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Review Article

EVOLVING TRENDS IN CONSORTIUM BLOCKCHAIN AND ENERGY CONSUMPTION: A BIBLIOMETRIC PERSPECTIVE ON CONSENSUS MECHANISMS

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ABSTRACT

This study conducts a comprehensive bibliometric analysis of blockchain technology, with particular emphasis on energy consumption, consortium blockchain models, data storage mechanisms, and security considerations. Recognized for its decentralized architecture, blockchain has emerged as a transformative technology across diverse industries, offering enhanced transparency, security, and operational efficiency. The analysis draws on scholarly publications indexed in two prominent databases, Scopus and Web of Science (WoS), spanning 14 years from 2010 to 2024. Using the R-based bibliometric tool "Biblioshiny," the study evaluates a dataset comprising 506 documents from 319 distinct sources. Contributions from 1,360 unique authors generated 1,329 author-specific keywords and referenced a total of 6,678 sources, yielding an average of 12.58 citations per document. The findings reveal a substantial volume of scientific output originating from China, underscoring its prominent role in advancing blockchain research. Overall, the study highlights the dynamic and collaborative nature of global research efforts in this domain, while identifying key trends and influential contributors.

1 INTRODUCTION

Blockchain technology, first introduced through the launch of Bitcoin in 2008, has evolved considerably and now plays a transformative role across multiple sectors beyond its original application in digital currencies [1]. Functioning as a decentralized ledger system, it offers promising solutions to issues concerning trust, transparency, and security in digital interactions. However, despite its advantages, blockchain presents several critical challenges, particularly about energy consumption, data storage, and cybersecurity [2]. Among these, the energy demands of blockchain networks, especially those utilizing Proof of Work (PoW) consensus protocols are of growing concern, as they require extensive computational power for transaction validation and mining. Studies indicate that the energy requirements of PoW-based systems can rival those of smaller

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nations, prompting increased academic interest in exploring more sustainable alternatives like Proof of Stake (PoS) and other hybrid consensus models [3].

Consortium blockchains represent a notable evolution in blockchain architecture, functioning as a hybrid model that integrates characteristics of both public and private blockchains. This structure permits a defined group of organizations to jointly manage the network, aiming to strike a balance between the decentralized nature of blockchain and the need for structured governance and efficient resource utilization [4]. Such a model is particularly well-suited for sectors like finance, supply chain logistics, healthcare, and government, where establishing trust among known and verified participants is critical [5]. A related and increasingly important area of research within blockchain technology is data storage. Traditional blockchain systems, which store every transaction directly on the chain, often face scalability challenges as the ledger size grows. To overcome these limitations while maintaining data integrity and security, researchers have proposed solutions such as off-chain storage techniques and sharding mechanisms [2,6].

Security remains a foundational pillar of blockchain technology. Its decentralized architecture and cryptographic protocols provide robust defenses against many traditional cyber threats. However, the emergence of advanced attack strategies and the anticipated impact of quantum computing introduce new vulnerabilities, highlighting the urgent need for ongoing improvements in security frameworks and encryption techniques [4,7]. This bibliographic analysis integrates insights from a broad spectrum of academic literature, technical reports, and case studies to present a holistic view of blockchain's current landscape particularly focusing on energy efficiency through consensus mechanisms, consortium blockchain models, data storage strategies, and security concerns. The study emphasizes the importance of continuous innovation and cross-disciplinary collaboration to address the prevailing challenges and to unlock the full capabilities of blockchain technology. It aims to serve as a valuable reference for researchers, industry professionals, and policymakers seeking to engage with the evolving dynamics and potential applications of blockchain systems.

The structure of the study is organized as follows: First, the methodology employed for the bibliographic analysis will be outlined, guided by the PRISMA flow diagram. This will be followed by a detailed presentation of the results, supported by various illustrative graphs and relevant documents. Finally, the study will conclude with a concise discussion summarizing the key findings and offering recommendations for future research directions. The present study employed the 'Biblioshiny' package within the RStudio environment to conduct an in-depth bibliometric analysis. R, a widely used open-source programming language, provides the computational foundation for Biblioshiny's interactive capabilities. Various data visualization techniques were utilized to extract and interpret meaningful insights through graphical representations. The bibliometric analysis was carried out across several key dimensions, including: general descriptive statistics, annual scientific production, average citations per year, and a three-field plot using a Sankey diagram. Additional areas of analysis included country-wise scientific output, relevant publishing sources, identification of core sources using Bradford's Law, and source productivity trends over time.

Further evaluations encompassed the identification of prominent authors, their local impact through H-index metrics, author productivity over time, and most locally cited researchers. The collaboration network among authors and the distribution of relevant affiliations were also analyzed. Geographical contributions were assessed through corresponding authors' countries and globally cited documents, alongside citation analysis by country. Additional insights were derived from reference publication year spectroscopy, thematic tree maps, frequent keywords, word cloud generation, trending topics, co-occurrence network mapping, thematic map analysis, and international collaboration networks. Lastly, factorial analysis was conducted to explore the structural relationships among research themes. This comprehensive approach was supported by relevant references from the analyzed research papers.

2 METHODS

This study adopted a structured approach for bibliographic data collection using two defined search strings to explore different thematic areas of blockchain research. As shown in Figure 1, the first string, "Consortium blockchain and its application," was used to extract data from Scopus and Web of Science (WoS). Scopus returned 317 documents, and WoS returned 201. After limiting the scope to article titles, abstracts, and keywords, and excluding short surveys and entries with missing data, the final counts were 314 from Scopus and 148 from WoS. These were merged into 462 combined documents, which were then de-duplicated, resulting in 324 unique records. The second string focused on energy-related themes in blockchain, used the query: "Energy Efficiency" OR "Energy Optimization" OR "Power Consumption" OR "Energy Consumption"

AND “Consensus Mechanism”. This returned 176 documents from Scopus and 95 from WoS. After similar filtering processes, 174 documents from Scopus and 87 from WoS were retained. These were combined into 261 records, and after removing duplicates, 182 unique documents were finalized.Finally, the unique documents from both search strings 324 from String 1 and 182 from String 2 were combined, resulting in a total of 506 unique documents. This comprehensive dataset forms the foundation for the bibliometric analysis presented in the study, offering insights into key research trends, prolific authors, thematic evolution, and regional contributions, especially highlighting China's leading role in the selected domains.

