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CLIMATE CHANGE, AGRICULTURAL PRODUCTION, URBANIZATION, AND CARBONIZATION: POTENTIAL SOLUTIONS FOR ENVIRONMENTAL SUSTAINABILITY

Circular economy, bioeconomy, and sustainable development goals: a systematic literature review

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Abstract
The circular economy (CE) and bioeconomy (BE) are recognized as potential solutions for achieving sustainable development, yet little research has examined their potential contribution to the United Nations' Sustainable Development Goals (SDGs). In this study, we conducted a bibliometric analysis of 649 articles published between 2007 and 2022, as well as a systematic literature review of 81 articles, to assess the extent to which the CE and BE communities have addressed the SDGs. Our analysis identified 10 research gaps including the limited number of empirical quantitative papers, particularly in the context of BE, and the underrepresentation of developing regions such as Latin America and Africa in the literature. Our main finding reveals that the CE community primarily focuses on SDG 12, Responsible Consumption and Production, followed by SDG 9, Industry, Innovation, and Infrastructure; SDG 7, Affordable and Clean Energy; and SDG 6, Clean Water and Sanitation. The BE community, on the other hand, focuses primarily on SDG 7, followed by SDG 9 and SDG 12. However, both communities lack attention to social SDGs such as quality education, poverty, and gender equality. We propose that a combination of CE and BE, known as circular bioeconomy, could help countries achieve all SDGs. Further research is needed to develop and implement circular bioeconomy policies that address these gaps and promote sustainable development. In this sense, our study identified an important research gap that needs more attention in the future.

Keywords Circular bioeconomy (CBE) · Sustainability · Global agenda · Sustainable development agenda · Bibliometrics · United Nations (UN)

Introduction and theoretical framework

The United Nations (UN) 2030 Agenda for Sustainable Development (Cf 2015) resolution has been challenging both developed and developing economies to achieve sustainable development (Assembly 2015; Khan et al. 2019). This has led to the establishment of 17 Sustainable Development Goals (SDGs) with 169 targets and 213 measurable indicators aimed at promoting well-being in economic, social, and environmental aspects (Costanza et al. 2016). However, these SDGs can differ among regions, countries, and local policymakers, requiring national plans for achieving sustainability (Belmonte-Ureña et al. 2021). To this end, various political agendas have been initiated globally under diverse concepts. For instance, the European Commission introduced the bioeconomy (BE) concept in 2012 (EC 2012) and the circular economy (CE) notion in 2015 (E. EC 2015). Similarly, China applied CE policy tools from the early 2000s (D'Amato et al. 2017; Murray et al. 2017), while the United States of America adopted the bioeconomy through a national blueprint (D'Amato et al. 2017).

The decline of sustainability in the wake of the global COVID-19 pandemic has sparked a significant demand for fresh research on environmental issues. Scholars have put forth various proposals to address this concern, introducing new micromodels such as The Sustainability Pyramid (Lim 2022). This framework advocates for the adoption of

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a hierarchical approach to promote sustainability, thereby facilitating the achievement of the Sustainable Development Goal 12. Additionally, researchers have also developed macromodels centered around the concept of the sharing economy, which fosters a novel economic paradigm in the digital age (Tham, Lim, & Vieceli 2022). It is worth noting that the successful implementation of changes in the field of bioeconomy necessitates the utilization of novel technologies, processes, and practices, all of which require collective action on the part of consumers. Hence, the bioeconomy approach underscores the importance of exploring consumers' perspectives and embracing shared responsibility in contributing to the development of bio-based products and services (Wilke et al. 2021). Moreover, the COVID-19 crisis has highlighted the urgent need for innovative responses across various domains. These responses encompass a wide spectrum of innovations, ranging from technological advancements to frugal and social innovations (Dahlke et al. 2021). Against this backdrop, circular economy emerges as a promising alternative to the aforementioned macromodels, as it has been thoroughly examined and evaluated in the present study.

The concepts of bioeconomy and circular economy have been developed over time and are considered complementary (del Mar Alonso-Almeida and Rodriguez-Anton 2019; McCormick and Kautto 2013; Rodriguez-Anton et al. 2019). The bioeconomy is concerned with the conversion of renewable biological resources into various materials, chemicals, and energy, such as food, feed, bio-based products, and bioenergy (EC 2012; O'Brien et al. 2017). It is a sustainable strategy based on life science innovations (Maciejczak & Hofreiter 2013), which generate competitiveness, economic development, and low-carbon growth (EC 2012; O'Brien et al. 2017). Conversely, the circular economy concept emerged from the literature on industrial symbiosis (D'Amato et al. 2017; Mishenin et al. 2018), which aims to reduce the environmental impacts of economic actors by reducing, reusing, recycling, and recovering materials during the productive process and consumption (Kirchherr et al. 2017; MacArthur 2013; Murray et al. 2017). Circular economy tackles various modern societal issues (Khan, Sharif, & Mardani), such as increasing demand for resources, population growth, consumption, and price volatility of raw materials, promoting better environmental performance and socioeconomic prosperity (Kirchherr et al. 2017). While these concepts are still being developed in parallel, some authors believe that bioeconomy and circular economy reinforce each other (D'Amato et al. 2017; Hetemäki et al. 2017). Recently, the concept of circular bioeconomy has emerged, which describes the circular and efficient use of renewable non-fossil raw materials and products (D'Amato et al. 2017; Sharif et al. 2019), providing a better understanding of sustainable development.

Bioeconomy and circular economy are closely related to several Sustainable Development Goals (EC 2012; E. EC 2015; Rodriguez-Anton et al. 2019). Bioeconomy might help the social aspects by creating jobs in agriculture and industry (SDG 8), the economic aspects by boosting innovation (SDG 9) and economic growth (SDG 8), and improving the environmental performance by reducing the use of resources through efficient use of natural resources (SDG 12) and increasing bioenergy (SDG 7) (O'Brien et al. 2017). Circular economy also helps achieve responsible consumption and production (SDG 12) through resource efficiency mechanisms and green growth (Rodriguez-Anton et al. 2019). According to the European Commission (E. EC 2015), CE is related to several sectors (i.e., infrastructure, health, education, industry, and agriculture) to promote new investments, employment, and economic growth. These linkages help several SDGs, such as decent work and economic growth (SDG 8); industry, innovation, and infrastructure (SDG 9); sustainable cities and communities (SDG 11); responsible consumption and production (SDG 12); and climate action (SDG 13) (Rodriguez-Anton et al. 2019). However, there is no consensus about the implications of the bioeconomy and circular economy for other Sustainable Development Goals. For example, a growing bioeconomy might increase the scale of global land use, affecting access and food price (Heimann 2019). Moreover, several studies analyze the potential negative impacts of the circular economy on sustainable development, especially those related to social inclusion and climate change (Belmonte-Ureña et al. 2021; D'Amato et al. 2017; Sehnem et al. 2019a, b).

Several studies have explored the potential of a circular bioeconomy (CBE) in contributing to the achievement of Sustainable Development Goals (SDGs). For instance, some authors have focused on analyzing the sources and production of agricultural waste and proposed pathways for further value addition through the application of various technologies, including biorefinery solutions. This bioeconomy perspective not only helps in reducing agricultural waste but also enables the generation of a wide array of value-added products within the economy (Kumar Sarangi et al. 2023). Additionally, other researchers have emphasized the role of CBE models in reducing reliance on fossil fuels. Specifically, they have highlighted the significance of biomethane as a flexible and environmentally friendly resource for mitigating climate change. The profitability associated with biomethane production has been found to have the potential to influence the energy policy landscape, thereby shaping future scenarios (D'Adamo et al. 2023). These studies collectively underscore the transformative potential of circular bioeconomy in contributing to sustainable development, addressing agricultural waste, and providing alternative resources for clean energy production.

The objective of this study is to investigate the literature on bioeconomy and circular economy in the context of SDGs. Specifically, this study aims to explore the relationship between bioeconomy and circular economy and their impact on economic, social, and environmental aspects. Despite the increasing interest in bioeconomy and circular economy, there is still a significant gap in the understanding of how these concepts interact with each other and their influence on SDGs. Moreover, there is a lack of knowledge about which SDGs are predominantly influenced by each concept and how the combination of bioeconomy and circular economy can contribute to sustainable development. Therefore, this study aims to address the following research questions: (1) What is the relationship between bioeconomy and circular economy in the context of SDGs? (2) Which SDGs are mainly influenced by bioeconomy and circular economy, respectively? (3) How can the combination of bioeconomy and circular economy contribute to sustainable development? (4) Which types of databases, unit analysis, and geographical areas are under investigation in selected literature? (5) What are the main literature gaps, and what is the future research agenda of the bioeconomy and circular economy linked to the SDGs? By answering these research questions, this study aims to provide a better understanding of the relationship between bioeconomy and circular economy and their potential contribution to sustainable development.

Previous research has examined the bioeconomy and circular economy concepts using bibliometric or systematic literature review methods (D'Amato et al. 2017; Ferreira Gregorio et al. 2018). In addition, some scholars have combined bioeconomy or circular economy with other aspects, including circular business models (Wiebke Reim et al. 2019; Suchek et al. 2021), eco-innovation (Prieto-Sandoval et al. 2018), business organizations (Salvador et al. 2022; Sarja et al. 2021), development strategy (Papadopoulou et al. 2022), and regional analysis (Arsova et al. 2022). However, only a few studies have analyzed both bioeconomy and circular economy concepts (D'Amato et al. 2017; Ferreira Gregorio et al. 2018; Salvador et al. 2022), and just one has linked bioeconomy to Sustainable Development Goals (Biber-Freudenberger, Ergeneman, Förster, Dietz, & Börner 2020). The previous literature on the bioeconomy and circular economy is summarized in Table 1, which was developed through bibliometric or systematic review methods.

To the best of our knowledge, an integrated structured literature review that relates the bioeconomy, circular economy, and their connection with Sustainable Development Goals (SDGs) is still missing. While some studies have explored the topics separately (as summarized in Table 1), they did not consider the intersections between the concepts, leading to a research gap. Moreover, none of the reviewed studies used quantitative analysis to avoid an eclectic approach that may neglect important factors or overemphasize others (Ferraz et al. 2021). By expanding the scope from circular economy to related keywords, such as bioeconomy, we can identify key topics and analyze how the fields can learn from each other. We focus on bioeconomy and circular economy because they both propose strategies for sustainable development worldwide (D'Amato et al. 2017), and their fragmentation hinders their progress (O'Brien et al. 2017). Thus, it is essential to evaluate the extent to which research conducted with these concepts contributes to addressing the SDGs' challenges.

In this sense, this article identifies the relevance of published articles in BE and CE with the targets to impact sustainable development. Note that our article corroborates with a collection of reviews on the Sustainable Development Goals, extending current reviews on business innovation to economic models (Azmat, Lim, Moyeen, Voola, & Gupta 2023). Thus, we systematically analyzed the relevant international literature on bioeconomy and circular economy linked to Sustainable Development Goals (SDGs). Our research identified that a systematic literature review based on this broader approach identifies structural gaps and future research agenda regarding bioeconomy and circular economy planning to achieve Sustainable Development Goals. The bibliometric tool helped us to identify the primary types of methods and databases used and the leading journals and authors for each research area. In addition, the combination of bibliometrics with an in-depth qualitative analysis of the research contents of the most relevant articles helped to identify research gaps in terms of data, topics, and methods, as well as reveal opportunities for mutual learning between different overlapping, or separate, areas of the literature.

