Conference Paper

Fusion of Blockchain and Sustainable Development Goals: A Bibliometric Analysis for Future Trends

Mohd Salim[1], Parvez Alam Khan[2*], Nasir Abdul Jalil[2,3], Satirenjit Kaur Johl[4], Syed Hasan Jafar[5], Fatima Irfan[6], and Mantasha Khan[7]

[1]Department of Commerce, Aligarh Muslim University Aligarh, India
[2,3,4]Department of Management and Humanities, Universiti Teknologi PETRONAS, 32610 Seri Iskandar, Malaysia
[5]Department of Finance, School of Business, Woxsen University, Hyderabad, India
[6]Department of Commerce and Business Management, Integral University Lucknow, India
[7]Faculty of Commerce, KMCL University, Lucknow, India

Corresponding Author: Parvez Alam Khan; email: parvezkhan.alam@gmail.com

Abstract.

Blockchain technology has emerged as a transformative solution for enhancing transparency and accountability across various dimensions of sustainable development. Given the limited exploration of Blockchain's synergy with sustainable development goals, there exists a compelling rationale to undertake a bibliometric literature review aimed at identifying forthcoming research trajectories. Employing the "Blockchain" AND "Sustainable Development Goals" keywords, an extensive search was conducted across Scopus and Web of Science databases. This endeavor yielded a corpus of 271 articles published within the span of 2017 to 2023. Subsequent adherence to inclusion and exclusion criteria refined this collection to 183 documents for meticulous Bibliographic Analysis through the Biblioshiny application of the Bibliometrix R package. The study charts a promising trajectory characterized by upward trends in recent years, unveiling the most prolific authors, productive nations, frequency of keywords, thematic evaluation, and collaborative endeavors. Delving into the systematic literature review, the research introduces five discernible future trends, along with a comprehensive research framework designed to amplify the generalizability of findings to pertinent stakeholders.

Keywords: blockchain, sustainable development goal, environmental challenges and bibliometric analysis

🔓 **OPEN ACCESS**

1. Introduction

The Sustainable development goal is a concern for every industry such as the oil & gas industry [1-5], chemical [6], pharmaceutical [7-9], the industrial revolution and recent waves of AI applications, big data [10], machine learning/deep learning, and Blockchain have disrupted the business. According to Ganther (2021), blockchain technology is anticipated to increase to $176 billion by 2025 and surge to $3.1 trillion by 2030. However, despite its potential, Blockchain has not yet lived up to the level of excitement around it. The anticipated maturation of blockchain technology is predicted to enhance its broader adoption[11, 12], expand the range of its applications, and hence enhance Blockchain's capacity to drive impactful disruptions. This aligns with the imperative to foster commercial processes, facilitate legal frameworks[13], and instigate the requisite cultural transformation and underlying organizational arrangements.

In light of the escalating concern of climate change and related environmental challenges[14-16], there has been a concurrent surge in attention towards the concept of sustainability[17-19]. The United Nations (UN) has established a set of objectives for sustainable development that cover everything from green energy to food safety [20]. Emerging technologies such as Blockchain technology has the potential to serve as a valuable instrument in addressing serious environmental challenges. The application of Blockchain with resolving the sustainable washing/SDG washing and greenwashing challenges for the policymakers. The authors posit that the aforementioned unethical washing fosters equitable practices within organizations, from purchasing materials to the supply chain process.

The integration of Green technology with the UN's Sustainable Development Goals offers a distinctive prospect [21] to expedite advancements towards a more equitable [17, 22], sustainable [23, 24], and inclusive global[25] community [26, 27]. By leveraging the inherent qualities of blockchain technology, such as transparency, traceability, and decentralization, it can enhance the ability to tackle urgent global concerns effectively. However, it is crucial to address the issues of scalability, environmental effect, and interoperability to fully harness blockchain technology's promise in promoting the Sustainable Development Goals (SDGs) [28].

The imperative to leverage the disruptive potential of blockchain technology for sustainable development necessitates the establishment of collaborative initiatives involving governments[29], businesses, and the global technology community. The literature is shown upward trends; however, there is a limited study to generalize the application

of Blockchain in achieving sustainable development goals. Therefore, the following research questions are raised.

1. What is the publication trend in the area of using Blockchain in sustainable development goals?

2. What are the most frequent authors' keywords used in the study?

3. What is the Thematic Evaluation

4. Who are the most cited authors on published documents, and what are their collaboration trends?

5. What are the future research trends in Blockchain in sustainable development goals?

To explore the answer to questions, the paper aims to report on the following objectives systematically.

1. To identify the publication trend area of using Blockchain in sustainable development goals

2. To identify the most used keywords in the study.

3. To identify the themes and network to other areas of research

4. To identify the collaboration trends.

5. To propose future research trends on Blockchain in sustainable development goal

In this research endeavour, we employed the search strings ("Sustainable Development Goals" OR "SDG" OR "Sustainable Development Goal") AND "Blockchain" to conduct a comprehensive literature search on both the Web of Science (WoS) and Scopus databases[30, 31]. The initial search yielded a total of 271 relevant documents, with 176 identified in Scopus and 95 in WoS. These documents formed the basis for our bibliometric analysis and provided valuable insights into the intersection of Sustainable Development Goals and Blockchain. This systematic literature search is conducted by using the Biblioshiny application of the Bibliometric R package.

This study found that there is a commendable yearly growth rate of 90.64%, and most studies are conducted in India. The keyword's occurrence reflects a multidisciplinary approach, incorporating digital technologies such as AI, IoT, and distributed ledger technology, mainly blockchain potential contributing towards sustainable development, sustainability, and circular economy. Lastly, the thematic and collaborative analysis

shows how Blockchain has evolved in different fields and been studied in different countries, followed by the significant research gap for future research. The structure of this article is as follows; section 2 establishes the methodology, section 3 describes the data analysis, section 4 discusses identifying the research gap for future research and lastly, the conclusion.

2. Methods

In this paper, we conducted a systematic literature review utilizing bibliometric analysis to provide a comprehensive overview of the current state of research at the intersection of sustainable development and Blockchain. By employing this method, we aimed to gather and connect relevant existing studies to present a clear and unbiased picture of the field [32]. The advantage of bibliometrics lies in its ability to handle large volumes of data concisely and objectively, making it well-suited for academic research [33, 34]. By exploring the internal relationships within the literature, bibliometric analysis allows researchers to trace the historical development of the field, gain insights into its current status, and identify potential directions for future studies [35-37]. The step-by-step process of data collection, screening, analysis, and visualization is depicted in Figure 3.