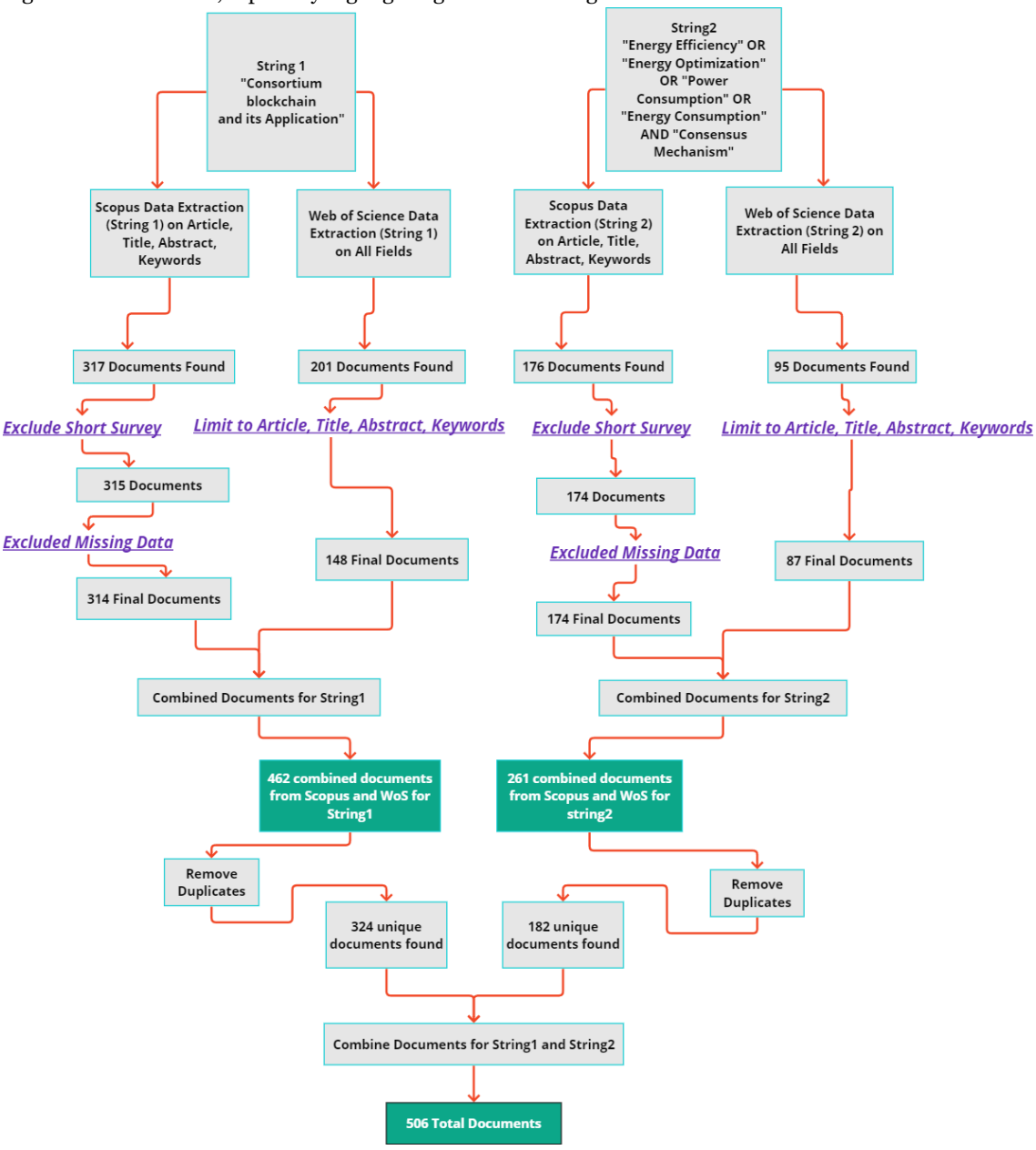

Figure 1: Workflow for associated document selection

3 Results and Discussion

A comprehensive overview of scientific production metrics spanning the period from 2010 to 2024. These metrics encompass a range of indicators, including the number of publication sources, annual growth rate, collaboration patterns, authorship distribution, and citation trends. The key findings derived from this data

are summarized in Table 1. The analysis highlights a progressively evolving and collaborative research landscape, with a marked increase in scholarly output and citation impact observed particularly between 2018 and 2024. This upward trend underscores the growing interest and engagement in the field, suggesting promising opportunities for future exploration and academic inquiry.

Table 1: Main Information Table

Metric	Key Findings
Sources	319 sources, reflecting a diverse array of publication outlets. The inclusion of diverse sources enhances the widespread dissemination of research findings [8].
Annual Growth Rate	The significant annual growth rate of 31.65% demonstrates a notable rise in scientific productivity during the specified period. Research indicates that enhanced collaboration and international partnerships frequently contribute to elevated growth rates in scientific output [9].
Authors	The involvement of 1360 authors reflects significant collaboration. Higher author counts are typically seen in fields with extensive interdisciplinary research [10].
Authors of Single-authored Docs	Only 15 single-authored documents suggest a strong trend toward collaborative research. This trend is supported by findings that collaborative works often yield higher impact [11].
International Co-Authorship	14.82% international co-authorship indicates substantial global collaboration, which is crucial for enhancing the quality and impact of research [12].
Co-Authors per Doc	An average of 4.24 co-authors per document signifies strong collaborative efforts. Studies show that multi-authorship is linked to higher citation rates and research quality [13].
Author's Keywords (DE)	The use of 1239 unique keywords reflects a wide range of research subjects being explored. Keyword diversity is essential for the visibility and retrieval of scientific work [14].
References	The substantial quantity of 6678 citations demonstrates a high level of involvement with the existing literature, which is crucial for comprehensive research and validation [15].
Document Average Age	An average age of 2.46 years for documents suggests recent and up-to-date research contributions [16].
Average Citations per Doc	An average of 10.58 citations per document indicates a high research impact. Higher citation averages are often associated with influential and high-quality research [17].
Documents	A dataset comprising 506 entries showcases robust scientific productivity and indicates potential avenues for further exploration within the specific research domain.

3.1 AVERAGE CITATIONS PER YEAR

The graph depicted in Figure 2 highlights the dynamics of average citations per year, illustrating an initial period of low impact, succeeded by a notable increase to an average of 8 citations per year in 2019, which highlights a universal citation distribution pattern across institutions [18]. Following that, there is a further fall that can be linked to several things, including the aging of the articles, changes in research trends, or shorter citation windows in the context of the phenomena of citation inflation and its long-term effects [19].

3.2 THREE FIELD PLOT (SANKEY PLOT)

The interrelationship between country, author, and research themes is further detailed in Table 2. China is at the forefront in terms of contributions and influence within the field. The broad range of subjects addressed indicates a robust and diverse research landscape that prioritizes technological advancements.