Consistent with the systematic literature reviews conducted by other authors (Lim, Kumar, & Ali 2022a, b; Mukherjee et al. 2022), our study contributes to the advancement of theory and practice in the field. Firstly, employing the literature review method enabled us to systematically investigate the findings of the articles under analysis and establish connections with the most prominent research topics. As a result, we identified two distinct clusters within the domains of circular economy (CE) and bioeconomy (BE) that displayed limited interconnectivity. This finding highlights the need for closer integration and collaboration between these clusters. Secondly, the systematic literature review facilitated a comprehensive understanding of the essential research in greater detail. Consequently, we identified several limitations within both research communities, including the scarcity of quantitative studies, restricted coverage of databases, and limited geographical regions represented in the literature. Thirdly, our study contributes by identifying ten research gaps in the existing literature

Table 1 Main published bioeconomy and circular economy articles using bibliometrics and systematic literature review

Author(s)	Method	Database	Period	Analyzed articles	Dimension	Combination	Contributions	Limitations
Ferreira Gregorio et al. (Ferreira Gregorio et al. 2018)	SLR	Scopus	1960–2017	449	CE/BE	-	This study contributes to economics and business management by conducting an in-depth analysis of relevant CBE publications	Only the Scopus database was analyzed, focusing on academic articles, books, and chapters. A subjective assessment was employed to categorize the literature
D'Amato et al. (D'Amato et al. 2017)	Biblio	WoS	1990–2017	1943	CE/BE	-	The authors engage in a comprehensive discussion encompassing the overlaps, divergences, synergies, and limits associated with the CBE concepts	The literature geographical distribution shows authors' affiliations countries. A predetermined number of topics was established before the analysis
Prieto-Sandoval et al. (Prieto-Sandoval et al. 2018)	SLR	WoS	1990–2017	162	CE	Eco-innovation	The authors contribute to defining the concept, principles, and determinants of a CE. This study also presents future research topics	The study analyzed academic articles. The authors used the Web of Science only. There was a subjective assessment of the articles
Reim et al. (Wiebke Reim et al. 2019)	SLR	Scopus	1990–2019	42	BE	Circular Business Models	This study proposes a research agenda for further understanding the implementation of circular business models and conceptualizing the essential areas to create a business model for a bio-economy	This study did not analyze indicators, the most used methods, the main limitations of the articles, and future recommendations or research gaps
Biber-Freudenberger et al. (Biber-Freudenberger et al. 2020)	Survey/SLR	WoS	2010–2020	-	BE	SDGs	This study analyzed the chances and risks of bio-economic growth. The authors revealed which bioeconomic innovations are more associated with benefits and which are more linked to risks	This study only discussed studies using the positive or negative implications for SDGs on Bioeconomy. Publications before 2010 were excluded

Table 1 (continued)

Author(s)	Method	Database	Period	Analyzed articles	Dimension	Combination	Contributions	Limitations
Sarja et al. (Sarja et al. 2021)	SLR	WoS/Scopus	2005–2018	69	CE	Business Organizations	This study provides an understanding of factors to implement CE in business organizations	Keywords were chosen through search strings. The review focused only on journal articles in English
Suchek et al. (Suchek et al. 2021)	SLR/Biblio	WoS	2016–2020	83	CE	Business model Innovation	The authors analyzed research topics between innovation and CE. It identified factors that affect the transition process	This study used only articles written in English on Business, Management, and Economics
Arsova et al. (Arsova et al. 2022)	SLR	WoS/Scopus	1999–2021	82	CE	Regional Context	This study analyzed the understanding of the CE concept and identified research gaps	The authors used subjective strings, filters, and inclusion/exclusion criteria around the search. The data handling and screening process were manual
Gil and Martínez (Gil Lamata & Latorre Martínez 2022)	SLR	WoS	2000–2019	89	CE	Sustainability	The study analyzed CE and sustainability concepts in depth. The authors presented a future research agenda	The qualitative approach produced subjective results. This study excludes SCI journals. Only one database was analyzed
Papadopoulou et al. (Papadopoulou et al. 2022)	SLR	Scopus/AgEcon	2013–2022	68	BE	Strategies	This study showed the evolution of BE topics and revealed that several countries have not yet adopted BE strategies	This study did not analyze publications on BE strategies. The grey literature and studies not written in English are not included
Salvador et al. (Salvador et al. 2022)	SLR/Interv	WoS/Scopus/ScienceDirect	-	114	CE/BE	Businesses	This study presented barriers, challenges, drivers, and opportunities for BE businesses	The findings were derived from a systematic search process employing specific terms and targeted databases

SLR systematic literature review, *Biblio* bibliometrics, *Interv.* semi-structure interviews, *WoS* Web of Science, *CE* circular economy, *BE* bioeconomy

and presenting associated challenges that can guide future research endeavors. By shedding light on these gaps, we aim to encourage further exploration and investigation in these areas. Finally, to provide a comprehensive overview, we presented a matrix illustrating the intricate relationship between bioeconomy, circular economy, circular bioeconomy, and each of the 17 Sustainable Development Goals (SDGs). Through this analysis, we discovered that research efforts should prioritize the exploration of social SDGs, emphasizing the need for studies that address the social dimensions of sustainable development. By offering these insights and findings, our study enhances the current understanding of the field and provides a foundation for future research to address the identified research gaps and contribute to the achievement of the SDGs.

The structure of this article comprises several sections that aim to present a comprehensive analysis of the bioeconomy and circular economy concepts related to Sustainable Development Goals. "Materials and methods" outlines the data and methods applied in this study. In this section, the authors describe the data sources and the procedural methods used to conduct the bibliometric and systematic literature review. "Results" presents the main findings of the study, including bibliometric results and the citation network's structure. This section also highlights the main literature clusters and provides insights into the research strategies, geographic areas, and scopes of the analyzed articles. The Results section also provides a systematic analysis of the central insights of the bioeconomy and circular economy communities, identifying ten research gaps that require further investigation. "Final remarks" summarizes the main findings of the study and discusses their implications for future research.

Materials and methods

This section presents the materials and methods that allowed us to answer the research question. This analysis combines Bibliometrics and Systematic Literature Review techniques. Several studies have used the Bibliometric tool to provide quantitative information about prominent authors, keywords, and citation networks (D'Amato et al. 2017; Suchek et al. 2021). This technique presents several advantages, such as analyzing a significant volume of scientific studies (Belmonte-Ureña et al. 2021; Donthu et al. 2021; Mukherjee et al. 2022; Snyder 2019). As posited by Donthu et al. (2021), bibliometric analysis can be classified into two primary categories. Firstly, performance analysis serves to evaluate the contributions of research constituents, shedding light on their individual achievements and impact. Secondly, science mapping delves into the interrelationships between these constituents, providing insights into the connections and networks that exist within the scientific landscape.

Furthermore, our approach to bibliometric analysis aligns with the framework proposed by Lim and Kumar (2023). By employing the 3S sensemaking principle—namely, scanning, sensing, and substantiating—we have effectively navigated the bibliometric landscape (Lim & Kumar). The initial scanning phase facilitated the systematic collection and organization of pertinent data, forming a robust foundation for subsequent phases. Moving beyond superficial observations, the sensing stage delved into intricate patterns, unveiling the underlying themes, trends, and fundamental drivers that characterize the field. The ultimate step, substantiating, establishes the credibility and reliability of our findings, thereby ensuring their resilience under rigorous examination. Through the lens of bibliometrics, we have critically assessed the scholarly output, encompassing publications, and gauged the scientific influence through citations, both at the level of research works (such as articles) and their contributors (comprising authors and geographic origins). Furthermore, our analysis has unveiled pivotal subjects including bioeconomy and circular economy, as well as their intersection in the circular bioeconomy. By scrutinizing various dimensions—social, economic, and environmental—we have shed light on key thematic areas. This multifaceted exploration has not only highlighted notable trends but has also illuminated existing gaps that warrant further investigation.

According to Lim and Kumar (2023), the bibliometric tool is an analytical technique usually combined with systematic literature reviews. This occurs because bibliometric studies failed to delve deeper into research communities, relevant concepts, and knowledge (Belmonte-Ureña et al. 2021). For this reason, we used the Systematic Literature Review technique, which presents advantages to deeply understanding research areas, especially in revealing research gaps (Alves & Mariano 2018; Ferraz et al. 2021; Jabbour 2013; Lim, Kumar, et al. 2022a, b; Mariano, Sobreiro, and do Nascimento Rebelatto 2015; Paul et al. 2021; W. Reim et al. 2015; Snyder 2019; Tranfield et al. 2003). In this sense, this article combined these techniques with some complementary steps, which can be summarized as follows:

Step 1: The keywords were refined through the analysis of keywords co-occurrence network and keywords used in previous studies (these studies are presented in Table 1).
Step 2: Through the pre-established keywords, we assessed the articles published in major databases.
Step 3: Screen and select articles reading their titles and abstracts.
Step 4: Create a protocol to classify publications, and we applied this protocol to the publications screened.

Step 5: Selection of articles for an in-depth analysis.
Step 6: Create the scientific production profile of each publication analyzed, revealing the main research strategies.
Step 7: Scope analysis of each filtered article based on geographical area, unit of analysis, and area/sector under investigation.
Step 8: Systematization of the results obtained in the four analyses conducted (bibliometric, citation network, research strategies, and scope) to reveal research gaps and future research agenda.

Figure 1 shows the PRISMA protocol with the steps of systematic literature review selection.

The first step was defining the keywords. Some studies pointed out that keywords must be chosen by reading previous literature (Kraus et al. 2022). In this sense, we analyzed 12 previous studies using systematic literature about bioeconomy and circular economy. Then, we combined these keywords with Sustainable Development Goals (SDGs). We refined these keywords through preliminary searches of the Web of Science (WoS) database. These preliminary keywords were essential for creating the co-occurrence network using the VOSviewer software. The co-occurrence network was crucial to identify relevant synonyms.

Using the keywords selected in Step 2, we searched articles on the WoS database in December 2022, based on the title, abstract, and keywords for articles, without any time or language restriction. When conducting research, authors are often faced with the decision of selecting the appropriate databases to utilize. Among the options available, Scopus and Web of Science (WoS) are widely recognized as the largest scientific databases housing a plethora of academic articles (Kraus et al. 2022; Snyder 2019). To mitigate the risk of obtaining biased findings resulting from the limitations of a single database, researchers may opt to employ multiple databases (Kraus et al. 2022). In the present study,

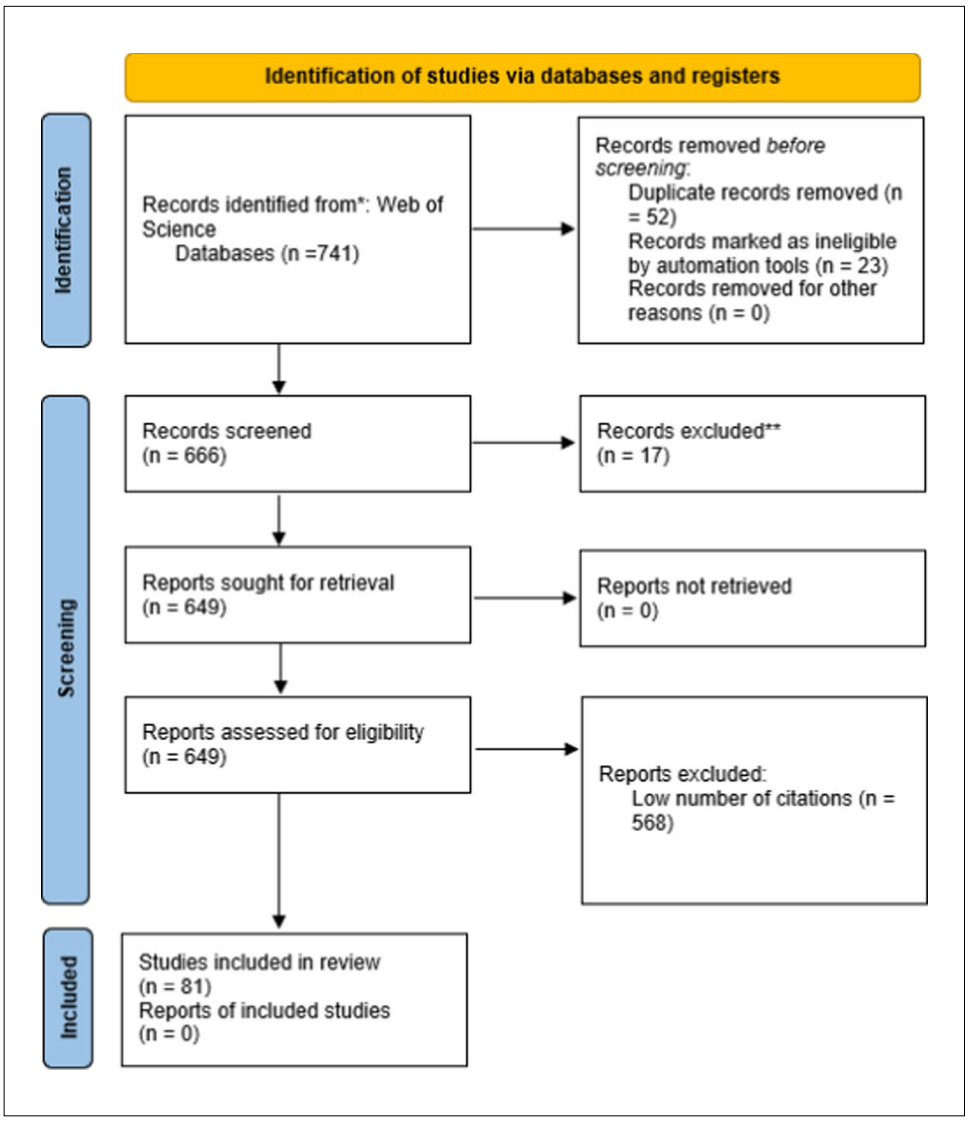


Fig. 1 PRISMA protocol

however, we chose to focus exclusively on the WoS database. This decision was based on several factors. Firstly, WoS boasts the most comprehensive global collection of articles and publishers pertaining to bioeconomy, circular economy, and Sustainable Development Goals (SDGs). By utilizing this database, we were able to access a broad range of relevant scholarly material. Furthermore, the decision to employ the WoS database aligns with the established practices of numerous systematic literature reviews, lending further credibility to our study (Alves & Mariano 2018; Ferraz et al. 2021; Jabbour 2013; Tranfield et al. 2003).

