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Bibliometric analysis of blockchain technology in risk management

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Abstract: This study presents a bibliometric analysis of the literature exploring the development and application of blockchain technology in risk management from 2020 to 2024. It highlights blockchain's transformative role across key sectors, including supply chain management, cybersecurity, financial services, and healthcare. Data visualization, conducted using VOSviewer, identifies significant trends, influential authors, and key research areas that drive the integration of blockchain in mitigating complex risks and serving as a viable solution. The findings reveal that integrating blockchain with advanced technologies such as artificial intelligence (AI) and the Internet of Things (IoT) enhances its capacity to offer transparency, security, and efficiency. The analysis shows a notable increase in research activity beginning in 2021, with cybersecurity and supply chain management emerging as primary focus areas. Additionally, recent years have seen growing interest in applying blockchain to financial services and healthcare, reflecting its expanding role across various sectors. Overall, the results highlight blockchain's potential to reshape risk management practices by enabling more transparent, secure, and adaptive systems. This research offers valuable insights for policymakers, industry leaders, and academics seeking to leverage blockchain in building resilient and future-ready risk management frameworks.

Keywords: *Bibliometric analysis, Blockchain in risk management, Blockchain technology, Risk assessment, Risk management.*

1. Introduction

Blockchain technology has recently attracted the attention of academia, businesses, and policymakers as a disruptive force with revolutionary potential. It has transformed how transactions are recorded, authenticated, and secured, and is often compared to an immutable and decentralized digital ledger. Beyond its beginnings in cryptocurrencies, it has several uses across numerous processes and sectors, such as supply chain management, healthcare, insurance, energy, and public administration [1].

Blockchain can potentially improve data security across multiple domains, decrease fraud, and increase transparency in risk management. It has the potential to completely transform how businesses handle uncertainty, from reducing cybersecurity threats to improving operational effectiveness [2].

Furthermore, blockchain's relevance in risk management is increased by its capacity to interface with new technologies like artificial intelligence (AI) and the Internet of Things (IoT). IoT devices, for instance, can provide real-time data to blockchain systems, giving them access to the most recent data on operational risks and asset performance. Once AI has analyzed these data streams, predictive risk management will be possible, assisting firms in anticipating and mitigating hazards before they become more serious [3].

Additionally, this field is relatively new, and gaining a deeper understanding of its direction and emerging trends is crucial. The rapid evolution of blockchain technology and its application in risk management necessitates exploring how research in this area is progressing. Through bibliometric analysis, key developments and patterns can be uncovered, offering valuable insights into the future potential of blockchain in addressing complex risk management challenges across various industries.

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This method highlights the opportunities and the areas that require further investigation within this emerging field [4].

Today, organizations face a complex risk landscape, including cybersecurity threats, operational vulnerabilities, financial uncertainties, and regulatory compliance pressures. Traditional risk management approaches often struggle to adapt swiftly to these evolving threats, particularly with the emergence of digital and interconnected systems. With its decentralization, transparency, and security features, blockchain technology presents a potential solution by enhancing risk management processes' accuracy, efficiency, and reliability. However, there remains limited comprehensive analysis on the role of blockchain across diverse industries, such as supply chain, healthcare, and financial sectors, each facing unique risk management challenges. This study addresses this gap by exploring blockchain technology's development, application, and emerging trends in managing risks across various fields, aiming to provide a holistic view of its potential and limitations [5, 6].

By performing a systematic bibliometric analysis to assess how blockchain technology has developed, trended, and affected risk management, among other relevant topics, between 2020 and 2024. This study aims to determine the major improvements, developments, and future directions in applying blockchain technology and the potential to fields among different countries, industries, perspectives, and affiliations [7]. A bibliometric analysis of blockchain technology in risk management attempts to achieve several different goals:

- First, by identifying and evaluating significant trends, popular writers, highly regarded publications, and major universities engaged in this field of study [8].
- Second, examine communication patterns between academics, organizations, and regions to understand the worldwide network of risk management and blockchain research. The analysis will provide an overview of existing knowledge and identify important emphasis areas by examining the major subjects and themes addressed in literature.
- Third monitoring the development of research approaches and areas of focus within this field and providing suggestions for new lines of inquiry based on bibliometric analysis.

2. Background and Related Work

Several recent studies have examined the relationship between blockchain technology and risk management, focusing on supply chain management, financial systems, and cybersecurity. This study aims to summarize the most important conclusions drawn from the literature, summarizing what is already known while drawing attention to new directions and areas that still need investigation. Bibliometric analysis serves as a powerful tool for mapping the evolution of a research field, identifying influential authors, institutions, and emerging themes over time. It allows scholars to monitor trends, assess the influence of scholarly contributions, and obtain a thorough understanding of the knowledge structure within a certain field. Policymakers, academics, and business executives can prioritize future goals, identify research gaps, and make well-informed decisions by utilizing bibliometric methodologies. This strategy is especially helpful in rapidly changing domains like blockchain technology, where the rate of innovation necessitates ongoing observation and evaluation [9].

The article by Nobanee and Ellili [10] provides a bibliometric analysis of sustainability and risk management literature from 1990 to 2020, examining 1233 documents from Scopus using VOSviewer software. The study identifies key themes, influential authors, and emerging trends, highlighting the growing significance of sustainability in addressing organizational risks and its broader impact on the economy. It also outlines areas for future research, emphasizing the need for organizations to integrate sustainability practices to mitigate economic risks [8].

The transformative potential of blockchain technology in supply chain management has been extensively explored. Nathani and Singh [11] highlight blockchain's ability to enhance transparency and traceability in supply chain risk management, reducing risks such as fraud and operational inefficiencies. The study emphasizes the need to implement blockchain as a standalone solution rather

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than an add-on, to leverage its benefits fully. However, challenges such as costs, human error, and the necessity for training are noted as barriers to adoption. The findings stress the importance of assessing organizational readiness and developing effective integration strategies for successful implementation while encouraging further research on blockchain's evolving role in supply chain management Nathani and Singh [11]. Cui, et al. [12] explore the adoption of blockchain technology in the pharmaceutical supply chain, particularly focusing on generic drugs. The study underscores blockchain's potential to improve transparency and trust, which could lead to increased sales and prices for generic drugs, especially among consumers with low-risk aversion. However, it also highlights that consumer perceptions play a critical role, as risk-averse individuals may still prefer original drugs, potentially limiting the benefits for generic manufacturers. The study stresses the importance of coordination among supply chain members and implementing regulatory measures to protect consumers, suggesting that effective blockchain adoption could improve market conditions and profitability [12]. In both studies, the importance of blockchain technology is emphasized for improving supply chain transparency and trust, whether in the pharmaceutical or larger industries. While Cui, et al. [12] emphasize the impact of blockchain on customer trust and market behavior, Nathani and Singh [11] concentrate on minimizing fraud and inefficiencies in supply chain management. According to both studies, blockchain has enormous potential to revolutionize risk management and supply chain efficiency. However, to fully realize these benefits, regulatory support, and cautious integration techniques are required.

Conversely, Chen, et al. [3] propose a blockchain solution for managing the COVID-19 pandemic, focusing on decentralization, automation, and immutability. The study highlights how blockchain can improve disease surveillance, contact tracing, and data accuracy while preserving privacy, and reducing risks such as sample variance, delays, and bias. The authors suggest that governments and organizations perform cost-benefit analyses before investing in blockchain solutions for pandemic control. This aligns with previous research by Nathani and Singh [11] and Cui, et al. [12] showcasing blockchain's potential for risk management across diverse sectors [13].

Additionally, Kovačević, et al. [14] analyze derivative financial instruments (PFIs), highlighting their advantages, disadvantages, and the risks inherent in their operations. They suggest measures to promote the Russian derivatives market and emphasize the role of blockchain technology in improving transparency and risk management. The study also points out that the COVID-19 pandemic has heightened the need for more resilient markets, as uncertainty and the lack of regulatory tools have amplified risks. This underscores the importance of technological solutions like blockchain in addressing challenges in the securitization and derivatives market [15]. This highlights even more how blockchain technology may be used in the financial industry, especially to handle complex derivatives markets. Risks like fraud, counterparty default, and operational inefficiencies can be significantly reduced by blockchain's ability to handle transactions in a transparent, immutable, and effective manner. Particularly in post-pandemic settings where risk management is more important than ever, blockchain can help address the issues raised by Kovačević, et al. [14] and contribute to more robust and effective financial systems by improving the security and traceability of financial instruments.

