Evolution and Trends in the Circular Economy: A Meta-Analysis from 2018 to 2024

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Abstract: The purpose of this work was to carry out a meta-analysis of research focused on the circular economy, to identify its evolution and trends in the period between 2018 and 2024. The systematic review method was used for the analysis, and in the coding, data extraction and results were using the Dimensions.ai platforms. (Digital Science) and Lens.org., each investigation was evaluated according to the quality standards of the PRISMA declaration; relevant studies were included in the review for discussion, provided they met the inclusion and exclusion criteria. More than 874,700 studies were identified, between grey literature and scientific articles, of which only 27 publications were included, representing the most essential of the systematic review. Between 2018 and 2024 there was a significant exponential growth of research in the circular economy, concentrated in a few countries, institutions, and disciplines; Spain, Italy, and the United Kingdom lead in research. Areas where the circular economy is addressed: materials sciences, environmental sciences, and food sciences, among others. Finally, based on the meta-analysis of the last seven years, the circular economy presents an evolution and trends in the following topics: urban development, climate change, resource management, environmental processes, sustainability, corporate social responsibility, social entrepreneurship, green infrastructure, smart cities, and resilience.

Keywords: circular economy, meta-analysis, knowledge management, sustainability.

Introduction

The circular economy emerges as an alternative paradigm in response to global sustainability challenges, proposing a transition from the linear economic model characterized by the "extract, use, and dispose" cycle towards a system that optimizes resource reuse and recycling. This approach is based on the premise of minimizing waste generation and maximizing resource efficiency through the implementation of reuse, repair, renewal, and recycling processes within production cycles. Specialized literature identifies this model as crucial for promoting sustainable production and consumption practices, contributing to economic development without compromising the regenerative capacity of natural systems (Velenturf *et al*., 2019; Momete, 2020; Robaina *et al*., 2020; Stanković *et al*., 2021).

Key indicators for assessing the implementation of the circular economy include, but are not limited to, per capita waste generation, waste intensity in the economy, recycling rates for different categories of waste, and the degree of incorporation of recycled materials into new products. These indicators allow for the quantification of progress towards achieving production and consumption systems that align with sustainability principles and resource use efficiency. Additionally, the circular economy approach emphasizes the importance of valuing ecosystem services and promoting renewable energy use, thus contributing to climate change mitigation and greenhouse gas emission reduction (Buchmann & Beazley, 2020; Ayçin & Kayapinar, 2021; Cui & Zhang, 2022; Banjerdpaiboon & Limleamthong, 2023).

Literature identifies various barriers to transitioning towards the circular economy, among which the lack of information and awareness, the persistence of economic models based on unsustainable practices, and the absence of adequate incentives for adopting circular practices stand out. Circular business models are essential for overcoming these barriers, showing a positive correlation between corporate environmental responsibility and the adoption of circular practices. The circular economy requires efficient and sustainable management of natural resources, including food production, water, carbon, and nitrogen management, as well as the provision of minerals and fossil fuels (Breure *et al*., 2018; Lawrenz *et al*., 2021; Bîrgovan *et al*., 2022; De Angelis, 2022).

The growing interest in the circular economy, both in the academic field and the professional sector, reflects its potential to facilitate a decoupling between economic growth and environmental impact. Environmental regulations play a key role in this context, promoting practices that align business performance with sustainability objectives. Comparatively, the circular economy presents solutions to the inherent contradiction between social development and

efficient resource use. Transportation infrastructure, for example, is a critical area where significant improvements can boost the implementation of the circular economy at an urban level (Kanojia & Visvanathan, 2021; Wang *et al*., 2023).

This work aims to conduct a meta-analysis of scientific literature focused on the circular economy, with the purpose of identifying trends and evolutions from 2018-2024. Through a systematic review, it seeks to synthesize the current state of knowledge in this field, establishing future research priorities and encouraging the development of new theories and research methodologies. Integrating results from previous studies using advanced statistical techniques generates relevant insights for academia and professional practice, thus contributing to the consolidation of the circular economy as an area of growing research importance (Villasís *et al*., 2020; Page *et al*., 2021). This methodological approach ensures a comprehensive understanding of the circular economy, highlighting its relevance to global sustainability and economic development.

Materials and Methods

To analyze the current state of knowledge on circular economy research, a systematic literature review was conducted, followed by a meta-analysis. This method involves reviewing, analyzing, and interpreting existing literature to locate, assess, and synthesize available evidence related to a specific research field (Linares *et al*., 2018). The systematic review entails an ordered and explicit evaluation of the literature, accompanied by a critical analysis using various tools and a qualitative summary of the evidence (Tawfik *et al*., 2019). It is particularly useful when the body of literature has not been exhaustively reviewed or exhibits a complex or heterogeneous nature amenable to review (Muka *et al*., 2019), as is the case with the evolution of the circular economy.