Figure 2 illustrates the keywords used in Step 3. Each of the keywords related to bioeconomy (blue) and circular economy (green) was combined with each of the keywords related to Sustainable Development Goals (gray). The keyword combinations show articles that analyze bioeconomy and circular economy combined with SDGs.

In accordance with Kraus et al. (2022), the systematic literature review method encompasses a screening process. This process begins with the identification and elimination of duplicate results obtained from databases. Subsequently, abstract screening is employed to exclude studies that do not align with the research criteria. Finally, the remaining documents undergo full-text screening to ensure their relevance and suitability for inclusion in the review. In this sense, we conducted Step 3. We verified the adherence of 741 publications based on reading the title and abstract. Some articles were excluded because they did not consider the entire research topic (17 articles), they were editorials (12 articles), and they were written in the non-English language (11 articles). We also found that 52 articles were duplicated in bioeconomy and circular economy research areas. Then, the final database presents 649 publications.

In Step 4, the publications were classified according to bioeconomy and circular economy research areas, as well as at least one Sustainable Development Goal (SDGs 1–17). This classification was necessary to create the citation network and bibliometric analysis. In Step 5, we selected the publication for the in-depth analysis. During this step, a complete reading of the 81 articles was made. Our number of articles for in-depth analysis is higher than the average (78 articles) of previous systematic literature reviews on the bioeconomy and circular economy (Arsova et al. 2022; Gil Lamata and Latorre Martínez 2022; Papadopoulou et al. 2022; Wiebke Reim et al. 2019; Sarja et al. 2021; Suchek et al. 2021). The in-depth analysis allowed us to identify research strategies (Step 6) and to perform the scope analysis (Step 7).

Finally, in Step 6, we conducted a structured review to present bibliometric, citation network, main research strategies, and scope analysis of bioeconomy and circular economy separately. Other authors pointed out that this approach is adequate to reveal research gaps and opportunities for future research (Step 8) (Alves & Mariano 2018; Ferraz et al. 2021; Mariano et al. 2015). In this sense, the bibliometric technique revealed the publication growth, the most relevant publications and authors, and the most relevant journals for bioeconomy and circular economy. The network analysis was crucial to illustrate this research area's main references and clusters. The primary research strategies analysis revealed the main methods used to investigate the problems of the bioeconomy and circular economy considering the SDGs.

Moreover, the exploration of sustainability approaches has been enriched by the contributions of various authors utilizing the multi-study technique (Lim 2023; Lim, Ciasullo, Douglas, & Kumar 2022). Notably, Lim et al. (2022a, b) employed a meta-systematic review approach, encompassing multiple studies, to examine the synergistic relationship between Environmental Social Governance (ESG) and Total Quality Management (TQM). Similarly, Lim (2023) adopted a methodological approach incorporating multiple

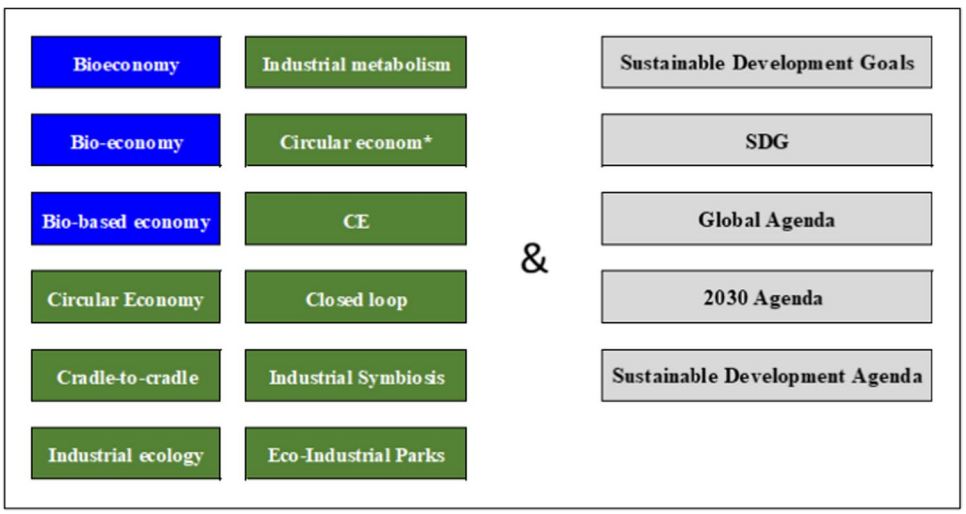


Fig. 2 Keywords used in this research "*" Replaces one or more characters of a word, for example "Econom*" also includes the expressions "Economics" and "Economies"

studies to assess the progress of consumption research and propose strategies aimed at inspiring consumers to embrace environmentally friendly practices while also promoting human well-being. Despite the significance of the multi-study strategy in advancing sustainability research, our study offers a comprehensive analysis that encompasses the geographical scope, unit of analysis for each publication, and the most extensively investigated areas and sectors within the realms of bioeconomy (BE) and circular economy (CE) studies. By providing this valuable insight, our research expands the existing knowledge base and enhances understanding in these fields.

Results

This section presents the results of the bibliometric and systematic literature review analysis conducted in this study. A bibliographic database search of the Web of Science identified 649 publications relevant to bioeconomy and circular economy. Using bibliometric techniques, we analyzed this dataset and narrowed down the selection to 81 relevant publications for the systematic literature review. The review process involved a detailed analysis of 17 publications on bioeconomy and 67 publications on circular economy. This selection process was necessary to ensure that the number of publications under analysis represented the most relevant and up-to-date articles in both research areas.

Bibliometric analysis

Examining publication growth over time is one of the most critical aspects of bibliometric analyses. In our study, we observed a consistent increase in the number of publications related to the bioeconomy and circular economy in association with Sustainable Development Goals from 2007 to 2022. Figure 3 depicts the number of articles published in each research community, indicating a steady upward trend in both areas over time.

In general (BE and CE), from 2007 to 2016, the number of publications was unimpressive. Interestingly, even after the Europe Commission reports (EC 2012; E. EC 2015), some years were necessary for studies on bioeconomy and circular economy linked to SDGs to appear. The curve presented exponential publication growth since 2017, which reveals an annual average rate of 202% (2017–2022). The bioeconomy curve did not present publications from 2007 to 2015. However, from 2017 to 2022, we found 135 articles linking the bioeconomy to SDGs, representing an average publication growth of 109% per annum (p.a.). Moreover, the circular economy curve presents exponential growth since 2017, showing an average publication growth of 192% p.a. In this sense, the circular economy

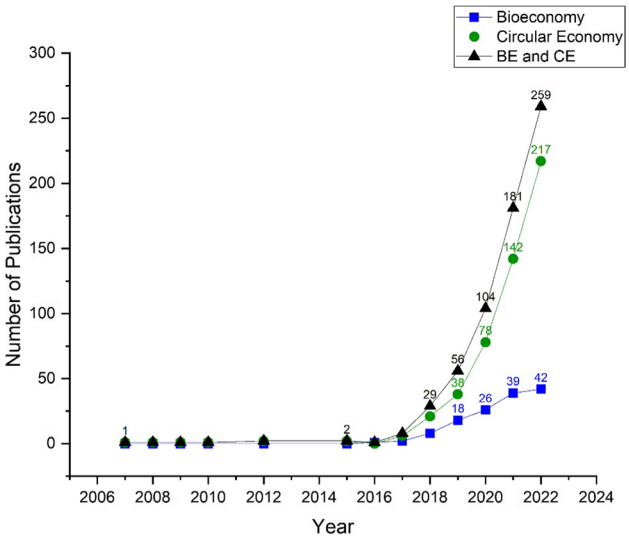


Fig. 3 Publication growth per research area (bioeconomy and circular economy)

curve shows an increasing slope while the growth of publications in the bioeconomy shows relatively less substantial growth during the last years.

Academic journals are critical in disseminating knowledge, particularly to research communities and scientific audiences. Figure 4 highlights the number of publications per research area in the top 10 most relevant journals. For the bioeconomy community, Sustainability (Switzerland), New Biotechnology, Renewable and Sustainable Energy Reviews, Journal of Cleaner Production, Science of the Total Environment, Forest Policy and Economics, Journal of Environmental Management, Environment Development and Sustainability, Amfiteatru Economic make up 50% of the publications found. For the circular economy community, the top 10 relevant journals are Sustainability (Switzerland), Journal of Cleaner Production, Journal of Industrial Ecology, Resources Conservation and Recycling, Science of the Total Environment, Energies, Sustainable Production and Consumption, Journal of Environmental Management, Applied Sciences-Basel, and Business Strategy and the Environment, which make up 41.34% of the publications found. Remarkably, the analysis of scientific publications in various journals reveals only one published paper for bioeconomy (59) and 209 papers for circular economy. These findings suggest that these concepts are still fragmented in the literature and associated with diverse research approaches.

The application of citation analysis serves as a valuable tool for determining the significance of scientific publications. This study employed local citations to analyze the most frequently cited papers within the analyzed network. Table 2 showcases the most notable publications regarding local citations in the focus network. Utilizing

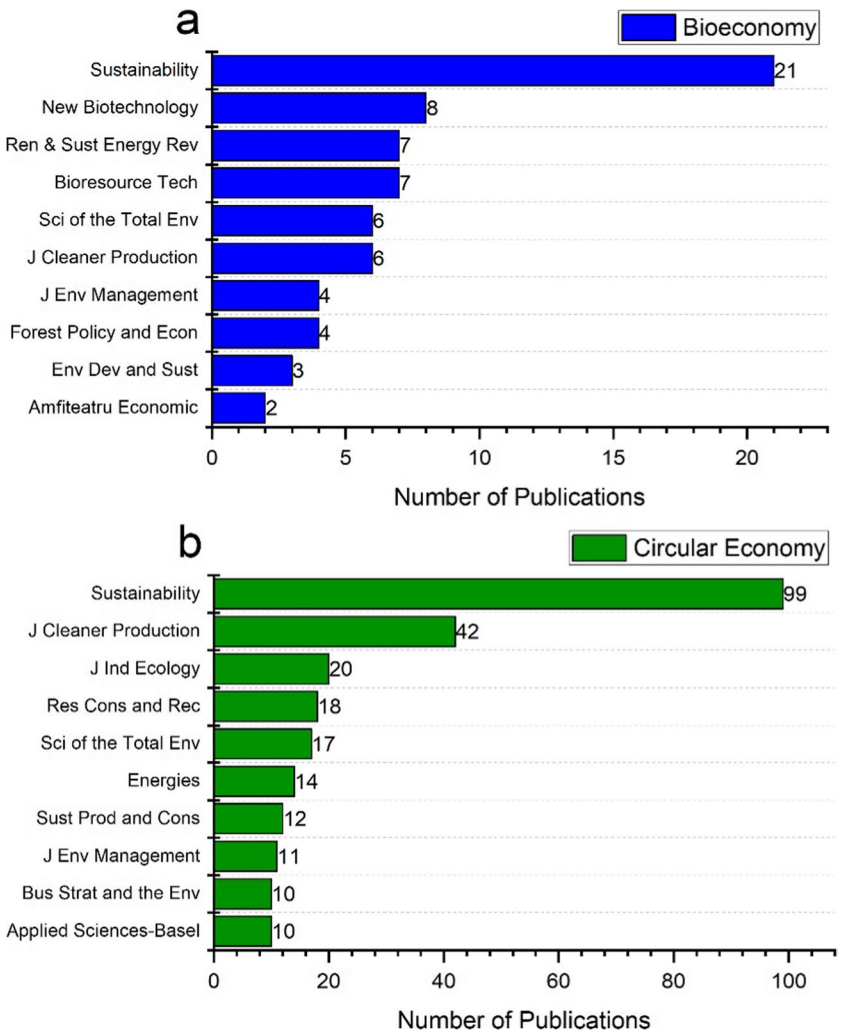


Fig. 4 Most relevant journals: **a** bioeconomy; **b** circular economy

local citations facilitated the identification of studies that occupy leading positions within the various analyzed clusters. It is important to note that recent papers may not have had sufficient time to accrue prominence (Mariano et al. 2015). The most locally cited article in the bioeconomy network was by Dietz et al. (Dietz et al. 2018). This study proposes strategies for promoting the expansion of the bioeconomy to achieve Sustainable Development Goals (SDGs) through effective governance tools. The most frequently cited article within the circular economy network was Schroeder's (Schroeder et al. 2019), which examines the potential of the circular economy to address SDGs. Other notable publications include studies that analyze circular economy strategies and assess the impact of COVID-19 on the global economy and ecosystems (Ibn-Mohammed et al. 2021), as well as investigations into the challenges and opportunities presented by biorefineries in the European Union to bolster bioeconomy (Hassan et al. 2019), among others.