Blockchain has been used in other areas such as cybersecurity and privacy. Azizi, et al. [16] explored the integration of blockchain technology in cybersecurity and privacy, focusing on its various architectures, challenges, and potential benefits. The authors emphasize blockchain's ability to address critical data protection issues and mitigate cybersecurity threats by improving trust and transparency in digital transactions. They highlight the significance of blockchain in enhancing security measures across multiple digital platforms, particularly in safeguarding sensitive information in an increasingly vulnerable digital environment. The paper also discusses the role of blockchain in fostering decentralized trust models, thereby reducing the risks associated with centralized systems in protecting data Maleh, et al. [17]. Also, Alamri, et al. [18] provides an in-depth analysis of cybersecurity risk management within Health Internet of Things (HIoT), Identity Management (IdM), and Blockchain (BC) systems, proposing a blockchain-based IdM framework specifically designed for HIoT

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environments. Their work underscores the need for robust cybersecurity frameworks by reviewing standards such as ISO 27005 and NIST 800-30, which emphasize comprehensive security assessments. Blockchain technology is highlighted as a critical tool in addressing security challenges, particularly through the creation of decentralized IdM solutions that improve data privacy and trust in healthcare applications The immutability, decentralization, and secure authentication capabilities of blockchain are emphasized as crucial advantages, particularly when it comes to safeguarding private medical information in IoT systems and connected medical equipment. The article highlights that blockchain's ability to secure distributed networks makes it the perfect tool for handling the growing complexity of healthcare cybersecurity [18].

Recent research underscores the growing importance of using blockchain technology to fortify security and trust within Internet of Things (IoT) ecosystems. A 2024 study by Almarri demonstrates how blockchain's decentralized and immutable features can prevent data manipulation, enable robust identity management, and support transparent, verifiable transactions [19].

Looking ahead, comprehensive reviews explore architectural strategies for integrating blockchain with IoT while addressing challenges of scalability, latency, and energy efficiency. A 2024 review highlights the role of lightweight consensus protocols and multi-layer architectures, including fog and edge computing, that enhance performance in resource-constrained IoT applications such as undersea and smart city systems [20]. These achievements support the focus of our research on effective and scalable blockchain-based solutions for challenging risk management situation.

Other authors examined the research trend within a specific research outlet. Hutchinson, et al. [21] along with a subsequent study published in IEEE Access, conducted a bibliometric analysis of Blockchain research, examining trends, citation metrics, publication venues, and funding sources from 2013 to 2018 [22]. Their findings indicate a significant rise in publications and citations, with IEEE Access and Lecture Notes in Computer Science emerging as the leading publication venues. The National Natural Science Foundation of China is identified as the primary funding agency supporting this growing field. The investigation demonstrates a change in focus from research on Bitcoin to more general Blockchain applications across a variety of fields, such as business economic computer science, and other academic topics [22].

Blockchain technology has the potential to transform a variety of industries when evaluated. Blockchain has improved data security and integrity in computer science and redefined transaction efficiency and transparency in corporate economics. The papers also discuss challenges to the validity of Blockchain research and offer suggestions for additional research, especially regarding ensuring scalability and regulatory compliance in a variety of applications. This shows how blockchain technology has spread beyond its initial focus on Bitcoin and is having an increasing influence.

Makridakis and Christodoulou [23] examine the transformative potential of blockchain technology, comparing its development trajectory to the early days of the Internet [23]. The authors emphasize blockchain's core features, such as its ability to establish trust, ensure immutability, and enable disintermediation across a wide range of industries. The paper explores future applications, including smart contracts and decentralized autonomous organizations (DAOs), which have the potential to revolutionize business operations and governance models. The authors also discuss the difficulties and doubts that surround blockchain technology despite its bright future, especially regarding its scalability, energy consumption, and the legal frameworks required for its wide use. They highlight how to be competitive, companies and sectors must adapt to these technological developments. The study also looks at how blockchain might affect industries like healthcare, where it could improve data security and privacy, supply chain management, where it could improve transparency and traceability; and the Internet of Things (IoT), which could facilitate more decentralized, safe, and Effective data management. This analysis highlights the potential uses of blockchain technology while also recognizing the real-world challenges that must be overcome before it can be fully implemented across a range of businesses [23].

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At the sector level, Shishehgarkhaneh, et al. [24] conducted a comprehensive analysis of the integration of blockchain technology within the construction industry, focusing on its synergy with Building Information Modeling (BIM) and the Internet of Things (IoT). Their study identifies a growing body of academic work on this topic, particularly between 2016 and 2022, with a notable concentration of contributions from developed nations, especially China [24]. To solve permanent issues like payment delays and inefficient data sharing, the assessment emphasizes how blockchain technology may increase supply chain transparency and boost construction operations efficiency. The construction sector can enhance stakeholder engagement, minimize fraud, and optimize project management by combining blockchain technology with BIM and IoT. In addition to current applications, the authors suggest future research directions in areas such as sustainability and the development of smart infrastructure. They emphasize blockchain's role in fostering more sustainable construction practices through improved resource tracking and reduced waste Shishehgarkhaneh, et al. [24].

Finally, Donthu, et al. [25] emphasize the utility of bibliometric analysis in handling vast amounts of scientific data, uncovering emerging trends, identifying collaboration networks, and exploring the intellectual structure within research domains. This method provides a structured and rigorous approach, allowing scholars to pinpoint knowledge gaps and generate new research ideas, which makes it particularly valuable in business research.

Table 1.
Related work.

Domain/Sector	Author(s)	Integrated Technology
Supply Chain Management	Cui, et al. [12]	IoT, AI, Smart Contracts
Cybersecurity	Almarri and Aljughaiman [19]	Cryptography, AI, IoT
Financial Systems	Kovačević, et al. [14]	Smart Contracts, Cryptography, AI
Healthcare (IoT and Security)	Alamri, et al. [18]	IoT, AI, Cryptography
Pharmaceutical Supply Chain	Cui, et al. [12]	IoT, Smart Contracts, AI
Derivatives and Financial Risk	Kovačević, et al. [14]	AI, Smart Contracts, Cryptography
Construction Industry	Shishehgarkhaneh, et al. [24]	IoT, AI, Smart Contracts
Blockchain in Public Policy	Makridakis and Christodoulou [23]	AI, Smart Contracts, Cryptography
Blockchain in Industry and Business	Donthu, et al. [25]	AI, IoT, Smart Contracts, Cryptography
Blockchain in IoT Ecosystems	Alamri, et al. [18]	IoT, Blockchain, Identity Management

3. Methodology

Given the quick development of this topic across several industries and the ongoing creation of new applications and ideas, bibliometric analysis is a perfect fit for researching blockchain. The method enables a thorough understanding of blockchain development, showcasing significant works and academics, and charting the development of blockchain applications in risk management and domains. This makes it an effective instrument for understanding the situation of blockchain now and its potential future angles by revealing new patterns and technological trends [26].

The primary data source for this research will be the Web of Science database, selected because of the width of its coverage of scientific journals from trusted, peer-reviewed domains. Because of its extremely high standards and wide indexing, the Web of Science is a significant resource for bibliometric analysis [27, 28].To collect relevant literature, a systematic search will be performed using keywords such as "blockchain technology, "risk management," "bibliometric analysis," and "risk assessment," to reach this symmetric ALL=(Blockchain) AND (ALL="Risk Management"). Filters applied for publication years (2020- July 2024). Because of the post-COVID-19 rise in digital transformation and increased investment in blockchain technology, 2020–2024 is especially pertinent for researching blockchain's impact on risk management. Organizations from various industries prioritized resilience and security during this time, hastening the adoption of blockchain technology for improved data protection, fraud prevention, and transparency. This period reflects significant changes

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in emerging applications, technological adoption, and regulatory attention that define blockchain's developing role in risk management. An understanding of current trends and plans that continue to impact blockchain's evolution across industries may be gained by examining advancements during these years [29]. And language (English), and much more, to determine the research into something specific and clear. The extracted bibliographic data, including titles, authors, publication years, journals, keywords, and citations, will serve as the foundation for the analysis.

VOSviewer software is used to examine and display the connections and patterns found in the gathered data. VOSviewer is an effective tool for building and visualizing bibliometric networks, which makes it possible to create network maps that show relationships between authors, keywords, citations, and other indicators. These VOSviewer-based analyses enable a detailed exploration of how blockchain research is structured, helping to map current trends, significant authors, and central research themes in risk management. This structured approach will provide a foundation for understanding the evolution and interdisciplinary connections within blockchain literature [30, 31].

The systematic methodology of this bibliometric analysis provides a structured overview of current research trends, important investments, and possible research gaps. It provides a starting point for further research into how blockchain might improve risk Management techniques in many industries. The bibliometric analysis was structured as follows [32-34].

