

Research Trends in Blockchain Technology for Regional Government Financial Management in Indonesia: A Bibliometric Analysis

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Abstract. Blockchain is an emerging technology that has been widely used in various sectors, including the financial sector. This study analyzes research trends on blockchain technology for regional government financial management in Indonesia using bibliometric techniques. Database searches identified 141 documents on blockchain in Indonesia and 34 documents specifically on financial blockchain from 2016-mid 2023. This research utilizes bibliometric methods complemented by a research question to uncover significant findings or trends in the literature related to the potential implementation of blockchain in regional government finance in Indonesia. Research on blockchain in the Indonesian financial sector has already been widely conducted, accounting for 24% of the research related to blockchain in Indonesia. This indicates that the financial sector has become one of the primaries focuses of blockchain-related research in Indonesia. Bibliometric analysis of the literature suggests that blockchain has potential to enhance transparency, efficiency, and accountability in regional government finance through features like smart contracts, immutable records, and decentralized networks. A private blockchain structure can provide security and control. This study informs blockchain implementation plans for regional finance in Indonesia.

Keywords: blockchain, finance, regional government, smart contract, Indonesia, bibliometric

1. Introduction

As an emerging technology, blockchain is receiving a lot of attention, especially from the financial sector. Blockchain is a digital technology that serves as a distributed and immutable decentralized ledger that record transactions cryptographically (Hewa et al., 2021). With advanced encryption and an immutable distributed ledger, blockchain technology enables secure peer-to-peer transfers among numerous users, maintaining a continuously connected list of recorded transactions without the involvement of third parties (Boakye et al., 2022), (Nanayakkara et al., 2021). According to Scopus data until August 2023, there were 2261 articles on the government blockchain, and constantly rising. This indicates that blockchain technology will advance further. Blockchain technology in the government sector is used in the financial system (Christen et al., 2023), value and tax (Setyowati et al., 2023), supply chain (Hu et al., 2023), public service systems (Shahaab et al., 2023), and land administration (Ameyaw & de Vries, 2023), etc. Blockchain technology is anticipated to significantly impact various sectors of the digital economy, particularly finance and investment (Ungson & Soorapanth, 2022). Several case studies have shown that common issues faced in government finance include lack of transparency, lack of verification processes, and inefficient administrative systems.

Indonesia's government structure is characterized by a democratic republic, and its financial system is a crucial component of the country's growing economy. The government plays a significant role in shaping economic policies and ensuring the stability of the financial sector. Blockchain has a significant impact on the financial sector, and there are some concerns regarding the risks involved in each transaction. Blockchain technology in banking, buying and selling, currency markets, and online services, such as cryptocurrencies like Bitcoin and Ethereum has a disruptive effect (Ahluwalia et al., 2020). In addition to the many benefits and potential concerns, a study of blockchains in government finance is required as a potential implementation. The use of blockchain in the Indonesian regional government finance system specifically covers this study. Due to the Law of the Republic Indonesia No. 23 of 2014 establishing a regional government and the Law of the Republic Indonesia No. 1 of 2022 regulating the financial balance between the central government and regional governments, transparency is the key demand in the political system. In the handling of regional government funds, this is particularly true. The regional government finance system frequently has issues, including transaction administration errors, nontransparent social assistance payment mechanisms, and nontransparent tax payment procedures, and many more. Effective financial management is essential to ensure that resources are allocated efficiently and transparently to support regional development goals.

Addressing these issues and improving financial management practices are crucial steps in ensuring the responsible and efficient use of public funds at the regional level, ultimately benefiting local communities and supporting development initiatives. The issues that occur in regional government finance will be explained based on previous research. Despite all the blockchain technology the benefit offers, it is still not commonly used in regional governments and becomes a challenge in the research process. Transparency and accountability are the keys to regional government financial management, and blockchain is a technology that can overcome this issue. Blockchain is theoretically resistant to data corruption because transactions are recorded as blocks of chronological data (Kassen, 2022). Blockchain is easily accessible and verifiable to support accountability on the validity of each transaction (Marchesi et al., 2022), (Setyowati et al., 2020). A smart contract on the blockchain is a computer program that automatically executes, confirms, or negotiates digital agreements or contracts based on the programmed rules and conditions (Hewa et al., 2021). With all its benefits, the use of blockchain can be a useful tool in optimizing the financial management of regional governments in Indonesia.

