

THE ROLES OF THE CIRCULAR ECONOMY AND INNOVATION RESEARCH IN MITIGATING CLIMATE CHANGE IN THE LAST DECADE

MOHD RIZAL RAZALLI¹, MOHD KAMARUL IRWAN ABDUL RAHIM¹, ALMINNOURLIZA BINTI NOORDIN¹, ABDUL KAFI¹, ALAWEE LATEH², MUHAMMAD FAKHRUL YUSUF³, MUHAMMAD KASHIF SHAD⁴, MOHD UZAIRI BIN AHMAD HAJAZI⁵

¹ SCHOOL OF TECHNOLOGY MANAGEMENT & LOGISTICS, COLLEGE OF BUSINESS, UNIVERSITI UTARA MALAYSIA, BUKIT KAYU HITAM 06010, MALAYSIA.

² DEPARTMENT OF BUSINESS ADMINISTRATION, FACULTY OF MANAGEMENT SCIENCES, PRINCE OF SONGKLA UNIVERSITY, THAILAND.

³ FACULTY OF INDUSTRIAL MANAGEMENT, UNIVERSITI MALAYSIA PAHANG, LEBUH PERSIARAN TUN KHALIL YAAKOB, GAMBANG, KUANTAN 26300, PAHANG, MALAYSIA

⁴ DEPARTMENT OF MANAGEMENT & HUMANITIES, UNIVERSITI TEKNOLOGI PETRONAS, SERI ISKANDAR, PERAK, MALAYSIA

⁵ FACULTY OF ECONOMICS AND BUSINESS, UNIVERSITI MALAYSIA SARAWAK, 94300 KOTA SAMARAHAN, SARAWAK

EMAIL: ¹rizal@uum.edu.my, ¹mk.irwan@uum.edu.my, ¹alminnourliza@uum.edu.my, ¹md.abdul.kafi@uum.edu.my, ²alawee.l@psu.ac.th, ³mfakhrul@umpsa.edu.my, ⁴Kashif.shad@utp.edu.my, ⁵ahmuzairi@unimas.my

ORCHID ID : ¹ 0000-0003-4196-9275, ¹0000-0003-4432-5539, ¹0009-0000-4911-5800, ¹0000-0002-7300-6898, ²0000-0003-3738-3431, ³0000-0002-8273-3843, ⁴0000-0003-3470-4092, ⁵0000-0002-4962-6499

Abstract:

Climate change presents urgent challenges that require innovative solutions, with the circular economy emerging as a critical framework for sustainable development. This study does a bibliometric analysis of literature on climate change, circular economy, and innovation sourced from the Scopus database, spanning from 2015 to January 2025. Employing VOSviewer and Biblioshiny to generate knowledge maps and visual representations. An examination of 173 documents yielded substantial insights regarding prevailing and nascent publication tendencies. Key author keywords included "climate change", "circular economy", "innovation", "sustainable development", and "sustainability". Journal of Cleaner Production emerged as the leader in productivity. Notably, Germany and Italy ranked as the most productive country in this field. The theme evaluation maps indicated a focus on essential study areas, including waste reduction, resource efficiency enhancement, and eco-innovation integration, wherein the circular economy facilitates climate action and fosters economic and environmental resilience. This study emphasises the interrelated functions of renewable energy, sustainable business strategies, and collaboration in tackling global environmental challenges. It highlights the circular economy's capacity to facilitate systemic transformation, alleviate climatic effects, and establish a low-carbon, sustainable future. The findings can assist researchers and manager in transitioning to a circular economy through innovation aimed at mitigating global warming.

Keywords: Climate Change, Circular economy, Innovation, Bibliometric mapping, Biblioshiny

1) INTRODUCTION:

The implications of climate change are no simply theoretical forecasts; they are manifesting in real time, altering the world and its ecosystems in unprecedented manners. Increasing global temperatures, melting polar ice, escalating storms and catastrophic droughts are but a few of the evident indicators of a planet in distress[1]. These alterations jeopardise biodiversity and significantly affect human lives, livelihoods, and economies. As governments and communities confront escalating challenges, it is evident that conventional approaches to environmental issues are inadequate. A deeper and comprehensive transformation is required. This transition is fundamentally rooted in the acknowledgement that our existing economic structures substantially contribute to the climate issue. For decades, the "take-make-dispose" consumption model has propelled economic expansion, but at an unsustainable expense. This linear model exhausts natural resources, produces substantial waste, and

markedly increases greenhouse gas emissions. If unregulated, this paradigm would further intensify the issues we encounter, driving ecosystems and civilisations into irreversible tipping points[2].

The circular economy offers a transformative alternative, emphasising sustainability, resource efficiency, and waste minimisation. The circular economy adopts a regenerative approach instead of perceiving materials and products as disposable. It aims to eliminate waste, prolong the use of products and materials, and rehabilitate natural systems. This transition conserves limited resources and diminishes the environmental impact of production and consumption. Transitioning to a circular economy enables firms and governments to establish systems that harmonise economic growth with ecological stewardship. This transformation cannot occur in solitary. Innovation must be pivotal to attain the scale and velocity necessary to address climate change. Advanced recycling technologies that recover valuable materials and digital systems that optimise resource utilisation and monitor sustainability parameters facilitate the flourishing of the circular economy[3]. Technological advancements, like artificial intelligence, blockchain, and renewable energy solutions, are currently revolutionising businesses, facilitating the efficient and successful implementation of circular practices[4].

Innovation extends beyond technology; it includes reimagining business structures, reshaping value chains, and promoting collaborations between the public and private sectors. Companies are investigating product-as-a-service models, wherein clients lease things instead of owning them, hence facilitating the reclamation and reuse of resources[5]. Governments are implementing policies that promote sustainable practices and stimulate investment in green technologies. Collectively, these initiatives are establishing a basis for a novel economic paradigm—one that prioritises sustainability alongside profits[6]. The convergence of climate action, circular economy principles, and innovation constitutes a formidable catalyst for transformation. It provides a framework for tackling critical concerns of our era, including carbon reduction, resource conservation, economic resilience, and the advancement of social fairness[7].