Main research strategies and geographical analysis

This subsection analyzes the research strategies employed in the 81 publications selected for the in-depth analysis and the primary databases and methods used over the years. The reviewed articles are categorized into five research-method categories: (i) literature review; (ii) empirical-quantitative studies, which use quantitative techniques to draw general conclusions about a specific issue using a sample of observations; (iii) empirical-qualitative studies, which employ descriptive data analysis and/or discuss case studies; (iv) theoretical studies with quantitative analyses that develop a new theory and test it; and (v) theoretical-conceptual studies, which present new theoretical frameworks and conceptual models. These categories allow us to assess the dominant research methods used in the field and identify gaps and opportunities for future research (Fig. 5).

For both research communities (represented by gray bars), we found a predominance of literature review studies (70.37%), followed by empirical-quantitative (14.81%),

Table 2 The 10 most local cited papers according to the research community

Rank	Bioeconomy		Circular economy	
	Article	Citation	Article	Citation
1	Dietz et al. (2018)	121	Schroeder et al. (2019)	408
2	Hassan et al. (2019)	121	Ibn-Mohammed et al. (2021)	243
3	Mak et al. (2020)	110	Kenne et al. (2012)	180
4	D'amato et al. (2020)	95	Nosratabadi et al. (2019)	151
5	Matharu et al. (2016)	95	Schandl et al. (2018)	145
6	Bell et al. (2018)	88	Van Zanten et al. (2018)	136
7	Sadhukhan et al. (2018)	77	Fatimah et al. (2020)	126
8	Teigiserova et al. (2019)	71	Bengtsson et al. (2018)	122
9	Barros et al. (2020)	71	Dantas et al. (2021)	118
10	Heimann (2019)	70	Haberl et al. (2019)	117

empirical-qualitative (12.35%), theoretical studies with quantitative analyses (1.23%), and theoretical-conceptual studies (1.23%). The blue bars represent the bioeconomy community, which shows a high concentration of publications using the literature review method (82.35%), followed by empirical-qualitative (11.76%) and empirical-quantitative (5.88%) studies. No studies were found using theoretical studies with quantitative analyses and theoretical-conceptual studies methods. The green bars represent the circular economy community, which presents most of its publications using the literature review method (67.19%), followed by empirical-quantitative (17.19%), empirical-qualitative (12.50%), theoretical studies with quantitative analyses (1.56%), and theoretical-conceptual studies (1.56%). In summary, Fig. 7 reveals a high concentration of studies using literature review as a research method, particularly in bioeconomy studies, and more empirical studies are needed for both research communities.

The present analysis focuses on studies that utilized a unit of analysis (as depicted in Fig. 6), which is crucial considering the limited employment of quantitative methods in the bioeconomy and circular economy fields.

Results indicate that the majority of studies investigating bioeconomy and circular economy are concerned with countries (50%), followed by companies or enterprises (20%), other regions (such as metropolitan areas, islands, etc.) (20%), municipalities or cities (6.67%), and finally, colleges and universities (3.33%). However, there is a dearth of research on regional development, particularly in the context of bioeconomy, as no studies analyzing regions were identified in this research community.

The limited number of regional studies in bioeconomy and circular economy research may be attributed to the dearth of available databases. Among the 81 publications analyzed, only two studies employed international databases, such as the World Bank (Coscieme et al. 2020) and

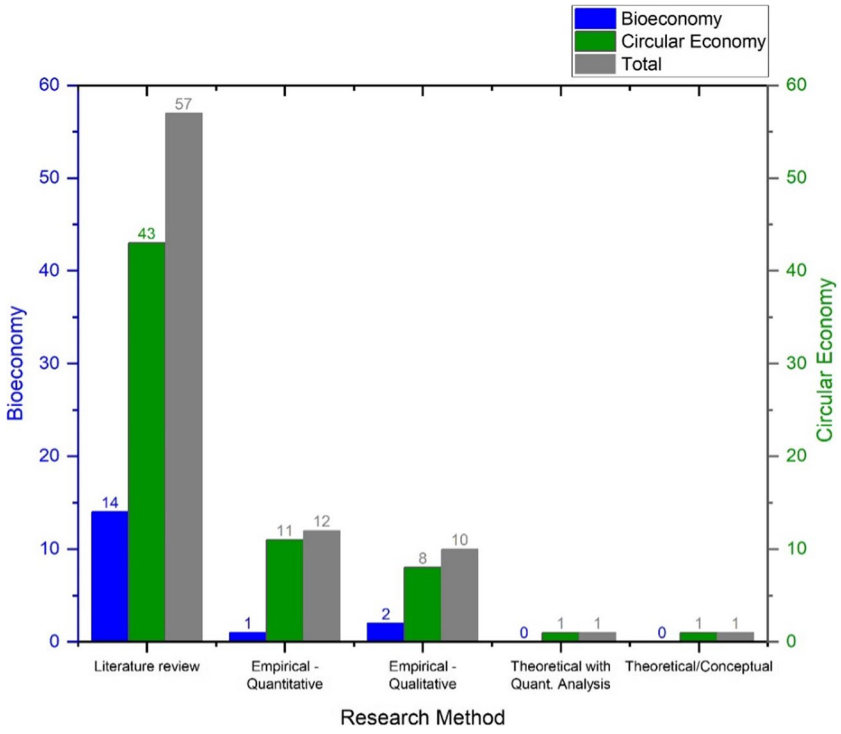


Fig. 5 Classification by research method

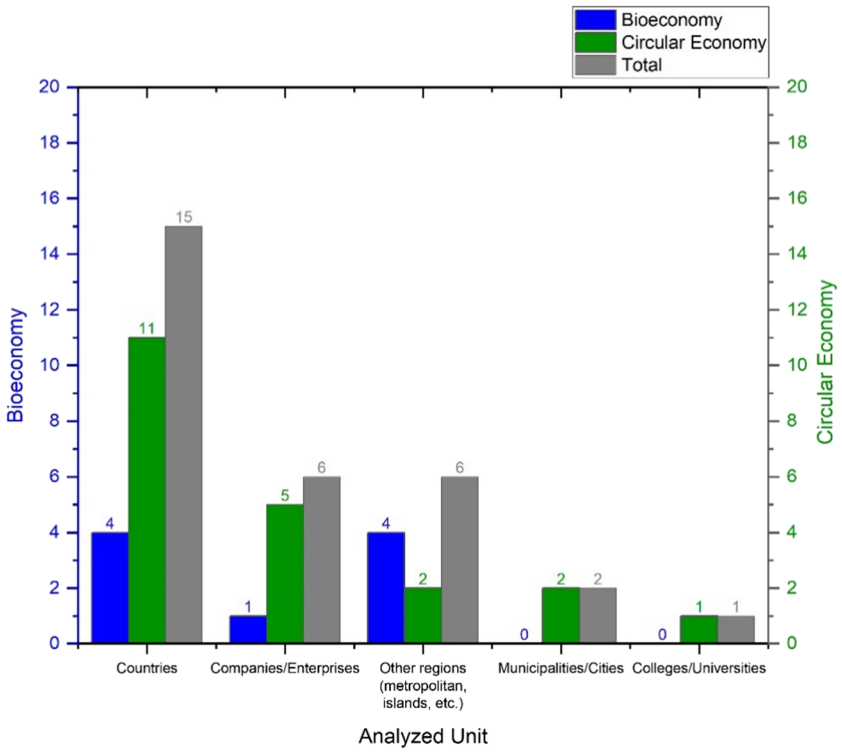


Fig. 6 Classification by analyzed units

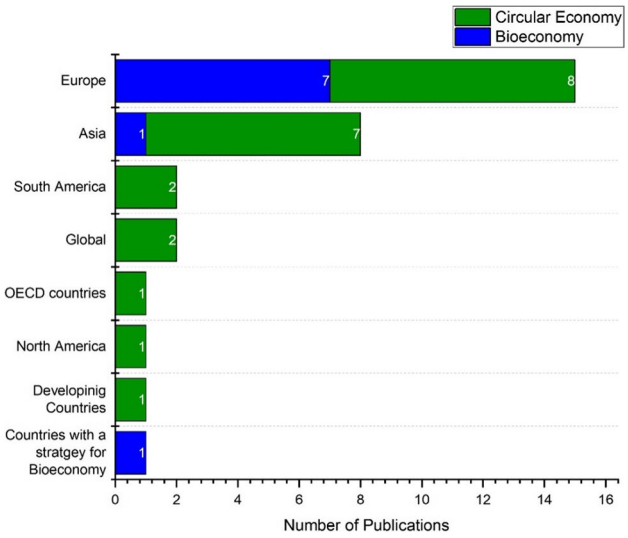


Fig. 7 Classification by geographical area

the Eurostat (Rodriguez-Anton et al. 2019). Other studies relied on literature review tools such as Web of Science, Scopus, and Google Scholar, as well as other primary databases, including Confederation of Navarre Entrepreneurs (Pla-Julián & Guevara 2019), Curaçao Environmental Statistics, and Curacao Tourism Board (Fuldauer et al. 2019). The lack of databases is consistent with other research gaps, such as the absence of longitudinal analyses that can provide insight into the evolution of the bioeconomy and circular economy over time. Furthermore, there is a limited number of studies that create indicators to offer policy recommendations on bioeconomy and circular economy, with only a few examples including the circular economy Index developed by Rodriguez-Anton et al. (Rodriguez-Anton et al. 2019), the Detrended Rate Matrix used by Ravanelli et al. (Ravanelli et al. 2018), and the indices for the lead recycling enterprise investigated by Pan et al. (Pan et al. 2019).

The present study further examined the geographical scope of the analyzed publications, as shown in Fig. 7. Out of the 81 studies analyzed, 31 were found to have a specific geographical focus, while 50 were classified as "not applicable" or of a general nature.

Most studies with a specific focus analyzed Europe (48.39%) or Asia (25.81%). In comparison, a smaller number of studies presented a global analysis (6.45%) (Landrigan et al. 2020), focused on South America (6.45%) (Pohlmann et al. 2020), or investigated countries with a strategy for bioeconomy (3.23%) (Dietz et al. 2018), developing countries (3.23%) (Schroeder et al. 2019), North America (3.23%) (Ravanelli et al. 2018), and OECD countries (3.23%) (Redlingshöfer et al. 2020). It is worth noting that bioeconomy publications were primarily focused on Europe (77.78%), which may be attributed to the European Commission reports and the availability of the Eurostat database for bioeconomy. In contrast, circular economy publications showed a more even distribution between Europe (36.36%) and Asia (31.82%). Nevertheless, Fig. 8 highlights a gap in the literature regarding the analysis of

developing nations (i.e., Latin America and Africa), which is crucial for guiding sustainable development in these countries.

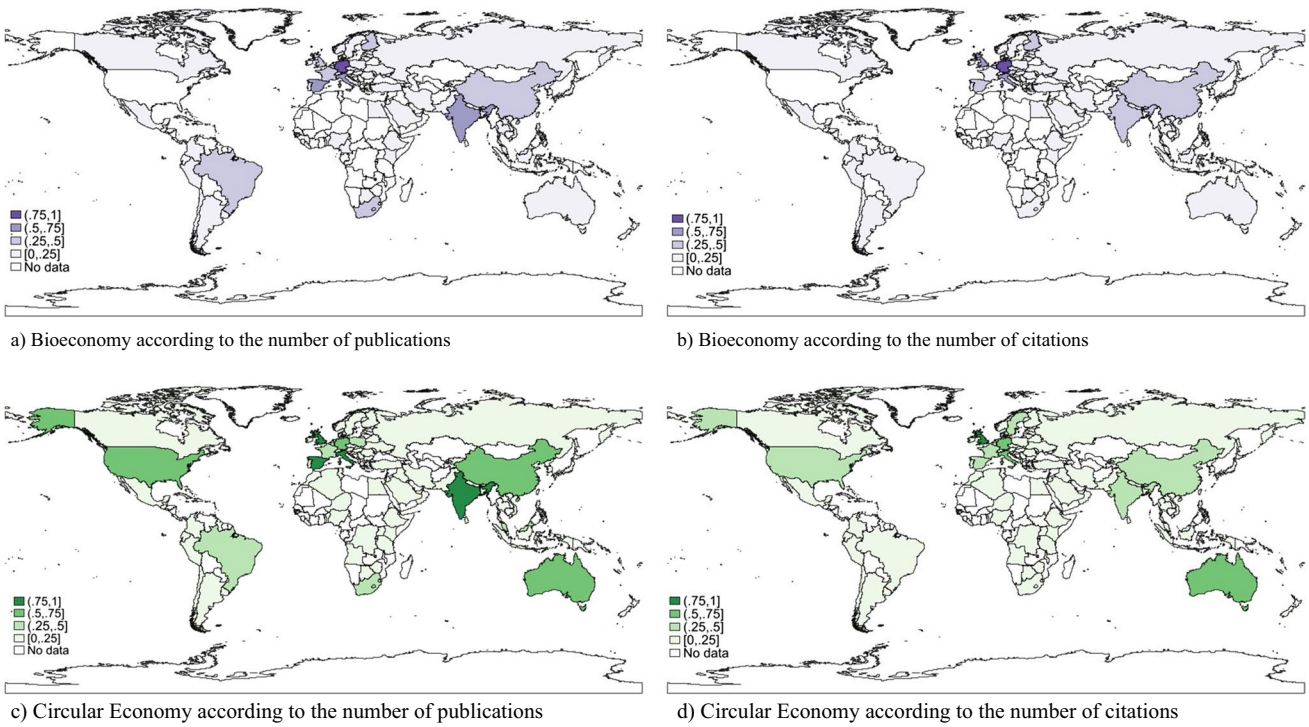
Science mapping

This subsection presents world maps that depict the number of publications and citations for each research community (Fig. 8). The use of dark colors in the maps indicates a higher number of citations or publications than lighter colors. The distribution of publications for bioeconomy across various regions is illustrated in Fig. 8a, which shows that Central Europe is more concentrated in terms of the number of publications when compared to other developed regions such as the USA and developing regions such as Latin America and Africa. Notably, even countries with bioeconomy development plans, such as Brazil, have low publication counts in this research area. Figure 8 b depicts a similar pattern, with a high concentration of citations observed in Central Europe, particularly in Germany. Figure 8 c portrays the number of publications dedicated to analyzing circular economy, indicating that this research area is more widely dispersed worldwide, with a high number of publications in Europe, the USA, India, China, and Australia compared to developing nations. Figure 8 d provides information on the number of citations for circular economy, which is concentrated in EU member nations and Australia.