Considering the issues with regional government finance regarding the transparency system, it is necessary to analyze them using quantitative methods with bibliometric evaluations to assess the current research conditions and the possible use of blockchain technology in regional government finance. The aim of this study to explore the research trend and the potential use of blockchain technology and smart

contracts in improving financial practices at the regional level in Indonesia. The possible adoption of blockchain technology in terms of transparency and security of transaction documentation may provide additional benefits upon its implementation. This study has several contributions that can be used as references and recommendations for blockchain implementation plans in the Indonesia's financial sector.

This research also uses research questions to conduct the study more efficiently and effectively, and to assist in presenting the research results systematically and organized.

1. How far is the research on blockchain in the financial sector in Indonesia?
2. What is the potential for implementing blockchain in regional government finance?
3. What are the most important features of blockchain for use in finance?

2. Background

2.1. Literature review

The research conducted by Prux et al. (2021) aimed to identify challenges and opportunities for using blockchain technology in the context of government accounting in Brazil. The use of blockchain technology in government accounting in Brazil has great potential to increase transparency and efficiency. This literature suggests the need for more pilot projects, partnerships between public agencies and academia, and expanded research across Brazilian states and municipalities to fully explore blockchain's applicability in government accounting.

Ranjan et al. (2022) suggests a blockchain system to enhance transparency and efficiency. It addresses the issue of untraceable government fund allocation in India, which is attributed to corruption. Blockchain's immutable ledger promises increased trust and record accuracy through secure and consistent data storage.

Sai Tarun Kumar Reddy et al. (2023) employed secure blockchain technology and encryption to ensure the safety and transparency of tender transactions. This approach safeguards critical information and reduces the risks associated with mismanaging tenders and contracts. Because effective tender and contract management is crucial for companies and government entities to secure necessary products and services. Mismanagement can lead to financial losses and reputation damage due to issues like favoritism, poor record-keeping, and hacking.

Weingärtner et al. (2021) proposed smart contracts to automate and rectify major weaknesses in public procurement procedures, encompassing bidding, supplier approval, and delivery verification processes. The research aims to establish a trustworthy and enduring blockchain-based system for recording government procurement of goods and services.

Nagarajan & Afjal (2023) highlights the significance of blockchain technology in the financial sector. It underscores the need for regulatory frameworks as it has transformative potential, addressing inefficiencies and providing innovative solutions. While it offers numerous benefits, challenges such as cost, energy consumption, cybersecurity, and regulation need to be addressed.

Bai et al. (2022) investigates the adoption challenges in supply chain finance (SCF) through a case study of a Chinese state-owned enterprise. It identifies technological barriers like framework selection and data governance, along with operational hurdles related to process transformation. Additional challenges include job displacement and regulatory issues. This research provides valuable insights and a conceptual framework for future SCF blockchain adoption studies.

Demirkan et al. (2020) explored the potential of blockchain technology in taxation. It discusses how blockchain offers a new approach to taxation, reduces tax expenditure, enhances transparency, combats tax evasion, and minimizes administrative burdens. The research emphasizes the benefits of blockchain for tax systems.

Singh et al. (2019) addresses the global need for faster payment and settlement cycles to reduce inefficiencies and risks in financial transactions. It presents a novel architecture integrating e-wallets of

different banks and institutions using blockchain, offering a foundation for Digital Ledger Technology (DLT) in India's financial sector. The design includes a swarm-based peer-to-peer network, reducing load on banks' Core Banking Solutions and decentralizing processing activities.

Sabila & Rahardjo (2019) proposed using blockchain for transparent monitoring of financial aid for schools from the Indonesian government. The study covers planning, implementation using Hyperledger, and functional and performance testing. The financial aid for schools (BOS-*Bantuan Operasional Sekolah*) has faced issues like corruption and lack of transparency.

From the various studies mentioned above, it is evident that the utilization of blockchain technology is predominantly limited to certain phases within the financial management lifecycle. However, it's crucial to recognize that financial management encompasses a broader spectrum, spanning from budgeting to financial execution and accountability. While blockchain's potential has been harnessed effectively in specific areas, there remains substantial untapped potential for its integration throughout the entire financial management process.

