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Circular Economy and Artificial Intelligence: Insights from a Bibliometric Analysis

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Abstract: This study presents a bibliometric analysis of the intersection between circular economy (CE) and artificial intelligence (AI), utilizing the Scopus data-base to explore research trends and performance metrics. Microsoft Excel and the "Analyze Results" feature in Scopus were employed for data visualization and analysis. Results reveal a steady increase in publications, with a significant surge post-2018, and the number of publications doubling since 2022, driven by global sustainability initiatives and advancements in AI. India leads in research output with 96 publications (48% single-country publications), followed by China and the UK. Sustainability Switzerland is the most prolific journal, contributing 33 articles (9.3%), while Seeram A. Ramakrishna emerges as the most influential author with 150,978 citations and five impactful publications. The field of study primarily focuses on environ-mental science and engineering, reflecting the practical applications of AI in optimizing CE processes. Preferred publication types include journals and book series, with Elsevier and Springer Nature as dominant publishers. De-spite moderate international collaboration, the study underscores the potential for enhanced partnerships to advance CE/AI integration. These findings provide valuable insights for researchers and policymakers aiming to maximize the societal and environmental benefits of this interdisciplinary field.

Keywords: Circular Economy, Artificial Intelligence, Bibliometric Analysis, Sustainable Development.

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1. Introduction

The increasing global focus on sustainability and technological innovation has highlighted the importance of integrating circular economy (CE) principles with artificial intelligence (AI). While CE emphasizes resource efficiency and waste minimization [1], AI offers advanced tools for data-driven decision-making, enabling optimized supply chains, predictive maintenance, and enhanced recycling processes [2].

Despite the growing interest, a comprehensive understanding of the research trends at this intersection remains underexplored. This paper aims to address this gap through a bibliometric analysis, identifying influential authors, key journals, leading institutions, and prevailing research themes.

2. Materials and Methods

The bibliometric analysis relied on the Scopus database, employing the search query:

TITLE-ABS-KEY ("circular economy" AND "artificial intelligence") AND PUBYEAR > 2008 AND PUBYEAR < 2025

The search was not confined to any specific publication types or languages to ensure comprehensive coverage of all relevant research. By keeping the scope broad, the analysis captured a diverse range of publications, reflecting the interdisciplinary nature of the field. The decision not to confine the search was supported by the manageable dataset size of 638 articles, which allowed for detailed analysis without becoming unwieldy. Additionally, including all publication types provided insights into emerging trends and contributions across journals, conferences, and book series, enhancing the robustness of the findings. Microsoft Excel and the "Analyze Results" feature in Scopus facilitated descriptive statistical analysis.

3. Results and Discussion

3.1. Evolution of Research Output and Scholarly Focus in CE/AI

The number of publications on CE/AI has steadily increased, with a significant surge beginning in 2018. This growth aligns with a convergence of factors, including heightened awareness of environmental sustainability, rapid advancements in AI technologies, and the increasing integration of CE principles in global policy frameworks. Key initiatives, such as the European Green Deal and the UN's Sustainable Development Goals [3], have further catalyzed research interest in this domain.

The period from 2022 onwards has been particularly notable, as the number of publications doubled, highlighting an accelerated scholarly and industrial focus on leveraging AI for CE practices. This period marks a clear turning point in scholarly focus, as evidenced by the exponential rise in publications and the diversification of research topics.

Key drivers of this surge include the emergence of AI tools like ChatGPT in 2022 [4], global post-pandemic sustainability priorities [5], supportive policies such as the European Green Deal [6], expanded academic-industrial collaborations [7], and the availability of robust datasets. These factors collectively accelerated interdisciplinary research at the CE/AI intersection [8], as illustrated in Figure 1.

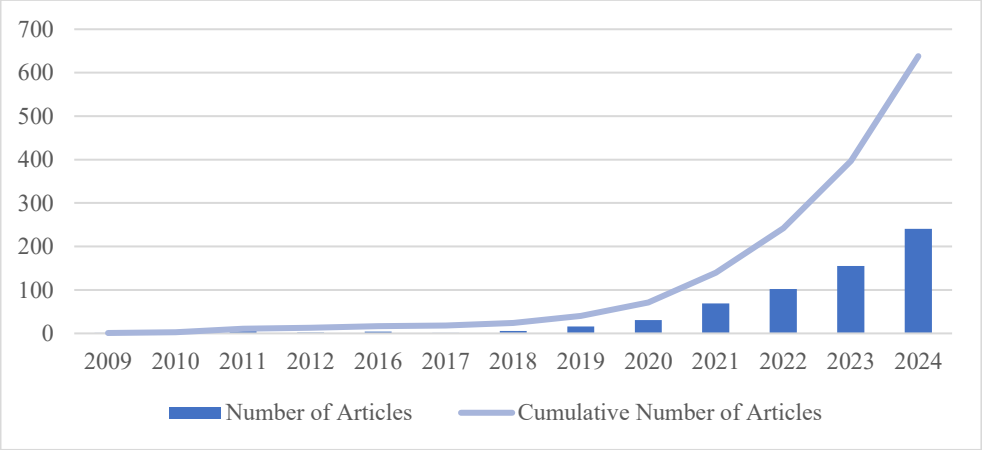

Figure 1: Yearly and Cumulative Trends in Scopus-Indexed Publications on CE/AI (2009–2024).

3.2. Preferred Sources in CE/AI

Table 1 outlines the most prolific sources publishing on CE/AI.

Table 1: The Most Prolific Sources in CE/AI Research (2009–2024).