2.1. Data collection

Selection of Database: Database selection is a crucial initial step in conducting a rigorous bibliometric study [38]. We have considered two of the most widely used bibliometric databases for this analysis: Web of Science (WoS) by Clarivate Analytics and Scopus by Elsevier [39]. While WoS offers extensive coverage of the natural sciences and engineering, Scopus provides greater coverage in the social sciences [40]. By merging data from these two databases, we can obtain more comprehensive insights across various fields of literature [41, 42].

Search Criteria: In this research endeavour, we employed the search strings ("Sustainable Development Goals" OR "SDG" OR "Sustainable Development Goal") AND "Blockchain" to conduct a comprehensive literature search on both the Web of Science (WoS) and Scopus databases. The initial search yielded a total of 271 relevant documents, with 176 identified in Scopus and 95 in WoS. These documents formed the basis for our bibliometric analysis and provided valuable insights into the intersection of Sustainable Development Goals and Blockchain.
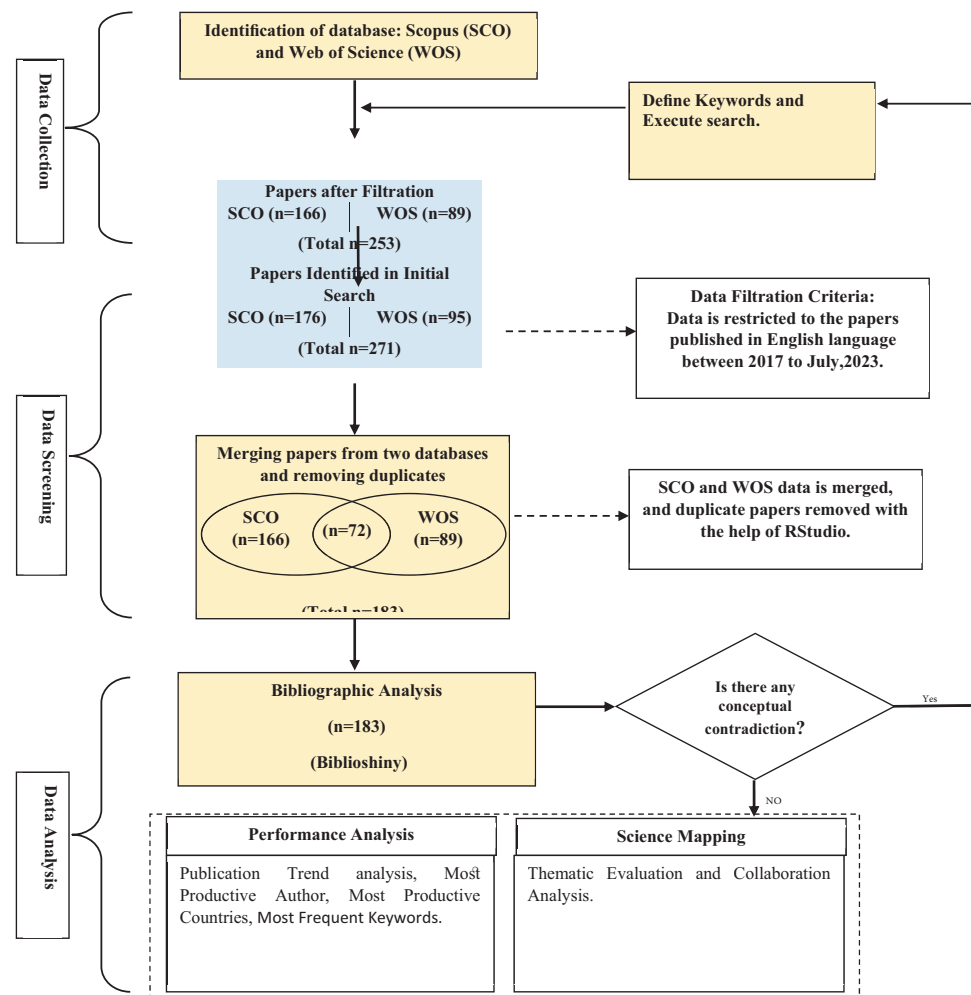
Figure 1: PRISMA flow diagram.

2.2. Data Screening

Filtration Criteria and Data Preparation: In this study, we employed a rigorous filtration process to guarantee the quality and relevance of the dataset. As part of this procedure, non-English language articles were excluded from the analysis, leading to a refined dataset that focused exclusively on English-language publications. The analysis encompassed the time frame between 2017 and July 2023, aiming to capture the most recent and pertinent research in the field. Following the filtration criteria, 253 English-language journal publications were retained for further investigation. Of these, 166 papers were obtained from Scopus, while 89 papers were sourced from the Web of Science (WoS).

Combining Data and Duplicate Removal: To consolidate the datasets from Scopus and Web of Science and eliminate potential duplicates, a meticulous process was

followed. First, Scopus publications were extracted and stored in a BibTeX format file named "SCO.bib." Similarly, Web of Science publications was exported as a plain text file labelled "WOS.txt," containing "Full record and cited references" for each publication. These datasets were merged using the RStudio software (version 2023.03.0) and the bibliometrix package functions. The publications were initially transformed into data frames using the functions "WOS - convert2df('WOS.txt')" and "SCO - convert2df('SCO.bib,' dbsource = 'scopus', format = 'bibtex')." Subsequently, the function "MergedFile - mergeDbSources(SCO, WOS, remove duplicated = TRUE)" was utilized to merge the datasets and eliminate any duplicate entries, culminating in a combined file named "MergedFile." As a result of this meticulous process, 55 duplicate documents were successfully removed from the dataset, leaving us with 183 papers that were ultimately considered for the bibliometric analysis [42].

