evaluate the centrality and density of the themes. Centrality measures how many connections a cluster has compared to the others, indicating the importance or influence of the themes. The density reflects the group's internal cohesion, revealing how strongly the elements are interconnected. In Thematic Network of Clusters, we explored the connection between the themes, highlighting the central theme of each period, chosen based on the highest density and centrality, where the thicker

lines indicate greater correlation. These analyses provide a deeper understanding of the dynamics and interconnections in research [22; 23]. The result of the first period can be seen in Figure 3.

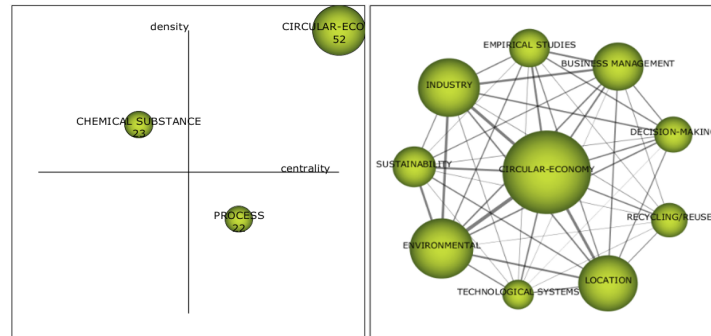


Figure 3 – Strategic Diagram and Thematic Network - 1st period (2007 - 2015).

The result of the graphs for the first period shows that the driving theme is "Circular Economy" because it is in the first quadrant, the theme "Chemical Substances" is highly developed more isolated and "Process" is a basic and transversal theme, in addition to which we can see that the driving theme (CE) has a strong/moderate association with themes such as "Environmental", "Industry", "Location", "Empirical Studies" and "Business Management". Figure 4 shows the result of the second period.

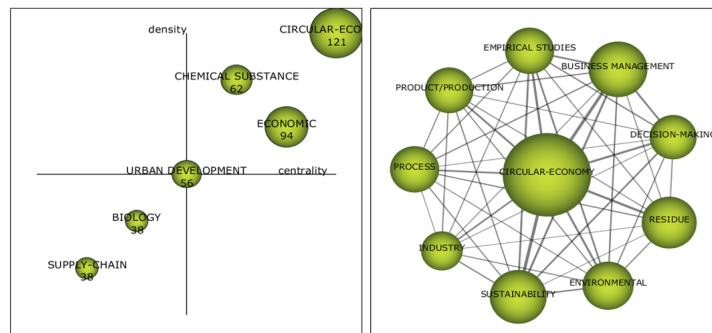


Figure 4 – Strategic Diagram and Thematic Network - 2nd period (2016 - 2020).

The result of the graphs for the second period shows that we have 3 driving themes, "Circular Economy", "Chemical Substances", and "Economy", and we have 2 themes in decline or emerging, "Biology" and "Supply-Chain", and themes the theme "Urban Development" as a generalized theme, in addition to the fact that we can see that the theme with greater centrality (CE) has a strong/moderate association with themes such as "Environmental", "Sustainability", "Decision-Making", "Residue", "Empirical Studies" and "Business Management". Figure 5 shows the result of the third period.

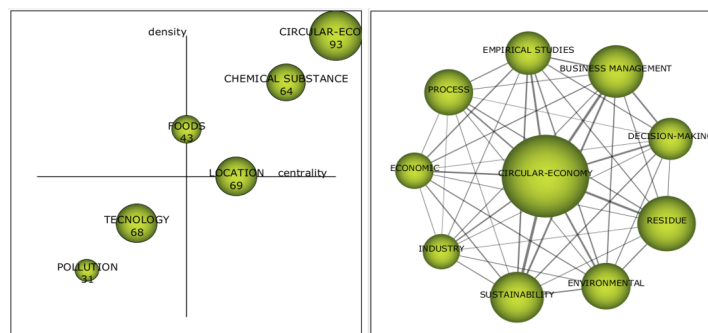


Figure 5 – Strategic Diagram and Thematic Network - 3rd period (2021 - 2024).

The result of the graphs for the third period shows that 2 themes are motor, "Circular Economy", "Chemical Substances" and 2 themes are declining or emerging, being "Technology" and "Pollution", and the topic "Food" is a theme that is between motor themes and highly developed and isolated themes, as well as the topic "Localization" is between the motor themes and the basic and transversal ones. The theme with greater centrality (CE) has a strong/moderate association with the same themes of the second period, the only change is that one of the themes that has a light/weak association change in the second period these themes was "Product/Production", "Process" and "Industry", in the third the theme "Product/Production" gives space to "Economy".

