

## CIRCULAR ECONOMY IN ROMANIA – A BIBLIOMETRIC ANALYSIS

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### Abstract

*Waste management is a priority at the level of the European Union, but also globally. Thus, the emphasis is on the transition from the current economic model to a sustainable one, that of the circular economy. In this context, this paper aims to carry out a bibliometric analysis on the topic of the circular economy in Romania, based on some papers published in the period 2014-2023. An analysis of the scientific literature was carried out in the Web of Science database, and the results were processed using VOSviewer. Based on the collected documents, the number of papers, types of scientific publications, journals and the most used keywords were identified. A total of 197 documents with the phrase "circular economy" in the title were identified, with a total of 895 keywords. It was found that the terms with the highest frequency are: circular economy, sustainability, recycling, sustainable development and waste. These terms were grouped into 13 clusters. The specialized literature shows that research is still focused on the topic of the circular economy.*

**Keywords:** *Circularity, waste, sustainable development, bibliometric analysis.*

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### Introduction

The circular economy is an economic model desired by the European Union to replace the traditional linear model, with the aim of achieving a more competitive economy, which would lead to a sustainable model by reducing the generation of waste and encouraging recycling. This model of sustainable production and consumption avoids the depletion of natural resources. The traditional model implies a limited lifetime of the products, compared to the current circular model, which involves reducing the materials used in production, reconditioning the product and extending its life cycle by keeping the products until the end of their life or reusing them. In this way, the amount of waste will be reduced.

The European Union's waste policy and the European Green Deal support the transition to a competitive circular economy by extracting good resources from waste and managing it efficiently. The legal basis of the European Union for the treatment and management of waste is the Waste Framework Directive, which also includes the concept of the waste hierarchy, with 5 levels: prevention of waste generation (as the first option), preparation for reuse, recycling, recovery and disposal (as last option). Contrary to the economic model promoted lately, the generation of municipal waste has registered an increasing trend. This was due to the increase in the consumption of goods from EU member countries. At the same time, the recycling rate was lower.

In recent years, interest in circular economy research has grown. Therefore, a comprehensive and quantitative review of the literature is needed to understand its progress and current status, to highlight significant research for this field. The purpose of the research is the analysis of publications about circular waste in order to have an overview of publications related to this field. The paper summarizes and analyzes circular economy publications from

2014 to October 2023 to identify current key research topics and development trends. The bibliometric analysis software VOSviewer was used to analyze 197 documents written by 662 authors and published in 44 sources retrieved from Web of Science (WoS).

### **1. Literature review**

Environmental problems are a global concern, being determined by the rapid evolution of technology, industrialization, urbanization and population expansion. Thus, as a result of the production activities, the excessive use of natural resources and the current consumption patterns, the quantities of waste are increasing (Reis et al., 2023). The importance of addressing this topic is due to the increased awareness of the depletion of natural resources and environmental changes. In this sense, waste management represents a great danger both for our environment and for future generations and is one of the most important environmental problems of our time (Yalçıntaş et al., 2023). Sustainability has become an area of great interest not only for decision makers but also for researchers to examine the concept of green economy, emphasizing sustainable development (Ellili, 2023).

European legislation sets objectives for recycling and reducing the amount of waste generated, and failure to meet them entails significant financial penalties, which is why more and more emphasis is placed on the circular economy (Marica, 2022).

In open systems, waste is transformed back into materials and objects through recycling, and therefore a linear economy is transformed into a circular economy (CE). Environmental factors support the argument for the sustainable implementation of a circular economy (Busu & Trica, 2019). The circular economy has emerged as a viable alternative to address the problems caused by increased consumption, including solid waste (Reis et al., 2023). Solid waste management is essential for maintaining the balance of ecological cycles that sustain life on Earth (Abdullah, 2023). Solid waste management is crucial for minimizing waste production, encouraging recycling and reusing, and guaranteeing appropriate disposal of hazardous substances (Olukanni et al., 2018).

The concept of circular economy is contemporary in the context of satisfying human needs, which are constantly growing and diversifying and which involve an ever-increasing consumption of resources. Therefore, at a global level, there is an increasing concern about the insufficiency of natural resources and the impact of their use on the environment, which is why it is recommended to identify effective management solutions. Thus, the need to transition from the take-make-consume-throw model of the linear economy to the 4 R model (reduce-reuse-recycle-redesign) is highlighted - specific to the circular economy in which products, at the end of their life cycle, continue to generate value through their component materials, which are maintained in the economy as long as possible through recycling and reuse (Dobre-Baron et al., 2022).