Accordingly, based on the ideas previously presented, this work set the following specific objectives: a) Locate impactful and prestigious documents in the field of the circular economy; b) Analyze the evolution of research focused on the circular economy. From this, the following research questions were derived: Which countries publish the most in the circular economy field? What are the research fields of the circular economy? What themes have circular economy research significantly influenced in the last seven years? And how many studies based on the “circular economy” theme have been published in the last 7 years? The period selected for this study, was chosen to capture the most recent and significant trends in the circular economy, ensuring a contemporary and relevant analysis of its growth and evolution. This timeframe coincides with the implementation of crucial policies and technological advancements that have had a profound impact on the adoption and development of circular economy practices globally. During these years, there was an acceleration in the enactment of laws and regulations that favor the reuse and recycling of resources, as well as the emergence of new technologies that facilitate these processes, aspects that are fundamental to understanding the current and future dynamics of the field. To address these questions, the work follows the methodological guidelines for a systematic literature review (Rubio *et al*., 2018). For this purpose, the quality standards of the PRISMA declaration were employed, which generally consist of identifying the research subjects, conducting exhaustive searches, selecting studies; reviewing and extracting data; generating inclusion criteria to assess the quality of the studies, analyzing, and synthesizing the data; and including, presenting, and discussing the results of the studies (Yepes *et al*., 2021).

Data collection was carried out in April 2024. Document tracking was performed in the scientific databases Dimensions and Lens.org, chosen for their efficient search engines, the volume and quality of stored information, the richness of metadata, and the ease of file downloading (Bestwick *et al*., 2022). Moreover, for a meaningful systematic review, it is essential to use effective global scientific literature databases (Donato & Donato, 2019; Siddaway *et al*., 2019). The search strategy was limited to “theme” specifically in the document title. The search term was validated with the ERIC thesaurus (Education Resources Information Center), which is an information system of the United Nations Food and Agriculture Organization (FAO) and essentially a searcher with a list of terms representing research themes in the field of education. In this sense, the key indexing terms were the words: “circular economy,” used with the intention of integrating a global vision of the research that has been conducted on this topic.

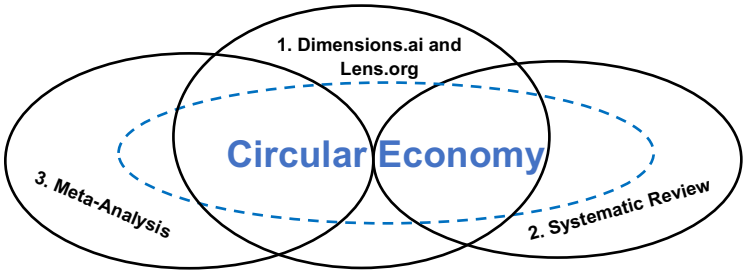

Figure 1. Model of the analysis method focused on circular economy research.

Inclusion and Exclusion Criteria

The search was restricted by document type: scientific articles and filtered by keyword matches only in the title. That is, searches in keywords, abstracts, or any other part of the document were not considered. This approach aimed to achieve greater precision and effectiveness in selecting articles related to the specific research topic. All forms of grey literature were excluded, namely: pre- and postgraduate theses, conference proceedings, research reports, memorandums, projects, patents, standards, scientific translations, documents from scientific societies, newsletters, workbooks, technical reports, software programs, autobiographies, offprints, weblogs, product and service catalogs from companies, dossiers, posters, surveys, and other documents outside of books and serial journals.

Regarding publication time, the restriction was limited to the years within the period 2018 – 2024, the selection of a seven-year period for this study focuses on capturing the most recent and emerging trends in the circular economy. This interval is critical, given the rapid evolution of relevant policies and technologies that could make previous data inadequately reflect current challenges and practices. During this time, significant policies and regulations have been implemented globally that have influenced the adoption of circular economy practices, allowing for a detailed analysis of the direct impact of these policies on the adoption of sustainable practices and on the research trajectory in this field. Additionally, substantial technological advancements have been observed that have facilitated or improved the implementation of circular practices. These advancements include improvements in recycling, biotechnologies, and information and communication technologies that optimize reverse logistics and efficient resource management. Studying this period enables a deep understanding of how these innovations have been integrated and adapted in practice. Limiting the analysis to the last seven years also allows for more effective management of the growing volume of literature, ensuring that the findings are relevant and applicable to contemporary practices and future projections in the circular economy. This approach provides researchers and policymakers with immediate feedback on the effectiveness of interventions, allowing for the adjustment of strategies in a dynamic and evidence-based manner.

Furthermore, the type of publication source was limited to "Article" only. There were no restrictions on language, country of origin, and discipline or thematic area; the aim was to analyze as many research studies related to the topic of interest as possible. A preliminary review of the articles was then conducted to include only those research that consider the circular economy as the main theme.