This article will examine the essential function of these interrelated concepts, investigating their potential to catalyse dramatic change on a global scale. This study analyses various article related with climate change, circular economy and innovation in Scopus data base to illuminate the significant potential of a circular, inventive strategy for addressing climate change. The stakes are unthinkable, yet so is the potential for significant action. By adopting the circular economy and leveraging innovation, we can redefine development, alleviate the effects of climate change, and establish a sustainable future for all. In this research we have research question as below:

RQ1: What are the key characteristics and evolving trends in research on climate change, the circular economy, and innovation?

RQ2: Who are the leading contributors, collaborative networks, and prominent institutions in the study of climate change, the circular economy, and innovation?

RQ3: Which journals have published the highest volume of research on climate change, the circular economy, and innovation?

RQ4: What are the most frequently used keywords in studies related to climate change, the circular economy, and innovation?

RQ5: What are the primary themes, future research directions, and evolutionary patterns in the field of climate change, the circular economy, and innovation?

This study used Scopus data to analyse circular economy and innovation research publications. The goal was to summarise global research trends in this subject. Scopus is considered the largest and most complete repository of cited and referenced literature on a wide range of topics. Scopus allows adding subjects not covered in WoS[8]. The study has the following sections to answer the research questions. In the "Introduction" section, the present understanding of climate change, circular economy and innovation, prior research, knowledge gaps, and study goals are summarised. The "Research methods" section describes this study's bibliometric and biblioshiny approach, including a flowchart and data analysis framework. The "Results" section answers study questions and suggests future research themes. In the "Conclusion" section, contributions, limits, and future research are summarised.

2) RESEARCH METHODS:

Bibliometric studies provide a complete framework for research output significance. Using quantitative and qualitative bibliometric analysis, journal and article publications and citation patterns can be examined over time.[9]. Quantifying scientific achievements provides a robust assessment of national and institutional research. Policies and science have been greatly influenced by such judgements [10]. This method helps academics choose and plan study subjects, anticipating future trends. It also produces statistical results for domain-specific growth pattern computation and estimation[11]. Previous studies have employed bibliometric techniques to explore the circular economy[12]. This study enhances a quantitative literature evaluation by linking diverse keywords related to circular economy and innovation. The methodology serves as a structured framework for evaluating textual communication among authors, thereby quantifying trends and characteristics within a specific study subject, focussing on research titles, keywords, authors and publication metrics.[13, 14]. It includes the examination of co-authorship ties, co-citation links, and bibliographic coupling links, enabling citation mapping to visualise topic clusters and supply chain management. [15]. Scopus, the largest abstract and citation database, was selected as

the primary data source due to its extensive search functionalities that facilitate the formulation of suitable search strings across diverse academic disciplines.

Thematic evaluation

Thematic evaluation provides an innovative method for measuring the progression of research domains. By examining the theme evolution across time, academics can acquire insights into the systematic advancement and progression of their respective fields. This study utilised Biblioshiny, a component of the Bibliometrix R package, to do theme assessment mapping [12].

3) MATERIAL AND METHODS:

3.1 Data collection

The Scopus database was selected for data collection on climate change, circular economy, and innovation research, including the period from 2015 to January 8, 2025. Scopus is the foremost global repository of citations and abstracts for scholarly papers from various publishers, offering a consolidated platform for academic researchers. Compared to other databases such as Web of Science (WoS) and Google Scholar, Scopus provides a broader selection of publications and facilitates effective keyword searches and bibliographic analysis [16]. Figure 1 illustrates the search strategy and methodologies employed for data collecting in this investigation.