Network analysis

Figure 9 presents the citation network generated from the 649 papers selected for our analysis. The individual publications represent the nodes in the network, and the links between them are depicted by arrows that indicate the direction of knowledge flow, with the cited node pointing towards the citing node. The size of each node corresponds to its local citations in the network, which is determined by the absolute number of links that the publication has within the identified main papers in the network. Each research community is represented by a unique color, such as red representing bioeconomy and green representing circular economy.

The citation network presented in Fig. 9 provides insights into the interconnections between the identified clusters. The network is composed of two main clusters that are distributed among the bioeconomy and circular economy communities. Small clusters and articles without any connections in the network are not shown to simplify the visualization. The red cluster is associated with the bioeconomy and consists of publications that discuss the relevance of bioeconomy strategies in the context of Sustainable Development Goals (SDGs). For instance, Dietz et al. (Dietz et al. 2018) present a theoretical framework for bioeconomy and SDGs, while Hassan et al. (Hassan et al. 2019) analyze the transformation of biomass into bioenergy and bioproducts in the EU, highlighting the synergy of bioeconomy with climate change



a) Bioeconomy according to the number of publications

b) Bioeconomy according to the number of citations

c) Circular Economy according to the number of publications

d) Circular Economy according to the number of citations

Fig. 8 Maps of number of publications and citations on bioeconomy and circular economy

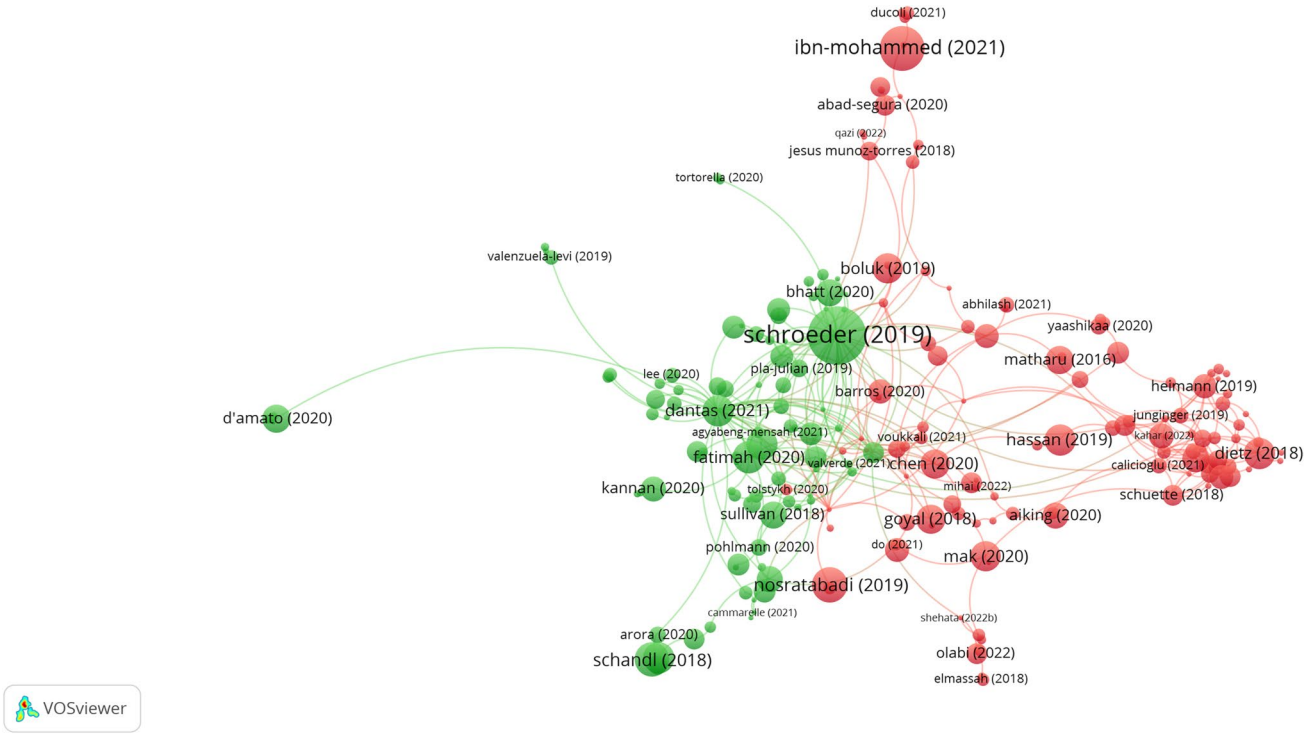


Fig. 9 Citation network

mitigation. Additionally, Mak et al. (Mak et al. 2020) discuss the role of the bioeconomy in reducing food waste.

On the other hand, the green cluster focuses on analyzing the circular economy and its relationship with SDGs. This cluster is led by Schroeder's paper (Schroeder et al. 2019), which highlights the importance of the circular economy in achieving sustainable development. Bhatt et al. (Bhatt, Ghuman, and Dhir 2020) investigate the intellectual structure of sustainable manufacturing and its link with circular economy practices, while Dantas et al. (2021) compare the synergies between circular economy and Industry 4.0. Schandl et al. (2018) use the concept of Industrial Ecology to analyze global material flows and resource productivity. Although not well connected with the green cluster, D'Amato et al. (D'Amato et al. 2020) contribute to the idea of a circular bioeconomy.

In summary, the citation network depicted in Fig. 6 highlights a significant disconnect between the bioeconomy and circular economy communities, particularly regarding their contributions to Sustainable Development Goals (SDGs) research. Given the potential for mutual learning between these communities, we thoroughly analyzed 81 articles based on the most cited articles in the literature.

Scope analysis and discussion of main arguments

This subsection presents a scope analysis of the link between bioeconomy and circular economy with Sustainable Development Goals (SDGs). Our main arguments are based on the articles analyzed in this study. Our findings indicate that the link between bioeconomy and circular economy with SDGs is complex and multifaceted to explain Sustainable Development Goals. The articles under analysis highlight the need for a systemic and holistic approach to achieving sustainable development. The bioeconomy and circular economy are viewed as key drivers of sustainability, as they can contribute to reducing greenhouse gas emissions, efficiently using resources, and creating new job opportunities. The distribution of articles according to the Sustainable Development Goals is presented in Table 3. Each article was classified under at least one main SDG.

Our analysis suggests that the link between bioeconomy and circular economy with SDGs is not yet fully explored. While some articles explicitly address this relationship, others do not. Additionally, we identified a lack of studies analyzing social aspects of sustainable development, such as reducing inequalities and poverty, which are fundamental to achieving SDGs.

Figure 10 depicts the interconnectedness between bioeconomy (blue), circular economy (green), circular bioeconomy (purple), and Sustainable Development Goals. The diagram highlights the limited attention that the bioeconomy and circular economy have given to specific areas of the 17 Sustainable Development Goals, particularly the social aspects. It is worth noting that a combination of bioeconomy

Table 3 Distribution of articles by the main Sustainable Development Goals

Sustainable development goals (SDGs)	BE	%	CE	%	BE + CE	%
SDG 1. No poverty	3	2.21	11	2.14	14	2.16
SDG 2. Zero hunger	10	7.35	25	4.87	35	5.39
SDG 3. Good health and well-being	5	3.68	20	3.90	25	3.85
SDG 4. Quality education	1	0.74	18	3.51	19	2.93
SDG 5. Gender equality	1	0.74	4	0.78	5	0.77
SDG 6. Clean water and sanitation	2	1.47	33	6.43	35	5.39
SDG 7. Affordable and clean energy	32	23.53	49	9.55	81	12.48
SDG 8. Decent work and economic growth	3	2.21	16	3.12	19	2.93
SDG 9. Industry, innovation, and infrastructure	29	21.32	58	11.31	87	13.41
SDG 10. Reduced inequalities	0	0.00	0	0.00	0	0.00
SDG 11. Sustainable cities and communities	1	0.74	32	6.24	33	5.08
SDG 12. Responsible consumption and production	11	8.09	169	32.94	180	27.73
SDG 13. Climate action	2	1.47	1	0.19	3	0.46
SDG 14. Life below water	6	4.41	2	0.39	8	1.23
SDG 15. Life on land	1	0.74	3	0.58	4	0.62
SDG 16. Peace and justice strong institutions	2	1.47	0	0.00	2	0.31
SDG 17. Partnerships to achieve the goal	1	0.74	3	0.58	4	0.62
All SDGs	26	19.12	69	13.45	95	14.64
Total	136	100.00	513	100.00	649	100.00

and circular economy, referred to as circular bioeconomy by D'Amato (D'Amato et al. 2017, 2020), can expand the synergies between these two concepts and the Sustainable Development Goals, thereby providing a more comprehensive approach.

Our analysis reveals that most articles concentrate on SDG 12, Responsible Consumption and Production, representing 27.73% of the articles reviewed. Additionally, some articles investigate the synergies between bioeconomy and circular economy with all SDGs, representing 14.64% of the total articles. Other frequently researched SDGs include SDG 9, Industry, Innovation and Infrastructure (13.41%), and SDG 7, Affordable and Clean Energy (12.48%). On the other hand, some SDGs are not well-represented in the bioeconomy and circular economy literature. For instance, SDG 5, Gender Equality, accounts for only 0.77% of the articles reviewed. Similarly, SDG 15, Life on Land, and SDG 17, Partnerships to achieve the Goal, each represent only 0.62% of the articles reviewed. SDG 13, Climate Action, and SDG 16, Peace and Justice Strong Institutions, are also underrepresented in the literature, each accounting for only 0.46% and 0.31% of the articles reviewed, respectively. Finally, SDG 10, Reduced Inequalities, is not represented in any of the articles analyzed.

The bioeconomy community's research focuses on several Sustainable Development Goals (SDGs) as demonstrated by the findings in Table 3. The primary focus is on SDG 7. Affordable and Clean Energy, accounting for 23.53% of the publications, followed by SDG 9 Industry, Innovation and Infrastructure (21.32%), synergies between bioeconomy with all SDGs (19.12%), and SDG 12. Responsible Consumption and Production (8.09%). For instance, Heimann's research (Heimann 2019) suggests that bioeconomy may help achieve all SDGs, although there may be trade-offs between the SDG targets. Similarly, Ronzon and Sanjuan (Ronzon and Sanjuán, 2020) found that the bioeconomy strategy aligns with 53 targets in 12 of the 17 SDGs for the EU Member States. The authors revealed that clean energies (SDG 7), recycling (SDG 11), and ecosystem preservation (SDG 15) have positive correlations with most of the other bioeconomy-related SDGs. However, there are negative correlations between agro-biodiversity (SDG 2), domestic material consumption of biomass (SDG 8 and 12), agriculture, and industrial developments (SDG 2 and SDG 9) and a wide array of bioeconomy-related SDG indicators.