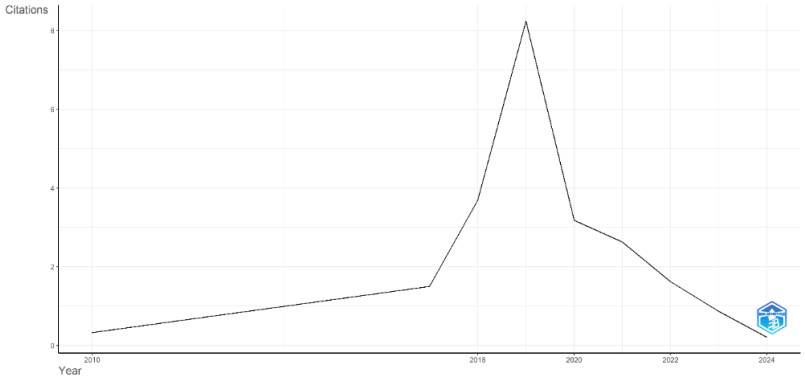

Figure 2: Annual Citations per Year

Table 2: Sankey Table (Country, Author, and Key Themes)

Country	Authors	Research Themes	References
China	Li J, Zhang S, Zhang J	Blockchain, Consortium Blockchain, Security	[1,2]
Australia	Zhang J	Internet of Things, Smart Contract	[4]
USA	Wang X	Privacy, Access Control	[20]
Singapore	Chen Y	Data Sharing, Consensual Algorithm	[21]
United Kingdom	Liu X, Wang Y	Authentication, Smart Contracts, Consensus	[22]
Canada	Yang L	Edge Computing, Blockchain Technology	[23]
Saudi Arabia	Zhang H	Ethereum, Blockchain, Privacy Protection	[24]

3.3 CORE SOURCES BY BRADFORD'S LAW

The illustration depicted in Figure 3 demonstrates the utilization of Bradford's Law to identify the primary sources within a particular discipline. This distribution model aids researchers and librarians in directing their attention toward the most influential sources, thereby improving the effectiveness of literature searches and the development of collections.

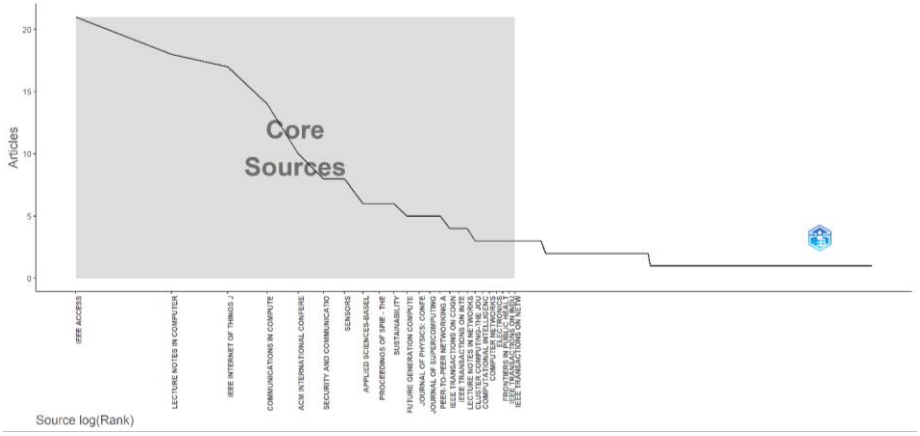

Figure 3: Core Sources by Bradford's Law

Table 3 presents a list of prominent journal titles along with their respective article publication counts and associated observations.

Table 3: Bradford's Table

Journal Name	Articles Published	Core Zone	Observations
IEEE Access	22	Core	High productivity journal
Lecture Notes in Computer Science	20	Core	High productivity journal
IEEE Internet of Things Journal	18	Core	High productivity journal
Sensors	16	Core	High productivity journal
Applied Sciences-Basel	15	Core	High productivity journal
Proceedings of SPIE	14	Core	High productivity journal
Sustainability	12	Core	High productivity journal
Future Generation Computer Systems	11	Core	High productivity journal
Communications in Computer and Information Science	10	Core	High productivity journal
ACM International Conference Proceedings Series	9	Core	High productivity journal
Security and Communication Networks	8	Core	High productivity journal
Journal of Supercomputing	7	Core	High productivity journal
Journal of Physics Conference Series	6	Core	High productivity journal
Other journals	<6	Peripheral	Lower productivity, scattered sources

3.4 SOURCES' PRODUCTION OVER TIME

The total number of articles published in different publications throughout 2010 to 2024. The sources considered in this analysis are ACM International Conference Proceeding Series, Communications in Computer and Information Science, IEEE Access, IEEE Internet of Things Journal, and Lecture Notes in Computer Science. Table 4 provides details on the initial year of publication and the cumulative occurrences in the year 2024 for the top four sources.

3.5 RELEVANT AUTHORS

The visualization presented in Figure 4 emphasizes the authors who have been most active within the dataset, showcasing their level of contribution based on the number of documents authored. "Na N" emerges as the most prolific author, having authored 21 documents. Following closely behind are "Zhang J" and "Zhang Y," each with 15 documents to their credit. Noteworthy contributors also include "Li J" with 13 documents and "Zhang S" with 12 documents. Among the authors with fewer contributions are "Chen Y," "Liu X," "Wang Y," "Wang Z," and "Chen S," each having authored between 10 and 11 documents.

Table 4: Source Productivity over Time

Source	Initial Year	Cumulative Occurrences (2024)	Observations
IEEE Internet of Things Journal	2017	~17	Rapid growth, highlighting the increasing research focus on the Internet of Things (IoT).
IEEE Access	2017	~21	Shows the highest growth, reflecting its increasing prominence and wide acceptance in the academic community.
Communications in Computer and Information Science	2017	~15	Significant growth post-2017, indicating rising popularity and relevance in this source.
ACM International Conference Proceeding Series	2017	~5	Shows a steady but limited increase in cumulative occurrences over time.

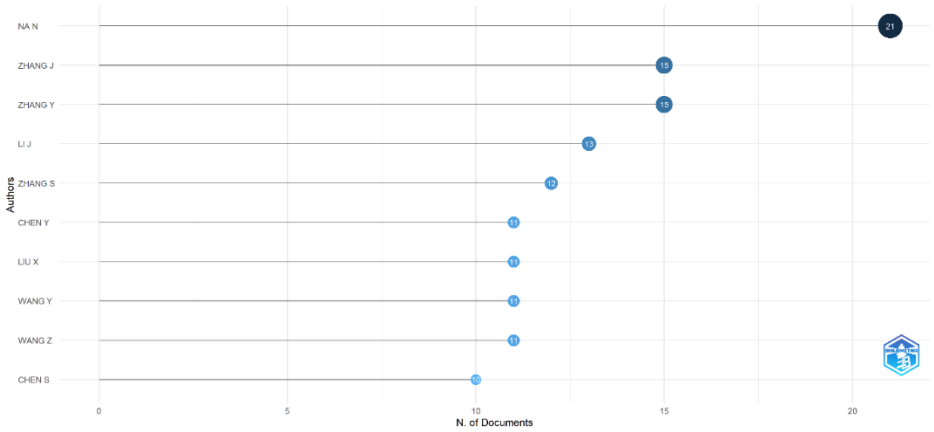

Figure 4: Most Relevant Authors

3.6 LOCAL IMPACT BY H-INDEX

The graph illustrated in Figure 5 shows the regional influence of authors as indicated by their H-index. Specifically, authors Chen S, Chen X, Chen Y, Wang X, Yan Y, and Zhang Y exhibit significant local impact within their respective fields, each possessing an H-index of 6. The authors **Javaid N, Li J, Wang J, and Wang L** have a marginally reduced influence in comparison to the preceding group, as indicated by an H-index of 5. Authors with higher article counts and citations demonstrate significant contributions to the various fields of blockchain technologies and energy consumption, while those with lower metrics may be in the early stages of their careers or working in less-cited areas. Table 5 provides observations on the productivity and citation of authors.