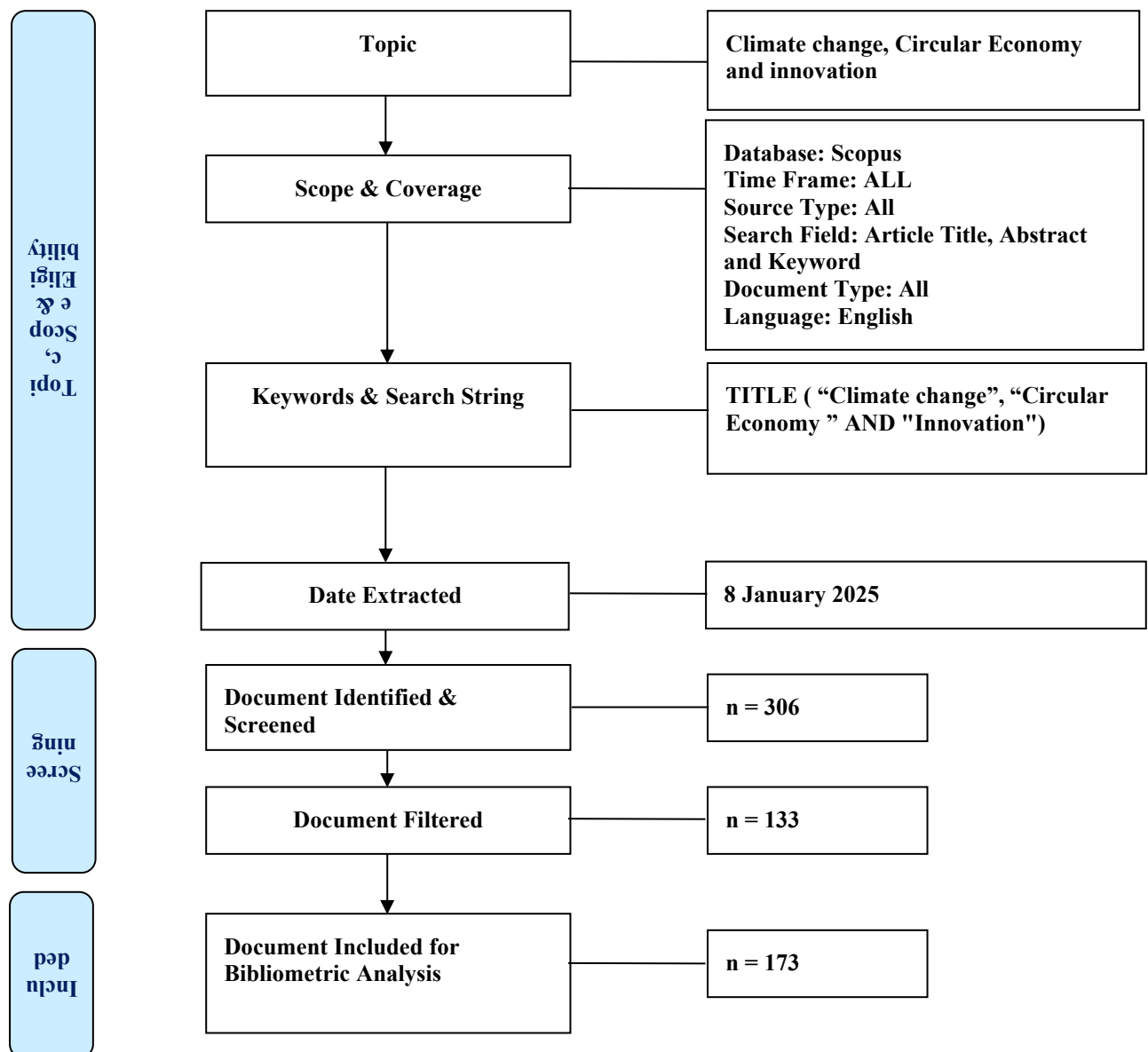


Figure 1: illustrates the article search strategy implemented in this analysis.

3.2 Search strategy

The selection of suitable keywords is essential in performing a bibliometric investigation. This study concentrated on three keywords, in accordance with the research questions. "Climate change", "circular economy" and

“innovation.” Consequently, the research encompassed three relevant keyword combination strings. The title of an article should convey pertinent information to engage readers, as it is the first element they encounter. The study utilized the following search query: ((TITLE-ABS-KEY ("circular economy") AND TITLE-ABS-KEY ("Climate change") AND TITLE-ABS-KEY (innovation)) AND (LIMIT-TO (LANGUAGE , "English"))). A total of 173 articles published between 2015 and January 8, 2025, Figure 1 depicts the results of a Scopus database search.

3.3 Tools and data analysis

VOSviewer has been widely adopted across many disciplines for bibliometric analysis, including business and finance [17], industry sector[18, 19]. This study utilised VOSviewer software to visually depict geographic distributions, authorship patterns, citation networks, keywords, and international collaborations in relation to circular economy and innovation research, in order to fulfil the research objectives and address the research questions. VOSviewer utilises many methods to generate visual bibliometric maps, emphasising specific structural components of the literature. The software employs a cohesive approach for mapping and clustering, based on a normalised word co-occurrence matrix and a similarity metric that assesses the strength of links between phrases[15]. Utilising citation data and bibliographic coupling, VOSviewer generates clusters derived from authors' keywords, countries, and institutions, thereby depicting the concentration of documents, keywords, and institutional participation in particular research areas. Additionally, original data obtained from Scopus in CSV format were analysed via Microsoft Excel. R Studio was utilised to better investigate issues pertaining to climate change, circular economy and innovation. Figure 2 depicts the different phases and analysis performed during this study.

4) RESULTS:

4.1 Descriptive analysis

This section analyses the study profile of climate change, circular economy, and innovation from 2015 to 2025. Table 1 encapsulates current publishing data, research trends, the most prolific authors, frequently cited articles, publication sources, the most productive institutions and nations, as well as author keywords.

Table 1: A list of publications and papers that have been read about climate change, the cycle economy, and new ideas.

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2015:2025
Sources (Journals, Books, etc)	113
Documents	173
Annual Growth Rate %	2.92
Document Average Age	3.23
Average citations per doc	19.45
References	10,988
AUTHORS	
Authors	748
Authors of single-authored docs	23
DOCUMENT TYPES	
article	143
conference paper	30

Source: Authors

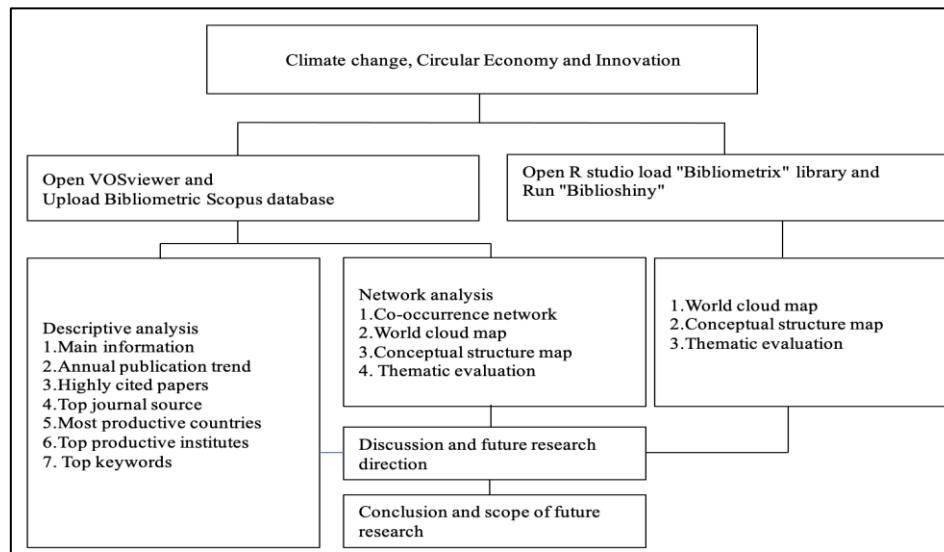


Figure 2: Step of Bibliometric analysis

Annual Publication Trends

For articles published between 2015 and 2025, the overall number of citations, the number of citations per article, and the number of citations per year were all factors in the publication trend study. Table 2 and Figure 3 show yearly publication patterns in innovation, climate change, and the circular economy. Particularly noteworthy is the dramatic rise in the number of publications, which went from 2 in 2017 to 48 in 2024. This expansion bodes well for the field as it approaches a major turning point in its history.