Research conducted within various disciplines has begun to adopt bibliometric analysis. By rigorously interpreting large amounts of unstructured data, bibliometric analysis helps to decipher and map the cumulative scientific knowledge and evolutionary nuances of established areas (Nurdini et al., 2023). The bibliometric performance analysis comprises descriptive matrices related to scientific domain publication, citation, frequency and trends (Alzard et al., 2022).

Bibliometrics is a search method that involves the development of an inventory of publishing activity at country level and is used for comparative analyzes of productivity in the scientific field. The results can represent points of reference for scientific and technological concerns, since longitudinal studies of scientific interests contribute to the determination of developing or regressing research areas (Patarlageanu et al., 2020).

## 2. Materials and Methods

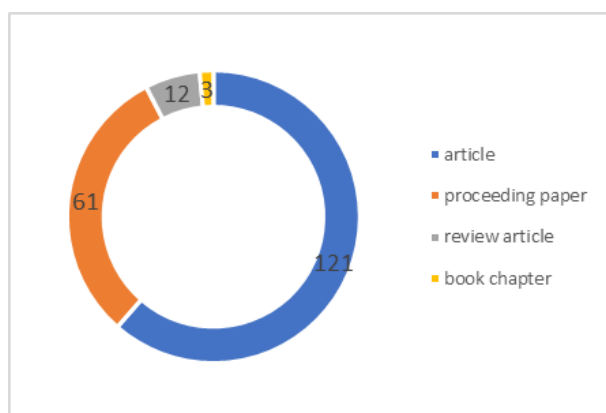
In order to achieve the aim of the research, bibliometric analysis was used as a method to investigate the state of research in the circular economy and waste management. By using this technique, the link between the number of documents published in the circular economy field and the frequency of citation of articles and the interest given to a certain theme/area of research was traced. Through the VOSviewer software, the data were presented graphically, through category maps. The data were collected from the Web of Science (WoS) database and a query was made for the term "circular economy", applying the filter only for Romania. Scientific mapping studies were conducted to examine the map of high-frequency terms and the description of the connections between them. In Romania, 197 documents related to the circular economy were published in the period 2014-2023 since in recent years, researchers have shown an increasing interest in waste circularity. Starting from the set of data and documents retrieved from WoS from 2014 to October 2023, this research uses descriptive analysis and bibliometric mapping techniques.

VOSviewer is a free program for creating and displaying bibliometric networks, which can be based on citations, bibliographic coupling, co-citations or author relationships. These networks may contain journals, research or individual publications. The entire bibliographic dataset was acquired in ".ciw" format from the WoS database.

In the term occurrence bubble map, the size of each bubble corresponds to the number of occurrences of the term, and the color of the bubble reflects the average number of citations received by papers that include that word. In the word co-occurrence network map, the node size reflects the number of occurrences for that term. The thickness of the lines connecting two terms reflects the degree of co-occurrences; if the line is thicker, the two terms occur together in more manuscripts (Bangau et al., 2023).

## 3. Results and discussions

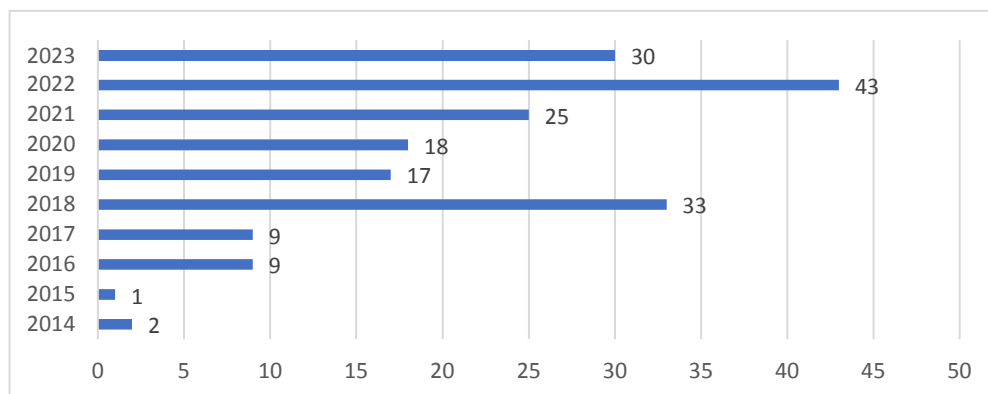
In Romania, 197 documents about the circular economy were published in the period 2014-2023. The collected documents are classified in Figure 1, to illustrate their types in the specialized literature. Of the total number of publications identified, 121 were articles, representing 61.42%. The second type of documents were the papers published in conferences, with a number of 61 papers, representing a percentage of 30.96%, and the third type of documents were 12 review articles with 6%. Three documents were published as book chapters.