Data Corrections: For data preparation and accuracy, the "MergedFile" dataset was converted to Microsoft Excel format (.xlsx) using the function "write.xlsx(MergedFile, file = 'Finaldata.xlsx')." The resulting dataset, "Finaldata.xlsx," underwent a manual examination in Microsoft Excel to identify and address any missing information. Furthermore, to ensure consistency and accuracy in the analysis, the Author Keywords and Keyword Plus entries were manually normalized. This involved unifying terms such as "IoT" and "Internet of Things," "AI" and "Artificial Intelligence," "Smart contracts" and "Smart contracts," "Blockchain" and "Bock-chain," and "SDGs" and "Sustainable Development Goals" using the Replace command in Microsoft Excel. This meticulous step facilitated a precise keyword count for the subsequent bibliometric analysis.

3. Data Analysis

In this study, we leveraged the powerful Biblioshiny program as a valuable tool for analysis and visualization to explore the current status and prospects of Sustainable Development Goals and Blockchain. Developed by Massimo Aria, Biblioshiny offers a comprehensive and user-friendly interface, making it an ideal choice for our research [43]. To access the Biblioshiny software, we executed the commands "install.packages('bibliometrix')" for installation, followed by "library(bibliometrix)" and "biblioshiny()" in the RStudio command workspace.

The analysis was conducted through extensive Performance Analysis and Science Mapping using the Biblioshiny software described by Moral-Muñoz, et al. [44]. The Performance Analysis encompassed various aspects, including analyzing publication trends, identifying the most productive authors and countries, and exploring the most

popular keywords. Additionally, Science Mapping techniques, such as the Coupling Network of Authors, Thematic Evaluation, and Collaboration Analysis, were employed to unveil insightful interrelationships and patterns within Sustainable Development and blockchain research.

By harnessing Biblioshiny's robust capabilities, we comprehensively understood the research landscape and potential future directions in this dynamic field of study. The program's advanced visualization and interpretation features allowed for effective data analysis, enabling us to draw well-informed conclusions and make valuable observations. The use of Biblioshiny proved to be a valuable asset in conducting this bibliometric analysis, empowering us to make meaningful contributions to understanding entrepreneurship and Blockchain's intersections in the context of Sustainable Development Goals.

4. Results

4.1. Overview

Table 1 presents a comprehensive overview of the dataset extracted from Scopus and Web of Science. A total of 183 documents were collected, showcasing a commendable yearly growth rate of 90.64% over the studied period. The average age of each document stands at 1.44 years, and they have garnered an average of 16.05 citations, indicative of the scholarly impact of the research. The dataset also encompasses substantial supporting information, comprising 1481 references and 620 keywords.

The dataset reflects the collaborative nature of the research, involving a diverse group of 566 individual contributors as authors. On average, each paper boasts 3.61 co-authors, with 21 authors presenting single-authored works. Notably, international collaborations account for 6.011% of authorships in the dataset, highlighting the global engagement and knowledge exchange in this field of study. This rich data set provides valuable insights into the collaborative landscape and researchers' multifaceted contributions to sustainable development and Blockchain.

4.2. Performance Analysis

Table 1: Descriptive Table.

MAIN INFORMATION ABOUT THE DATA	
Description	**Results**
Timespan	2017:2023
Documents	183
Annual Growth Rate	90.64 %
Document Average Age	1.44
Average citations per document	16.05
References	1481
DOCUMENT CONTENTS	
Keywords Plus (ID)	821
Author's Keywords (DE)	620
AUTHORS	
Authors	566
Authors of single-authored docs	21
AUTHORS COLLABORATION	
Co-Authors per Doc	3.61
International co-authorships	6.011 %

4.2.1. Publication Trend analysis

The table presents a comprehensive overview of the publication trends in the field of Sustainable Development Goals (SDGs) and Blockchain in Fig 2. Notably, there has been a consistent and exponential growth in the number of articles published over the years, indicating a rising interest in exploring the potential of blockchain technology in addressing sustainable development challenges. The field appears to be maturing, as evidenced by the doubling of articles from 2018 to 2019 and the subsequent acceleration in publications in 2020, 2021, and 2022. In particular, 2022 witnessed a significant publication spike, highlighting intensified research and exploration. As of July 2023, there have already been 48 articles published, suggesting a continued and stable interest in this domain. This burgeoning interest in the intersection of SDGs and blockchain technology will likely attract researchers from diverse disciplines, potentially leading to innovative and impactful solutions to global sustainability issues. The increasing publication trend signifies a promising outlook for the field, with the potential for further growth and meaningful contributions to sustainable development efforts worldwide.
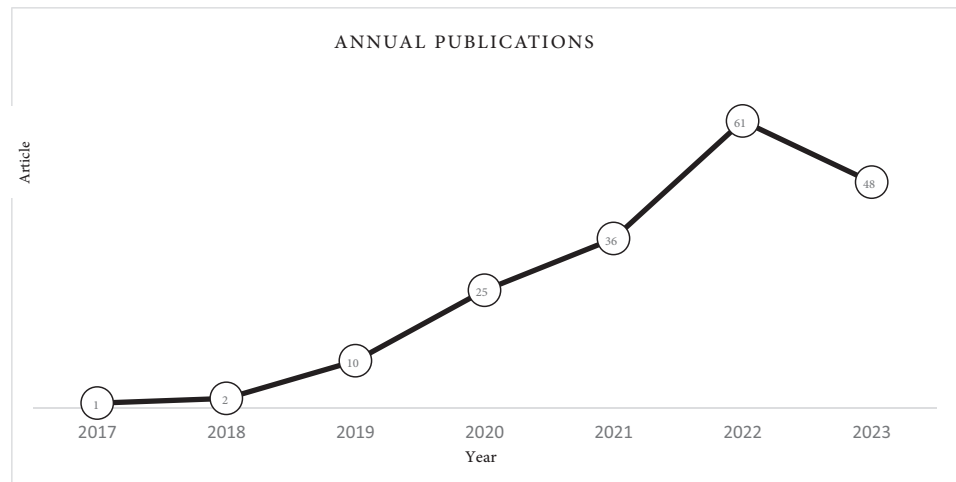
Figure 2: Publication Trend.