The Indonesian government, including provincial and local governments, manages the Regional Revenue and Expenditure Budget (APBD-*Anggaran Pendapatan dan Belanja Daerah*) through an integrated information system mandated by Law of the Republic Indonesia No. 23 of 2014. This system, part of the Electronic Government System (SPBE-*Sistem Pemerintahan Berbasis Elektronik*), covers program planning, financial execution and reporting, government procurement, performance accountability, monitoring, and evaluation. To enhance transparency and accountability, the government promotes non-cash payments. The implementation involves external stakeholders such as the Ministry of Home Affairs, which functions as the policy maker for regional budget management and the approval of APBD; financial institutions responsible for fund storage and disbursement for both regional income and expenditure; the Directorate General of Taxation, which collects tax payments from regional government expenditures; the Directorate General of Fiscal Balance, responsible for disbursing General Allocation Funds (DAU-*Dana Alokasi Umum*) to regional governments; the Supreme Audit Agency (BPK-*Badan Pemeriksa Keuangan*), an institution overseeing the implementation of regional budget management; the Regional People's Representative Council (DPRD-*Dewan Perwakilan Rakyat Daerah*), responsible for budgeting and overseeing APBD; and the public, including businesses, organizations, individuals, and related parties.

2.2. Blockchain technology

Blockchain is a technology for distributed ledgers to record and store data to ensure transparency, security, and immutability. Blockchain technology is part of a larger group of digital ledgers that can be divided into three core types: centralized, decentralized, and distributed (Ciotta et al., 2021). Blockchain records are referred to as transactions or events. The collection of its records can be defined as a block, and the relationship between them is a node. Each node in the blockchain system manages chain copy and can confirm the accuracy of all transactions (Laatikainen et al., 2023). A blockchain is a trusted tool for recording and keeping information because of its distributed nature, which ensures reliable and secure information storage. Distributed ledger technology is an advantage of blockchain because each data record in a newly created block contains summary information (hash) of all previous blocks (Kassen, 2022). The context technique allows the nodes to concur on a legitimate ledger status during the validation process. The blockchain concept is an ongoing process that continues as long as it successfully transfers the hash code from one block to another, as shown in Fig. 1.

According to (Perera et al., 2020), there are different generations of blockchain. Transactions involving cryptocurrencies were conducted using Blockchain 1.0. For the creation, transaction, and authentication of the blockchain's values, encryption techniques are necessary for cryptocurrencies. Smart contracts, which form the foundation of this blockchain generation, were introduced with Blockchain 2.0 for use in commerce, finance, and economics applications. It is described as a protocol for computerized transactions that fulfill the conditions of a contract. Smart contracts provide the ability to specify business logic, conditions, and triggers to allow for more complex programmed transactions

while enhancing the system of user mutual trust. With the help of self-executing contracts, which are backed up using a consensus process, smart contracts make it possible to digitize and automate commercial workflows. Blockchains are where smart contracts are deployed and carried out. Computer codes are used to create smart contracts. For nonfinancial uses of distributed ledgers, Blockchain 3.0 has been introduced. The use of Blockchain 3.0 is acknowledged for purposes other than money, markets, and economics, especially those relating to research, health, government, culture, art, and other areas. Nonfinancial activities can reflect the currency attributes in applications based on Blockchain 2.0 and Blockchain 3.0 by combining them with others linked to finance, governance, and education. In numerous industries, use cases have been developed and put into practice. Currently, blockchain is still being developed for use in fields other than finance. Meanwhile, research on blockchain in the financial industry is expanding rapidly, particularly for domestic financial operations.