Data Coding and Extraction

The results obtained from the scientific database Dimensions.ai (Digital Science) were processed, and information was identified that allowed for the analysis of statistical data from 2018 to 2024, research categories based on the Standard Research Classification of Australia and New Zealand (ANZSRC), leading researchers, and origin titles (name, publications, citations, significance, and median). VOSviewer version 1.6.20 software was used to generate, group, and visualize networks (Van & Waltman, 2020). VOSviewer allows for the visualization of existing clusters related to co-authorships, citations, occurrences of title words, and keywords, enabling specialized analysis (Cruz *et al*., 2020). These clusters were identified as groups with similar disciplinary interests according to the field of the circular economy.

Once the selection of articles was completed, the different clusters were analyzed in relation to their research and main arguments. In addition to the mentioned data, the potential risk of bias in the articles was assessed, as the conclusion of any literature meta-analysis will be valid if, and only if, the primary studies it comprises are reliable (Moreno *et al*., 2018). Finally, an analysis of the main characteristics and findings of the scientific fields was conducted, aiming to precisely identify certain knowledge gaps and research lines that the field or area of knowledge presents (Vargas *et al*., 2022).

Table 1. Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Publication Type: Article	Conference proceedings, books, book chapters, theses, monographs, among others.
Publications from 2018 to 2024	Publications outside the specified period
Open Access Publications (Hybrid)	Open access publications type: gold, closed, green, and bronze.
Field of Research: Economics	Other research fields.
Sustainable Development Goal: Sustainable Cities and Communities	Duplicate articles.

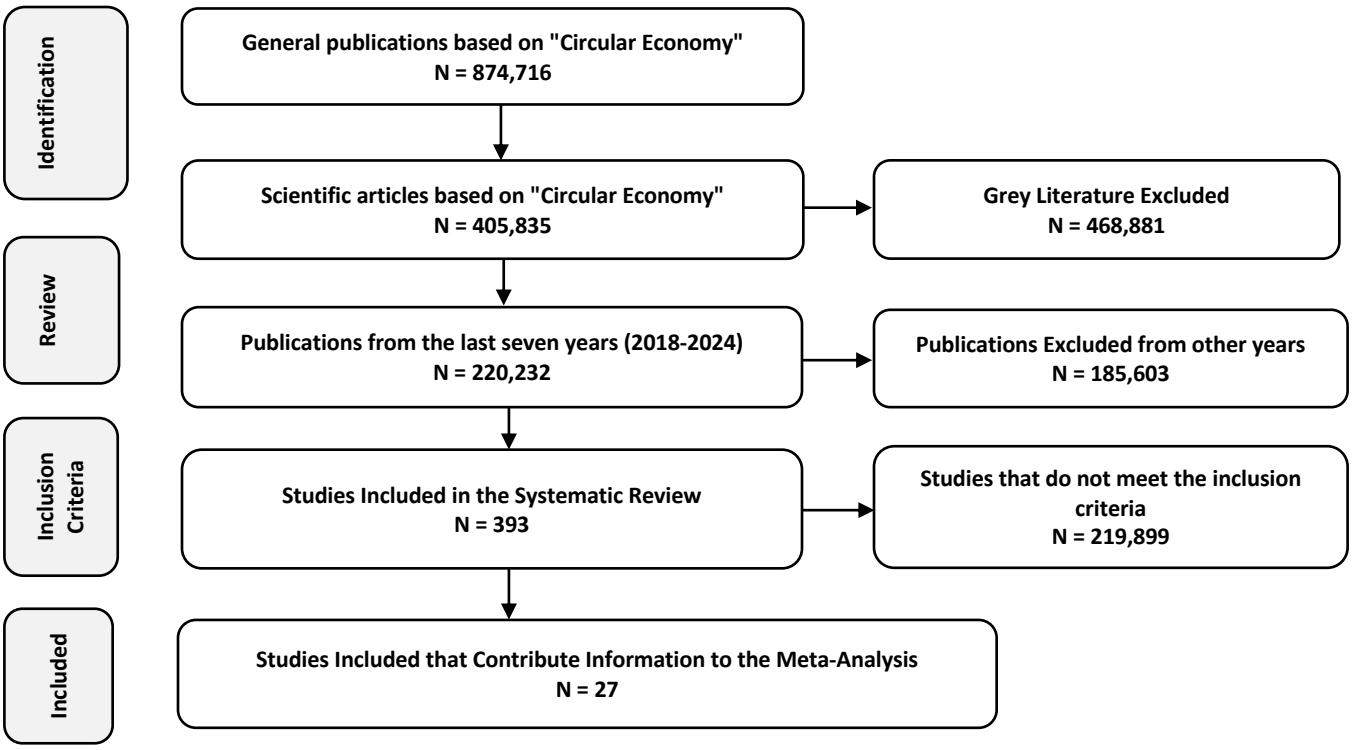

Figure 2. Flow diagram according to the PRISMA statement.

Results and Discussion

A total of 874,716 documents, including articles, books, chapters, conferences, reviews, letters, and notes related to the study object, were found. However, with the application of all inclusion and exclusion criteria, the articles selected for this research were gradually reduced to twenty-seven. It is possible to observe a period of approximately seven years (timeline 2018 - 2024) for the development of research in circular economy, and year by year there was an

exponential increase in scientific articles. Figure 3 illustrates this growth, highlighting the increasing volume and scope of scientific articles annually.