4.2.2. Most Productive Author

The table 2 showcases the most relevant authors in the intersection of Sustainable Development Goals (SDGs) and Blockchain, with their rankings based on the number of articles, fractionalized citations (AF), and average citations per article. Notably, authors from India dominate the top positions, led by Rajesh Singh, who has ten articles and an AF score of 1.51, indicating high citations beyond his publications. Singh's significant impact is further exemplified by his impressive average of 5.5 citations per article. Anita Gehlot follows closely with nine articles and an AF of 1.35, achieving a slightly higher average citation count of 5.55. The presence of multiple Indian authors signifies the country's growing prominence in research on sustainable development and Blockchain. However, it's worth noting that the fifth-ranked author, Niki Naderi from Iran, has a high AF score of 6 but a comparatively low total citation count (2) and average citations per article (0.33), indicating a need for further research validation and recognition. Beyond India and Iran, authors from diverse countries like South Africa, China, Spain, and the UK also make notable contributions, highlighting the global collaboration and knowledge exchange in this vital field. The table provides valuable insights into the key players shaping research at the nexus of SDGs and Blockchain. It showcases the continued relevance of these interdisciplinary topics in driving sustainable development and technological innovation on a global scale.

Figure ?? comprehensively depicts the top ten distinguished researchers in the field of Sustainable Development Goals and Blockchain, along with their research productivity over time. Each researcher is represented by a circle, with the size of the circle indicating the number of articles they have published. Additionally, the colour intensity of the circle

TABLE 2: Most Productive Author.

Rank	Author	Country	Articles	AF	Citations	Avg (Citation/ Article)
1	Rajesh Singh	India	10	1.51	55	5.5
2	Anita Gehlot	India	9	1.35	50	5.55
3	Sheikh Vaseem Akram	India	7	1.04	48	6.85
4	Neeraj Priyadarshi	India	7	1.04	45	6.42
5	Niki Naderi	Iran	6	6.00	2	0.33
6	Bhekisipho Twala	South Africa	5	0.77	33	6.6
7	Jiewu Leng	China	3	0.45	233	77.66
8	Higinio Mora	Spain	3	0.83	44	14.66
9	Xuan Zhang	China	3	0.60	35	11.66
10	Richards Adams	UK	2	0.67	186	93

corresponds to the number of citations each researcher's articles have received. Larger circles denote a higher volume of published papers, while deeper colours signify a more significant number of citations, indicating the impact and recognition of their work.
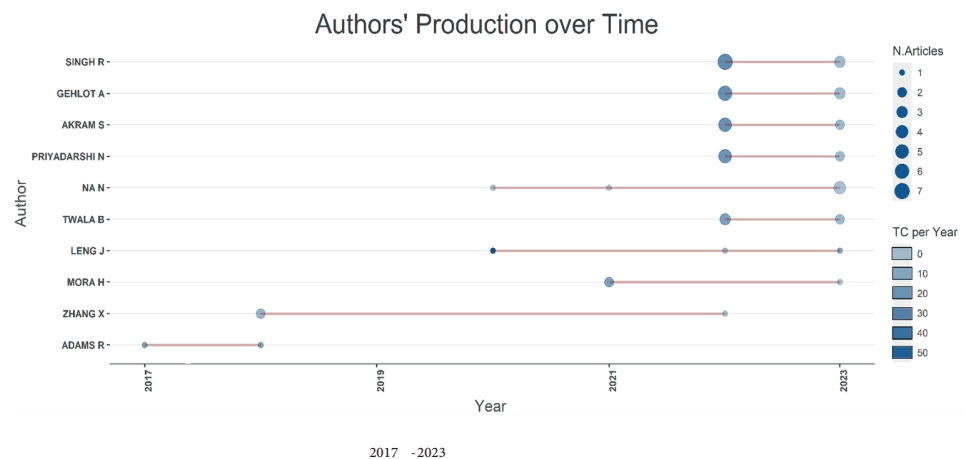

Figure 3: Authors' productive year 2017-2023.

4.2.3. Most Productive Countries

The global map showcases the top ten countries in Sustainable Development Goals (SDGs) and Blockchain research, ranked by the total number of research papers (TP) they produced from 2017 to July 2023, along with their total number of citations (TC) in Fig 4. India emerges as the leading contributor with 28 research papers. Yet, its relatively low citation count of 165 suggests that despite its prolific output, the impact

and recognition of Indian research in this area may need improvement. On the other hand, China stands out with 23 research papers and a significantly higher citation count of 380, highlighting the country's remarkable research impact and influence in the field. Australia and the UK also exhibit noteworthy contributions, with 17 and 15 research papers, respectively. Still, Australia surpasses others with an impressive citation count of 491, emphasizing the quality and recognition of its research. While Italy shows promise with 12 research papers and 294 citations, the United States surprisingly lags with only ten research papers and a low citation count of 41, indicating that research quantity does not always equate to impact. South Korea's seven research papers and 50 citations demonstrate a positive research impact, while Indonesia's lack of citations (TC=0) signals a need for enhanced visibility and recognition of its research efforts. South Africa, with six research papers and 83 citations, also shows promising signs of research impact. Overall, this analysis underscores the importance of research quality and impact over sheer quantity, and it highlights the potential for international collaboration to advance sustainable development and blockchain technology research further globally. As a Research Scholar, I recognize the significance of fostering cooperation among nations to address the pressing challenges in these domains and promote global sustainable development.
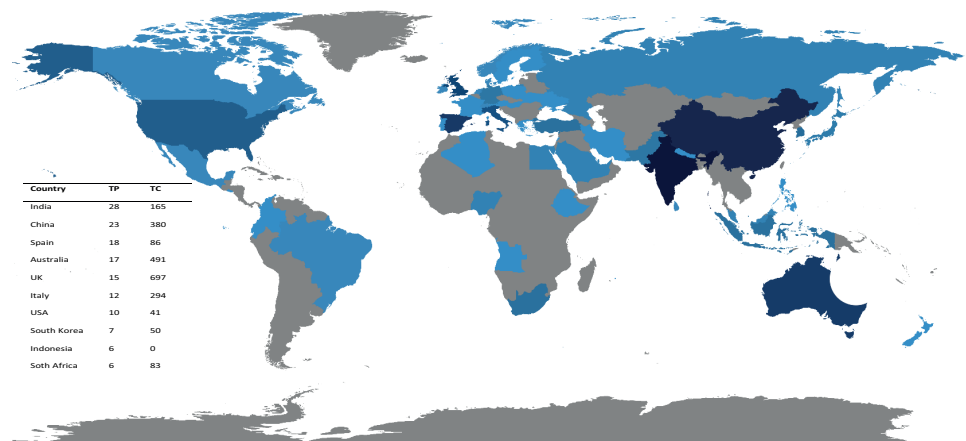
Country	TP	TC
India	28	165
China	23	380
Spain	18	86
Australia	17	491
UK	15	697
Italy	12	294
USA	10	41
South Korea	7	50
Indonesia	6	0
Soth Africa	6	83

Figure 4: Most Productive Countries.