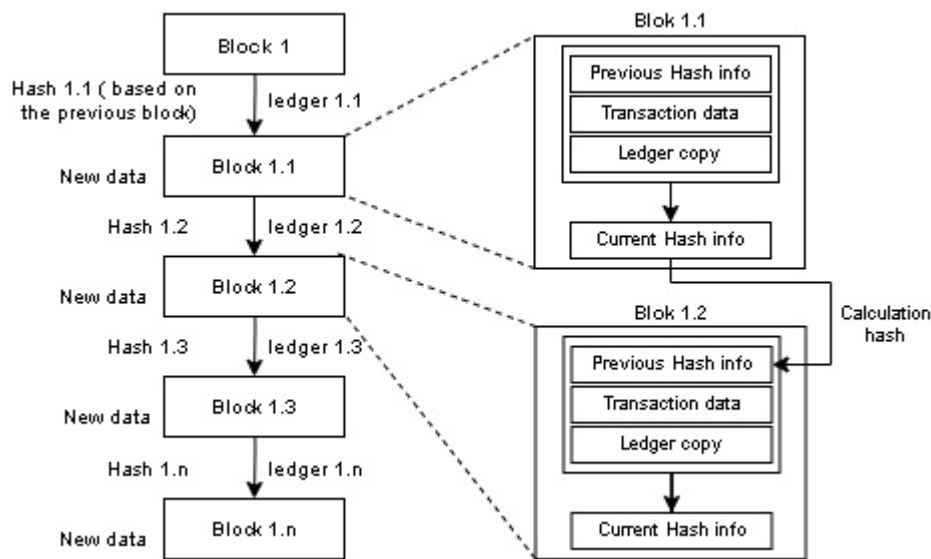


Fig. 1: The concept of data on the blockchain

2.3. Blockchain technology in the financial sector

The digital revolution resulting from the implications of blockchain on the financial or banking sector impacts on improving services effectively and efficiently (Boakye et al., 2022). Blockchain technology has demonstrated its ability to manage potential and transform contemporary financial management over the past fifteen years (Patel et al., 2022). The organization of intermediaries, payment methods, transactions for payments, management of assets, contracts for insurance, procurement, and many other areas are all impacted by blockchain in the financial sector. The characteristics of blockchain on the transaction side can reduce costs significantly, not requiring intermediaries or third parties in the transaction validation process (Patel et al., 2022). Blockchain in the financial sector is a trust solution that ensures that transactions cannot be changed. The most important aspect of blockchain is a secure financial system because if data changes, no transactions can be made (Wang et al., 2022).

2.4. Blockchain technology in Indonesia

Global blockchain innovations impact how blockchain is used in Indonesia. Information and Communication Technology (ICT) is advancing rapidly, which has sparked innovation in the traditional financial sector. In the meantime, the traditional financial industry itself is dealing with several concerns, namely, the problem of inefficiency in the provision of financial services and public mistrust brought on by some financial scandals. Central Bank Digital Currency (CBDC), is one of the rapidly evolving uses of blockchain technology in the financial sector. CBDC is a fiat currency that was created by the government and is based on a blockchain network. The governments of other nations in the world, and Indonesia's government, are actively planning and implementing a CBDC. CDBC was announced by

the Indonesian government through Bank Indonesia (Haryono, 2022). In 2016, Indonesia outlawed the use of Bitcoin, Ethereum, Dash, Litecoin, and Ripple for domestic transactions (Renduchintala et al., 2022). Although they are still illegal as a form of payment, cryptocurrencies will be allowed for trading as commodities in Indonesia in 2021 (Ungson & Soorapanth, 2022).

Blockchain research in Indonesia has been conducted on the taxation system (Setyowati et al., 2023), supply chains (Alamsyah et al., 2023), and the use of smart contracts on drug data (Jaya et al., 2023). Due to its rapid transmission speed, blockchain can improve the efficiency of the tax system, making it more difficult or perhaps impossible for parties participating in the tax administration chain to evade taxes (Setyowati et al., 2023). Blockchain technology's traceability feature is used in the coffee business to address inefficiencies. By recording the transportation of coffee beans, blockchain can increase the effectiveness of the coffee supply chain (Alamsyah et al., 2023). The benefits of other blockchain features are also used in drug data records. Implementation of the Ethereum blockchain can integrate data stored with smart contracts (Jaya et al., 2023).

2.5. Regional financial management in Indonesia

Regional government finance systems in Indonesia refer to the financial management and operations of regional governments, provinces, and regions within the country. These systems involve the collection, allocation, and use of public funds at the regional level to support various government initiatives, services, and development projects. Regional government finance systems in Indonesia are subject to regulations and oversight by both regional and central government authorities to ensure responsible and efficient use of public funds and promote transparency and accountability. The Indonesian government operates under a decentralized system with two main levels, the central government and regional governments. Indonesia is divided into provinces, which are further divided into districts and municipalities. Regional governments have the authority to govern and make decisions related to development, public services, and regulations within their jurisdictions (Adiputra et al., 2018). To implement regional development, the preparation of an APBD is required. Developing and implementing the APBD considers the specific characteristics of the regional government. This includes various stages such as planning, authorization, execution, evaluation, and accountability, which involve both the executive and legislative branches in ensuring the effective use of funds (Adiputra et al., 2018). Both the executive, legislative, and third parties, such as banks are participating organizations that will later be involved in the formation of a regional government finance blockchain network.

Regional government finance management is closely linked to the challenges present in each stage. Table 1 presents several examples of research constraints that have been conducted in Indonesia. These constraints are derived from previous research. Each literature has different constraint factors, weaknesses, and impacts. Some constraints related to regional government can serve as references in this study.