3.7 AUTHORS' PRODUCTION OVER TIME

The graph in Figure 6 illustrates the number of articles released by different authors between 2018 and 2024, in addition to their total citations per year (TC per Year). It presents a forecast model for publication productivity derived from past data, emphasizing the correlation between time and publication yield [25].

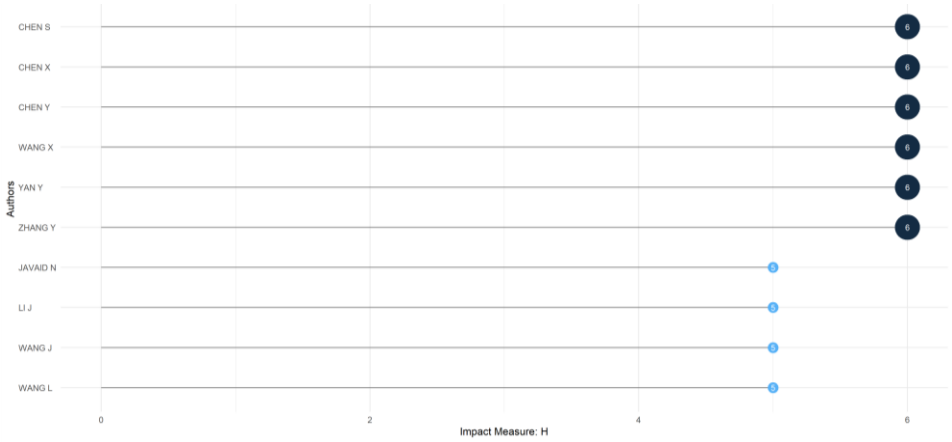

Figure 5: Authors' Local Impact by H index

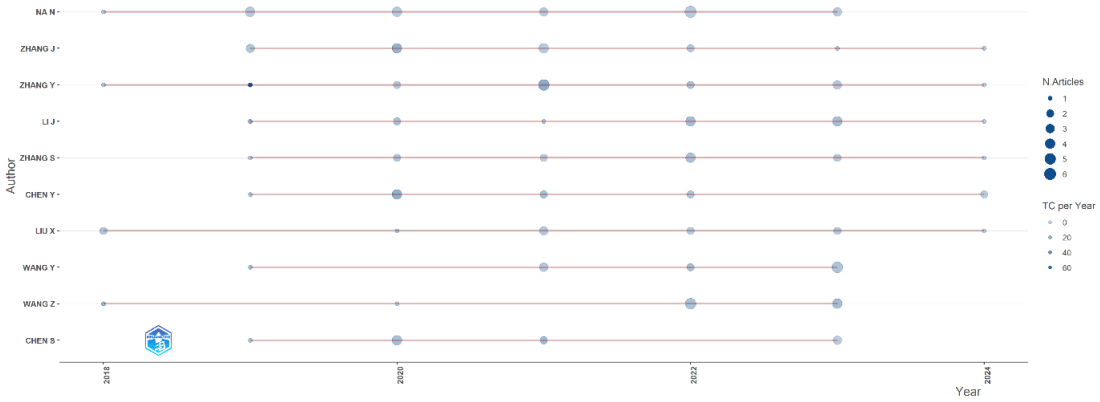

Figure 6: Authors' Production over Time

Table 5: Author's Production over Time

Author	Number of Articles	Citations per Year (TC)	Observations
Na N	2	20	Moderate productivity and citation
Zhang J	5	40	High productivity and moderate citation
Zhang Y	3	60	Moderate productivity and high citation
Li J	2	20	Moderate productivity and citation
Zhang S	3	40	Moderate productivity and moderate citation
Chen Y	2	20	Moderate productivity and citation
Liu X	1	0	Low productivity and no citation
Wang Y	2	20	Moderate productivity and citation
Wang Z	1	20	Low productivity and moderate citation
Chen S	3	40	Moderate productivity and moderate citation

3.8 MOST LOCAL CITED AUTHORS

The provided graph in Figure 7 displays the most locally cited authors along with their respective citation counts.

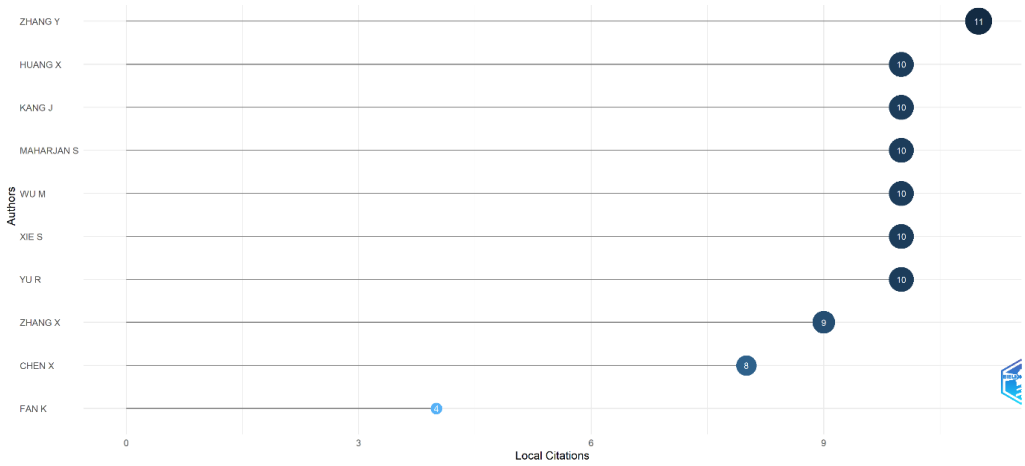

Figure 7: Most Local Cited Authors

The analysis reveals that Zhang Y is the most locally cited author, followed closely by several other authors with significant local citations. This reflects their substantial influence and the high relevance of their research within their respective fields.

3.9 COLLABORATION NETWORK BETWEEN AUTHORS

The network graph displayed in Figure 8 illustrates the connections between researchers who have collaborated on projects, emphasizing key individuals and groups that are pivotal in scientific partnerships. The cluster analysis reveals that the leading author in the field of blockchain from China is Zhang Y, who has a wide collaboration network compared to other authors. Studying these networks can assist in recognizing influential researchers, promoting new partnerships, and improving the overall productivity and influence of research endeavours.