**Figure 1. Types of documents published**

*Source: Web of Science*

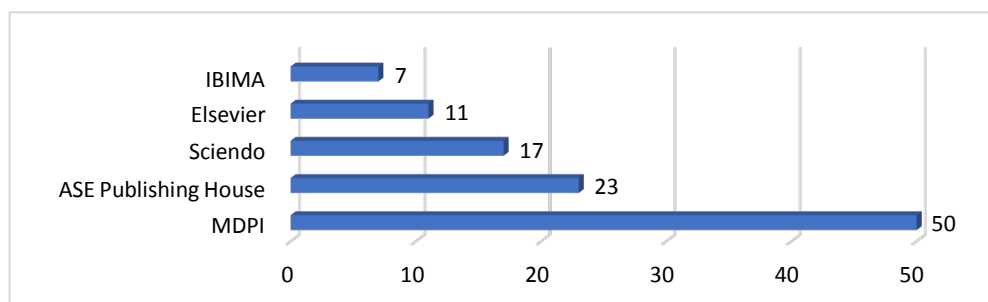
According to the study, a total of 662 authors contributed to the topic. The documents analyzed from 2014 to October 2023 contained in total 895 keywords, of which 161 words have a frequency of at least 2 occurrences. Regarding the number of articles published per year, it can be seen that the interest in this subject has gradually increased, reaching a maximum of 43 articles in 2022, but it must be taken into account that the analysis for the year 2023 includes only three trimesters (Figure 2.).



**Figure 2. Number of publications on circular economy published in 2014-2023**

*Source: Web of Science*

Figure 3 illustrates the first 5 publications where the selected articles from the analyzed period can be found. It is noted that the main contributor to publications in this field is MDPI (Sustainability), followed by ASE Publishing House (The Amfiteatru Economic Journal) and other publications.



**Figure 3. Top scientific publications for the documents analyzed**

*Source: Web of Science*

Regarding the words frequently used as keywords in circular economy research, according to table 1, the following can be found: "circular economy" occupies the first place with a percentage of 14% and 153 occurrences; "sustainability" being in second place with 3.5% having 32 appearances; "recycling" occupies the third place, with a frequency of 2.6% and 24 appearances; on the 4th place is "sustainable development" which has a frequency of 2.3% with 21 occurrences and the 5th word in the top frequency is "waste", with 19 occurrences which means 2.1% of the total.

**Table 1. Co-occurrence of words**

Words	Frequency of occurrence of the word	%
Circular economy	153	17
Sustainability	32	3.5
Recycling	24	2.6
Sustainable development	21	2.3
Waste	19	2.1

*Source: Web of Science*

Keywords represent the essence and summary of the critical points of a research article. Keyword analysis can help identify research hotspots, trends, topics and directions. This analysis can be performed across time slices to identify changes in direction in a particular research area (Alzard et al., 2022).

The result of the present study is divided into thirteen groups, represented by different colors. Cluster 1 (red) contains 22 keywords: awareness, collection, combustion, energy, energy recovery, environmental, framework, generation, household waste, improvement, index, model, msw, optimization, quality, resource recovery, resources, risk, strategies, sustainable development, systems, technology. In the second group, Cluster 2 (green) contains 19 keywords: barriers, business, business model innovation, challenges, circular economy, consumer behavior, eco-innovation, education, firms, frugal innovation, green economy, innovation, linear economy, moderating role, performance, sharing economy, social enterprise, supply chains, sustainable entrepreneurship. Cluster 3 (blue) contains 18 keywords: attitude, consumer behaviour, determinants, electrical and electronic equipment, electronic equipment, electromic waste, equipment, fly-ash, lessons, metals, poisson regression, products, pyrolysis, recovery, recycling behavior, repair, reuse, waste. Cluster 4 (yellow) includes 17 keywords: business models, circular material use rate, circularity indicators, cluster analysis, developing-countries, eu, indicators, mechanical-biological treatment, municipal solid-waste, path analysis, principles, questionnaire, rural areas, sustainable consumption, sustainable production, university, waste generation. Cluster 5 (Violet) contains 16 keywords: bioeconomy, biomass, CO2 emissions, cointegration, countries, economic growth, environmental assessment, Europe, granger causality, gross domestic product, growth, panel data analysis, panel-data, quantitative analysis, renewable energy, unit-root tests. Cluster 6 (turquoise) has 16 items: China, competitiveness, consumption, context, European union, impacts, industry, moderating effect, procurement, production, regression analysis, smart, strategy, supply chain, system, waste management. Cluster 7 (orange) contains 15 keywords: circular business model, digitalization, e-waste, energy efficiency, financial performance, impact, implementation, industry 4.0, internet of things, market, models, perspective, solid-waste management, supply chain management, sustainability. Cluster 8 (brown) includes 13 items: beta-carotene, corporate social responsibility, design, emissions, energy consumption, environmental impact, future, life-cycle assessment, lithium-ion batteries, management, resource productivity, technologies, transition. Cluster 9 (pink) includes 11 items: eco-design, efficiency, environmental protection, iasi, municipal waste, opportunities, plastics, recycle, Romania, secondary raw materials, tool. Cluster 10 (coral pink) includes 8 items: cities, drivers, electrical and electronic equipment, environment, green, policy, public procurement, resources use. Cluster 11 (pale green) contains 4 items: artificial intelligence, chatbots, recycling, software. Cluster