Table 2: Yearly Publications Trend

Year	Total publications (TP)	Total citations (TC)	Citation per paper (C/P)
2015	3	54	18.00
2016	5	308	61.60
2017	2	115	57.50
2018	6	244	40.67
2019	10	516	51.60
2020	17	824	48.47
2021	22	537	24.41
2022	32	451	14.09
2023	24	145	6.04
2024	48	166	3.46
2025	4	5	1.25
Total	173	3,365	19.45

Source: Authors

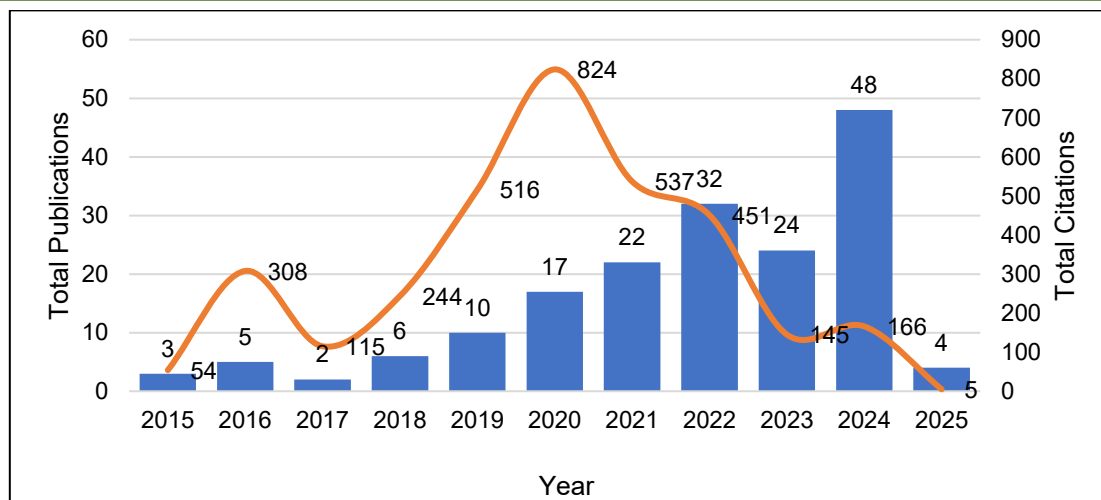


Figure. 3: The annual publications trends
Source: Authors

Highly cited papers

Table 3 presents the top 10 most cited papers, including authors, Titles, publication year, total citations, citations per year, journal names and DOI. The paper titled “Circular business models: Business approach as driver or obstructor of sustainability transitions?” by Hofmann F. (2019) received a total of 186 citations, averaging 26.57 citations per year.

Table 3: Most highly cited documents

No.	Author(s)	Title	Source Title	TC	C/Y	DOI
1	Hofmann F. (2019)	Circular business models: Business approach as driver or obstructor of sustainability transitions?	Journal of Cleaner Production	186	26.57	10.1016/j.jclepro.2019.03.115
2	Venkata Mohan S. et al.(2019)	Can circular bioeconomy be fueled by waste biorefineries — A closer look	Bioresource Technology Reports	183	26.14	10.1016/j.biteb.2019.100277
3	Naims H. (2016)	Economics of carbon dioxide capture and utilization—a supply and demand perspective	Environmental Science and Pollution Research	180	18	10.1007/s11356-016-6810-2
4	Durán-Romero G. et al. (2020)	Bridging the gap between circular economy and climate change mitigation policies through eco-innovations and Quintuple Helix Model	Technological Forecasting and Social Change	146	24.33	10.1016/j.techfore.2020.120246
5	Li L. et al. (2020)	Green innovation and business sustainability: New evidence from energy intensive industry in China	International Journal of Environmental Research and Public Health	127	21.17	10.3390/ijerph17217826
6	Manzanares P. (2020)	The role of biorefining research in the development of a modern bioeconomy	Acta Innovations	112	18.67	10.32933/ActaInnovations.37.4
7	Garrett R.D. et al. (2020)	Drivers of decoupling and recoupling of crop and livestock systems at farm and territorial scales	Ecology and Society	104	17.33	10.5751/ES-11412-250124
8	Hofmann F. & Jaeger-Erben M. (2020)	Organizational transition management of circular business model innovations	Business Strategy and the Environment	102	17	10.1002/bse.2542
9	Fang K. et al. (2017)	Carbon footprints of urban transition: Tracking circular economy promotions in Guiyang, China	Ecological Modelling	99	11	10.1016/j.ecolmodel.2017.09.024
10	Gorissen L. et al. (2016)	Transition thinking and business model innovation-towards a transformative business model and new role for the reuse centers of Limburg, Belgium	Sustainability (Switzerland)	75	7.5	10.3390/su8020112

Most productive source titles

Table 4 shows the most popular source titles produced between 2015 and 2025 out of a total of 173 articles published in various journals. With seventeen titles covering topics like innovation, the circular economy, and climate change, Journal of Cleaner Production is among the leading publishers in this field.

Table 4: Most productive source title

Source Title	TP	TC	C/P	h	Citable Year	PYS
Journal of Cleaner Production	17	582	34.24	9	8	2018
Sustainability (Switzerland)d	15	343	22.87	10	10	2016
Business Strategy and the Environment	6	110	18.33	3	6	2020
Journal of Environmental Management	3	59	19.67	2	4	2022
Technological Forecasting and Social Change	3	191	63.67	3	6	2020
International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM	3	17	5.67	2	8	2018
Resources, Conservation and Recycling	3	69	23.00	2	8	2018
Frontiers in Sustainability	3	39	13.00	1	6	2020
Circular Economy and Sustainability	3	4	1.33	2	3	2023
Frontiers in Environmental Science	2	9	4.50	1	4	2022

Note (s): TP = Total publications; TC = Total citations; h=h-index; PYS = Publication year start

Most productive countries

According to the Scopus database, research materials on circular economy and innovation were obtained from 57 countries. Table 5 enumerates the ten most productive countries, each providing over 10 articles. Germany and Italy are the most productive, with 44 articles (25.48%). These findings demonstrate an intensified emphasis on climate change, circular economy, and innovation research in these nations relative to others.

Table 5: Most contributing countries of circular economy and innovation research

No.	Country	Total Publication	Percentage
1	Germany	22	12.72%
2	Italy	22	12.72%
3	China	21	12.14%
4	United Kingdom	21	12.14%
5	United States	20	11.56%
6	India	15	8.67%
7	Spain	12	6.94%
8	Netherlands	11	6.36%
9	Sweden	11	6.36%

Most prolific institutions

Table 6 describes the 10 institutions with the highest production from the analysis of 173 papers pertaining to climate change, circular economy, and innovation research. The Technische Universität Berlin has contributed six papers. The aforementioned institutions contributed 33 articles, signifying a focused impact on the field.