Publication Trends: Examining the number of publications throughout time revealed information about the expansion and changing interest in risk management applications using blockchain technology.

Network Visualization: Keywords and co-authorship networks were created to show how study topics are related to one another, highlighting key themes and clusters in the area.

Institutional and Geographical Distribution: By analyzing the authors' affiliations and nations of residence, we were able to identify the top universities and areas advancing blockchain research in risk management.

Research Area Focus: To evaluate the range and specialized focus areas in blockchain risk Management research, several sectors, and applications such as supply management, cybersecurity, and financial systems—were emphasized.

4. Data analysis and Results

4.1. Publication Years

The term "publication years" describes the years that research studies, papers, or documents are released. Examining the years of publication makes it easier to follow the development of research over time by highlighting patterns, periods of high interest, or changes in emphasis within a topic [35]. The figure and table below explain that according to the data.

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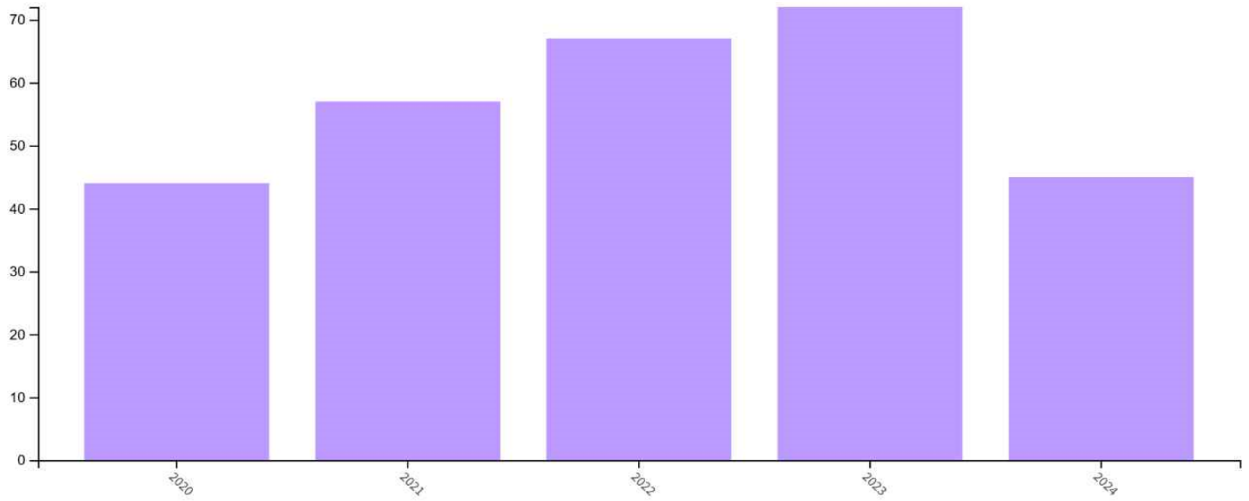

Figure 1.
Publication years.

The analysis of publication data shows interesting patterns in the academic output of blockchain technology in risk management during the past few years.

Table 2.
Publication years.

Publication Year	Record count	% of 285
2024	45	15.789
2023	72	25.263
2022	67	23.509
2021	57	20.000
2020	44	15.439

In 2023, the highest number of records was recorded, with 72 publications, accounting for 25.263% of the total 285 publications analyzed. This indicates a peak in research activity within that year.

Following closely behind 67 publications, or 23.509% of the total, is the year 2022. Strong interest in the topic has been found in both years, pointing to a developing trend in research. On the other hand, 2021 had 57 publications, or 20% of the total, indicating a little lower but still significant level of scientific activity.

The years 2020 and 2024 had fewer publications, with 44 (15.439%) and 45 (15.789%), respectively, indicating a decline in research output in 2020 followed by a modest increase in 2024. Overall, the data shows that research activity was trending upward until 2023, after which it paused and then somewhat increased in 2024. The subject, in my opinion, shows the field will expand in further research.

4.2. Citation Map

The Citation Map's purpose is to graphically depict, using citations, the connections between academic papers. It displays the frequency and sources of citations to a specific study or group of studies. This map makes it easier to see important, influential works, research trends, and the connections between various fields of study. According to the years, the citation map in your research probably shows the most important publications in the fields of risk management and blockchain. It also aids in tracking the development of concepts over time, demonstrating the discipline's scholarly influence and information flow [36, 37]. To clarify the update of citations by the year the next figure will explore that:

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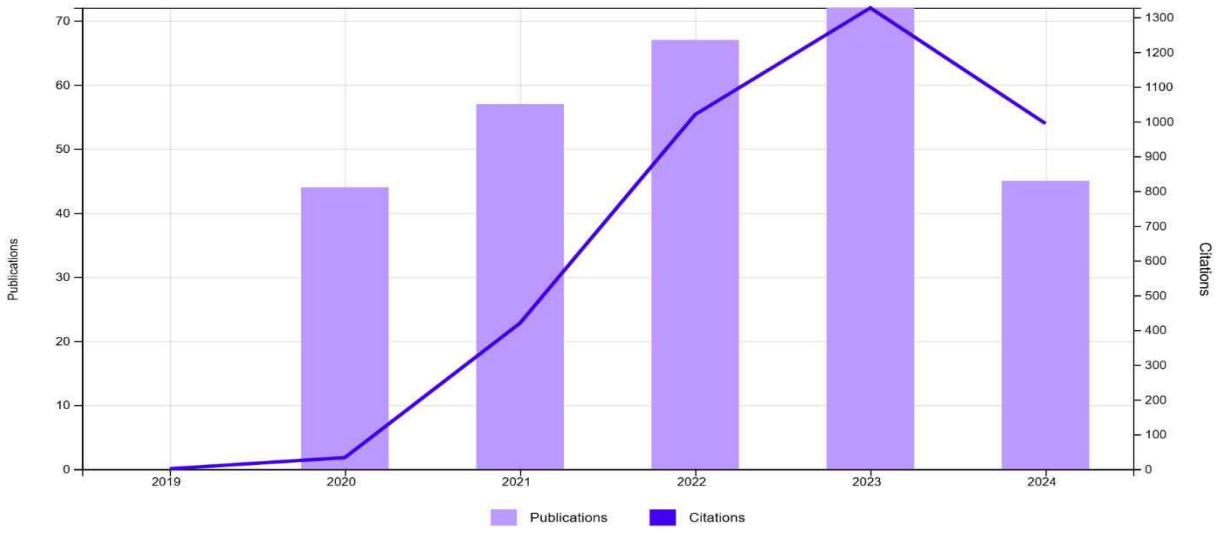

Figure 2.
Citation map by years.

The graph shows the trend of publications and citations related to risk management and blockchain research from 2019 to 2024. From 2019, the number of articles climbed continuously and reached 2023.

Citation growth follows the same pattern, peaking in 2023 concurrent with publication growth. The minor drop in 2024 in terms of citations and publications could be the result of further research specialization or a shift in emphasis toward new fields.

Overall, the data show that the field is becoming increasingly popular, especially in the years 2021–2023, when the research took off. However, there is still a lot of potential for investigation and implementation in numerous fields.

4.3. Major Universities Publishing Blockchain Risk Management Research

Refers to the university institutions or organizations that have produced the most research publications on the application of blockchain technology to risk management. Leading centers of research and ability are highlighted by this analysis, which also highlights the academic institutions that are actively contributing to this field of study. The report summarized in Table 2 shows where major research efforts are concentrated and which universities may be leading innovation, thought leadership, and breakthroughs in blockchain applications for risk management by looking at the publication output of these top universities [38].

Table 3.
Major Universities Publishing Blockchain Risk Management Research.

Affiliations	Record Count	% of 285
Asia University Taiwan	5	1.754
fpt University	4	1.404
Imperial College London	4	1.404
Indian Institute of Management iim System	5	1.754
National Institute of Technology Nit System	6	2.105
Old Dominion University	4	1.404
University of Essex	4	1.404
University of New South Wales Sydney	5	1.754
University of South Africa	4	1.404
University of Texas System	5	1.754

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It is showing 10 out of 609 entries.

The range of participating organizations is highlighted by the affiliations analysis in the academic literature on blockchain technology in risk management. Several universities are well-known in this sector, according to the statistics, however, the scale of their involvement is considerable.