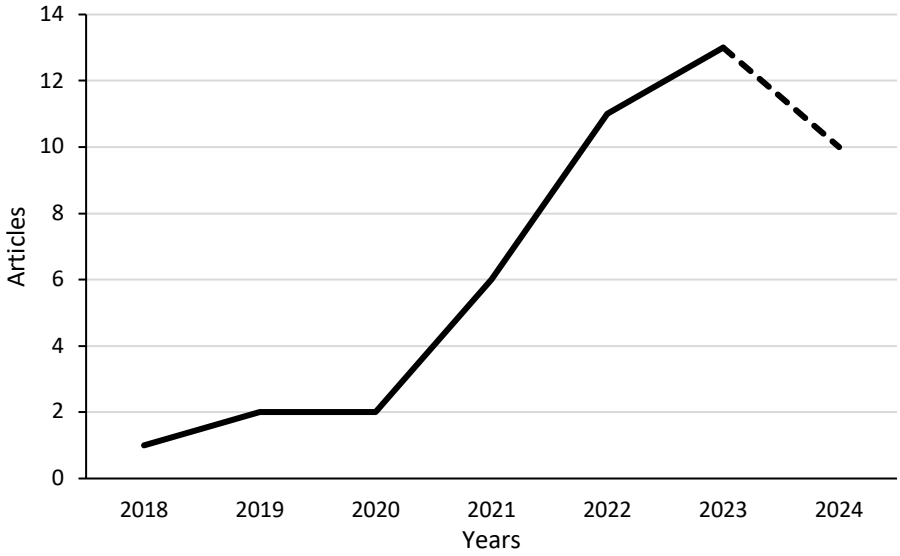

Figure 3. Origin and evolution of research in Circular Economy.

To better understand the dynamics and advancements in the field of circular economy, it is crucial to identify the most influential and active knowledge sources. Figure 4 features a word cloud that highlights the academic journals which frequently publish research on this topic. This visualization not only reflects the diversity and richness of current discussions but also serves as a guide for researchers and professionals looking to deepen their knowledge of the specialized literature. The journals are selected based on their significant contributions to the development and understanding of the circular economy, providing a snapshot of the key platforms for dissemination and academic debate in this crucial area.

Figure 4. Main academic journals with publications on Circular Economy.

The countries leading the research related to circular economy are Spain, Italy, and the United Kingdom. However, there is a group of countries showing good dynamics, including the United States, China, and Germany. It is important to note the emergence of a third group comprising the Netherlands, Poland, and Portugal, which have more recently joined the research efforts.

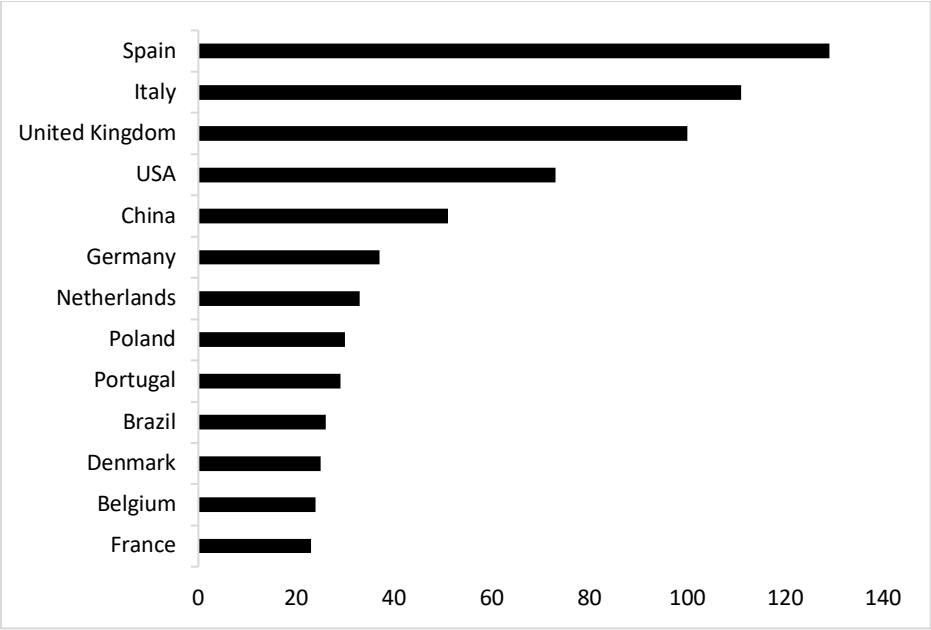

Figure 5. Leading countries in Circular Economy research.

As for the thematic areas where this type of research is carried out, there are notable studies in: chemistry, materials science, raw materials, environmental sciences, food sciences, polymers, process engineering, and to a lesser extent, other fields.