4.2.4. Most Frequent Keywords

The most often used keywords the author provides in academic publications on Sustainable Development Goals (SDGs) Fig 5. Notably, "blockchain" is the most prevalent term, with a frequency of 99, indicating the technology's significant impact and relevance in sustainable development endeavours. The prominence of "sustainable development

goals" with a frequency of 82 underscores the strong emphasis on aligning research efforts with the United Nations' SDGs, reflecting the field's commitment to addressing global challenges and promoting sustainable practices, including "AI" (Artificial Intelligence) with a frequency of 28 highlights the integration of advanced technologies to enhance sustainability initiatives. The frequent mention of "sustainability" (frequency of 26) and "IoT" (Internet of Things, frequency of 22) further accentuates the intersection of cutting-edge technologies and sustainable development objectives. Interestingly, "COVID-19" appears 11 times, signifying its profound impact on research discussions within this domain. The presence of terms like "big data," "cryptocurrency," "circular economy," "innovation," and "supply chain" signifies the multifaceted approach to sustainable development and blockchain research. The map reflects a multidisciplinary approach, incorporating digital technologies such as AI, IoT, and distributed ledger technology and their potential contributions to sustainable development.
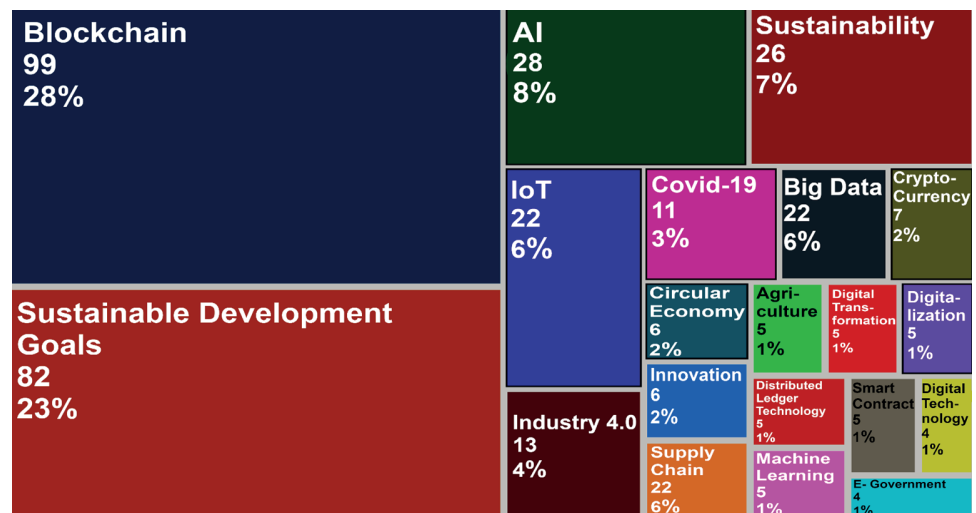

Figure 5: Most Frequent Keywords.

4.3. Science Mapping

4.3.1. Thematic Evaluation

Figure 7 illustrates the thematic evolution of selected authors' keywords from 2016 to 2022, employing a Sankey diagram generated using the bibliometrix package in R-Studio. As advocated by Aria, et al. [45], Sankey diagrams serve as valuable tools to depict the relationships between different themes and their historical development. In this context, "thematic evolution" pertains to changes in the frequency and co-occurrence of keywords over time, shedding light on the progression of specific study

themes [46]. The map comprises smaller boxes, each representing distinct themes, with the size of the box indicating the frequency of appearance [47]. A line connects each box on the map, with more robust connections denoting closer relationships between two topics [48]. This approach enables us to gain insights into the dynamic evolution of research themes and their interconnections over the specified time frame.
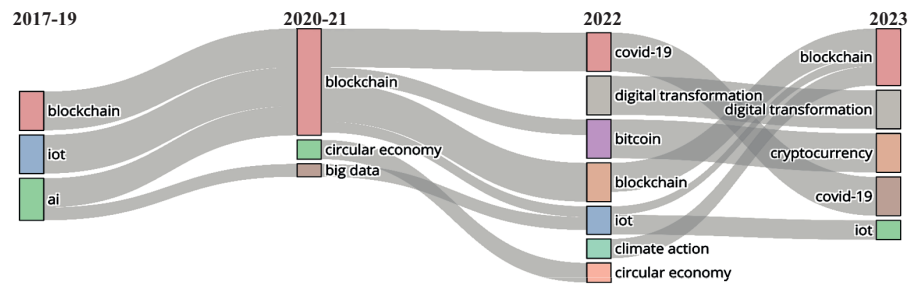

Figure 6: Thematic Evolution year 2017-2023.

The Figure 6 represents the thematic evolution in sustainable development goals and Blockchain over different periods. From 2017 to 2019, there was a focus on AI and its relationship with sustainable development goals and big data. In the following years, from 2020 to 2021, Blockchain emerged as a prominent topic with discussions around its use in various contexts, such as sustainable development goals, IoT, and COVID-19. Blockchain was also associated with cryptocurrency and distributed ledger technology during this period. In 2022, there was a shift towards digital transformation, and Blockchain continued to be explored in the context of sustainability, industry 4.0, and climate action. In 2023, the emphasis on COVID-19 remained, and the discussions also included digital transformation and the Internet of Things (IoT). Blockchain has been a significant topic throughout these periods, and its intersections with AI, big data, and IoT have been actively explored. The evolution shows that Blockchain has become a central theme in sustainable development discussions, further exploring its potential applications across various sectors. The increasing integration of Blockchain with other emerging technologies indicates its potential to drive innovation and address complex challenges in achieving sustainable development goals.