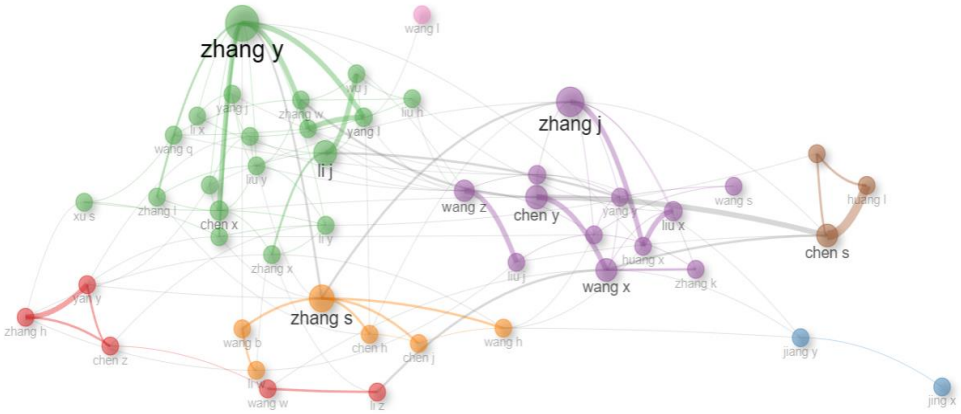

Figure 8: Collaboration Network between Authors

3.10 RELEVANT AFFILIATIONS

The graph depicted in Figure 9 emphasizes the key affiliations based on the number of articles they have produced. It indicates that the primary institutions contributing to research output are mainly situated in China, underscoring the country's prominent position in scientific research and technological progress.

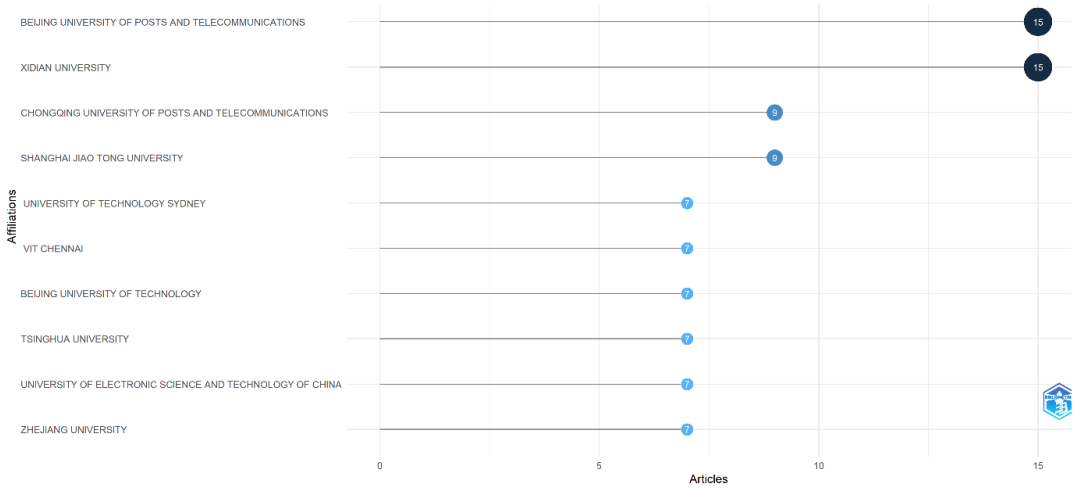

Figure 9: Most Relevant Affiliations

Beijing University of Posts and Telecommunications and Xidian University are the most productive, representing their considerable influence in the areas of blockchain technology.

3.11 CORRESPONDING AUTHOR'S COUNTRIES

The bar graph in Figure 10 shows the number of documents created by authors from different countries, with a distinction made between publications from a single country (SCP) and those from multiple countries (MCP).

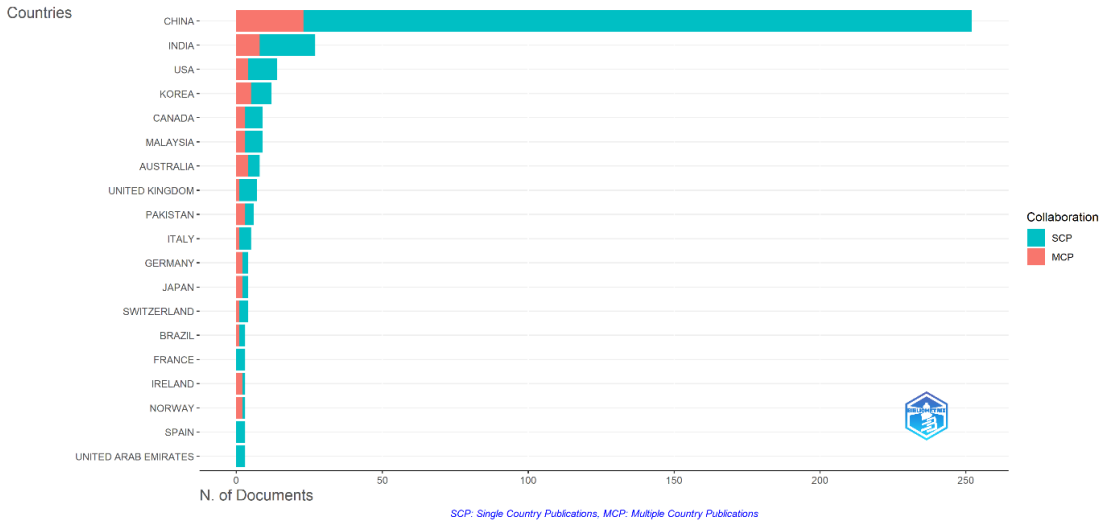

Figure 10: Corresponding Author's Countries

The study shows that China, India, and the USA are the leading countries in terms of research productivity in blockchain, with China leading the way. The high number of publications involving multiple countries indicates strong international collaboration, particularly among these top nations.

3.12 GLOBAL CITED DOCUMENTS

The graph shown in Figure 11 consists of the most cited documents worldwide and their citation counts. Further Table 6 below summarizes the citation data and key research findings of these highly cited documents.

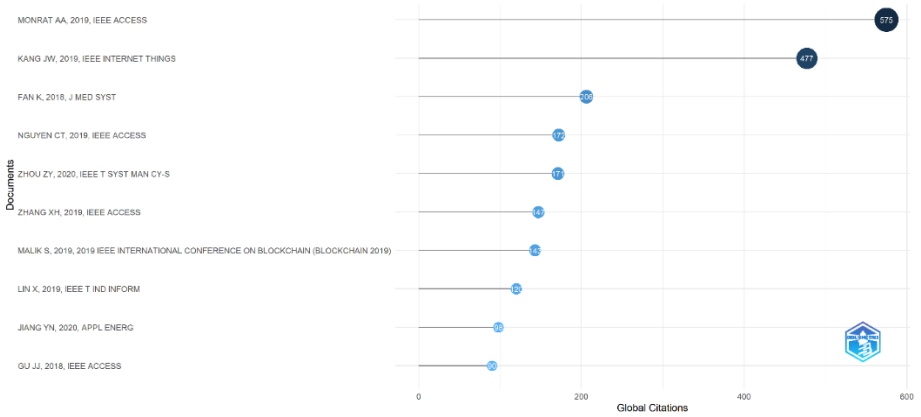

Figure 11: Most Global Cited Documents

In 2019, the document "MONRAT AA" published in IEEE ACCESS had the highest number of citations at 575, while "KANG JW" published in IEEE INTERNET THINGS followed closely with 477 citations.