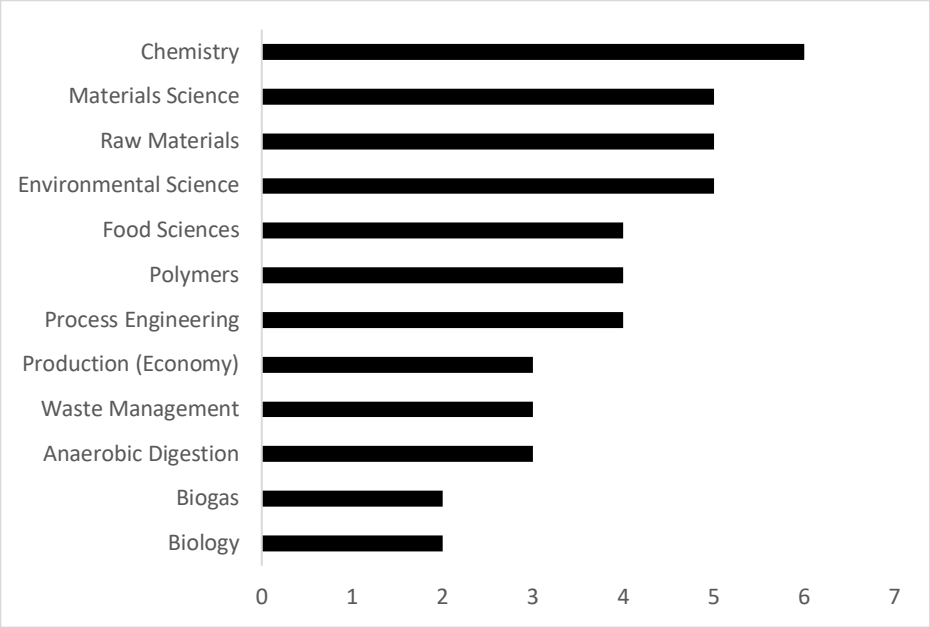

Figure 6. Leading fields of study in Circular Economy.

Furthermore, in the evolution and trends of research on circular economy, formations of various groups of researchers collaborating with each other are observed. In this sense, their investigations cover a wide range of topics from social innovation, bioeconomy, forestry policy, economic efficiency, forestry value chains, environmental impact, organic agriculture, among others. Below is a network with the names of the leading most-cited researchers worldwide in the field of circular economy.