Table 6: Most productive institutions

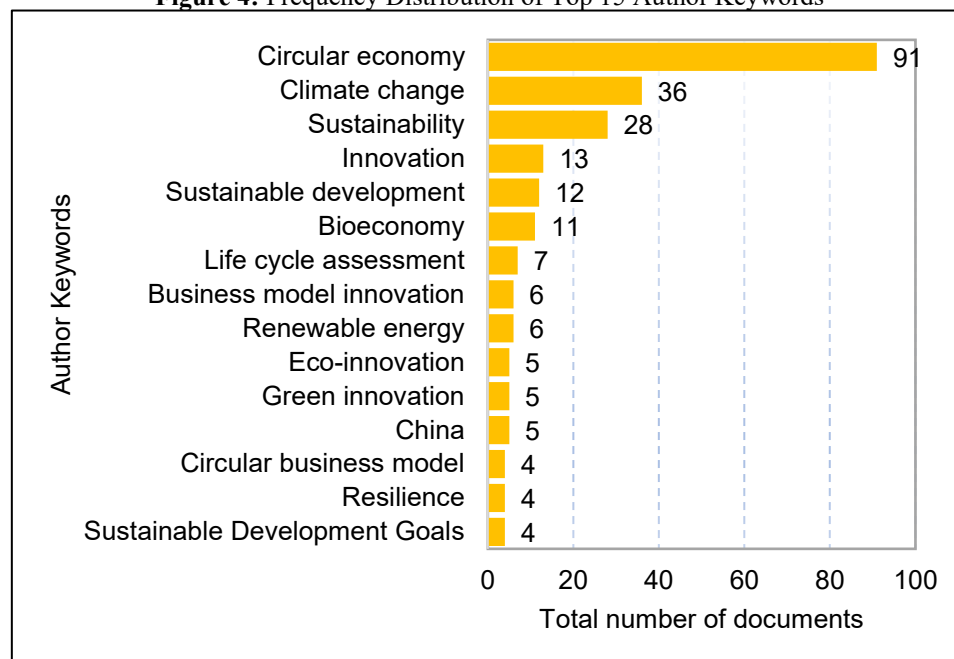
No.	Affiliation	Total Publication	Percentage
1	Technische Universität Berlin	6	3.47%
2	Sant'Anna Scuola Universitaria Superiore Pisa	4	2.31%
3	The Royal Institute of Technology KTH	3	1.73%
4	Wageningen University	3	1.73%
5	Consiglio Nazionale delle Ricerche	3	1.73%

6	Università degli Studi di Firenze	3	1.73%
7	ETH Zürich	3	1.73%
8	Lunds Universitet	3	1.73%
9	Freie Universität Berlin	3	1.73%
10	Srinakharinwirot University	2	1.16%

Top frequent authors' keywords

Figure 4 displays the most frequently used authors' keywords in the domain of circular economy and innovation. The term "circular economy" appeared 91 times, followed by "climate change" with 36 occurrences and "sustainability" with 28 occurrences.

Figure 4: Frequency Distribution of Top 15 Author Keywords



A word cloud of authors' keywords in bibliometric analysis visually represents the most commonly used terms in an article's keywords, aiding in the identification of dominant themes in an author's research. The magnitude of each phrase in the cloud correlates with its frequency of occurrence. Figure 5 illustrates the word cloud map of authors' keywords in the domains of climate change, circular economy, and innovation research, indicating that "circular economy," "climate change," "sustainability," and "innovation" are constantly central research themes. This analysis reveals a correlation among innovation, sustainability, climate change, and the circular economy, highlighting the interrelatedness of these ideas in research.



Figure 5: Word cloud by author's keywords

The word cloud analysis reveals that certain terms may frequently appear in an author's keyword list without being represented in the conceptual framework of those keywords. This inconsistency occurs because the word cloud visually represents the frequency of individual terms, while the author's conceptual keyword structure highlights the relationships among those terms and phrases.

4.2 Bibliometric mapping analysis of the circular economy and innovation research

Bibliometric mapping analysis helps discover research domains and grasp the study area's structure, including themes, topics, terminology, and relationships. This study uses Van Eck and Waltman [15] through the VOSviewer software (Leiden University, Netherlands). Visualisation of Similarities (VOS) global analysis technique with VOSviewer software (Leiden University, Netherlands) to demonstrate bibliometric mapping results. VOSviewer uses multiple methods to visualise bibliometric maps, emphasising literary production characteristics. A comprehensive clustering and mapping approach uses standardised term co-occurrence to assess term associations in this tool. It's also useful for network research[11]. VOSviewer colour-codes terms by their scientific literature debut year to visualise the conceptual environment. Fonts and rectangles with bigger sizes indicate more frequent use of the phrase. In this study, we utilised VOSviewer to visualise co-authorship and collaboration networks and R Studio to analyse keyword co-occurrences and thematically assess climate change, circular economy, and innovation.

Keyword co-occurrence network

Keyword analysis identifies important circular economy and innovation research compositions by focussing on keywords. Author keyword co-occurrence networks illuminated domain-relevant research ideas. Use larger font sizes and circles to highlight commonly used keywords. The lines between terms indicate their association (Vošner et al., 2016). For clarity, associated keywords are often grouped by colour. The absence of lines between keywords indicates a lack of established connections. Terms positioned closer to the centre of the network diagram signify a higher degree of co-occurrence, implying a stronger correlation.

To investigate associated keywords in the circular economy and innovation research, Figure 6 identifies three thematic clusters: (i) Circular Economy, (ii) climate change, and (iii) sustainability, each represented in distinct colors. Each color corresponds to a group of related concepts, illustrating how different aspects of the circular economy are interlinked.