Table 6: Most Global Citation

Document	Global Citations	Relevant Research Papers
MONRAT AA, 2019, IEEE ACCESS	575	This document's high citation count reflects its significant impact on blockchain technology. High citation rates often indicate influential and widely recognized research [26].
KANG JW, 2019, IEEE INTERNET THINGS	477	This paper's substantial citations are indicative of its relevance and contribution to the Internet of Things (IoT) field [27].
FAN K, 2018, J MED SYST	206	The document underscores the importance of this work in medical systems and technology, reflecting its influence on healthcare research [28].
NGUYEN CT, 2019, IEEE ACCESS	172	This document is highly cited for its contributions to the field of cybersecurity and network systems [29].
ZHOU ZY, 2020, IEEE T SYST MAN CY-S	171	Reflects significant contributions to systems management and cyber security, illustrating its wide acceptance and influence.
ZHANG XH, 2019, IEEE ACCESS	147	Indicates notable impact in the field of engineering and technology, particularly in innovative research areas [30].
MALIK S, 2019, IEEE INTERNATIONAL CONFERENCE ON BLOCKCHAIN 2019	143	The conference paper in advancing blockchain technology research [31].
LIN X, 2019, IEEE T IND INFORM	120	Demonstrates significant impact in industrial informatics and its applications, with broad recognition in the field [32].
JIANG YN, 2020, APPL ENERG	98	Reflects important contributions to applied energy research, highlighting its influence on sustainable energy practices [33].
GU JJ, 2018, IEEE ACCESS	90	Indicates notable impact in technological advancements and applications, reflecting broad recognition and influence [34].

3.13 REFERENCE PUBLICATION YEAR SPECTROSCOPY

The graph described in Figure 12 represents data on the quantity of cited references within the spectroscopy field across different periods. The black line represents the total count of cited references annually, whereas the red line displays the deviation from the 5-year median. The pattern observed in referenced sources underscores the ongoing expansion and increasing significance of spectroscopy studies. Substantial progress has been made over the years, particularly with a notable surge in research endeavours during the initial years of the 21st century

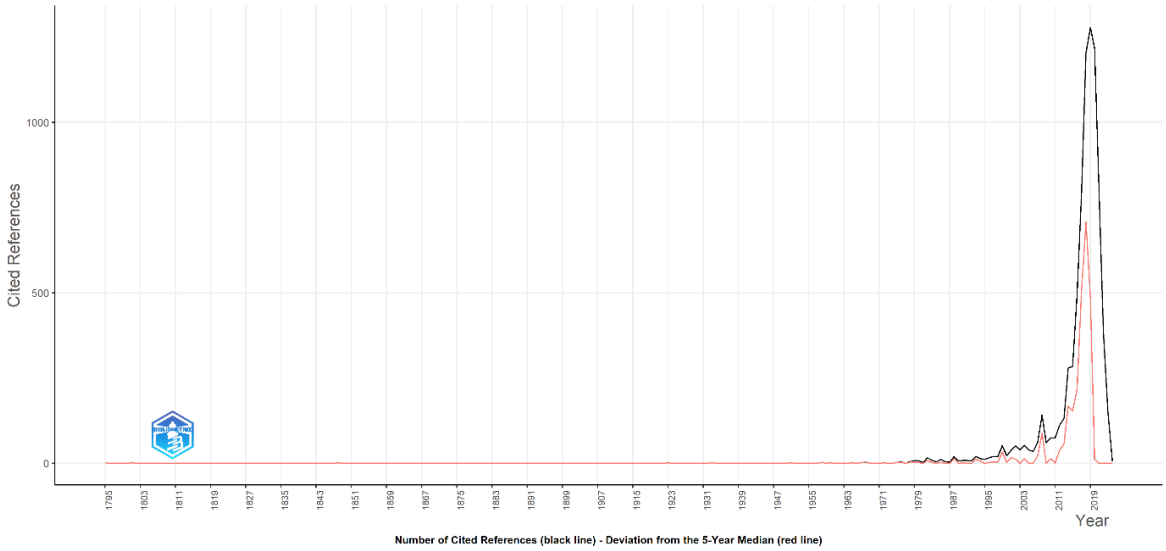

Figure 12: Reference Publication Year Spectroscopy

3.14 RELEVANT WORDS

The graph shown in Figure 13 illustrates the key terms found in academic research papers, showing the frequency of their appearances. The findings indicate that blockchain is a prominent subject in contemporary research, with a notable focus on its practical uses, security measures, and operational effectiveness.

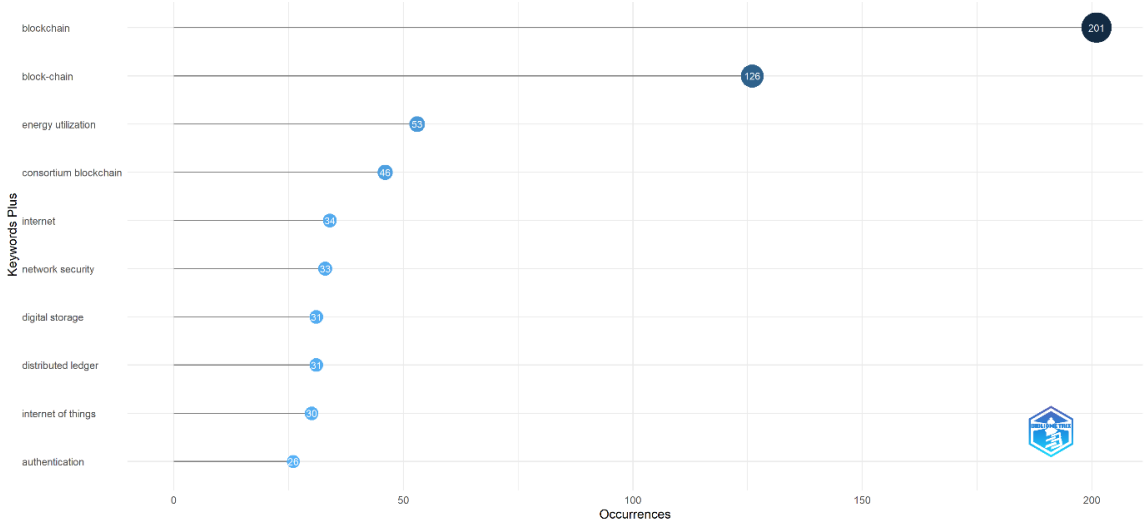

Figure 13: Most Relevant Words

The increasing emphasis on terms such as energy consumption and collaborative blockchain in academic discourse suggests a continued focus on tackling issues associated with energy usage and cooperative blockchain platforms. This pattern underscores the rising significance of blockchain technology across diverse fields and its capacity to foster innovation and enhance security within digital infrastructures.