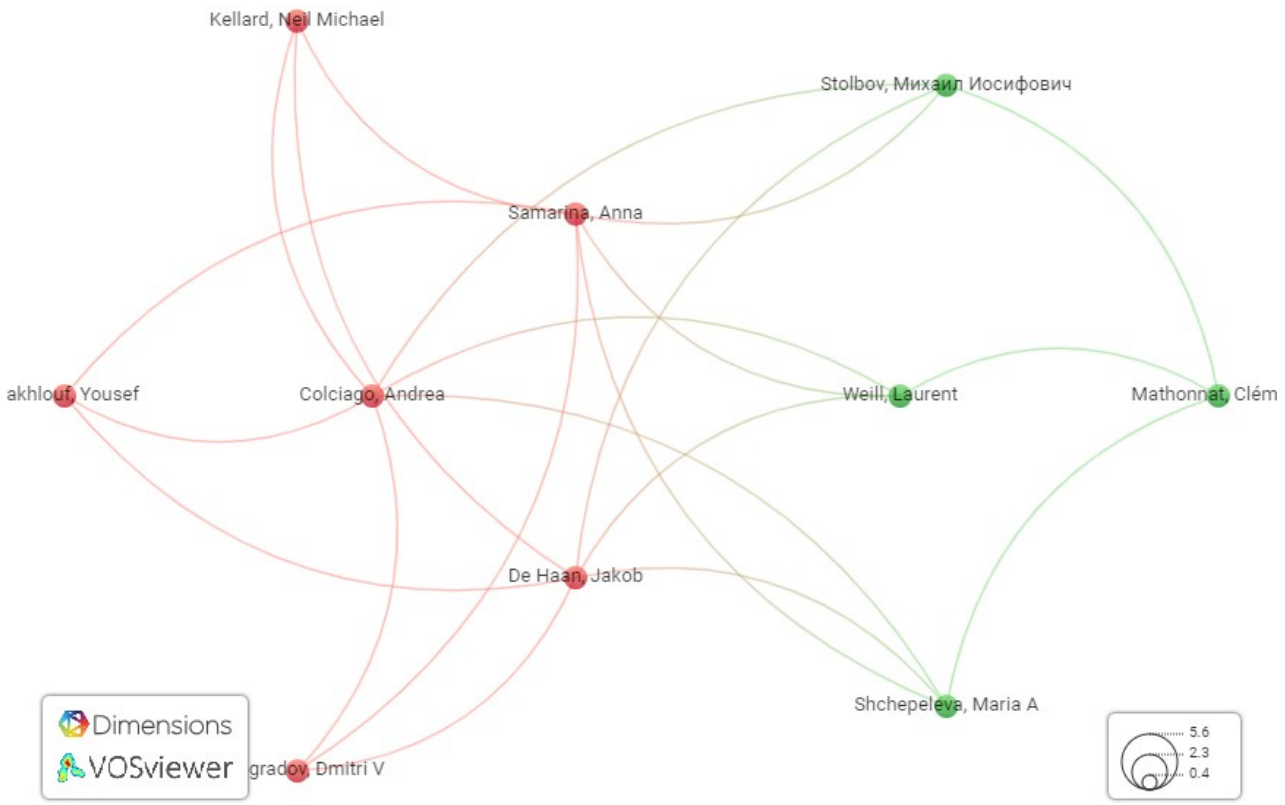

Figure 7. Most cited researchers in Circular Economy.

Table 2 presents a summary of twenty-seven studies included, following the application of the PRISMA declaration quality standards.

According to Table 2, studies conducted in the field of the circular economy range from urban development, climate change, resource management, fishing community strategies, environmental processes, sustainability, corporate social responsibility, social entrepreneurship, green infrastructure, smart cities, to resilience.

Finally, an analysis of the policies, actions, results, and achievements of countries at the forefront of the circular economy is presented.

The study of circular economy practices reveals a significant emphasis on waste management dynamics and material recycling, highlighting a shift from linear economic models to more regenerative circular approaches. This shift is evident in the evolution of policies and innovations discussed in various countries and industries (Bakhshoodeh & Santos, 2022). Firstly, the integration of circular economy principles has led to new business models that emphasize resource efficiency and waste reduction. For example, advancements in sustainable production methods have demonstrated substantial benefits in reducing the environmental footprint of industries, particularly in countries leading in circular economy research such as Spain, Italy, and the United Kingdom. These nations have developed robust frameworks and policies that not only promote recycling and waste management but also encourage the adoption of circular practices across multiple sectors. Secondly, the fundamental role of technological innovations in facilitating the transition to a circular economy is highlighted. The adoption of technologies such as biotechnologies for material recovery and information systems for monitoring resource flows has enhanced the efficiency of circular processes. These technologies aid in the effective implementation of circular practices by allowing more precise tracking of materials, improved waste segregation, and enhanced lifecycle assessments of products and services.

Table 2. Studies with Impacts in the Field of Circular Economy.

Authors	Studies	Impacts in the Circular Economy
Heeren & Hellweg (2019)	Building Material Tracking in Space and Time: Prospective and Georeferenced Modelling of Building Stocks and Construction Material Flows	Investigation of six scenarios with different assumptions related to per capita floor area, building stock turnover, and building material.
Bugge *et al.*, (2019)	Governance for System Optimization and Change: The Case of Urban Waste	Analysis of urban waste systems to explore how local authorities can address challenges related to climate change, urbanization, and resource depletion.
Kadfak (2020)	More Than Just Fishing: Livelihood Strategy Formation in an-Urban Fishing Community in Mangaluru, India	Analysis of the livelihood strategies of fishermen and youth in an urban fishing community in India.
Drangert (2021)	Urban Water and Food Security in This Century and Beyond: Resource-Smart Cities and Residents	Reduced use of hazardous chemicals in consumer products facilitates treatment to a quality that allows for water and nutrient reuse/recycling.
Savini (2021)	The Circular Economy of Waste: Recovery, Incineration and Urban Reuse	Analysis of how the political economy of waste utilities is changing in response to circular economy programs.
Benabderrazik *et al.,* (2022)	Climate Resilience and Human-Water Dynamics. The Case of Tomato Production in Morocco	Description of the interactions of environmental and socio-economic processes that influence the livelihoods of farmers involved in tomato production in Morocco.
Olena & Olena, (2022)	Urban Metabolism as Background for the Development of Circular Cities in Ukraine	Investigation of the sustainability of Ukrainian cities from the perspective of the urban metabolism model.
Malkamäki *et al.,* (2022)	Public Perceptions on the Use of Forests to Drive the European Bioeconomy: Findings from Eight University Cities	Identification of five communities across six dimensions, ranging from biocentrism to distributive aspects and adherence to political goals.
Arbués & Villanúa (2022)	Why Do Spanish Households Separate Their Electronic Waste for Proper Disposal? An Econometric Analysis	Methodology for the management of electronic waste.
Huo *et al.,* (2022)	Modeling the Impact of Corporate Social Responsibility on Sustainable Purchase Intentions: Insights into Trust and Brand Loyalty	Study of the role of corporate social responsibility in improving sustainable purchase intentions.
Qing *et al.,* (2022)	The Research of Sustainable Environmental Performance of Manufacturing Firms: Mediating Role of Organizational Support and Moderating Role of CSR	Investigation of the impact of green entrepreneurial orientation, social entrepreneurship, and organizational ambidexterity on sustainable environmental performance.
Niskanen & Rohracher (2022)	A Policy of Calculation: Negotiating Pathways towards Zero-Energy Buildings in Sweden	Analysis of the implementation of the European Energy Performance of Buildings Directive in Swedish legislation.
Jnr & Petersen (2022)	Validation of an Enterprise Architecture Framework Developed for Smart City Digitalization: A Mixed-Mode Approach	Presentation of an Enterprise Architecture Framework to facilitate the digitization of urban environments.
Ye *et al.,* (2022)	The Impact of Corporate Social Responsibility on the Sustainable Financial Performance of Italian Firms: The Mediating Role of Corporate Reputation	Study of the impact of corporate social responsibility dimensions (employee, customer, community, and environment) on the sustainable business performance of the manufacturing industry.