4.3.2. Collaboration Analysis

Figure 7 depicts the global collaboration map generated by the biblioshiny software. Forty paired countries collaborated worldwide. The map shows countries' collaborative efforts in Blockchain and sustainable development goals (SDGs). Australia has collaborated with Mauritius, New Zealand, and South Africa, each once. China has emerged as

an active participant in various collaborations, partnering with Indonesia (twice), Jordan, Korea, Pakistan, Saudi Arabia, Spain, and Turkey simultaneously. India's collaborations involve Angola, Mexico, South Africa, Spain, the United Kingdom, and the USA, with multiple interactions with Mexico and South Africa. Other notable collaborations include Indonesia with Jordan and Saudi Arabia, Italy with France and Malaysia, and Korea with Pakistan and Turkey. Countries like Mexico, Spain, and the USA have collaborated with different partners. These collaborative efforts signify a global commitment to sustainable development and the exploration of blockchain technology for transformative advancements. However, further context and analysis are necessary to fully understand the depth and impact of these collaborations on the shared objectives of global progress and innovation.
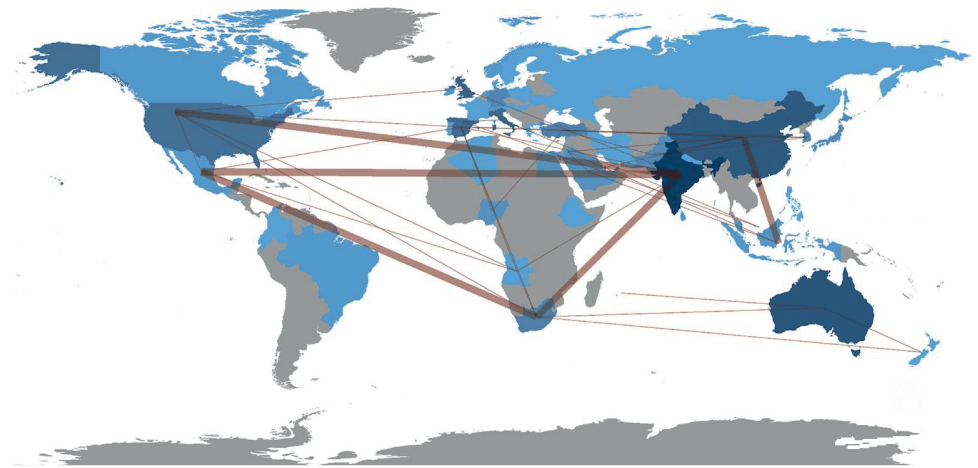
Figure 7: Global Collaboration Map.

5. Discussions

The analysis of publication trends reveals a growing interest in the intersection of Sustainable Development Goals (SDGs) and Blockchain, with exponential growth in articles published over the years, indicating increased exploration of blockchain technology's potential in sustainable development. The dominance of Indian authors, like Rajesh Singh and Anita Gehlot, highlights India's prominence in this research, while collaborations from diverse countries emphasize global knowledge exchange. However, the analysis also emphasizes the importance of research impact over quantity, with China and Australia showcasing significant research impact. The most frequent keywords reflect the field's multidisciplinary nature, with AI, IoT, and COVID-19 being prominent themes. The thematic evolution underscores Blockchain's central position, exploring

intersections with AI, big data, and IoT, with a shift towards digital transformation in 2022. Global collaborations signify a unified commitment to sustainable development and blockchain research. The analysis provides the significance of fostering inter-disciplinary collaborations and promoting responsible research to unlock blockchain technology's full potential in addressing global sustainability challenges and driving meaningful progress.

5.1. Future Research Opportunities:

1. (a) **Interdisciplinary Collaboration:** While there is evidence of interdisciplinary research in the field, there may still be opportunities for greater collaboration between experts from different domains. Encouraging cross-disciplinary research can lead to more comprehensive and innovative solutions to sustainability challenges.

    (b) **Research Impact and Recognition:** The analysis highlights variations in research impact and recognition among different countries and authors. Addressing the factors contributing to these disparities can help ensure that impactful research gets the recognition it deserves.

    (c) **Long-term Impact Assessment:** As the field continues to grow, there is a need for longitudinal studies to assess the long-term impact of blockchain applications on achieving Sustainable Development Goals. Understanding these technologies' outcomes and contributions is crucial to shaping future research and policy decisions.

    (d) **Ethical and Social Implications:** With the increasing adoption of blockchain technology in sustainable development initiatives, there is a need to address ethical and social implications. Research focusing on the potential risks, privacy concerns, and equitable access to blockchain-based solutions can help in responsible technology deployment.

    (e) **User Acceptance and Behavior in Blockchain Adoption:** Understanding user acceptance and behavior is critical for successful blockchain implementation in sustainable development initiatives. Research should explore factors influencing user attitudes toward blockchain technology, their willingness to adopt it, and any potential resistance or concerns. This understanding will help in tailoring user-centric blockchain solutions that effectively support sustainable development objectives.

5.2. Future Recommendations:

1. (a) **Global Research Collaborations:** Encouraging more international collaborations can foster a diverse and comprehensive understanding of sustainable development challenges. Governments and funding agencies should support joint research projects to facilitate knowledge exchange and mutual learning.

    (b) **Policy and Regulatory Frameworks:** As blockchain technology is increasingly applied to address SDGs, policymakers should develop supportive regulatory frameworks that promote innovation while managing potential risks. Engaging academia, industry, and civil society stakeholders in policy discussions can ensure balanced and inclusive governance.

    (c) **Public Awareness and Education:** Raising public awareness about the potential of blockchain technology in sustainable development can create a more informed and engaged global community. Educational initiatives and outreach programs can bridge the gap between research findings and practical implementation.

    (d) **Data Sharing and Standards:** Encouraging data sharing and establishing standardized protocols within the blockchain ecosystem can enhance project collaboration and interoperability. Open data initiatives can facilitate cross-border research and data-driven solutions for sustainable development.

    (e) **Ethical Considerations:** Researchers and practitioners should prioritize ethical considerations in developing and implementing blockchain-based solutions. Ethical guidelines and impact assessments should be an integral part of sustainable development projects involving blockchain technology. After analyzing publication trends, author productivity, country contributions, keywords, thematic evolution, and collaboration patterns reveals a thriving and promising landscape at the intersection of Sustainable Development Goals and Blockchain. The identified research gaps and future recommendations can guide researchers, policymakers, and stakeholders in making informed decisions and leveraging blockchain technology's potential to achieve sustainable development objectives on a global scale.