Several authors have focused on the significance of bioeconomy in achieving specific Sustainable Development Goals (SDGs). For instance, Hassan et al. (2019) highlighted the importance of biorefineries in Europe to promote cost-effective conversion of lignocellulosic biomass into bioenergy and bioproducts, thereby contributing to SDG 7 (Affordable and Clean Energy). Sadhukhan et al. (2018) explored the prospects of innovative biorefinery systems in sustainable development in Malaysia, emphasizing the advantages of extracting recyclable, metal, high-value chemicals, fuels, electricity, and bio-fertilizers from municipal solid or urban waste to achieve SDG 7. Similarly, D'Amato et al. (D'Amato et al. 2020) studied the principles of bioeconomy at the industry level to foster cost reduction, innovation, and competitiveness for Finnish SME companies, which could contribute to SDG 9 (Industry,

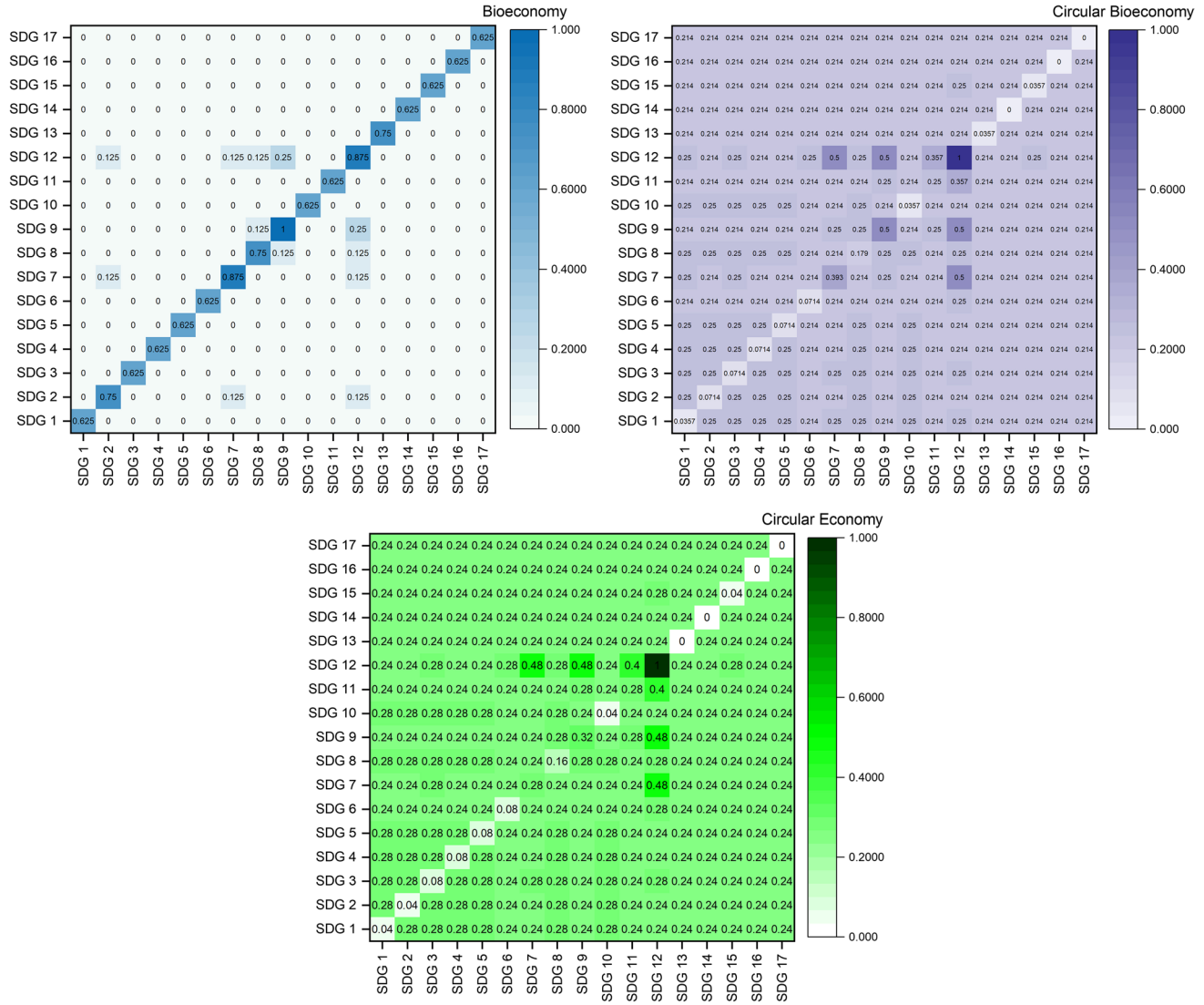


Fig. 10 Relationship between bioeconomy (blue), circular economy (green), circular bioeconomy (purple), and Sustainable Development Goals

Innovation, and Infrastructure). The authors concluded that SMEs play a crucial role in transitioning to bioeconomy due to their flexibility, dynamism, and capability of generating innovations. Lokko et al. (2018) explored the potential of biotechnology to transform developing nations into industrialized ones, demonstrating that bio-based industries ensure sustainability and reduce negative environmental impacts, which is relevant to SDG 9. Other studies have highlighted the significance of bioeconomy in achieving SDG 12 (Responsible Consumption and Production). For instance, Cubas et al. (Cubas, Bianchet, Reis, & Gouveia 2022) identified the excessive use of petroleum derivatives in cosmetics, which bioeconomy practices could mitigate. Overall, these studies show that bioeconomy can contribute significantly to achieving several SDGs, including SDG 7, SDG 9, and SDG 12.

Nevertheless, it is important to note that the bioeconomy community overlooks other SDGs, including SDG 4 Quality Education, SDG 5 Gender Equality, SDG 15 Life on Land, SDG 17 Partnerships to achieve the Goal, SDG 13 Climate Action, SDG 16 Peace and Justice Strong Institutions, and SDG 10 Reduced Inequalities, with less than 2% of publications for each. For example, Onpraphai's study (Onpraphai et al. 2021) is the only one to focus on the significance of education and learning for the bioeconomy, while Baublyte's study (Baublyte et al. 2019) provides a distinctive perspective by exploring the viewpoints of female leaders in the forest industry concerning gender diversity in the context of the forest-based bioeconomy approach. These findings reveal that further research is necessary to provide a more comprehensive understanding of how bioeconomy relates to the less studied SDGs. In this regard, this study provides a

starting point for researchers to investigate the potential contributions of bioeconomy to achieving social SDGs, while considering the interdependencies between different goals.

The circular economy community primarily focuses on SDG 12, Responsible Consumption and Production (32.94%). In fact, the United Nations Sustainable Development Goals (SDGs) website recognizes the circular economy (CE) as a key component of knowledge resources for SDG 12. In addition, all SDGs connected with circular economy represent 13.45% of the publications under analysis, followed by SDG 9, Industry, Innovation, and Infrastructure (11.31%); SDG 7, Affordable and Clean Energy (9.55%); and SDG 6, Clean Water and Sanitation (6.43%). However, less attention has been given to the SDGs of SDG 1, No Poverty (2.14%); SDG 5, Gender Equality (0.78%); SDG 15, Life on Land (0.58%); SDG 17, Partnerships to achieve the Goal (0.58%); SDG 14, Life Below Water (0.39%); and SDG 13, Climate Action (0.19%). Strikingly, no studies were found to have focused on SDG 16, Peace and Justice Strong Institutions, and SDG 10, Reduced Inequalities.

Several studies have investigated the role of the circular economy in dealing with the challenges of achieving SDG 12 (Responsible Consumption and Production). For instance, Kenne et al. (Kenné et al. 2012) explored the use of production planning and control involving combined manufacturing and remanufacturing operations within a closed-loop reverse logistics network. Van Zanten et al. (2018) focused on the use of animal source food to control livestock, while Goyal et al. (Goyal et al. 2018) examined the alignment and management of resource flows across the value chain by integrating reverse logistics, design innovation, collaborative ecosystem, and business model innovation. Other studies have analyzed the synergies between nanotechnology and circular economy (Gottardo et al. 2021) and the potential of circular economy to boost innovation ecosystems and industrial sustainability (Tolstykh et al. 2020), which help achieve SDG 9 (Industry, Innovation and Infrastructure). Moreover, circular economy helps achieve SDG 7 (Affordable and Clean Energy) through smart and efficient energy systems (Pietrzak et al. 2022) and SDG 6 (Clean Water and Sanitation) using reuse of drinking water treatment sludges (Dias et al. 2021) and smart drip irrigation systems (Abdelzaher and Awad 2022). These findings are in agreement with Rodriguez et al. (Rodriguez-Anton et al. 2019) and Schroeder et al. (Schroeder et al. 2019), who asserted that CE has great potential for job creation and promotion of sustainable models, particularly in the pursuit of SDGs 6, 8, 9, 11, 12, 13, 14, and 15.

Despite the increasing interest in circular economy (CE), it is still unclear how it addresses important concepts related to Sustainable Development Goals (SDGs). While CE is commonly associated with SDG 12 — Responsible Consumption and Production, it has been found that some SDGs are underrepresented, such as those promoting economic growth and jobs (SDG 8 Decent Work and Economic Growth), eliminating poverty (SDG 1 No Poverty), improving sustainable food production (SDG 2 Zero Hunger), and improving biodiversity protection in the oceans (SDG 14 Life Below Water) and on land (SDG 15 Life on Land) (Schroeder et al. 2019). Limited attention has been given to some SDGs, which may hinder the development and implementation of CE policies that aim to tackle poverty (Shikwambana et al. 2021), gender inequality (Khalikova et al. 2021), and life below water (Pauna & Askham 2022). In fact, some CE studies question the suitability of the concept to deal with the complexities and interdependencies of sustainable development and worry about potential negative impacts on social inclusion and climate change (Sehnem et al. 2019a, b) (Sehnem et al. 2019a, b). Therefore, a more comprehensive and integrated approach is needed to address the broader range of SDGs and ensure that CE policies promote sustainable development.

Finally, while the bioeconomy and circular economy literature does tend to focus on some SDGs more than others, this does not mean that these are the only areas of research that are important for achieving sustainable development. It is necessary to explore the connections between the different SDGs, including those that are less researched, and how bioeconomy and circular economy can contribute to their achievement. Future research could explore the potential of green growth approaches and other environmental aspects that have not been fully considered in the literature. Overall, our study contributes to understanding the link between bioeconomy and circular economy with SDGs. However, we recognize that further research is needed to deepen our understanding of this relationship.

Literature gaps

The current study conducted a systematic literature review, which revealed various potential avenues for future research on the bioeconomy and circular economy in the context of Sustainable Development Goals. The analysis identified ten significant research gaps, presented in detail in Table 4. These gaps encompass a range of issues, including but not limited to the need for longitudinal analyses, the dearth of regional studies, insufficient use of quantitative research methods, lack of available databases, inadequate attention to developing indicators, and the need for more research on developing countries. Identifying these research gaps highlights the potential for future studies to make essential contributions to the understanding of bioeconomy and circular economy and their relationship with sustainable development.

We have divided these gaps into four aspects:

Theory Our systematic literature review highlights a notable research gap concerning the examination of the relationship

Table 4 Literature gaps

Category	Gaps
Theory	*G1*. There are relatively few studies connecting bioeconomy and circular economy
	G2. The bioeconomy community tends to omit social aspects, although it assumes positive effects through creating jobs
Missing topics	*G3*. Few studies analyze social SDGs (i.e., reducing inequalities, poverty, zero hunger, etc.)
	G4. More studies analyzing inequalities, gender, health, and education are needed for both communities
	G5. There is a lack of studies analyzing developing regions (i.e., Latin America, and Africa, among others)
Data	*G6*. There are no available global databases providing information on bioeconomy and circular economy
	G7. A very limited number of studies have created economic, social, and/or environmental indicators for bioeconomy and circular economy
Method	*G8*. There is a lack of quantitative studies applying mathematical and statistical models for both bioeconomy and circular economy
	G9. No studies were found analyzing bioeconomy and circular economy over the years
	G10. There are relatively few studies analyzing regional data within a country

between the bioeconomy (BE) and circular economy (CE) research communities (D'Amato et al. 2017; Ferreira Gregorio et al. 2018; Salvador et al. 2022). Addressing this limitation is crucial as it enhances our comprehension of how these two fields can be integrated to effectively contribute to sustainable development. In light of this, we advocate for greater collaboration and cooperation among the international scientific community working on BE and CE to address *Gap 1*.

Moreover, our analysis revealed a significant oversight within the bioeconomy research field regarding the social dimensions of the Sustainable Development Goals (SDGs) (Baublyte et al. 2019; Tóth & Zachár, 2021). This finding holds great importance as it presents a challenge for the scientific community to substantiate the relevance of bioeconomy in fostering improved social conditions within countries. Addressing *Gap 2* necessitates allocating research funds specifically dedicated to projects that explore the social dimensions of bioeconomy. By supporting such initiatives, the scientific community can contribute to filling this research gap and furthering our understanding of the social implications and potential benefits associated with bioeconomy.