With 6 publications or 2.105% of the 285 total records, the National Institute of Technology (NIT) System stands out as having the most records. Five papers, or 1.754% of the total, were contributed by Asia University Taiwan, the Indian Institute of Management (IIM) System, the University of New South Wales Sydney, and the University of Texas System. This suggests that these institutions have an important, but modest, representation. Of the total records, 1.404% were supplied by 4 publications from FPT University, Imperial College London, Old Dominion University, University of Essex, and the University of South Africa., dispersed core of research in this field.

4.4. Countries Leading Blockchain Research in Risk Management

Refers to the countries that have produced the highest number of research publications on blockchain technology in risk management. This metric is shown in Figures 3 and 4 and Table 3, where significant research activity is concentrated geographically, highlighting the countries that are leading advancements in this field. Analyzing the top countries provides insight into global research trends, indicating regions with strong academic, governmental, or industrial interest in blockchain applications for risk management and potentially showcasing global leaders in technological innovation and policy development related to blockchain [39].

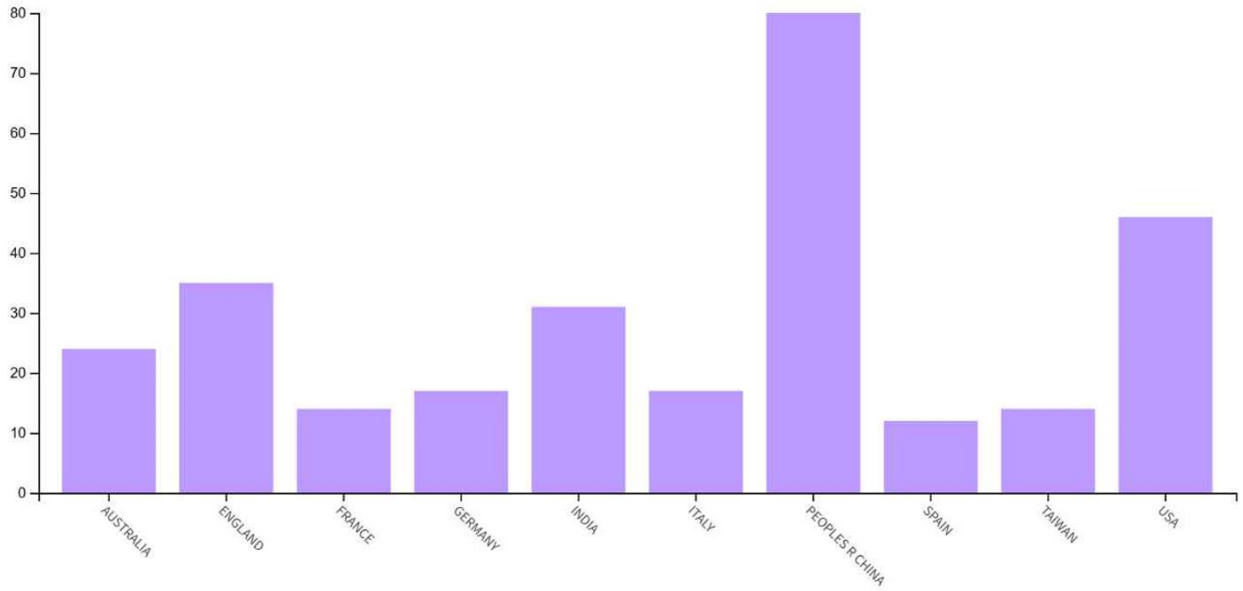

Figure 3.
Top countries.

Figure 4 presents the top universities and their associated countries:

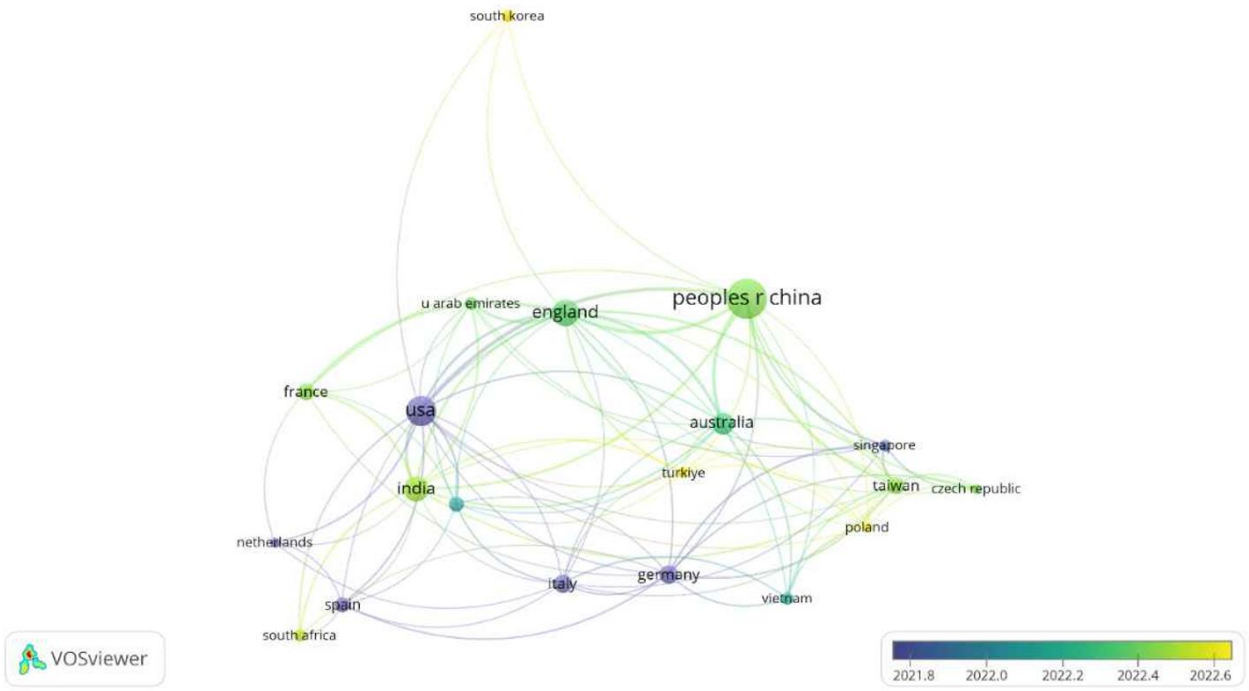

Figure 4.
Top countries.

As shown in Table 3, the countries are organized from the top

Table 4.
Countries Leading Blockchain Research in Risk Management.

Countries/Regions	Record Count	% of 285
CHINA	80	28.070
USA	46	16.140
ENGLAND	35	12.281
INDIA	31	10.877
AUSTRALIA	24	8.421
GERMANY	17	5.965
ITALY	17	5.965
FRANCE	14	4.912
TAIWAN	14	4.912
SPAIN	12	4.211

The analysis of publication data by country or region reveals significant insights into the global distribution of research on blockchain technology in risk management

Having provided 80 articles, or 28.070% of the 285 records in total, the People's Republic of China leads by a significant amount. Due to China's high level of research engagement and output, this predicts a leading role in the sector. With 46 articles or 16.140% of the total, the USA comes in second, showing a strong but less significant presence than China. With 35 articles, England comes in second place with 12.281% of the total, indicating a significant contribution from the UK. India's strong contribution to the research is shown by its 31 publications, or 10.877%, of the total.

Australia has 24 publications, or 8.421% of the total, which indicates a moderate level of activity. With 17 articles for each, or 5.965% of the total, Germany and Italy provide a significant but lesser amount of research when compared to the top countries. With 14 publications apiece, France and Taiwan have contributed 4.912%, which is a relatively lesser but still significant amount. With 12

articles or 4.211%, Spain completes the list, proving a lesser but significant involvement. Overall, the data points to a focus on research activity in a small number of important countries, with China at the forefront and other nations contributing to different degrees. This indicates a promising future for China given its advancements and developments in this field.

4.5. Top Publishers

Refers to the journals or publishers that have released the most research publications on using blockchain technology in risk management. Finding the leading publishers makes it easier to see which scholarly and commercial publications are actively sharing research in this area. This data identifies important blockchain research platforms at the next table, highlighting where important studies are expected to be published and which publications are crucial to advancing knowledge and creativity in risk management blockchain applications [40].

Table 1.
Top Publishers.

Publishers	Record Count	% of 285
Elsevier	49	17.193
IEEE	40	14.035
Mdpi	39	13.684
Springer Nature	39	13.684
Emerald Group Publishing	24	8.421
Wiley	8	2.807
Frontiers Media Sa	7	2.456
Hindawi Publishing Group	5	1.754
Taylor & Francis	17	5.965
World Scientific	4	1.404

According to a review of the top 10 publishers who are involved in risk management and blockchain research, Elsevier is at the top with 49 papers or 17.193% of the total output. IEEE comes closely behind with 40 articles (14.035%), demonstrating its strong presence in studies regarding technology. With 39 articles apiece (13.684%), MDPI and Springer Nature both make an equal contribution to open-access research.