6. Conclusion

The study's novelty is investigating research trends of blockchain technology applications on SDG performance. The application of Blockchain with resolving the sustainable

washing/SDG washing and greenwashing challenges for the policymakers. The authors posit that the aforementioned unethical washing fosters equitable practices within organizations, from purchasing materials to the supply chain process. This approach aims to satisfy the needs of diverse consumers, especially manufacturing firms, by promoting environmentally sustainable practices throughout their production and supply chain operations of manufacturing firms without compromising all environmental SDGs, social SDGs and economic SDGs[18, 49]. The exciting evidence proves that Blockchain technology has emerged as a novel solution for improving transparency and accountability in various aspects of sustainable development. The lack of research on the intersection of blockchain technology and sustainable development goals is a catalyst for undertaking a bibliometric literature assessment to identify and analyze emerging research directions. The keywords "Blockchain" and "Sustainable Development Goals" were examined in the Scopus and Web of Science databases. A total of 271 articles were obtained from 2017 to 2023. After applying the inclusion and exclusion criteria, 183 papers were selected for bibliographic analysis using the Biblioshiny application of the Bibliometrix R package. This study shows the positive upward trends in recent years, Most Productive Authors, Productive countries, keywords occurrence, Thematic Evaluation and collaborative analysis. The systematic literature review also proposes five future trends for various stakeholders to explore the opportunities and application of Blockchain in achieving the SDG Goals.

Ethical Approval

Not applicable.

7. Consent to Participate

All authors have equally participated in drafting the articles.

8. Consent to Publish

All authors have agreed on the final draft to submit for publication.

Acknowledgement

Funding

Competing Interests

The authors have no conflict of interest.

Availability of data and materials

Available on Request

References

[1] Toha MA, Johl SK. "Does Proactive Eco Eco-Innovation Matter in the Energy Sector?" in European Conference on Management, Leadership & Governance, 2021: Academic Conferences International Limited, pp. 420-XIV.

[2] Toha MA, Johl SK. Panel dataset to assess proactive eco-innovation in the paradigm of firm financial progression. Data (Basel). 2021;6(12):131.

[3] Toha MA, Akter R, Uddin MS. Paradigm of sustainable process safety management for industrial revolution 4.0: A circular economy and sustainability perspective. Process Safety Progress. 2022;41 S1:S17–26.

[4] Toha MA. Eco-innovation, board of directors and firms financial performance: A study on Malaysian Energy Listed Companies. Universiti Teknologi Petronas; 2021.

[5] Shah SQ, Lai FW, Shad MK, Jan AA. Developing a green governance framework for the performance enhancement of the oil and gas industry. Sustainability (Basel). 2022;14(7):3735.

[6] Warsi Khan H, Kaif Khan M, Moniruzzaman M, Al Mesfer MK, Danish M, Irshad K, et al. Evaluating ionic liquids for its potential as eco-friendly solvents for naproxen removal from water sources using COSMO-RS: computational and experimental validation. Environ Res. 2023 Aug;231(Pt 1):116058.

[7] Khan HW, Zailan AA, Bhaskar Reddy AV, Goto M, Moniruzzaman M. "Ionic liquid-based dispersive liquid-liquid microextraction of succinic acid from aqueous streams: COSMO-RS screening and experimental verification," Environmental technology. no. just-accepted, pp. 1-43, 2023.

[8] Khan HW, Elgharbawy AA, Shah MU, Negash BM, Khan MK, Khan K, et al. Exploring ionic liquids for formaldehyde separation via computational COSMO-RS screening. Chemical Engineering Research and Design. 2023;196:588–598.

[9] Khan HW, Elgharbawy AA, Bustam MA, Goto M, Moniruzzaman M. Ionic liquid-based green emulsion liquid membrane for the extraction of the poorly soluble drug ibuprofen. Molecules. 2023 Mar;28(5):2345.

[10] Abdul Jalil N, Wong Ei Leen M. "Big Data in the Era of Pandemic COVID-19: Application of IoT based data analytics, Machine Learning and Artificial Intelligence," in Proceedings of the 5th International Conference on Big Data and Education. 2022:361-367.

[11] Toufaily E, Zalan T, Dhaou SB. A framework of blockchain technology adoption: an investigation of challenges and expected value. Inf Manage. 2021;58(3):103444.

[12] Aysan AF, Bergigui F, Disli M. Blockchain-based solutions in achieving SDGs after COVID-19. J Open Innov. 2021;7(2):151.

[13] Juszczyk O, Shahzad K. Blockchain technology for renewable energy: principles, applications and prospects. Energies. 2022;15(13):4603.

[14] Jan AA, Lai FW, Asif M, Akhtar S, Ullah S. Embedding sustainability into bank strategy: implications for sustainable development goals reporting. International Journal of Sustainable Development & World Ecology. 2023;30(3):229–43.

[15] Yusuf M, Khan HW, Beg M, Ekeoma BC, Nishat A, Al-Othman AL. Effect of Climate Change on Air Quality: A Nigerian Perspective. Climate Change Impacts on Nigeria: Environment and Sustainable Development. Springer; 2023. pp. 19–38.

[16] Malik H, Khan HW, Hassan Shah MU, Ahmad MI, Khan I, Al-Kahtani AA, et al. Screening of ionic liquids as green entrainers for ethanol water separation by extractive distillation: COSMO-RS prediction and aspen plus simulation. Chemosphere. 2022 Oct;311(Pt 2):136901.

[17] Khan PA, Johl SK, Ntim CG. Nexus of Comprehensive Green Innovation, Environmental Management System-14001-2015 and Firm Performance. Cogent Business & Management. 2019;6(1):1691833.

[18] Khan PA, et al. "Injecting green innovation reporting into sustainability reporting," in SHS Web of Conferences, 2021, vol. 124: EDP Sciences, p. 05003. https://doi.org/10.1051/shsconf/202112405003.

[19] Toha MA, Johl SK, Khan PA. Firm's sustainability and societal development from the lens of fishbone eco-innovation: A moderating role of ISO 14001-2015 environmental management system. Processes (Basel). 2020;8(9):1152.

[20] Khan PA, Johl SK, Akhtar S. Firm sustainable development goals and firm financial performance through the lens of green innovation practices and reporting: a proactive approach. Journal of Risk and Financial Management. 2021;14(12):605.