Missing topics The Missing Topics aspect revealed a scarcity of studies that explore the social dimensions of the Sustainable Development Goals (SDGs) (e.g., reducing inequalities, poverty, achieving zero hunger, gender, health, and education). To bridge *Gap 3* and *Gap 4*, international journals could consider proposing special issues and implementing other strategies to encourage a higher number of studies analyzing the interconnectedness between BE, CE, and social aspects. By undertaking these measures, the academic community can advance our understanding of the social implications and impacts of BE and CE, fostering progress towards achieving the broader objectives of sustainable development.

Additionally, our analysis revealed a notable research gap in the literature concerning the examination of bioeconomy and circular economy in developing regions. Specifically, there is a dearth of studies that assess the significance of these concepts in Latin America and Africa. Noteworthy, certain developing regions possess significant forest resources. For example, the Amazon rainforest in Brazil faces numerous environmental and social challenges (Lapola et al. 2023). Bridging *Gap 5* requires international collaboration and cooperation between researchers from both developed and developing areas. Studies focused on developing countries hold the potential to provide valuable insights for policymakers and contribute to the advancement of sustainable development in these regions.

Data Our findings indicate that both the bioeconomy and circular economy research communities face challenges in accessing worldwide databases. However, it is noteworthy that the European research community benefits from the availability of the Eurostat database (Rodriguez-Anton et al. 2019; Ronzon and Sanjuán, 2020). The availability of regional data plays a crucial role in conducting empirical tests and formulating targeted regional policies. Consequently, the support of governments is vital for the development of regional databases to address *Gap 6* and provide essential data for these research communities.

Furthermore, our analysis revealed a scarcity of studies focused on creating economic, social, and environmental indicators for bioeconomy and circular economy. However, the existence of regional databases would empower scientists to develop and measure these indicators effectively. Addressing *Gap 7* is of utmost importance since indicators

serve as critical tools for analyzing the progression of these concepts over time, making comparisons between countries or regions, and formulating policy recommendations. By tackling this research gap, researchers can enhance their ability to track and evaluate the advancements and impacts of bioeconomy and circular economy, facilitating evidence-based decision-making and policy formulation.

Method The research communities in bioeconomy and circular economy employ inconsistent methods, potentially impeding comparability and limiting opportunities for integrated analysis. *Gap 8* highlights the scarcity of quantitative studies utilizing mathematical and statistical models to investigate both concepts, which are vital for elucidating the interplay and impact between the two. However, conducting such research necessitates the availability of regional databases, as the increasing number of quantitative studies relies on robust data sources. The lack of quantitative studies and databases also poses challenges for longitudinal studies, inhibiting the assessment of the transition and progress of bioeconomy and circular economy over time (*Gap 9*). Furthermore, *Gap 10* underscores the need for studies that analyze regional data within a country. This is particularly important for regions characterized by significant social, economic, and environmental heterogeneity, as tailored policy recommendations are required to address their unique challenges and opportunities.

In summary, this study contributes to the advancement of theory and practice in the domains of circular economy (CE) and bioeconomy (BE) through the utilization of a literature review method. By analyzing relevant articles and establishing connections with prominent research topics, we discovered limited interconnectivity between two distinct clusters, underscoring the significance of closer integration and collaboration. Additionally, our systematic literature review shed light on several limitations, including a scarcity of quantitative articles, restricted database coverage, and limited geographical representation. These findings highlight the need for further exploration in these areas, particularly with regard to social Sustainable Development Goals (SDGs).

Final remarks

In conclusion, our systematic literature review of bioeconomy and circular economy research in the context of Sustainable Development Goals has revealed several key findings and research gaps. Our study found that there is a limited number of studies that link the two clusters, bioeconomy and circular economy, and that there is a lack of databases available to researchers. Additionally, there are discrepancies in the methods adopted between the clusters. These findings suggest a need for more collaboration and standardization in research approaches between the two fields.

Furthermore, our review revealed that most of the studies focus on Europe and Asia, with a significant lack of research on developing regions. This gap is significant because bioeconomy and circular economy policies can tremendously impact developing countries, where sustainability challenges are more prominent. Therefore, researchers need to investigate the potential benefits and challenges of the bioeconomy and circular economy in these regions. Our review also highlighted a lack of attention to social aspects such as reducing inequalities, poverty, and zero hunger. Incorporating social dimensions into bioeconomy and circular economy research could help develop policies that address these issues and promote sustainable development more effectively. Additionally, our review identified a scarcity of longitudinal studies and the creation of indicators to provide policy recommendations on bioeconomy and circular economy.

This study has identified several limitations that could provide directions for future research. One limitation is associated with using bibliometric methods and keywords as the sole elements of analysis to examine the contribution of conceptual domains in different SDGs. While this approach effectively identified patterns and trends in the literature, it may not have captured all relevant studies or domains. To overcome this limitation, future studies could consider incorporating other sources of research material, such as conference proceedings, books, and book chapters, as well as using alternative methods for analysis. Another limitation is the narrow focus on scientific articles published between 2007 and 2022, which excludes potentially relevant studies outside this time frame. Expanding the scope to include a broader range of research material and a longer time horizon could provide a more comprehensive understanding of the relationship between green growth approaches and the SDGs. Moreover, the analysis did not include all environmental aspects (i.e., green growth), which is another limitation. Future research could explore alternative methods of analysis, incorporate a broader range of research material and a longer time horizon, and consider additional environmental factors to deepen our understanding of the linkages between bioeconomy and circular economy approaches and the SDGs. Such research can help to advance sustainable development agendas and promote the transition towards a more sustainable and equitable future. Finally, our systematic literature review provides an overview of the current state of research in bioeconomy and circular economy, highlighting the need for more research and collaboration to achieve Sustainable Development Goals.

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Data availability The database is public and online thought the Web of Science. Tables and analysis may be available upon request to the corresponding author.

Declarations

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References

Abdelzaher M, Awad MM (2022) Sustainable development goals for the circular economy and the water-food nexus: full implementation of new drip irrigation technologies in upper Egypt. Sustainability 14(21):13883

Alves MWFM, Mariano EB (2018) Climate justice and human development: a systematic literature review. J Clean Prod 202:360–375

Arsova S, Genovese A, Ketikidis PH (2022) Implementing circular economy in a regional context: a systematic literature review and a research agenda. J Clean Prod 368:133117. https://doi.org/10.1016/j.jclepro.2022.133117

Assembly G (2015) Resolution adopted by the General Assembly on 11 September 2015. United Nations, New York

Azmat F, Lim WM, Moyeen A, Voola R, Gupta G (2023) Convergence of business, innovation, and sustainability at the tipping point of the sustainable development goals. J Bus Res 167:114170. https://doi.org/10.1016/j.jbusres.2023.114170

Barros MV, Salvador R, Francisco AC, Piekarski CM (2020) Mapping of research lines on circular economy practices in agriculture: from waste to energy. Renew Sust Energ Rev 131109958. https://doi.org/10.1016/j.rser.2020.109958

Baublyte G, Korhonen J, D'Amato D, Toppinen A (2019) "Being one of the boys": perspectives from female forest industry leaders on gender diversity and the future of Nordic forest-based bioeconomy. Scand J for Res 34(6):521–528

Bell J, Paula L, Dodd T, Németh S, Nanou C, Mega V, Campos P (2018) EU ambition to build the world's leading bioeconomy—Uncertain times demand innovative and sustainable solutions. New Biotechnol 40:25–30. https://doi.org/10.1016/j.nbt.2017.06.010

Belmonte-Ureña LJ, Plaza-Úbeda JA, Vazquez-Brust D, Yakovleva N (2021) Circular economy, degrowth and green growth as pathways for research on sustainable development goals: a global analysis and future agenda. Ecol Econ 185:107050

Bengtsson M, Alfredsson E, Cohen M et al (2018) Transforming systems of consumption and production for achieving the sustainable development goals: moving beyond efficiency. Sustain Sci 13:1533–1547. https://doi.org/10.1007/s11625-018-0582-1

Bhatt Y, Ghuman K, Dhir A (2020) Sustainable manufacturing. Bibliometrics and content analysis. J Clean Prod 260:120988

Biber-Freudenberger L, Ergeneman C, Förster JJ, Dietz T, Börner J (2020) Bioeconomy futures: expectation patterns of scientists and practitioners on the sustainability of bio-based transformation. Sustain Dev 28(5):1220–1235

CF O (2015) Transforming our world: the 2030 agenda for sustainable development. New York, United Nations

Coscieme L, Mortensen LF, Anderson S, Ward J, Donohue I, Sutton PC (2020) Going beyond gross domestic product as an indicator to bring coherence to the Sustainable Development Goals. J Clean Prod 248:119232

Costanza R, Daly L, Fioramonti L, Giovannini E, Kubiszewski I, Mortensen LF, ... Wilkinson R (2016) Modelling and measuring sustainable wellbeing in connection with the UN Sustainable Development Goals. Ecol Econ 130:350–355. https://doi.org/10.1016/j.ecolecon.2016.07.009

Cubas ALV, Bianchet RT, Reis IMASD, Gouveia IC (2022) Plastics and microplastic in the cosmetic industry: aggregating sustainable actions aimed at alignment and interaction with UN Sustainable Development Goals. Polymers 14(21):4576

D'Adamo I, Ribichini M, Tsagarakis KP (2023) Biomethane as an energy resource for achieving sustainable production: economic assessments and policy implications. Sustain Prod Consum 35:13–27

D'Amato D, Droste N, Allen B, Kettunen M, Lähtinen K, Korhonen J, ... Toppinen A (2017) Green, circular, bio economy: a comparative analysis of sustainability avenues. J Clean Prod 168:716–734. https://doi.org/10.1016/j.jclepro.2017.09.053

D'Amato D, Veijonaho S, Toppinen A (2020) Towards sustainability? Forest-based circular bioeconomy business models in Finnish SMEs. Forest Policy Econ 110:101848

Dahlke J, Bogner K, Becker M, Schlaile MP, Pyka A, Ebersberger B (2021) Crisis-driven innovation and fundamental human needs: a typological framework of rapid-response COVID-19 innovations. Technol Forecast Soc Chang 169:120799

Dantas TET, de-Souza ED, Destro IR, Hammes G, Rodriguez CMT, Soares SR (2021) How the combination of circular economy and Industry 4.0 can contribute towards achieving the Sustainable Development Goals. Sustain Prod Consum 26:213–227

del Mar Alonso-Almeida M, Rodriguez-Anton JM (2019) Circular supply chain and business model in apparel industry: an exploratory approach. In: The circular economy and its implications on sustainability and the green supply chain. IGI Global, pp 66–83. https://doi.org/10.4018/978-1-5225-8109-3.ch004

Dias R, Sousa D, Bernardo M, Matos I, Fonseca I, Vale Cardoso V, ... Daam MA (2021) Study of the potential of water treatment sludges in the removal of emerging pollutants. Molecules 26(4):1010. https://doi.org/10.3390/molecules26041010

Dietz T, Börner J, Förster JJ, Von Braun J (2018) Governance of the bioeconomy: a global comparative study of national bioeconomy strategies. Sustainability 10(9):3190

Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM (2021) How to conduct a bibliometric analysis: an overview and guidelines. J Bus Res 133:285–296

EC (2012) Innovating for sustainable growth: a bioeconomy for Europe. Retrieved from Brussels: Directorate-General for Research and Innovation (European Commission). https://doi.org/10.2777/6462

EC E (2015) Closing the loop—an EU action plan for the circular economy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, Belgium.