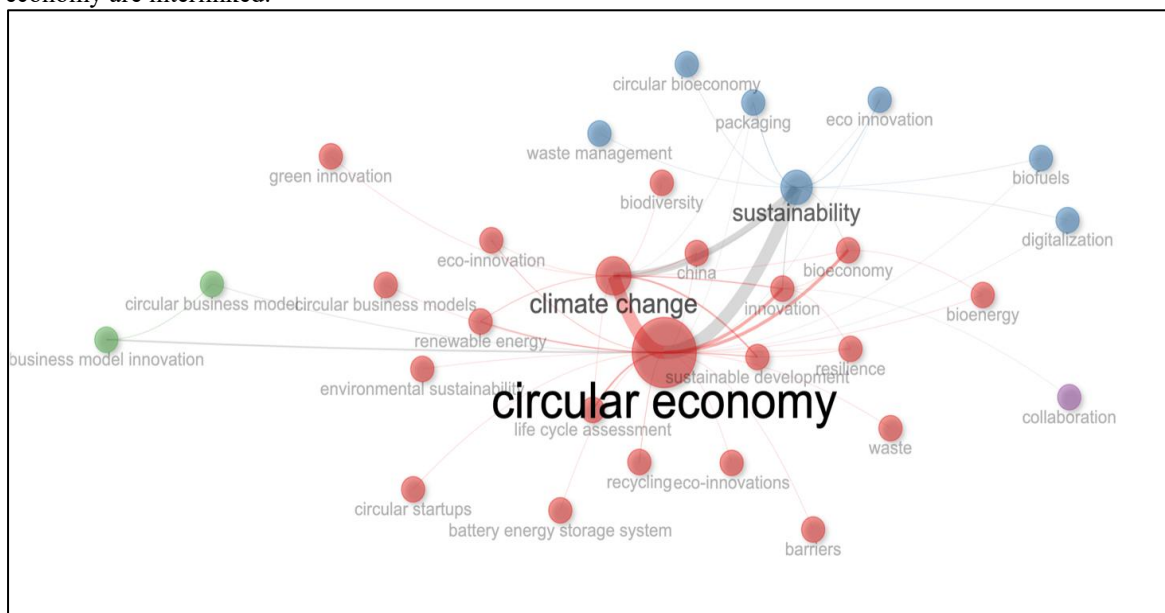


Figure 6: Author's keywords co-occurrence analysis

Primary Theme, the phrase "circular economy" serves as the primary node, signifying its status as the focal point of the map. This notion underscores the minimisation of waste and the reutilisation of resources to establish a more sustainable system, closely associated with other critical subjects such as climate change, sustainability, and innovation.

Climate Change is intimately associated with concepts such as sustainable development, eco-innovation, renewable energy, and environmental sustainability. This cluster emphasises the significance of the circular economy in addressing climate change through the promotion of renewable resources and sustainable practices. Sustainability and Bioeconomy. Elements such as bioeconomy, biodiversity, packaging, and digitalisation signify advancements aimed at improving sustainability. These subjects correspond with initiatives to establish circular systems, reduce environmental effect, and advocate for sustainable solutions.

Business Models and Innovation. Elements such as business model innovation, circular business models, and circular startups signify the emphasis on incorporating circular principles into enterprises. These concepts emphasise the necessity for entrepreneurial and inventive strategies to effectively execute circular economy ideas.

Collaboration and resilience underscore the need of partnerships and adaptation in attaining sustainability objectives. These words highlight the collaborative endeavour necessary across sectors and communities.

4.3 Thematic evaluation

This research used Biblioshiny software to analyse the author's keywords climate change, circular economy and innovation research and evaluate the main research topics from 2015 to 2025.

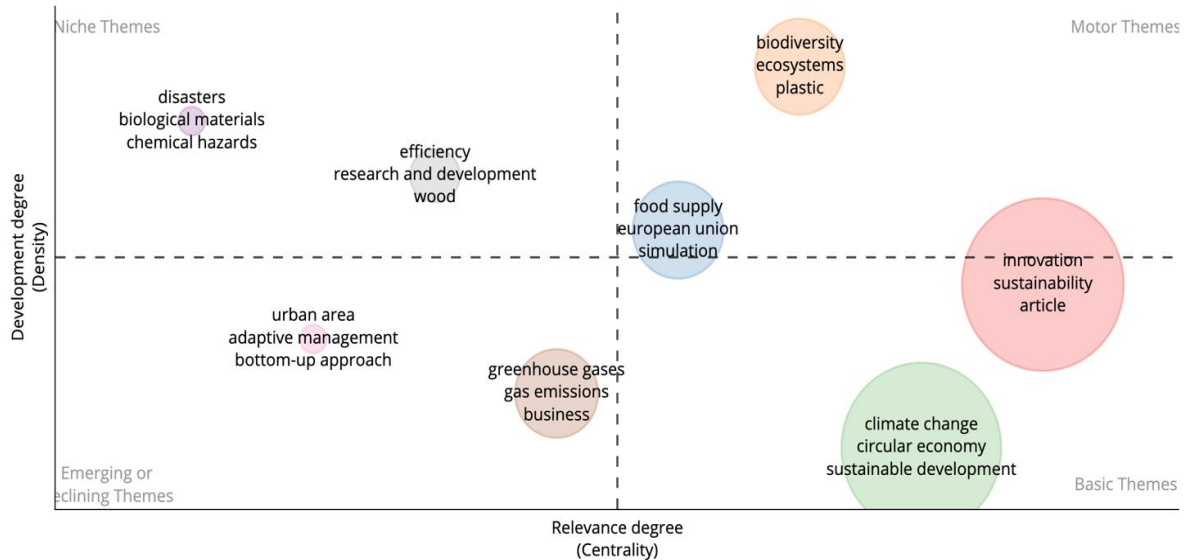


Figure 7: The strategic thematic map based on author's keywords

Figure 7 presents a summary of contemporary research and prospective developments in the circular economy and innovation, as depicted by the topics throughout the four quadrants.

1. Core Themes, primary focus is Innovation and Sustainability. These themes are essential for advancement in climate change, the circular economy, and innovation, functioning as "engines" for additional development and implementation.
2. Niche themes centred on terms related to disasters, biological materials, and chemical hazards. These may denote specialised domains, such as hazard mitigation or materials science, with minimal intersection with the overarching circular economy and innovation dialogues.
3. Concepts such as Urban Area, Adaptive Management, and Bottom-Up Approach. These themes may represent nascent concepts or practices that have yet to achieve widespread acceptance or significance in this domain.
4. Fundamental themes for future exploration and growth emerge with the terms Climate Change, Circular Economy, and Sustainable Development.