With 24 publications (8.421%), Emerald Group Publishing comes in fifth place, highlighting its emphasis on practical research and management. Taylor & Francis highlight its contributions to interdisciplinary studies by adding 17 publications (5.965%) to the mix important but lesser contributions are made by Wiley (8 publications, 2.807%) and Frontiers Media SA (7 publications, 2.456%), especially in peer-reviewed and open-access journals. With five (1.754%) and four (1.404%) articles, respectively, Hindawi Publishing Group and World Scientific round out the top 10, demonstrating their significant yet specialized contributions to risk management and blockchain research. These publishers are generally essential to advancing knowledge in this field because they prioritize technological innovation, multidisciplinary collaboration, and accessibility.

4.6. Industry or Specialized Related to Blockchain

This refers to the industries or domains where blockchain technology is most widely used or studied. It covers sectors including chain management, banking, healthcare, and cybersecurity, where blockchain technology allows academics to determine which sector to use now or in the future, as shown in Table 5 [41, 42].

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Table 6.
Industry or specialized related to blockchain.

Web of Science Categories	Record Count	% of 285
Computer Science Information Systems	57	20.00
Management	39	13.68
Engineering Electrical Electronic	34	11.93
Computer Science Interdisciplinary Applications	30	10.53
Telecommunications	27	9.47
Business Finance	26	9.12
Engineering Industrial	26	9.12
Operations Research Management Science	23	8.07
Computer Science Artificial Intelligence	22	7.72
Economics	20	7.02

The review of the Web of Science risk management categories and blockchain research shows a wide variety of sectors engaged in this area. Computer Science Information Systems is the most popular category, with 57 articles, or 20,000 % of all research published. This suggests that the use of blockchain technology in risk management and its applications depend on information systems. With 39 papers (13.684%), management comes in second, indicating the increased interest in integrating blockchain into corporate plans and management processes. 34 papers (11.930%) in Engineering Electrical and Electronic Engineering follow, highlighting the significance of blockchain in Electrical and Electronic Engineering, especially in security and systems integration-related fields. The 30 publications (10.526%) in the Computer Science Interdisciplinary Applications category demonstrate how blockchain research is multidisciplinary, spanning both technological and non-technological domains. The reliability of blockchain in communication networks and related businesses is further shown by the significant presence of telecommunications with 27 articles (9.474%).

The engineering and business finance sectors each contribute 26 papers (9.123%), demonstrating the considerable influence of blockchain technology on industrial processes and financial systems. 23 papers (8.070%) in the field of operations research management science show that blockchain technology is being investigated as a potential tool for improving operations and improving decision-making.

The final two top categories are Economics (20 papers, 7.018%) and Computer Science Artificial Intelligence (22 publications, 7.719%), which highlight the uses of blockchain in AI-driven systems and economic frameworks. This broad application of blockchain technology in technological innovation and commercial operations is demonstrated by its diverse distribution across industries.

4.7. Researching Area

Refers to the academic disciplines or fields of study contributing to research on blockchain technology, such as computer science, business economics, engineering, and operations management. Unlike "Industry or specialized related to blockchain," which focuses on the sectors where blockchain is applied (e.g., finance or healthcare), "Researching Area" emphasizes the academic and theoretical foundations that support and explore blockchain's functionality, development, and implications across various fields as shown in table 6 [43].

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Table 7.
Researching Area.

Research Areas	Record Count	% of 285
Computer Science	102	35.79
Business Economics	87	30.53
Engineering	76	26.67
Science Technology Other Topics	26	9.12
Telecommunications	27	9.47
Operations Research Management Science	23	8.07
Environmental Sciences Ecology	22	7.72
Mathematics	15	5.26
Physics	7	2.46
Public Administration	6	2.11

Complementing the analysis of the industries involved in blockchain and risk management research, with 35.789% of articles, computer science is in the lead, highlighting its importance in both industry applications and technical advancements.

Business Economics (30.526%), which is like industry categories like Management and Business Finance, demonstrates a major interest in how blockchain may affect business models and economic systems.

Engineering covers up 26.667% of the study, which is consistent with the industry's emphasis on blockchain applications in the fields of electrical, electronic, and industrial engineering. The research and industrial domains of telecommunications (9.474%) and operations research management science (8.070%) are highly represented, highlighting the significance of blockchain technology in communication networks and processes for making decisions.

The industry's increasing focus on sustainability and governance is supported by the growing effect of blockchain technology in emerging fields like Public Administration (2.105%) and Environmental Sciences Ecology (7.719%). All things considered, the relationship between fields of study and sectors of the market highlights how widely applicable and innovative blockchain technology can be in many different fields.

4.8. Most-Cited Authors

This defines the authors with the most impact based on the citation count shown in the next figure by Vosviwer. These authors are making an impact on the topic. The co-authorship network visualized in the map reveals clusters of highly interconnected authors, highlighting collaboration patterns within the blockchain and risk management research domain. The color-coded clusters indicate different research groups or thematic areas. This map underscores the collaborative nature of the field, with significant contributions from a few key authors driving research and development [44].

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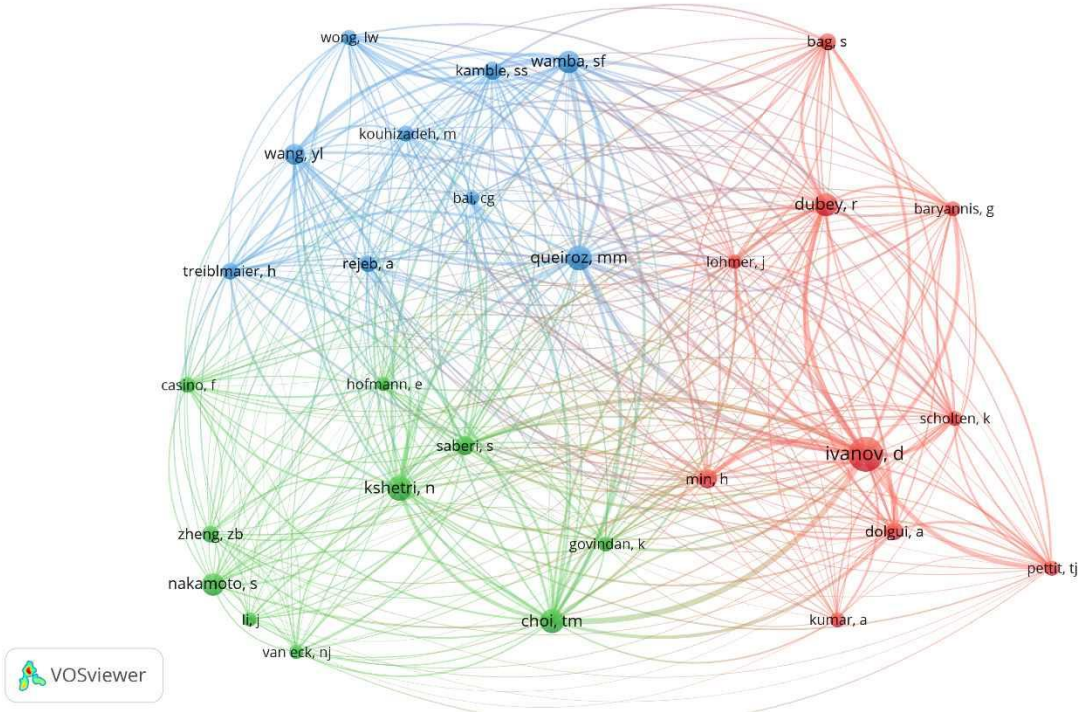

Figure 5.
Most Cited Authors.
Source: Wong [31] and Wang, et al. [27]

The different colors on the map represent clusters of authors working in related areas within blockchain technology and risk management. The blue cluster likely represents authors focused on supply chain management or the integration of blockchain technology within logistics and business operations, as indicated by common keywords in these sectors. The green cluster corresponds to authors in the cybersecurity or privacy fields, where blockchain enhances data protection and security protocols. The red cluster likely represents research on financial systems and the economic applications of blockchain, particularly in improving transparency and reducing financial risks in areas like financial transactions or derivatives.

4.9. Most-Cited Titles

Refers to the studies or publications on risk management using blockchain technology that have gotten the most citations from other researchers as shown in the next table. Highly cited titles are regarded as fundamental or very useful research on the subject since citations show a publication's impact and influence within the academic community [45].