includes notions related to waste, recycling, and sustainable development. The analysis of scientific output revealed that the circular economy research area is growing year by year. Regarding the limitations of the study, the scope of the present study is limited to the WoS database thus, some publications may be omitted. In order to have an overall picture of the publications related to waste circularity, data can be retrieved from other databases also. In addition, the analysis can be extended, as it only covers the state of research in the field of circular waste in Romania over a certain period of time and future research can focus on a longer period of time or even an analysis at European or global level.

## References

1. Alzard MH, El-Hassan H, El-Maaddawy T, Alsalami M, Abdulrahman F, Hassan AA. (2022). A Bibliometric Analysis of the Studies on Self-Healing Concrete Published between 1974 and 2021. *Sustainability*. 14(18):11646. <https://doi.org/10.3390/su141811646>.
2. Busu, M.; Trica, C.L. (2019). Sustainability of Circular Economy Indicators and Their Impact on Economic Growth of the European Union. *Sustainability*. 11, 5481. <https://doi.org/10.3390/su11195481>.
3. Bungau Constantin C., Bungau Tudor, Prada Marcela Florina, Prada Ioana Francesca, Moleriu Radu Dumitru. (2023). Sustainable Development through Green Buildings: Updated Bibliometric Analysis of the Literature in the Field. *Revista Română de Materiale / Romanian Journal of Materials*. 53 (1), 82 – 93.
4. Dobre-Baron, O.; Nițescu, A.; Niță, D.; Mitran, C. (2022). Romania's Perspectives on the Transition to the Circular Economy in an EU Context. *Sustainability*. 14, 5324. <https://doi.org/10.3390/su14095324>.
5. Ellili, N. (2023). Bibliometric analysis of sustainability papers: Evidence from Environment, Development and sustainability. *Environ Dev Sustain*. <https://doi.org/10.1007/s10668-023-03067-6>.
6. Marica Elena. (2022). Bibliometric Analysis of Publications on Ecological Concrete. *Annales Universitatis Apulensis Series Oeconomica*. 24(2), 107- 113.
7. Nurdini A, Nurcahyo R, Prabuwo AS. (2023). Waste from Electric Vehicle: A Bibliometric Analysis from 1995 to 2023. *World Electric Vehicle Journal*. 14(11):300. <https://doi.org/10.3390/wevj14110300>.
8. Olukanni, D. O., Aipoh, A. O., & Kalabo, I. H. (2018). Recycling and reuse technology: waste to wealth initiative in a private tertiary institution, Nigeria. *Recycling*. 3(3), 44. DOI: 10.3390/recycling3030044.
9. Patarlageanu Simona Roxana, Mihai Dinu & Marius Constantin. (2020). Bibliometric Analysis of the Field of Green Public Procurement. *Amfiteatru economic*, vol. 22(53), pages 1-71.
10. Reis, W.F.; Barreto, C.G.; Capelari, M.G.M. (2023). Circular Economy and Solid Waste Management: Connections from a Bibliometric Analysis. *Preprints*. 2023090239. <https://doi.org/10.20944/preprints202309.0239.v1>.
11. Yalçıntaş D, Oğuz S, Yaşa Özeltürkay E, Gülmez M. (2023). Bibliometric Analysis of Studies on Sustainable Waste Management. *Sustainability*. 15(2):1414. <https://doi.org/10.3390/su15021414>.