3.15 WORD CLOUD

The word cloud diagram depicted in Figure 14 visually represents the key terms prevalent in blockchain research, emphasizing the central topics and their significance relative to their frequency of appearance. The terms "Blockchain" and "block-chain" emerge as the most prominent, underscoring their fundamental importance within the field [35]. Key terms such as "consortium blockchain," "energy utilization," and "digital storage" reflect focused research areas within the broader blockchain domain. The importance of "consortium blockchain" [4]which explores the Hyperledger Fabric's distributed operating system.

Figure 14: Word cloud of Blockchain

Terms like "network security," "distributed ledger," and "cryptography" are critical for understanding blockchain's technical underpinnings and its application to secure data transactions, [25]The relevance of "smart contract" and "Internet of Things" is highlighted in research addressing blockchain's application in automated contract execution and secure IoT environments [36]
"Authentication" and "privacy" are significant concerns in blockchain technology, with numerous studies addressing these issues [37]. These topics are crucial for ensuring secure and private transactions within blockchain networks. The word cloud analysis reveals that blockchain and related technologies are central themes in current research, with a significant focus on security, privacy, and practical applications such as smart contracts and IoT.

3.16 TRENDING TOPICS

The trending topics shown in Figure 15 highlight the evolution and frequency of various themes within blockchain research over recent years.

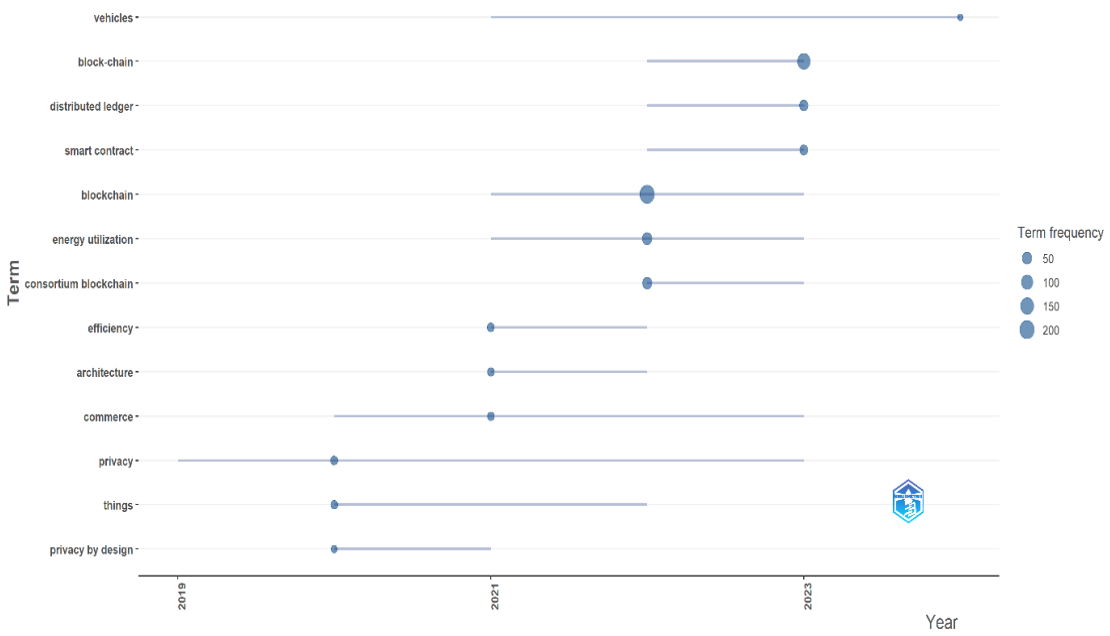

Figure 15: Trending Topics

Table 7 illustrates that the terms "blockchain" and "block-chain" are highly popular and frequently searched topics, with "distributed ledger" and "smart contract" following closely behind. Additionally, “energy utilization”, “efficiency”, and related subjects are also trending prominently.

Table 7: Trending Topics

Term	Term Frequency	Paper References
Vehicles	50	[38]
Block-chain	200	[24][35]
Distributed Ledger	150	[2]
Smart Contract	150	[39]
Blockchain	200	[1]
Energy Utilization	100	[6]
Consortium Blockchain	50	[4]
Efficiency	100	[6]
Architecture	50	[2]
Commerce	50	[38]
Privacy	50	[40]
Things	100	[36]
Privacy by Design	50	[40]

3.17 THEMATIC MAP ANALYSIS

The graphical representation depicted in Figure 16 illustrates a thematic map that delineates the evolution and significance of different themes within the field of blockchain research spanning the years 2010 to 2024. The graph categorizes themes into four quadrants: Niche Themes, Motor Themes, Emerging or Declining Themes, and Basic Themes. It is evident from the graph that Energy, consortium blockchain, and consensus mechanism are classified under the motor theme. The thematic map provides a detailed overview of the blockchain research domain, emphasizing key areas of advancement and fundamental themes.