Table 8.
Most-cited titles.

Title	Publication Year	Total Citations
Convergence of blockchain and artificial intelligence in IoT network for the sustainable smart city	2020	221
Analysis of resilience strategies and ripple effect in blockchain-coordinated supply chains: An agent-based simulation study	2020	201
Blockchain: case studies in food supply chain visibility	2020	200
Improving supply chain resilience through industry 4.0: A systematic literature review under the impressions of the COVID-19 pandemic	2021	190
Does digitalising the supply chain contribute to its resilience?	2021	138
Potentials of blockchain technologies for supply chain collaboration: a conceptual framework	2021	93
Supply chain management 4.0: a literature review and research framework	2021	86
A Bibliometric Analysis of Sustainability and Risk Management	2021	83
Cybersecurity in logistics and supply chain management: An overview and future research directions	2021	75
Role of big data analytics capabilities to improve sustainable competitive advantage of MSME service firms during COVID-19 multi-theoretical approach	2022	70

The most cited authors in blockchain research demonstrate significant influence, particularly in areas like supply chain management, resilience, and emerging technologies. For his work on blockchain and artificial intelligence in smart cities, Saurabh Singh has received the most citations (221), followed by Lohmer, et al. [46] (201), who focuses on resilience techniques in blockchain-coordinated supply chains. While Spieske, et al. [47] (190 citations) studies supply chain resilience during COVID-19, Hobson, et al. [48] (200 citations) focuses on blockchain in food supply chains. Other important works are from Abdulrahman, et al. [49] on blockchain partnership (93 citations) and Zouari, et al. [50] on digitalizing supply chains (138 citations). These writers greatly helped the advancement of the supply chain, long-term viability, and technological integration of blockchain technology.

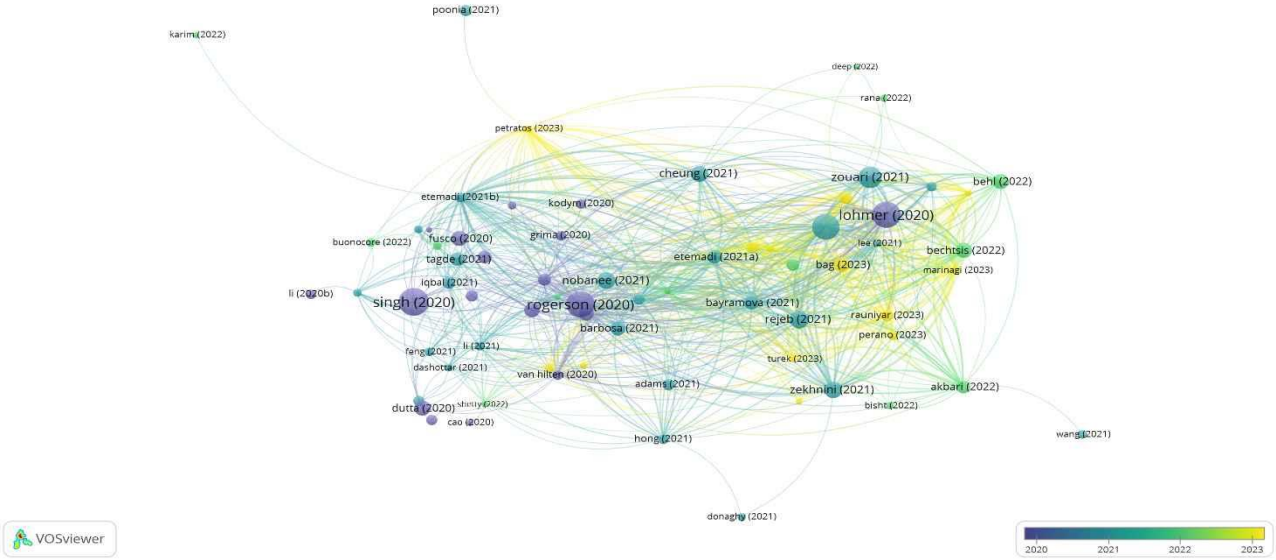

Figure 6.
Most cited titles.
Source: Kirby [35]; Wang, et al. [27]; Wong [31]; Hobson, et al. [48] and Azizi, et al. [16]

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This network represents citations among various academic papers over a specified time frame. Here's a breakdown of its components:

- Nodes Each: node (represented as a circle) corresponds to a specific publication or author. The node's size often reflects the number of citations or the impact of the publication—the larger the node, the more influential the work.
- The lines connecting the nodes indicate their relationships, typically showing citations. A thicker line suggests a stronger connection (more citations between the papers).
- Colors: The color gradient (from purple to yellow) typically indicates the year of publication, with purple representing earlier years and yellow indicating more recent publications. This allows you to visualize trends over time in the literature.
- Clusters: The arrangement of the nodes into groups or clusters may indicate research themes or topics that are related. Papers that are often cited together may cluster in proximity, suggesting a shared focus or area of study.

4.10. Network Visualization of the Most Related Keywords of Blockchain

This visualization helps researchers identify key trends, understand the landscape of blockchain studies, and recognize emerging areas for further exploration. It serves as a useful tool for mapping the field and guiding future research directions [51].

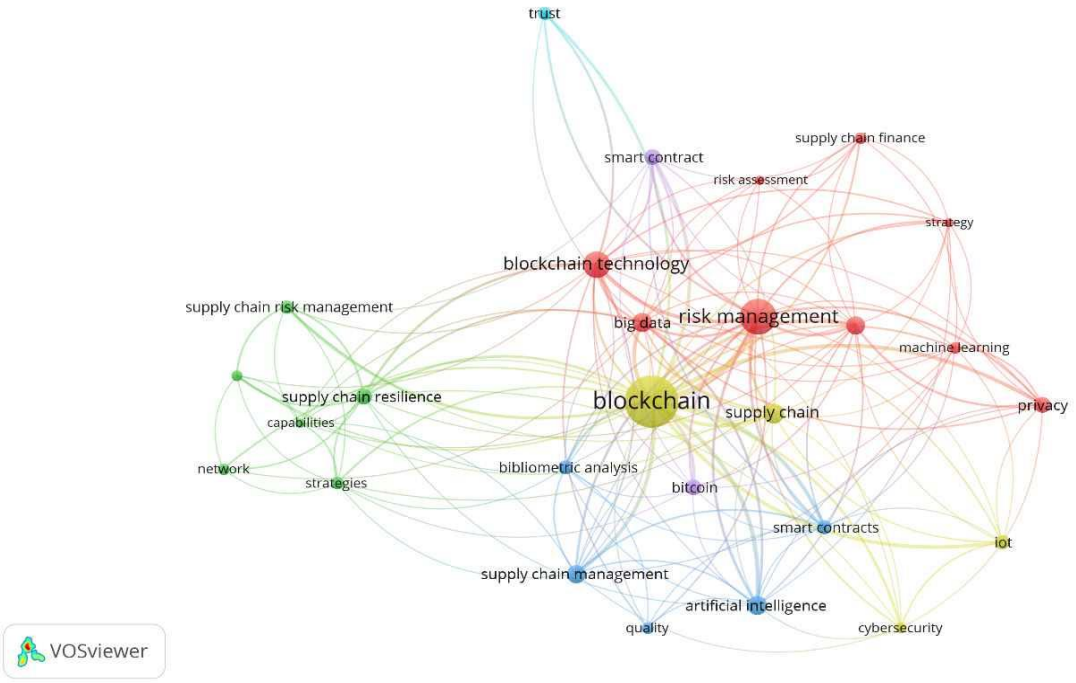

Figure 7.
Network visualization.

The network visualization of blockchain's key terms shows several important fields in which blockchain technology is applied, At the center of the network is the term blockchain, closely connected to important concepts like risk management, blockchain technology, supply chain, and privacy, reflecting their relevance in blockchain research and applications.

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The visualization clusters highlight certain study areas. The red cluster, for example, shows a strong connection between the implementation of blockchain technology in risk management and the secure processing of huge amounts of data. It also integrates big data, machine learning, and risk management. The green cluster focuses on supply chain resilience and strategies, highlighting blockchain's role in enhancing the resilience and management of supply chains. Additionally, the blue cluster shows the connection between smart contracts, artificial intelligence, and cybersecurity, indicating blockchain's role in automating processes and improving security through decentralized systems. The important role of blockchain in ensuring the security and privacy of linked devices in IoT systems is highlighted by the yellow cluster, which contains words like IoT and privacy. Overall, the visualization highlights how blockchain is becoming more and more integrated technologies like artificial intelligence (AI) and big data, especially in areas like supply chain management, risk management, and privacy protection. This shows how the technology can be used to address current problems in a variety of industries.