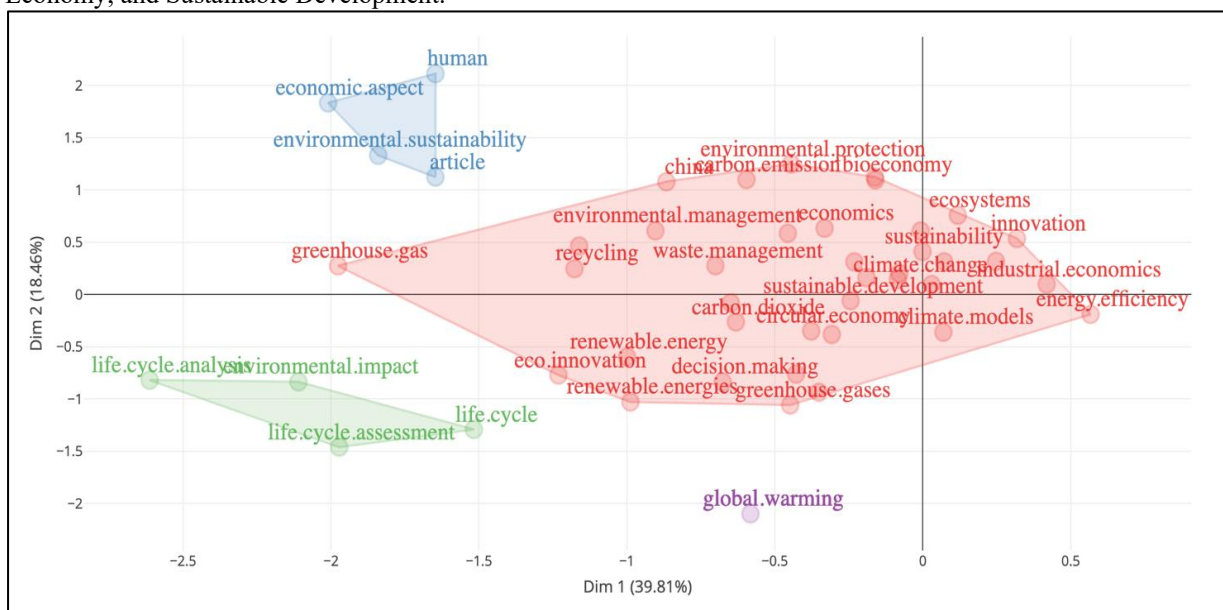


Figure 8: Conceptual structure map based on author's keywords

This conceptual structure map, based on Multiple Correspondence Analysis (MCA) and depicted in Figure 8, establishes four principal groupings, each represented by distinct colours, that guide the logical framework of circular economy and innovation research.

1. Red Cluster: Climate Change and Circular Economy, Keywords: Circular economy, climate change, sustainable development, greenhouse gases, renewable energy, waste management, carbon dioxide, innovation, and energy efficiency. This cluster emphasises core themes pertaining to climate action, sustainability, and the circular economy. It emphasises interrelated subjects such as mitigating greenhouse gas emissions, embracing renewable energy sources, and enhancing energy efficiency. Innovation and waste management are crucial to attaining sustainable development objectives.
2. Green Cluster: Life Cycle Assessment and Ecological Impact, Keywords: Life cycle, life cycle assessment, environmental impact, life cycle analysis. This cluster is analytical, focussing on approaches and frameworks for assessing environmental impacts across the lifecycle of products and processes. These methodologies are essential for evaluating sustainability and informing decision-making in domains such as resource management and circular design.
3. Blue Cluster: Socioeconomic and Sustainability Dimensions, Keywords: Economic dimension, human, environmental sustainability. This cluster focuses on the economic aspects of sustainability. It links environmental sustainability with human and economic considerations, highlighting the necessity of incorporating these viewpoints into policy formulation and actual implementation.
4. Purple Cluster: Climate Change. This compact yet notable cluster embodies a concentrated concept primarily about global warming. It highlights the fundamental dilemma that links all other clusters and necessitates innovation, circular economy methods, and sustainable development.

5) DISCUSSION AND FUTURE RESEARCH DIRECTION:

This study seeks to conduct a thorough assessment of the existing literature on climate change, circular economy, and innovation by bibliometric analysis. This type of analysis evaluates research output and publications pertaining to a certain study domain. Moreover, insights derived from bibliometric data are essential for evaluating trends within a particular research subject.

The study findings clarify the varied characteristics of research contributions within a specific field, serving as a guide for researchers aspiring to achieve high-impact output. This research concentrated on articles pertaining to climate change, circular economy, and innovation sourced from the Scopus database. The total number of published documents in this category was 173, obtained through a specific search query. Literature has explored the ramifications of climate change, circular economy, and innovation, encompassing climate action, sustainability, greenhouse gas emission mitigation, adoption of renewable energy sources, enhancement of energy efficiency, and waste management. Furthermore, life cycle assessment, resource management, and circular design are essential in this field for mitigating climate change.

Moreover, articles concerning climate change, circular economy, and innovation have exhibited a consistent rise from 2018 to 2022, with a significant surge anticipated in 2024 and thereafter. Notwithstanding advancements in the discipline, there persist domains for inquiry that further studies may investigate. The papers were distributed throughout more than 57 nations, with Germany and Italy emerging as the primary contributors; nevertheless, China, the United Kingdom, and the United States also played key roles during the developmental phases.

While bibliometric analysis offers a rigorous methodological framework, it is crucial to acknowledge particular limitations to provide a comprehensive understanding for readers and to guide future research initiatives. A limitation arises from reliance on certain keywords, perhaps omitting results from other relevant domains within the abstract and keyword sections. Some studies expressly state significant topics in their titles, while others only reference them in abstracts or keywords, resulting in a misalignment between the research focus and the intended search terms. Consequently, rigorous data filtering and purification are essential prior to analysis, as no search query can guarantee total accuracy. Consequently, the possibility of false positives and negatives must be recognised, as noted by Sweileh, et al. [20].