Table 1. Constraints on regional government finance in Indonesia

Literature	Constraint factors	Weakness	Impact
Application of government accounting standards (Jatmiko et al., 2020)	Understanding accounting systems	• Internal Control System. • Reporting control system. • Control system over the implementation of revenue and budget.	Loss of potential revenue, weakness in the internal control structure, the internal control unit has not been optimal, and SOP has not run optimally.
Transparency of local government	Transparency	Preparation of nontransparent regional financial statements.	Corruption in the government sector.

(Adiputra et al., 2018)			
Regional government financial performance (Putra et al., 2020)	Efficiency	The financial performance of the government in Indonesia is inefficient	The level of income received by regional governments is not too large

3. Methodology

This study uses a quantitative method by using previous studies as a reference and source of analysis. Microsoft Office Excel was used in this study to select and evaluate possibly relevant materials, while Bibliometrix-Biblioshiny, a bibliometric software, was use to conduct the analysis. The analysis included annual scientific production, relevant affiliations, relevant sources, trend topics, and a thematic map.

3.1. Metode

In this research, bibliometrics is used to evaluate Scopus data based on titles, abstracts, and keywords to understand the potential implementation of blockchain in the regional government finance of Indonesia. Bibliometrics is a quantitative analysis of books, articles, and other publications. Bibliometric analysis has been applied in various professional fields to visualize the status of knowledge, features, evolution, and emerging trends (Guo et al., 2021). Bibliometric analysis facilitates a comprehensive understanding of a research area, mapping its boundaries, identifying influential authors, and suggesting new directions for future research (Tandon et al., 2021). The research process consists of three steps: planning, data overview, and writing the results of the analysis. As illustrated in Figure 2, the research process involves a thorough planning phase, an overview of the collected data, and the presentation of the results. The first stage is data collection, the second stage is bibliometric analysis and information visualization, the third stage is the analysis of blockchain potential, and the fourth stage involves conclusions and research recommendations for further studies.

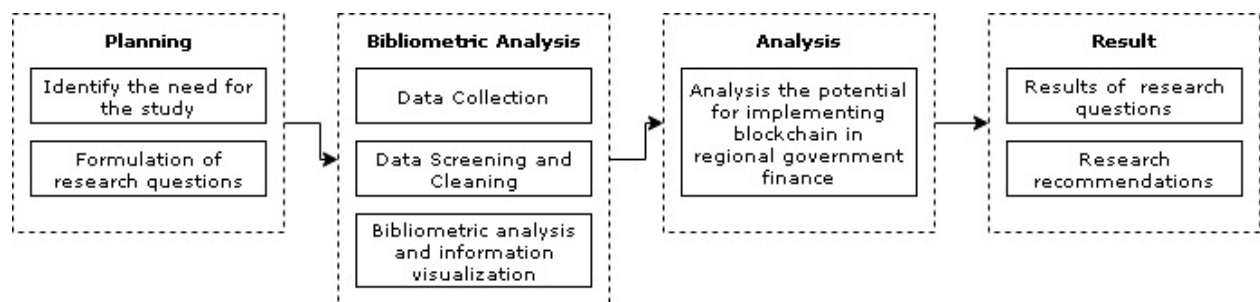


Fig. 2: Research process

3.2. Sources of data

This research is based on electronic information obtained from articles published on blockchain research in Indonesia between 2016 and mid-2023, sourced and retrieved from the Scopus on September 19, 2023. This period was chosen because research on blockchain technology in Indonesia developed quite rapidly. This approach provides an opportunity for many researchers, companies, and government institutions to access high-quality research that can offer sufficient insights to support their decision-making processes. Based on the research data on blockchain in Indonesia, a specific analysis was conducted regarding financial blockchain in Indonesia and regional government finances.

3.3. Selection and extraction of data

The keywords and search query successfully identified relevant articles on financial blockchain in Indonesia through their titles, abstracts, and keywords, as shown in Table 2. The search was conducted with consideration for the appropriateness of the analysis to yield relevant conclusions. The search process in the Scopus database considered criteria, as outlined in Table 3.

Tabel 2. Search string and keywords

Keywords related to blockchain in Indonesia	Data quantity
"Indonesia" AND ("blockchain" OR "block chain" OR "smartcontract" OR "smart-contract" OR "cryptocurrency" OR "cryptocurrencies" OR "bitcoin" OR "hyperledger")	199
▶ Keywords related to finance AND ("finance" OR "financial" OR "fintech" OR "financing" OR "banking")	57
▶ Keywords related to the government AND "government"	10

These keywords can capture all articles related to blockchain in Indonesia based on their titles, abstracts, and keywords. The bibliometric analysis process consists of three main stages. Stage 1 involves the search and data collection process, starting with a systematic literature search on Scopus to gather all articles related to blockchain in Indonesia using the keywords as listed in Table 2. Stage 2 involves article screening by reading the titles and abstracts, considering various criteria for the selection and assessment of potentially relevant articles, as specified in Table 3.