Table 2 Continued. Studies with Impacts in the Field of Circular Economy.

Authors	Studies	Impacts in the Circular Economy
Jun *et al.,* (2022)	Green Infrastructure: A Systematic Literature Review	References on green infrastructure for sustainable environmental development.
Kourtit (2022)	Quantitative Performance Evaluation of Asian Star Cities Using a DEA Cascade System: An Interpretation of Capability	Presentation of an operational comparative framework for judging the complex performance of urban agglomerations in Asia.
Angelidou *et al.,* (2022)	Emerging Trends of Smart Cities, Transport and Energy in Urban Environments: Results of a Pan-European Foresight Exercise with 120 Experts	Study of the evolution of the fields of smart cities, smart transport, and smart energy to 2030 from a scientific and technological perspective, to inform future policies for urban development in Europe.
Virág *et al.,* (2022)	How Much Infrastructure Is Needed to Support Decent Mobility for All? An Exploratory Assessment	Exploration of the relationships between levels of mobility, mobility infrastructure, and well-being.
Dai *et al.,* (2022)	Influence of CSR and Leadership Style on Sustainable Performance: Moderating Impact of Sustainable Entrepreneurship and Mediating Role of Organizational Commitment	Analysis of the impact of corporate social responsibility, transactional and transformational leadership.
Nielsen & Havbro (2022)	Towards a Theoretical Information Ontology on Risk, Resilience and Sustainability and an Outline for Education - Part II	Study on Risk, Resilience and Sustainability and an Outline for Education.
Nguyen *et at.*, (2022)	Living Labs: Challenging and Changing Power Relations in Smart Cities?	Identifying Power Imbalances Between Citizens, Other Organizational Actors, and Smart Cities.
Papamichael *et al.,* (2023).	Metaverse and circular economy.	The Metaverse and circular economy merger aims to redefine sustainable growth by enhancing resource management and innovation.
Kumar *et al.,* (2023).	Green finance in circular economy: a literature review.	Green financing promotes the circular economy, overcoming legal obstacles and promoting investments that reduce emissions and optimize resources.
Voukkali *et al.,* (2023)	Waste metrics in the framework of circular economy.	The implementation and monitoring of circular business models enhances sustainability and efficiency, optimizing resources and reducing waste.
Vranjanac *et al.,* (2023).	Modeling circular economy innovation and performance indicators in European Union countries.	Innovation in the circular economy is important to improve its performance in the EU and promote a transition towards a more sustainable economic model in the use of resources.
Rim *et al.,* (2024).	Recycling Law for the Promotion of the Circular Economy and its Characteristics in the Democratic People's Republic of Korea	The Recycling Law in North Korea emphasizes enhancing the circular economy via a comprehensive legal framework, setting a precedent for other nations.
Alnoor *et al.,* (2024)	Benchmarking circular economy behaviors for Iraqi energy companies based on modes of interaction with green technology and environmental, social and governance rating.	Interaction with green technology and ESG ratings is essential for promoting the circular economy in energy companies, improving resource management, and reducing gas emissions.

Table 3. Comparative Analysis of Leading Countries in the Circular Economy.