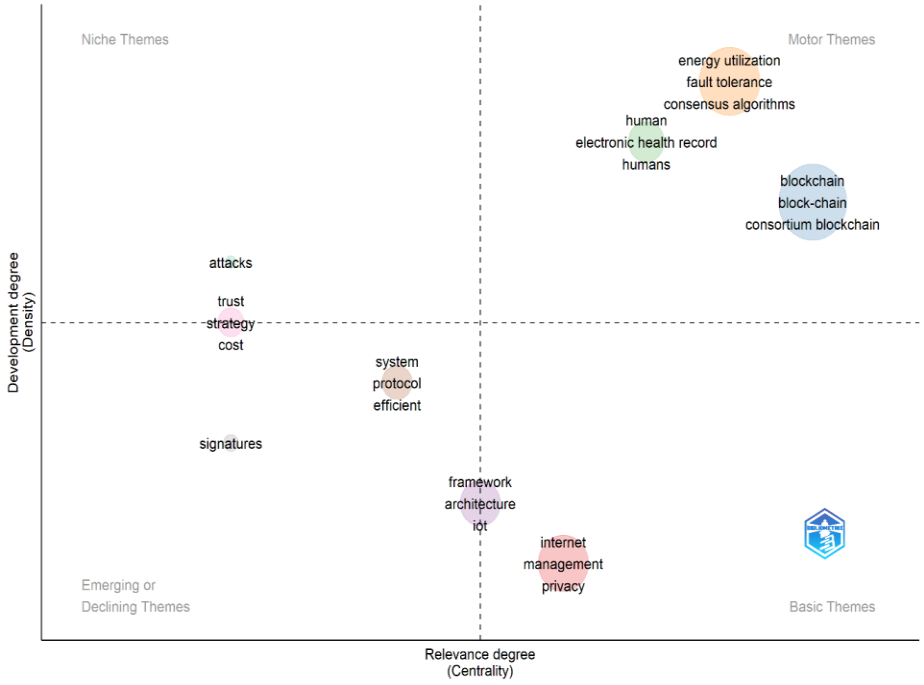

Figure 16: Thematical map Analysis of Blockchain Research

3.18 FACTORIAL ANALYSIS GRAPH WITH RESEARCH PAPER REFERENCES

The graph depicted in Figure 17 presents a factorial analysis demonstrating the associations and dispersals of different research terms across two dimensions, namely Dim 1 and Dim 2. Dim 1 (58.67%) signifies a focus on the Internet of Things (IoT) in conjunction with blockchain and security applications, while Dim 2 (17.47%) pertains to more general, specific applications like security and energy efficiency.

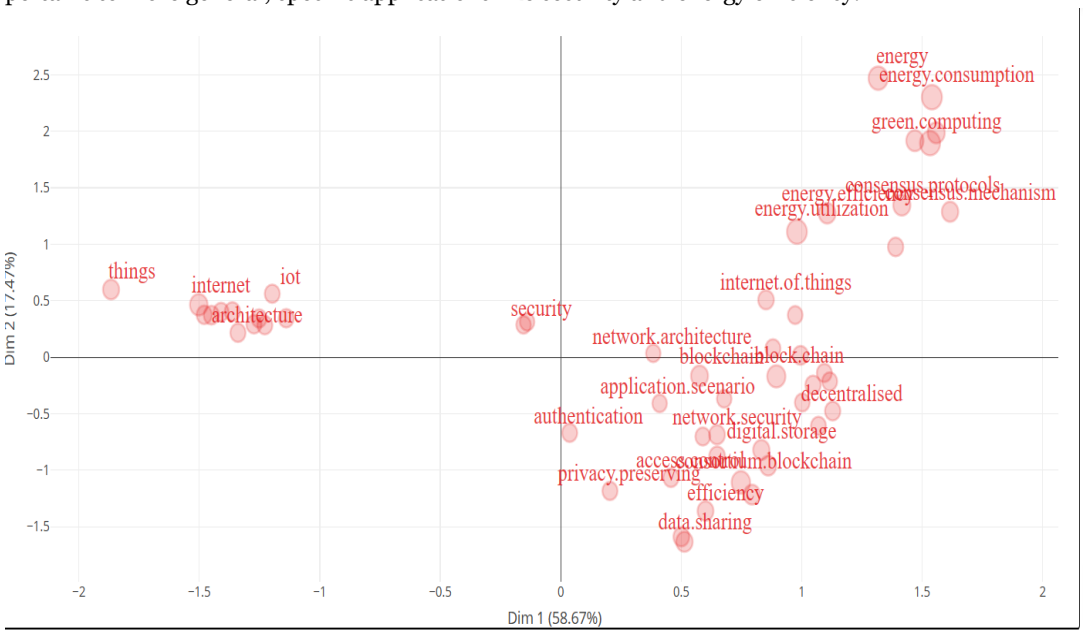

Figure 17: Factorial Analysis Graph Considering Research Paper References

Table 8 summarizes the key clusters identified in the graph, their corresponding terms, and relevant research paper references:

Table 8: Factorial Analysis

Cluster	Key Terms	Relevant Research Papers
1	Blockchain for IoT Security and Efficiency	[41]
2	Green IoT and Blockchain Integration	[42]
3	Secure and Energy-Efficient Architecture	[43]
4	Optimized Blockchain-SDN Framework for IoT	[44]
5	Blockchain in Energy Management	[45]

4 Conclusion and Future Work

This research undertook a bibliometric analysis centered on energy consumption, security challenges, and implications within the domain of consortium blockchain technology. Data was retrieved using two carefully formulated search strings applied to Scopus and Web of Science (WoS), two of the most reputable academic databases. After initial extraction, the datasets were meticulously cleaned by removing duplicates, entries with missing information, and short survey articles. The refined dataset comprised a total of 506 documents, which formed the basis for the subsequent analysis conducted using the Biblioshiny package in R. The analysis revealed contributions from 1,360 authors who collectively used 1,239 unique keywords. Notably, only 15 publications were authored individually, underscoring the collaborative nature of blockchain-related research. The trend in publication volume showed a modest beginning up to 2017, followed by a rapid rise in output, peaking around 2023. Interestingly, the highest average citations per document (approximately 8.1) occurred in 2020, with a decline in subsequent years, potentially due to factors such as post-pandemic effects, publication aging, or evolving research priorities. A Sankey diagram indicated that China was the dominant contributor in the field, with other nations like India, Brazil, South Africa, and the United Kingdom also making notable progress. The analysis further identified IEEE, Lecture Notes in Computer Science, and ACM as the leading sources of publication. Among these, the IEEE Internet of Things Journal demonstrated particularly strong growth. The most prominent authors included Zhang J and Zhang Y, while researchers like Chen S, Chen X, and Chen Y showed high impact based on the local H-index. Zhang Y emerged as the most locally cited author, while the most cited document globally appeared in IEEE Access, accumulating 575 citations. Institutions such as Beijing University of Posts and Telecommunications and Xidian University were among the top contributors. Country-wise, China, India, and the USA led in both single-country and multi-country authored papers, with China showing the highest overall influence, recording 2,401 citations in blockchain-related research. Keyword analysis confirmed that "blockchain" was the most frequently used term, appearing in 201 instances and accounting for approximately 14% of the total keyword occurrences. Visual tools like word clouds and thematic maps revealed that terms such as “blockchain,” “energy utilization,” and “consortium blockchain” have gained prominence over time. Trending topics included “Internet of Things,” “distributed ledger,” and “energy utilization,” while co-occurrence network analysis identified “blockchain” as the central hub linked with energy, security, and consortium-related themes. Thematic mapping highlighted “blockchain,” “consensus algorithm,” and “consortium blockchain” as motor themes. Collaborative networks showed strong bilateral efforts, especially between China and India. Lastly, factorial analysis revealed significant interconnections among research terms, highlighting the multidimensional nature of the field. While this study provided in-depth insights into the bibliometric trends of consortium blockchain research, it focused primarily on themes of energy efficiency and consensus mechanisms. Future work can extend this framework by incorporating emerging technologies and broader application areas. Though only Scopus and WoS were used in this study, additional scholarly databases could enrich future analyses. Moreover, while R and Biblioshiny provided effective tools for this study, future research can benefit from the integration of more advanced programming languages and techniques, including artificial intelligence and machine learning, to derive deeper insights from complex bibliometric datasets.

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