	Source	Type	TP (%)	TC	CiteScore 2023	Publisher
1	Sustainability Switzerland	Journal	33 (9,3)	413020	6,8	Multidisciplinary Digital Publishing Institute (MDPI)
2	Journal Of Cleaner Production	Journal	22 (6,2)	375170	20,4	Elsevier
3	IFIP Advances In Information And Communication Technology	Book Series	16 (4,5)	4628	1,6	Springer Nature
4	Journal Of Environmental Management	Journal	9 (2,5)	153390	13,7	Elsevier
5	Lecture Notes In Mechanical Engineering	Book Series	8 (2,2)	16299	0,9	Springer Nature
6	Procedia CIRP	Conference Proceeding	7 (2)	14365	3,8	-
7	Technological Forecasting And Social Change	Journal	7 (2)	72165	21,3	Elsevier

TP: total publications; TC: total citations

MDPI leads in publication volume with 33 articles (9.3%) in Sustainability Switzerland, emphasizing open-access dissemination. Elsevier and Springer Nature demonstrate broader academic impact through high citation counts and diverse publication types. For instance, Elsevier's Journal of Cleaner Production, with 375,170 citations and a CiteScore of 20.4, reflects significant influence in sustainability research.

Springer Nature, on the other hand, is distinguished by its focus on book series, catering to interdisciplinary and technical research needs. The Springer book series IFIP Advances in Information

and Communication Technology contributes 16 publications with a CiteScore of 1.6, providing a platform for bridging environmental and technological disciplines. This strategic focus on book series enhances comprehensive explorations in emerging fields, complementing the journal-centric approaches of Elsevier and MDPI.

These variations in focus highlight the complementary roles of different publishers in advancing CE/AI research.

3.3. Top Publishing Countries, Institutions, and International Collaboration in CE/AI

India ranks first with 96 publications (48% single-country publications), followed by China and the UK (Table 2). Together, these three countries account for over one-third of all publications, reflecting their dominant role in advancing research at the intersection of CE and AI. Leading institutions include O.P. Jindal Global University in India and the Ministry of Education of the People's Republic of China. Despite these significant contributions, international collaboration remains moderate, suggesting potential for enhanced global partnerships to further expand the field's impact.

The UK emerges as the leading country in international collaborations, followed by the US and China. This leadership reflects the UK's active involvement in global partnerships, facilitated by its academic institutions and policy frameworks encouraging cross-border research. In contrast, countries like India exhibit higher single-country publication rates (48%), highlighting the potential for expanding collaborative networks to further enhance the global impact of CE/AI research.

Table 2: The Top 7 Leading Countries and Academic Institutions in CE/AI Research.

Rank	Country	TPc	SCP (%)	The most productive academic institution	TPi
1	India	96	48	O.P. Jindal Global University	6
2	China	84	42,9	Ministry of Education of the People's Republic of China	7
3	United Kingdom	69	37,7	University of Johannesburg	4
4	Italy	52	45,6	Università degli Studi di Salerno	5
5	United States	52	40,3	University of Washington	3
6	Germany	43	49,4	Rheinisch-Westfälische Technische Hochschule Aachen	4
7	Spain	40	44,9	Universidad del Pais Vasco	7

3.4. Leading Authors in CE/AI Research

Table 3 lists the most productive authors in the CE/AI field.

The total publications for each author are closely aligned, ranging between 4 and 5, indicating a balanced contribution among the leading researchers in this field. Notably, these authors are concentrated in regions known for significant academic and technological advancements, such as Europe and Asia, highlighting the role of these continents in advancing CE/AI research. Interestingly, almost all authors were first authors for their initial publications, except for Seeram A. Ramakrishna, whose earliest publication dates back to 1991, reflecting his longstanding influence in the field.

Table 3: The 7 Most Prolific Authors Contributing to CE/AI Research.

	Author	Year 1P*	TP	h-index	TC	Current affiliation	Country
1	Ramakrishna, Seeram A.	1991b	5	150	150978	National University of Singapore	Singapore
2	Cetin, Sultan	2021a	5	5	329	Faculteit Bouwkunde van de TU Delft	Netherlands
3	Baumgartner, Rupert J.	2003a	4	39	6299	Universität Graz	Austria
4	Ghoreishi, Malahat	2020a	4	6	213	LAB University of Applied Sciences	Finland
5	Gruis, Vincent H	2000a	4	19	998	Afdeling Management in the Built Environment	Netherlands
6	Landeta-Manzano, Beñat	2013a	4	6	264	Universidad del Pais Vasco	Spain
7	Luthra, Sunil	2011a	4	69	15689	All India Council for Technical Education	India

"Year 1P*" denotes the year of first publication, while superscripts indicate the role in co-authorship: a for First author and b for Co-author.

4. Conclusion

This bibliometric analysis highlights the growing academic interest and practical relevance of integrating circular economy (CE) principles with artificial intelligence (AI). India, China, and the UK are top contributors, collectively accounting for over one-third of publications. Sustainability Switzerland leads among journals, while Elsevier and Springer Nature contribute significantly with high citation counts and varied formats. Publications have doubled rapidly since 2022, driven by AI advancements, heightened sustainability awareness, and supportive policies like the European Green Deal. Collaboration trends show the UK, US, and China as leaders in international partnerships, with room for broader collaboration.

While this study focuses on publication trends, sources, and authorship, nearly half of the research is concentrated in engineering (16%), environmental science (15%), and computer science (14%), reflecting its interdisciplinary nature. CE and AI convergence represents a transformative strategy for sustainable development, offering innovations like real-time resource optimization and predictive maintenance. Future research should integrate these technologies across sectors, enhance collaboration, and address regional disparities.

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