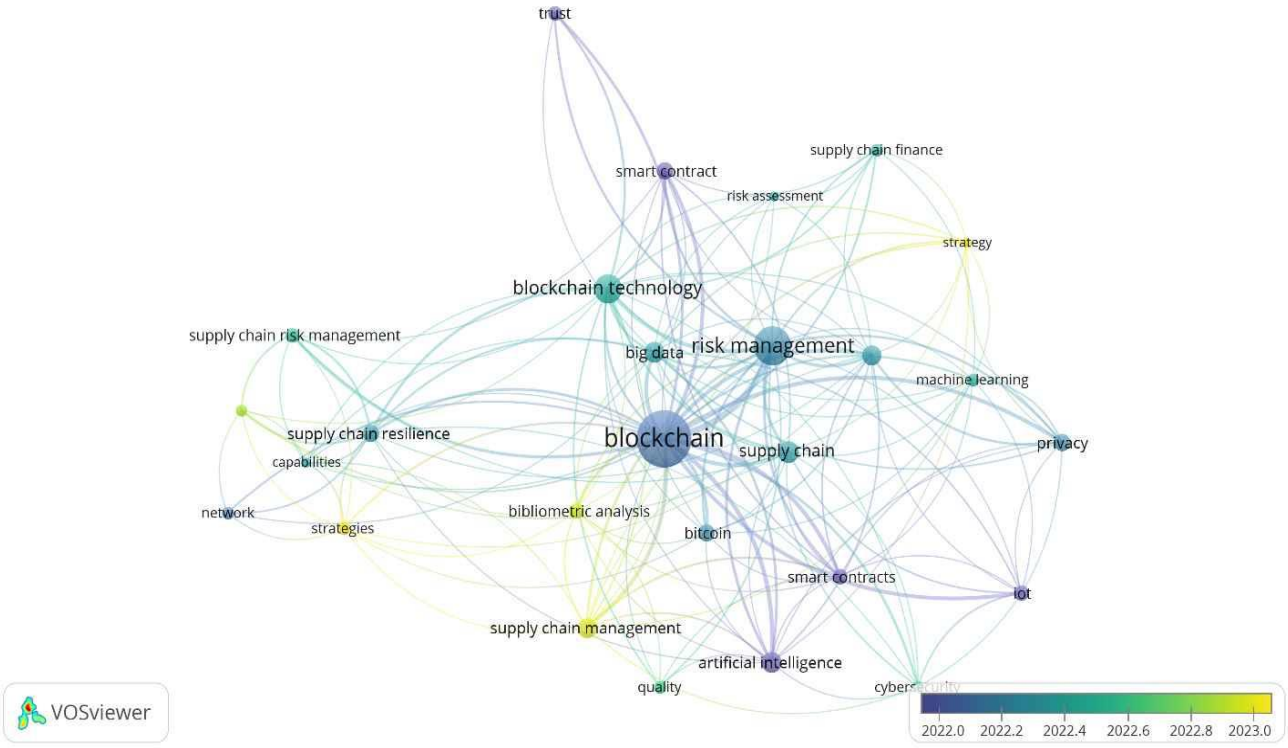

Figure 8.
Network overlay visualization by years.

This second network visualization graph of blockchain keywords includes a time scale, showing how the keywords have evolved over a specific period. The color gradient, ranging from yellow (early 2022) to blue (early 2023), indicates when each keyword became prominent in research. The blockchain term is still at the core, showing ongoing importance a range of academic fields. Numerous topics, like supply chain management, risk management, and blockchain technology, are shaded in blue, suggesting that these subjects have remained significant throughout the observation period. Some newer keywords, such as IoT and privacy, are represented in lighter blue or closer to the yellow end of the spectrum, suggesting that their connection to blockchain research has become more prominent in recent times.

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The graphic reflects new trends and uses in the blockchain space while also highlighting the diversity of research subjects related to blockchain. It also shows how interest in specific concepts, such supply chain resilience, privacy, and the Internet of Things, has risen over time.

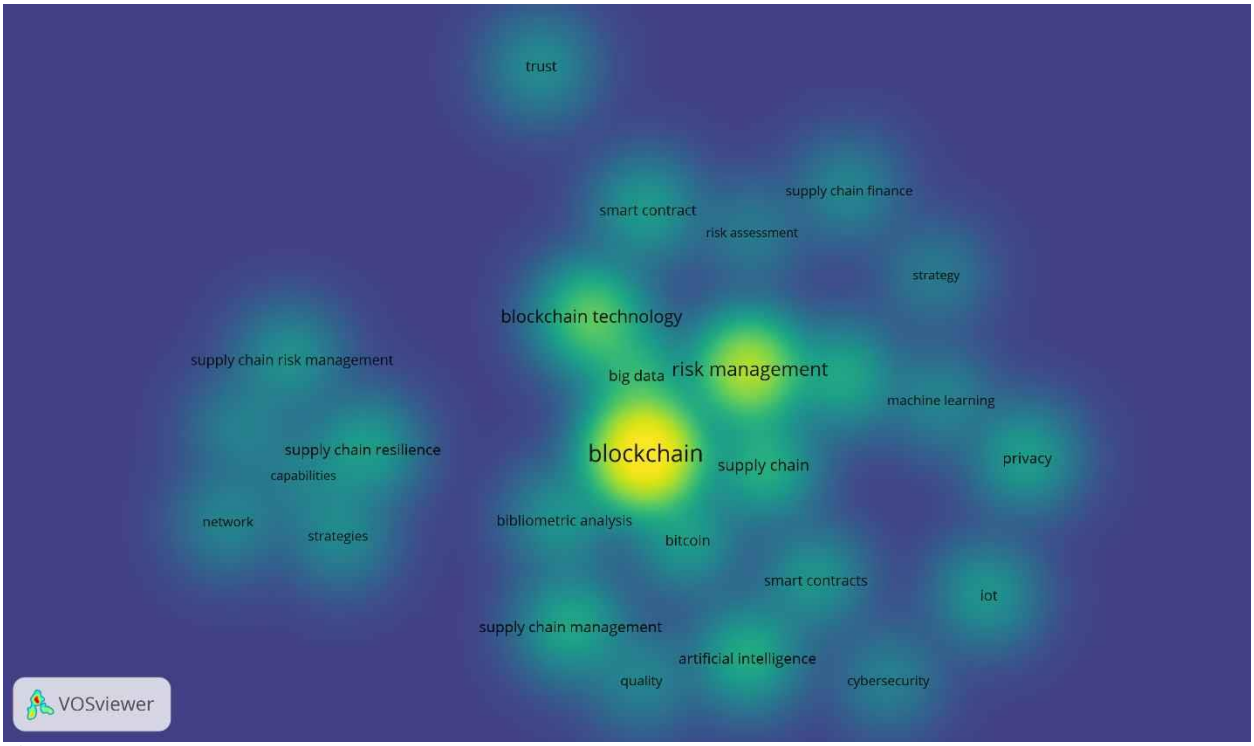

Figure 9.
Density Visualization.

This heatmap visualization of blockchain-related keywords highlights the density of research focus on specific terms. The brighter, more concentrated areas, such as around blockchain, risk management, and blockchain technology, indicate that these topics are central and frequently discussed in the research.

4.11. Author Keyword Map

An Author Keyword Map visualizes the most frequently used keywords by authors in a specific research field. It shows the relationships between keywords, helping to identify key research themes, trends, and the interconnectedness of different topics.