5) CONCLUSION:

The study's findings significantly enhance the existing knowledge by elucidating contemporary research trends in circular economy and innovation. A total of 173 papers on these subjects were evaluated, utilising VOSviewer software for scientific mapping and R software for thematic analysis. The study examines essential aspects and current trends in the literature, encompassing the most prolific authors, collaborative networks, leading countries, and notable organisations. The analysis emphasises the journals that have disseminated the most research and offers insights into knowledge advancement, notably with co-occurrence patterns in climate change, circular economy, and innovation studies. Moreover, the study emphasises topic assessments and provides thematic maps as a foundation for subsequent research. The application of a bibliometric methodology enhances and supplements previous research, providing significant insights into historical trends. This research aims to aid scholars in recognising deficiencies in the domains of climate change, circular economy, and innovation, while proposing potential avenues for further investigation. The study's limitation is in its sole dependence on the Scopus database as the principal source for document collection. While Scopus is a comprehensive database for scholarly publications, it possesses limitations in its breadth. Future research would benefit from the incorporation of

additional datasets, such as WoS, as the integration of many databases is expected to boost the breadth and importance of the results.

5) Acknowledgements

We thank all author for their contributions to this work. This research was supported by the Fundamental Research Grant Scheme (FRGS) (Ref code: FRGS/1/2023/SS01/UUM/02/1). The content of this article is solely the responsibility of the authors and does not necessarily represent the official views of the Ministry of Higher Education (MoHE).

6) Conflict of interest: "The authors declare that there is **no** conflict of interest".

7) REFERENCES:

- [1] D. Liu, X. Guo, and B. Xiao, "What causes growth of global greenhouse gas emissions? Evidence from 40 countries," *Sci Total Environ*, vol. 661, pp. 750-766, Apr 15 2019, doi: 10.1016/j.scitotenv.2019.01.197.
- [2] K. Govindan and M. Hasanagic, "A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective," *International Journal of Production Research*, vol. 56, no. 1-2, pp. 278-311, 2018, doi: 10.1080/00207543.2017.1402141.
- [3] A. Genovese, A. A. Acquaye, A. Figueroa, and S. C. L. Koh, "Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications," *Omega*, vol. 66, pp. 344-357, 2017/01/01/ 2017, doi: <https://doi.org/10.1016/j.omega.2015.05.015>.
- [4] A. Urbinati, D. Chiaroni, and V. Chiesa, "Towards a new taxonomy of circular economy business models," *Journal of cleaner production*, vol. 168, pp. 487-498, 2017.
- [5] Y. Sun et al., "Technological Innovation Research: A Structural Equation Modelling Approach," *Journal of Global Information Management (JGIM)*, vol. 29, no. 6, pp. 1-22, 2021, doi: 10.4018/JGIM.20211101.0a32.
- [6] Y. Ren, K.-J. Wu, M. K. Lim, and M.-L. Tseng, "Technology transfer adoption to achieve a circular economy model under resource-based view: A high-tech firm," *International Journal of Production Economics*, vol. 264, p. 108983, 2023.
- [7] M. Pichlak and A. R. Szromek, "Linking Eco-Innovation and Circular Economy—A Conceptual Approach," *Journal of Open Innovation: Technology, Market, and Complexity*, vol. 8, no. 3, p. 121, 2022/09/01/ 2022, doi: <https://doi.org/10.3390/joitmc8030121>.
- [8] J. Wang, T. Zheng, Q. Wang, B. Xu, and L. Wang, "A bibliometric review of research trends on bioelectrochemical systems," *Current Science*, pp. 2204-2211, 2015.
- [9] M. Aria and C. Cuccurullo, "bibliometrix: An R-tool for comprehensive science mapping analysis," *Journal of informetrics*, vol. 11, no. 4, pp. 959-975, 2017.
- [10] Y.-W. Chang, M.-H. Huang, and C.-W. Lin, "Evolution of research subjects in library and information science based on keyword, bibliographical coupling, and co-citation analyses," *Scientometrics*, vol. 105, pp. 2071-2087, 2015.
- [11] A. Kafi et al., "Meta-analysis of food supply chain: pre, during and post COVID-19 pandemic," *Agriculture & Food Security*, vol. 12, no. 1, p. 27, 2023/08/23 2023, doi: 10.1186/s40066-023-00425-5.
- [12] M. R. Razalli, Abdul Rahim, M.K.I., Noordin, A., Kafi, A., Lateh, A., Yusuf, M.F., Shad, M.K., "Global trends of circular economy and innovation research: A bibliometric analysis,," *International Journal of Sustainable Development and Planning*, vol. 19, no. 12, pp. 4527-4537, 2024. [Online]. Available: <https://doi.org/10.18280/ijstdp.191202>.
- [13] Y. Ding, G. G. Chowdhury, and S. Foo, "Bibliometric cartography of information retrieval research by using co-word analysis," *Information processing & management*, vol. 37, no. 6, pp. 817-842, 2001.
- [14] B. Gupta and S. Bhattacharya, "Bibliometric approach towards mapping the dynamics of science and technology," *DESIDOC Journal of Library & Information Technology*, vol. 24, no. 1, 2004.
- [15] N. Van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *scientometrics*, vol. 84, no. 2, pp. 523-538, 2010.
- [16] M. E. Falagas, E. I. Pitsouni, G. A. Malietzis, and G. Pappas, "Comparison of PubMed, Scopus, web of science, and Google scholar: strengths and weaknesses," *The FASEB journal*, vol. 22, no. 2, pp. 338-342, 2008.
- [17] A. Mansour, A. Ahmi, O. M. J. Popoola, and A. Znaimat, "Discovering the global landscape of fraud detection studies: a bibliometric review," *Journal of Financial Crime*, vol. 29, pp. 701-720, 06/14 2021, doi: 10.1108/JFC-03-2021-0052.
- [18] M. S. I. Sarker and I. Bartok, "Global trends of green manufacturing research in the textile industry using bibliometric analysis," *Case. Stud. Chem. Environ. Eng.*, vol. 9, p. 100578, 2024/06/01/ 2024, doi: <https://doi.org/10.1016/j.cscee.2023.100578>.
- [19] Y. Bhatt, K. Ghuman, and A. Dhir, "Sustainable manufacturing. Bibliometrics and content analysis," *Journal of Cleaner Production*, vol. 260, p. 120988, 2020/07/01/ 2020, doi: <https://doi.org/10.1016/j.jclepro.2020.120988.s>