Fatimah YA, Govindan K, Murniningsih R, Setiawan A (2020) Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: a case study of Indonesia. J Clean Prod 269:122263. https://doi.org/10.1016/j.jclepro.2020.122263

Ferraz D, Falguera FP, Mariano EB, Hartmann D (2021) Linking economic complexity, diversification, and industrial policy with sustainable development: a structured literature review. Sustainability 13(3):1265

Ferreira Gregorio V, Pié L, Terceño A (2018) A systematic literature review of bio, green and circular economy trends in publications in the field of economics and business management. Sustainability 10(11):4232

Fuldauer LI, Ives MC, Adshead D, Thacker S, Hall JW (2019) Participatory planning of the future of waste management in small island developing states to deliver on the Sustainable Development Goals. J Clean Prod 223:147–162

Gil Lamata M, Latorre Martínez MP (2022) The circular economy and sustainability: a systematic literature review. In: Cuadernos de Gestión. Universidad del País Vasco - Instituto de Economía Aplicada a la, Empresa (IEAE)

Gottardo S, Mech A, Drbohlavová J, Małyska A, Bøwadt S, Sintes JR, Rauscher H (2021) Towards safe and sustainable innovation in nanotechnology: state-of-play for smart nanomaterials. NanoImpact 21:100297

Goyal S, Esposito M, Kapoor A (2018) Circular economy business models in developing economies: lessons from India on reduce, recycle, and reuse paradigms. Thunderbird Int Bus Rev 60(5):729–740

Haberl H, Wiedenhofer D, Pauliuk S, Krausmann F, Müller DB, Fischer-Kowalski M (2019) Contributions of sociometabolic research to sustainability science. Nat Sustain 2(3):173–184. https://doi.org/10.1038/s41893-019-0225-2

Hassan SS, Williams GA, Jaiswal AK (2019) Moving towards the second generation of lignocellulosic biorefineries in the EU: drivers, challenges, and opportunities. Renew Sustain Energy Rev 101:590–599

Heimann T (2019) Bioeconomy and SDGs: does the bioeconomy support the achievement of the SDGs? Earth's Future 7(1):43–57

Hetemäki L, Hanewinkel M, Muys B, Ollikainen M, Palahí M, Trasobares A, Potoćnik J (2017) Leading the way to a European circular bioeconomy strategy, vol 5. European Forest Institute Joensuu, Finland

Ibn-Mohammed T, Mustapha K, Godsell J, Adamu Z, Babatunde K, Akintade D, ... Yamoah F (2021) A critical analysis of the impacts of COVID-19 on the global economy and ecosystems and opportunities for circular economy strategies. Resour Conserv Recycl 164:105169. https://doi.org/10.1016/j.resconrec.2020.105169

Jabbour CJC (2013) Environmental training in organisations: from a literature review to a framework for future research. Resour Conserv Recycl 74:144–155

Kenné J-P, Dejax P, Gharbi A (2012) Production planning of a hybrid manufacturing–remanufacturing system under uncertainty within a closed-loop supply chain. Int J Prod Econ 135(1):81–93

Khalikova VR, Jin M, Chopra SS (2021) Gender in sustainability research: Inclusion, intersectionality, and patterns of knowledge production. J Ind Ecol 25(4):900–912

Khan SAR, Sharif A, Golpîra H, Kumar A (2019) A green ideology in Asian emerging economies: from environmental policy and sustainable development. Sustain Dev 27(6):1063–1075

Kirchherr J, Reike D, Hekkert M (2017) Conceptualizing the circular economy: an analysis of 114 definitions. Resour Conserv Recycl 127:221–232

Kraus S, Breier M, Lim WM et al (2022) Literature reviews as independent studies: guidelines for academic practice. Rev Manag Sci 16:2577–2595. https://doi.org/10.1007/s11846-022-00588-8

Kumar Sarangi P, Subudhi S, Bhatia L, Saha K, Mudgil D, Prasad Shadangi K, Arya RK (2023) Utilization of agricultural waste biomass and recycling toward circular bioeconomy. Environ Sci Pollut Res 30(4):8526–8539. https://doi.org/10.21203/rs.3.rs-1178197/v1

Landrigan PJ, Stegeman JJ, Fleming LE, Allemand D, Anderson DM, Backer LC, Czerucka D (2020) Human health and ocean pollution. Ann. Glob Health 86(1). https://doi.org/10.5334/aogh.2831

Lapola D, Pinho P, Barlow J, Aragão LEOC, Berenguer E, Carmenta R, Liddy HM, Seixas H, Silva CVJ, Silva-Junior CHL, Alencar AAC, Anderson LO, Armenteras D, Brovkin V, Calders K, Chambers J, Chini L, Costa MH, de Faria BL et al (2023) The drivers and impacts of Amazon forest degradation. Science 379(6630):eabp8622. https://doi.org/10.1126/science.abp8622

Lim WM (2022) The sustainability pyramid: a hierarchical approach to greater sustainability and the United Nations Sustainable Development Goals with implications for marketing theory, practice, and public policy. Australas Mark J 30(2):142–150

Lim WM (2023) Avengers, assemble the literature! A multi-study review of consumption, environmental values, and planetary health research. J Consum Behav. https://doi.org/10.1002/cb.2188

Lim WM, Kumar S (2023) Guidelines for interpreting the results of bibliometrics analysis: a sensemaking approach. Global Bus Organ Excell. https://doi.org/10.1002/joe.22229

Lim WM, Ciasullo MV, Douglas A, Kumar S (2022a) Environmental social governance (ESG) and total quality management (TQM): a multi-study meta-systematic review. Total Qual Manage Bus Excell 1–23. https://doi.org/10.1080/14783363.2022.2048952

Lim WM, Kumar S, Ali F (2022b) Advancing knowledge through literature reviews:'what', 'why', and 'how to contribute.' Serv Ind J 42(7–8):481–513

Lokko Y, Heijde M, Schebesta K, Scholtès P, Van Montagu M, Giacca M (2018) Biotechnology and the bioeconomy—towards inclusive and sustainable industrial development. New Biotechnol 40:5–10

MacArthur E (2013) Towards the circular economy. J Ind Ecol 2(1):23–44

Maciejczak M, Hofreiter K (2013) How to define bioeconomy? Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa I Agrobiznesu 15(4):243–248

Mak TM, Xiong X, Tsang DC, Iris K, Poon CS (2020) Sustainable food waste management towards circular bioeconomy: policy review, limitations and opportunities. Biores Technol 297:122497

Mariano EB, Sobreiro VA, do Nascimento Rebelatto, D. A. (2015) Human development and data envelopment analysis: a structured literature review. Omega 54:33–49

Matharu AS, de Melo EM, Houghton JA (2016) Opportunity for high value-added chemicals from food supply chain wastes. Bioresour Technol 215:123–130. https://doi.org/10.1016/j.biortech.2016.03.039

McCormick K, Kautto N (2013) The bioeconomy in Europe: an overview. Sustainability 5(6):2589–2608

Mishenin Y, Koblianska I, Medvid V, Maistrenko Y (2018) Sustainable regional development policy formation: role of industrial ecology and logistics. Entrep Sustain Issues 6(1):329–341

Mukherjee D, Lim WM, Kumar S, Donthu N (2022) Guidelines for advancing theory and practice through bibliometric research. J Bus Res 148:101–115

Murray A, Skene K, Haynes K (2017) The circular economy: an interdisciplinary exploration of the concept and application in a global context. J Bus Ethics 140:369–380

Nosratabadi S, Mosavi A, Shamshirband S, Zavadskas EK, Rakotonirainy A, Chau KW (2019) Sustainable business models: a review. Sustainability 11(6):1663. https://doi.org/10.3390/su11061663

O'Brien M, Wechsler D, Bringezu S, Schaldach R (2017) Toward a systemic monitoring of the European bioeconomy: gaps, needs and the integration of sustainability indicators and targets for global land use. Land Use Policy 66:162–171

Onpraphai T, Jintrawet A, Keoboualapha B, Khuenjai S, Guo R, Wang J, Fan J (2021) Sustaining biomaterials in bioeconomy: roles of education and learning in Mekong River Basin. Forests 12(12):1670

Pan H, Geng Y, Dong H, Ali M, Xiao S (2019) Sustainability evaluation of secondary lead production from spent lead acid batteries recycling. Resour Conserv Recycl 140:13–22

Papadopoulou C-I, Loizou E, Chatzitheodoridis F (2022) Priorities in bioeconomy strategies: a systematic literature review. Energies 15(19):7258

Paul J, Lim WM, O'Cass A, Hao AW, Bresciani S (2021) Scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR). Int J Consum Stud 45(4):O1–O16

Pauna VH, Askham C (2022) Using information flow analysis to establish key data gaps in the assessment of marine microplastic pollution. J Ind Ecol 26(6):1895–1907

Pietrzak MB, Olczyk M, Kuc-Czarnecka ME (2022) Assessment of the feasibility of energy transformation processes in European Union Member States. Energies 15(2):661

Pla-Julián I, Guevara S (2019) Is circular economy the key to transitioning towards sustainable development? Challenges from the perspective of care ethics. Futures 105:67–77

Pohlmann CR, Scavarda AJ, Alves MB, Korzenowski AL (2020) The role of the focal company in sustainable development goals: a Brazilian food poultry supply chain case study. J Clean Prod 245:118798

Prieto-Sandoval V, Jaca C, Ormazabal M (2018) Towards a consensus on the circular economy. J Clean Prod 179:605–615

Ravanelli R, Nascetti A, Cirigliano RV, Di Rico C, Leuzzi G, Monti P, Crespi M (2018) Monitoring the impact of land cover change on surface urban heat island through Google Earth Engine: proposal of a global methodology, first applications and problems. Remote Sensing 10(9):1488

Redlingshöfer B, Barles S, Weisz H (2020) Are waste hierarchies effective in reducing environmental impacts from food waste? A systematic review for OECD countries. Resour Conserv Recycl 156:104723

Reim W, Parida V, Ortqvist D (2015) Product-Service Systems (PSS) business models and tactics - a systematic literature review. J Clean Prod 97:61–75. https://doi.org/10.1016/j.jclepro.2014.07.003

Reim W, Parida V, Sjödin DR (2019) Circular business models for the bio-economy: a review and new directions for future research. Sustainability 11(9):2558

Rodriguez-Anton J, Rubio-Andrada L, Celemín-Pedroche M, Alonso-Almeida M (2019) Analysis of the relations between circular economy and sustainable development goals. Int J Sust Dev World 26(8):708–720

Ronzon T, Sanjuán AI (2020) Friends or foes? A compatibility assessment of bioeconomy-related Sustainable Development Goals for European policy coherence. J Clean Prod 254:119832

Sadhukhan J, Martinez-Hernandez E, Murphy RJ, Ng DKS, Hassim MH, Ng KS, Yoke Kin W, Md Jaye IF, Leung Pah Hang MY, Andiappan V (2018) Role of bioenergy, biorefinery and bioeconomy in sustainable development: Strategic pathways for Malaysia. Renew Sust Energ Rev 81(P2):1966–1987. https://doi.org/10.1016/j.rser.2017.06.007

Salvador R, Barros MV, Donner M, Brito P, Halog A, Antonio C (2022) How to advance regional circular bioeconomy systems? Identifying barriers, challenges, drivers, and opportunities. Sustainable Production and Consumption

Sarja M, Onkila T, Mäkelä M (2021) A systematic literature review of the transition to the circular economy in business organizations: obstacles, catalysts and ambivalences. J Clean Prod 286:125492

Schandl H, Fischer-Kowalski M, West J, Giljum S, Dittrich M, Eisenmenger N, Geschke A, Lieber M, Wieland H, Schaffartzik A, Krausmann F, Gierlinger S (2018) Global material flows and resource productivity: forty years of evidence. J Ind Ecol 22(4):827–838. https://doi.org/10.1111/jiec.12626

Schroeder P, Anggraeni K, Weber U (2019) The relevance of circular economy practices to the sustainable development goals. J Ind Ecol 23(1):77–95

Sehnem S, Jabbour CJC, Pereira SCF, de Sousa Jabbour ABL (2019a) Improving sustainable supply chains performance through operational excellence: circular economy approach. Resour Conserv Recycl 149:236–248

Sehnem S, Vazquez-Brust D, Pereira SCF, Campos LM (2019b) Circular economy: benefits, impacts and overlapping. Supply Chain Manag: Int J 24(6):784–804

Sharif A, Raza SA, Ozturk I, Afshan S (2019) The dynamic relationship of renewable and nonrenewable energy consumption with carbon emission: a global study with the application of heterogeneous panel estimations. Renew Energy 133:685–691

Shikwambana S, Malaza N, Shale K (2021) Impacts of rainfall and temperature changes on smallholder agriculture in the Limpopo Province South Africa. Water 13(20):2872

Snyder H (2019) Literature review as a research methodology: an overview and guidelines. J Bus Res 104:333–339

Suchek N, Fernandes CI, Kraus S, Filser M, Sjögrén H (2021) Innovation and the circular economy: a systematic literature review. Bus Strateg Environ 30(8):3686–3702

Teigiserova DA, Hamelin L, Thomsen M (2019) Review of high-value food waste and food residues biorefineries with focus on unavoidable wastes from processing. Resour Conserv Recycl 149:413–426. https://doi.org/10.1016/j.resconrec.2019.05.003

Tham WK, Lim WM, Vieceli J (2022) Foundations of consumption and production in the sharing economy. Electron Commer Res, 1–24.

Tolstykh T, Shmeleva N, Gamidullaeva L (2020) Evaluation of circular and integration potentials of innovation ecosystems for industrial sustainability. Sustainability 12(11):4574

Tóth G, Zachár J (2021) Towards food justice–the global-economic material balance analysis of hunger, food security and waste. Agronomy 11(7):1324

Tranfield D, Denyer D, Smart P (2003) Towards a methodology for developing evidence-informed management knowledge by means of systematic review. Br J Manag 14(3):207–222. https://doi.org/10.1111/1467-8551.00375

Van Zanten HHE, Herrero M, Van Hal O, Röös E, Muller A, Garnett T, Gerber PJ, Schader C, De Boer IJM (2018) Defining a land boundary for sustainable livestock consumption. Glob Chang Biol 24(9):4185–4194. https://doi.org/10.1111/gcb.14321

Wilke U, Schlaile MP, Urmetzer S, Mueller M, Bogner K, Pyka A (2021) Time to say 'good buy'to the passive consumer? A conceptual review of the consumer in the bioeconomy. J Agric Environ Ethics 34(4):20