Countries	Policies	Actions	Results and Achievements
Spain	Circular Economy Action Plan: In 2018, Spain presented its Circular Economy Action Plan, which established a series of points to drive the transition towards a circular economy. This plan included specific targets for waste reduction and promoting reuse and recycling. Law on Waste and Contaminated Soils: In 2020, a new Law on Waste and Contaminated Soils was approved that included provisions to promote the Circular Economy, such as the prohibition of the destruction of unsold stocks and the promotion of reuse.	Expansion of Selective Collection: Selective collection systems have been implemented in many regions of Spain to increase the collection of recyclable materials such as paper, cardboard, glass, and plastic. Promoting the Circular Economy in the Construction Sector: The reuse of construction materials and sustainable management of construction waste are promoted. Investment in Research and Development: Funds have been allocated for the research and development of technologies and processes that promote the Circular Economy, such as eco-innovation and eco-design of products.	Spain has made significant progress in waste recycling, with increasing recycling rates for paper, cardboard, glass, and plastic packaging. The reuse and repair of products has also gained momentum, with the emergence of companies and projects dedicated to the collaborative economy and extending the life of products. Public-private partnerships have been established to promote the Circular Economy in sectors such as fashion, electronics, and food.
Italy	National Circular Economy Plan (Piano Nazionale della Transizione Circolare): Italy adopted a specific national plan for the Circular Economy, with concrete objectives and actions to promote the transition towards a more circular economy. Circular Economy Law (Legge Circolarità): Italy has introduced laws and regulations to drive the Circular Economy, including waste reduction and promoting recycling and reuse.	Promoting Recycling and Waste Management: Italy has established selective collection systems in many regions to increase the separation of recyclable waste, including paper, cardboard, glass, and plastic. Investment in Research and Development: Italy invests in research and development of innovative technologies and solutions to promote the Circular Economy. This includes research on eco-innovation, sustainable design and promoting sustainable production and consumption.	Italy has made progress in waste recycling, with constantly increasing recycling rates for a variety of materials. Circular Economy projects have been established in different sectors, such as sustainable fashion, e-waste management and the promotion of reusable products and services. Public-private partnerships and training programs have been created to foster the Circular Economy among businesses and the public.
United Kingdom	*Resources and Waste Strategy: The UK has launched a comprehensive resources and waste strategy that sets out specific targets and actions to move towards a more circular economy. This strategy includes promoting recycling, reducing waste, and tackling plastic pollution.* *Single-Use Plastics Tax: The government has introduced a tax on single-use plastic packaging to encourage the reduction and recycling of plastics.*	Promoting Recycling and Waste Management: The UK has set ambitious targets to increase recycling rates and reduce the amount of waste sent to landfill. Selective collection programs and investment in advanced recycling facilities are promoted to improve waste management. Investment in Research and Development: Funds are allocated for the research and development of technologies and processes that promote the Circular Economy, including innovation in sustainable product design.	The UK has made significant progress in waste recycling, with constantly increasing rates for a variety of materials, including paper, cardboard, glass, and packaging. Incentive programs and public-private collaborations have been established to encourage the reuse and repair of products. The sustainable fashion sector was growing, with a greater emphasis on circularity in fashion and promoting the purchase of second-hand clothing. Initiatives have been launched to address the sustainable management of e-waste and reduce food waste.

Moreover, the discussion in academic circles, as addressed in the bibliometric analysis by Marín *et al*., (2023), points to an increasingly recognized need for interdisciplinary approaches to tackle the complex challenges of the circular economy. This includes combining knowledge from environmental sciences, engineering, and economics to devise solutions that are not only technologically viable but also economically and socially sustainable. Furthermore, the focus on urban development and infrastructure in the context of the circular economy indicates an important area for future research and policy formulation. As urban areas continue to grow, implementing circular principles at the city level becomes increasingly crucial. This involves designing urban spaces and infrastructures that support sustainable living and resource efficiency, from buildings and transportation to water and waste management systems (Santos & Bakhshoodeh, 2021).

Additionally, the involvement of various social stakeholders and policy frameworks that support circular economy practices is crucial. Effective legislation, public-private partnerships, and community engagement are vital for the widespread adoption of circular practices. These elements ensure that the benefits of circular economy models are maximized, leading to more sustainable economic growth and environmental protection. In summary, the circular economy represents a transformative approach that challenges traditional economic models and offers a pathway to sustainable development. Although significant progress has been made, ongoing efforts in policy, innovation, and collaboration are essential to fully leverage the potential of practices in terms of circular economy.

Conclusions

Over the past seven years, the study of the circular economy has demonstrated significant exponential growth, with research primarily focused on a few countries and disciplines. Despite this geographical and academic concentration, the global implications of these studies are vast and diverse.

Policies and Regulatory Framework: Spain, Italy, and the United Kingdom have adopted specific strategies and laws to foster the circular economy, setting clear targets for waste reduction and the promotion of recycling and reuse. It is crucial that future policies focus on integrating environmental performance indicators that effectively measure the real impact of circular practices on environmental sustainability.

Recycling and Waste Management: Investment in selective collection systems and improvements in waste management have resulted in increased recycling rates and a reduction in the amount of waste sent to landfills. The results suggest that integrating advanced and innovative technologies could further enhance these systems.

Investment in Research and Development: The three countries have demonstrated a robust commitment to the research and development of technologies that support the transition to a more circular economy. International collaboration and knowledge exchange could accelerate the development of global sustainable solutions.

Achievements and Results: Advances in recycling and the promotion of reuse are evident, with emerging initiatives in sectors such as sustainable fashion, electronic waste management, and food waste reduction. For future research, it would be beneficial to focus on analyzing the long-term effectiveness of these initiatives in reducing the environmental footprint.

Public-Private Collaboration: Partnerships between the government, industry, and civil society have been crucial to the success of circular economy policies. It is recommended to strengthen these collaborations and explore new strategic alliances that include additional stakeholders such as NGOs and local communities.

Recommendations for Future Policies: For more effective implementation of the circular economy, it is recommended that future policies incorporate clear and accessible incentives for small and medium-sized enterprises, and that more innovation centers be established to function as incubators for circular technologies.

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