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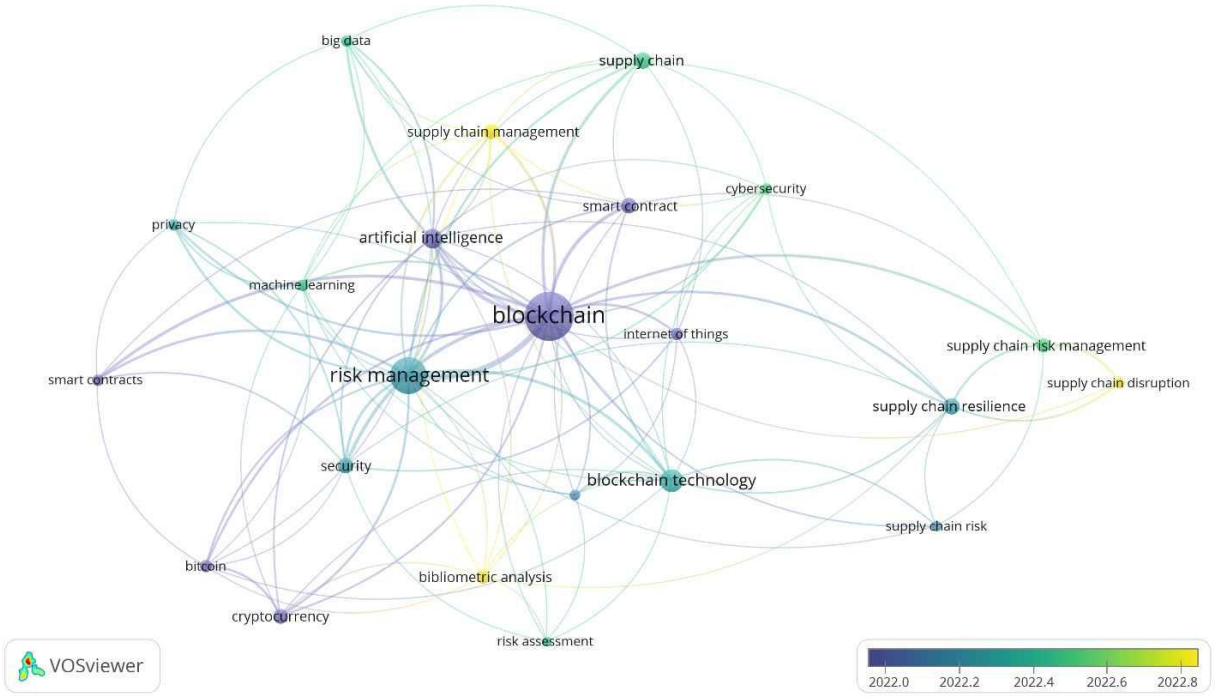

Figure 10.
Author Keyword Map by Years.

This author's keyword map visualizes the relationships and frequency of use between key terms related to blockchain research over time. Blockchain sits at the center of the map, heavily connected to other important topics like risk management, artificial intelligence, and supply chain, indicating these are major areas of focus for researchers.

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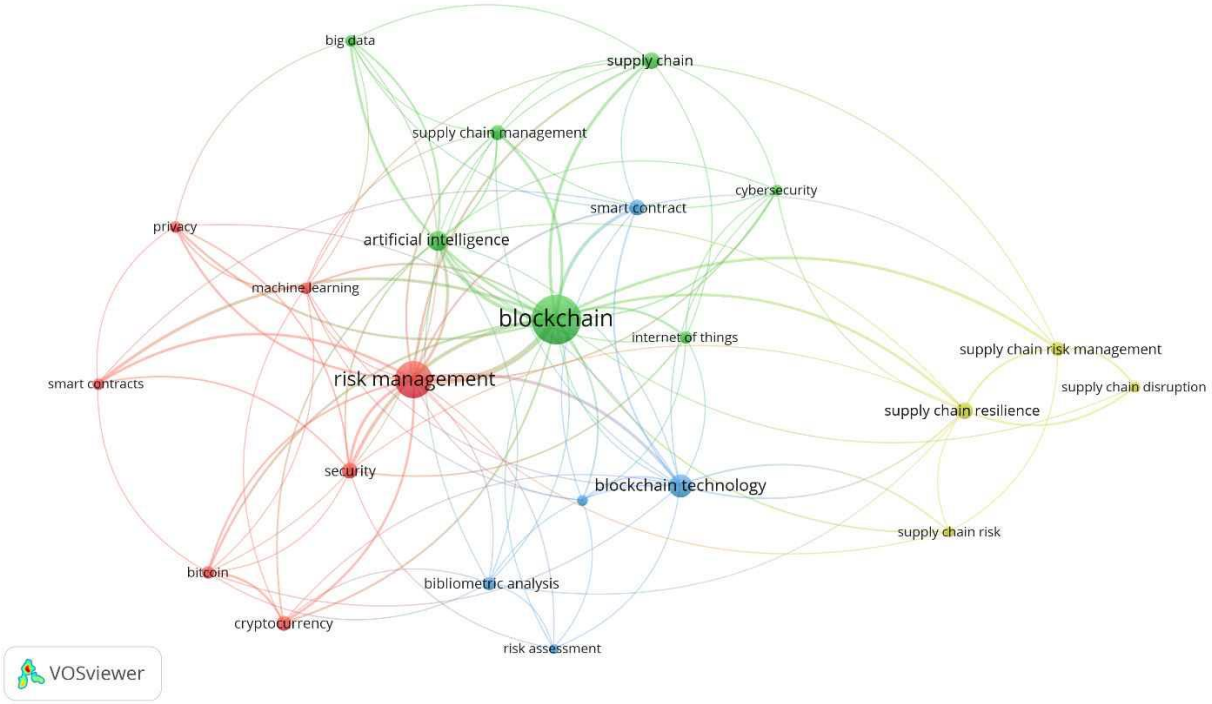

Figure 11.
Author Keyword Map.

This author's keyword map, which groups terms based on different thematic areas, shows the Blockchain research clusters. The main node is blockchain, which has significant connections to supply chains (green cluster) and risk management (red cluster), suggesting significant study in these fields. Meanwhile, the blue cluster, which includes blockchain technology, bibliometric analysis, and risk assessment, suggests a focus on blockchain's technical and evaluative aspects. The map shows how study topics are divided and highlights how blockchain may be applied widely to supply chain resilience, risk management, and technical developments.

5. Discussion and Recommendation

This study's bibliometric analysis revealed a growing interest in blockchain applications in risk management, particularly within the domains of cybersecurity, financial systems, supply chain management, and more. Our analysis shows that blockchain's ability to secure data, provide transparency, and streamline operations makes it highly suitable for these industries. However, challenges remain, Numerous restrictions and difficulties with blockchain technology prevent its wider use. Because it might be difficult to integrate several blockchain systems easily, interoperability is still a problem. Some businesses may be prevented from adopting it due to the high implementation costs, which include infrastructure, maintenance, and training. Furthermore, blockchain systems frequently function more slowly than conventional digital systems, which can be problematic in situations where time is of the essence. Blockchain's transparency is one of its advantages, but it can also cause sensitive company data to be compromised. Finally, incorporating blockchain technology into current procedures can be challenging and frequently calls for major changes to operations [52].

Despite these challenges, the benefits of blockchain technology make it a valuable investment. Its transparency enhances traceability and accountability, reducing fraud and improving trust across networks. The security features of blockchain, with its immutable and decentralized structure, provide robust protection against data tampering and unauthorized access. Additionally, blockchain's ability to

streamline processes and eliminate intermediaries can lead to cost savings and operational efficiencies over time. While initial implementation may be complex, the long-term advantages—such as increased trust, security, and efficiency—are well worth the effort.

Future studies should focus on creating blockchain applications that serve the requirements of sectors like healthcare and environmental management, investigating regulations that encourage innovation without giving up security and creating scalable blockchain systems that can manage big datasets. To integrate blockchain into their current risk management frameworks, companies should invest in safe, interoperable solutions, start with pilot blockchain initiatives, and develop partnerships with tech expertise. Blockchain technology is being explored across diverse industries, each benefiting in unique ways: in supply chain management, it enhances transparency and traceability; in financial systems, it strengthens data security; and in healthcare, it improves patient data management and privacy. Key research is emerging from countries like China, the U.S., and the U.K., where institutions lead in exploring blockchain's applications and potential. This global investment in research and development signals a promising future for blockchain, with transformative impacts anticipated across sectors worldwide.

6. Conclusion

In conclusion, this study highlights blockchain technology's transformative potential across various sectors, particularly in redefining risk management by enhancing transparency, data security, and operational efficiency. Blockchain's role in strengthening cybersecurity, streamlining financial transactions, and ensuring supply chain resilience underscores its expansive impact on key industries and research areas [53].

Great powers like China, the United States, and the United Kingdom have made significant contributions to the advancement of blockchain research, confirming its applicability on a worldwide scale. Blockchain can enable safe, transparent data interchange and spur business model innovation by resolving existing constraints and conforming to regulatory standards.

Expert insights emphasize that, with appropriate regulatory support and collaborative efforts between academia, industry leaders, and policymakers, blockchain could revolutionize industries much like the internet did, suggesting that ongoing exploration and development will be essential for full use.

Despite this, research in this field is increasing, and the results are constantly changing according to the Web of Science because the data was exported from 2020 until July 2024. Even the research in this area is evolving daily. If the same queries are used after some time, the number of studies will likely change. This indicates that blockchain's relevance and adoption in risk management continue to grow as advancements are made and new challenges are addressed.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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