#### 4 Discussion and Conclusion

The bibliometric analysis and SLR in this study provided an in-depth understanding of the evolution of Circular Economy (CE) research over the last 17 years. The 8 articles identified in the first stage of the research (SLR) played a crucial role in contextualizing the bibliometric review on the subject. A comprehensive summary of these articles reveals valuable insights into the methodological approaches employed. Notably, 6 of the articles chose to use the VOSviewer tool for analysis [13; 14; 15; 16; 19; 20], and 3 of them complimented this choice with other tools [13; 15; 20], such as Bibliometrix and WoS Core Collection. BibExcel was the choice of 1 article [17], while another did not specify the tool used [18]. Among these articles, 5 did not impose thematic restrictions on their research [14; 15; 16; 19; 20], while the remaining 3 chose to combine the keywords "Circular Economy" with "Management", "Construction", and "Sharing Economy", thus limiting the area of investigation [13; 17; 18]. Regarding the database, a diversity of choices was observed, with 3 studies using the WoS database exclusively [15; 16; 17], 2 using Scopus [14; 18], and 3 exploring both together [13; 19; 20]. The variation in the number of articles selected for analysis was significant, ranging from 253 to 5007, representing the minimum and the maximum, respectively. The analysis period they have covered is the years 1996 to 2020.

The analyses evaluated traditional bibliometric data, highlighting information on author, country, keyword, year of publication, institution, area, citations, and predominant journal. As these aspects have already been addressed in previous research, the present one proposed a bibliometric analysis focused on the evolution, centrality, density, and connectivity of the themes

explored in CE, using innovative tools such as SciMAT and Biblioshiny. The analysis scope extended to 2023, incorporating a robust set of 8000 articles for a more comprehensive investigation.

The approach adopted in the research focused on the evolution, density, centrality, and connections of CE themes, complementing and expanding pre-existing studies. The thematic analysis identified notable changes over three sub-periods (2007-2015, 2016-2020 and 2021-2024), highlighting the progression of "Recycling" towards the consolidation of the "Circular Economy" as a central theme, evidencing a conceptual expansion.

Thus, this review article was able to answer questions ii and iii (Which collaborators stand out the most (authors, journals, countries, and institutions?) and What are the predominant thematic areas in CE?) through the SLR, acknowledging that other researchers have already addressed such information. The findings of these previous studies highlighted the author Yong Geng, the Journal of Cleaner Production, China, and the institution Delft University of Technology as the most outstanding contributors on the topic. At the same time, the predominant thematic area was identified as environmental science. About the bibliometric analysis, this study allowed us to answer questions i and iv (What is the direction of publications related to CE? and What are the priority themes in EC research?). Notably, CE publications follow a dynamic and evolutionary trajectory over time, as evidenced by the transition of thematic emphases. The analysis reveals that the EC initially focused heavily on the "Recycling" theme, evolving towards consolidating the "Circular Economy" as a central theme. This thematic shift suggests a conceptual expansion in the approach to CE over the years. This analysis contributes to an in-depth understanding of thematic evolution and highlights the importance of advanced methodological approaches in analyzing scientific literature. In addition, the results of the cluster analysis in SciMAT reveal a significant thematic diversification, covering areas such as "Chemical Substance", "Technology" and "Urban Development", while the "Location" cluster suggests a regionalized concentration of studies. Therefore, the responses obtained through this survey, complemented by SLR and bibliometric analysis, not only validate the previous conclusions of other researchers, but also provide a comprehensive and up-to-date view of emerging trends in Circular Economy research. This multifaceted approach contributes to a more complete and contextualized understanding of the CE landscape, providing valuable insights for researchers, practitioners, and scholars interested in the topic.

While this study used the Scopus and Web of Science (WoS) databases to identify the analyzed articles, we acknowledge that this approach may introduce a bias in article selection. To mitigate this bias and improve the diversity and representativeness of the results, future research could consider including other databases and information sources, thus broadening the geographical scope of the analysis [24][25][26]. Additionally, it is important to recognize that this study has inherent limitations, such as the possibility of selecting incomplete or non-representative articles. We suggest that future research address these limitations and consider other research directions, such as analyzing regional trends and the impact of public policies on the adoption of the Circular Economy [27][28][29]. These reflections can enhance the academic value of the study and contribute to a continuous and exploratory dialogue in this important research area [30][31].



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