[21] Wang X, Javaid MU, Bano S, Younas H, Jan A, Salameh AA. Interplay among institutional actors for sustainable economic development—Role of green policies, ecoprenuership, and green technological innovation. Frontiers in Environmental Science; 2022. p. 1557.

[22] Khan PA, Johl SK, Kumar A, Luthra S. Hope-hype of green innovation, corporate governance index, and impact on firm financial performance: a comparative study of Southeast Asian countries. Environmental Science and Pollution Research. 2023 Apr;30(19):55237–54.

[23] Jan AA, Lai FW, Tahir M. Developing an Islamic Corporate Governance framework to examine sustainability performance in Islamic Banks and Financial Institutions. Journal of Cleaner Production. 2021;315:128099.

[24] Jan A, Mata MN, Albinsson PA, Martins JM, Hassan RB, Mata PN. Alignment of islamic banking sustainability indicators with sustainable development goals: policy recommendations for addressing the covid-19 pandemic. Sustainability (Basel). 2021;13(5):2607.

[25] Jan A, Marimuthu M, Hassan R, Mehreen. Sustainable Business Practices and Firm's Financial Performance in Islamic Banking: Under the Moderating Role of Islamic Corporate Governance. Sustainability (Basel). 2019;11(23):6606.

[26] Khan PA, Johl SK, Akhtar S. Vinculum of sustainable development goal practices and firms' financial performance: A moderation role of green innovation. J Risk Financ Manag. 2022;15(3):96.

[27] Khan PA, Johl SK, Johl SK. Does adoption of ISO 56002⬛2019 and green innovation reporting enhance the firm sustainable development goal performance? An emerging paradigm. Bus Strategy Environ. 2021;30(7):2922–2936.

[28] Jan A et al. "Islamic corporate sustainability practices index aligned with SDGs towards better financial performance: Evidence from the Malaysian and Indonesian Islamic banking industry," Journal of Cleaner Production. 2023 Jun;405. https://doi.org/10.1016/j.jclepro.2023.136860

[29] Kasinathan P, Pugazhendhi R, Elavarasan RM, Ramachandaramurthy VK, Ramanathan V, Subramanian S, et al. Realization of Sustainable Development Goals with Disruptive Technologies by Integrating Industry 5.0, Society 5.0, Smart Cities and Villages. Sustainability (Basel). 2022;14(22):15258.

[30] Khan PA, Johl SK, Akhtar S, Asif M, Salameh AA, Kanesan T. Open innovation of institutional investors and higher education system in creating open approach for SDG-4 quality education: a conceptual review. Journal of Open Innovation. 2022;8(1):49.

[31] Jan AA, Lai FW, Siddique J, Zahid M, Ali SE. A walk of corporate sustainability towards sustainable development: a bibliometric analysis of literature from 2005 to 2021. Environmental Science and Pollution Research. 2023 Mar;30(13):36521–36532.

[32] Zhu L, Ali M, Macioszek E, Aghaabbasi M, Jan A. Approaching sustainable bike-sharing development: A systematic review of the influence of built environment features on bike-sharing ridership. Sustainability (Basel). 2022;14(10):5795.

[33] Jokić M, Ball R. Qualität und Quantität wissenschaftlicher Veröffentlichungen: Bibliometrische Aspekte der Wissenschaftskommunikation. Forschungszentrum Jülich, 2006.

[34] Xue X et al. "Global trends and hotspots in research on rehabilitation robots: a bibliometric analysis from 2010 to 2020," 2022;9:806723. https://doi.org/10.3389/fpubh.2021.806723

[35] Zhao H, Zhang F, Kwon JJ. "Corporate social responsibility research in international business journals: An author co-citation analysis," vol. 27, no. 2, pp. 389-400, 2018.

[36] Durieux V, Gevenois PA. "Bibliometric indicators: quality measurements of scientific publication," 2010;255(2):342-351.

[37] Bilal, et al. Virtual Learning During the COVID-19 Pandemic: A Bibliometric Review and Future Research Agenda. 2022. pp. 1353–1368.

[38] Ayan B, Güner A, Son-Turan SJL. "Blockchain technology and sustainability in supply chains and a closer look at different industries: A mixed method approach." 2022;6(4):85. https://doi.org/10.3390/logistics6040085

[39] Zhu J, Liu WJ. "A tale of two databases: The use of Web of Science and Scopus in academic papers" 2020;123(1):321-335.

[40] Mongeon P, Paul-Hus AJ. The journal coverage of Web of Science and Scopus: a comparative analysis. 2016;106: 213–228.

[41] Kumpulainen M, Seppänen MJ. "Combining Web of Science and Scopus datasets in citation-based literature study" 2022;127(10):5613-5631. https://doi.org/10.1007/s11192-022-04475-7

[42] Echchakoui SJ. "Why and how to merge Scopus and Web of Science during bibliometric analysis: the case of sales force literature from 1912 to 2019," 2020;8:165-184.

[43] Aria M, Cuccurullo CJ. "bibliometrix: An R-tool for comprehensive science mapping analysis." 2017.11(4):959-975.

[44] Moral-Muñoz JA, Herrera-Viedma E, Santisteban-Espejo A, Cobo MJ. "Software tools for conducting bibliometric analysis in science: An up-to-date review," 2020;29(1).

[45] Aria M, Misuraca M, Spano MJ. Mapping the evolution of social research and data science on 30 years of Social Indicators Research. 2020;149:803–831.

[46] Hu H, Wei X, Hao Z. "Theme evolution analysis of public security events based on hierarchical dirichlet process," in Frontier Computing: Theory, Technologies and Applications (FC 2018) 7, 2019: Springer, pp. 40-49. https://doi.org/10.1007/978-981-13-3648-5_5

[47] Srivastava and Planning, "Mapping the influence of influencer marketing: a bibliometric analysis." 2021;39(7):979-1003.

[48] Xiao Z, Qin Y, Xu J, Antucheviciene J, Zavadskas EKJB. "The journal Buildings: A bibliometric analysis (2011–2021)." 2022;12(1):37. https://doi.org/10.3390/buildings12010037

[49] Jan A, Rahman HU, Zahid M, Salameh AA, Khan PA, Al-Faryan MA, et al. Islamic corporate sustainability practices index aligned with SDGs towards better financial performance: Evidence from the Malaysian and Indonesian Islamic banking industry. Journal of Cleaner Production. 2023;405:136860.