Table 3. Data screening and cleaning criteria

Criteria	
1.	Publications focused on blockchain in Indonesia
2.	Publications aligned with research objectives
3.	Non-Conference review articles

After the data screening process, **stage 3** involves bibliometric analysis based on the refined data. The analysis process is conducted using only relevant data to ensure that the research objectives make a significant contribution to blockchain in Indonesia, particularly in the financial sector.

4. Results and Discussion

The overview process includes the bibliometric analysis of relevant literature and the analysis of its connections to the research questions. We used Bibliometrix-Biblioshiny, an R-tool for comprehensive science mapping analysis, to analyze the annual scientific production, relevant affiliations, relevant sources, trend topics, and thematic map.

4.1. Result

4.1.1. Overview of the data

The annual Scopus scientific data regarding blockchain in Indonesia are shown in Figure 3. There are 199 research data points related to blockchain in Indonesia, however after undergoing the screening and data cleaning process, 141 relevant research data points were obtained. These 141 research data points will be used in the bibliometric analysis. Based on the research data obtained as shown in Figure 4, the number of studies on blockchain in Indonesia is increasing each year.

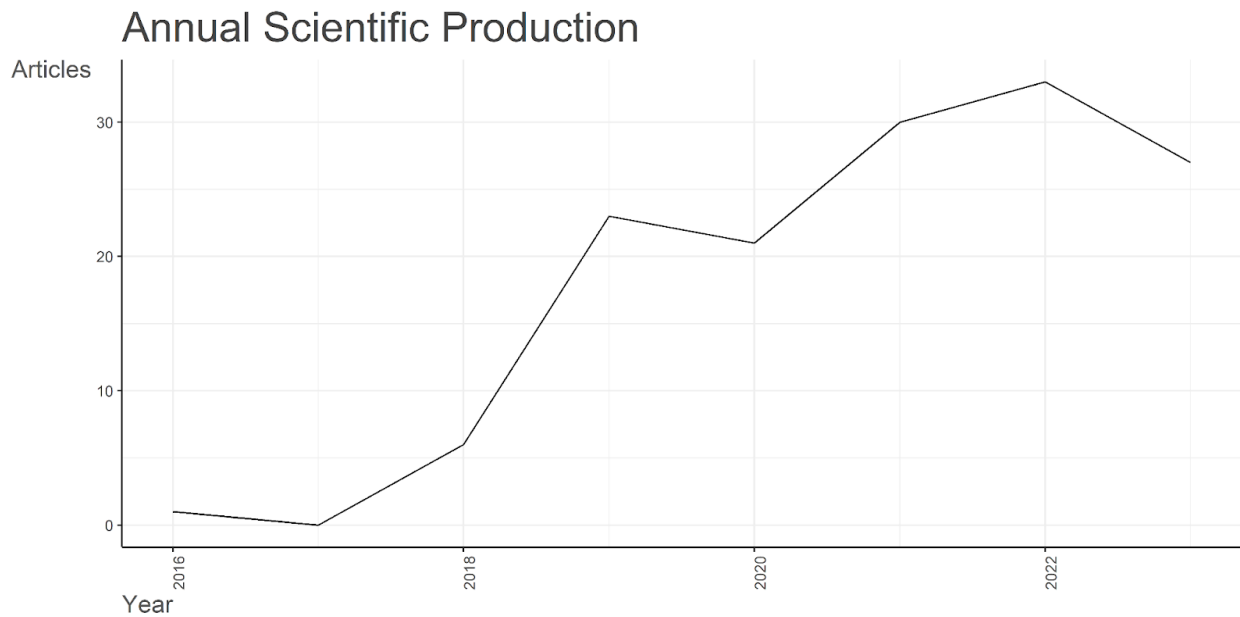


Fig. 3: Research on blockchain in Indonesia

In seeking the potential implementation of blockchain in the financial sector in Indonesia, an analysis of the research developments that have been conducted is required. In Figure 4, it shows the results of the analysis of blockchain research in Indonesia in the financial sector. The analysis was conducted using data on blockchain in Indonesia, totaling 54 data points, and has been filtered down to 34 data points in the financial sector. The results indicate that there have been fluctuations in research outcomes from 2016 to mid-2023, with both increases and decreases in the research conducted.

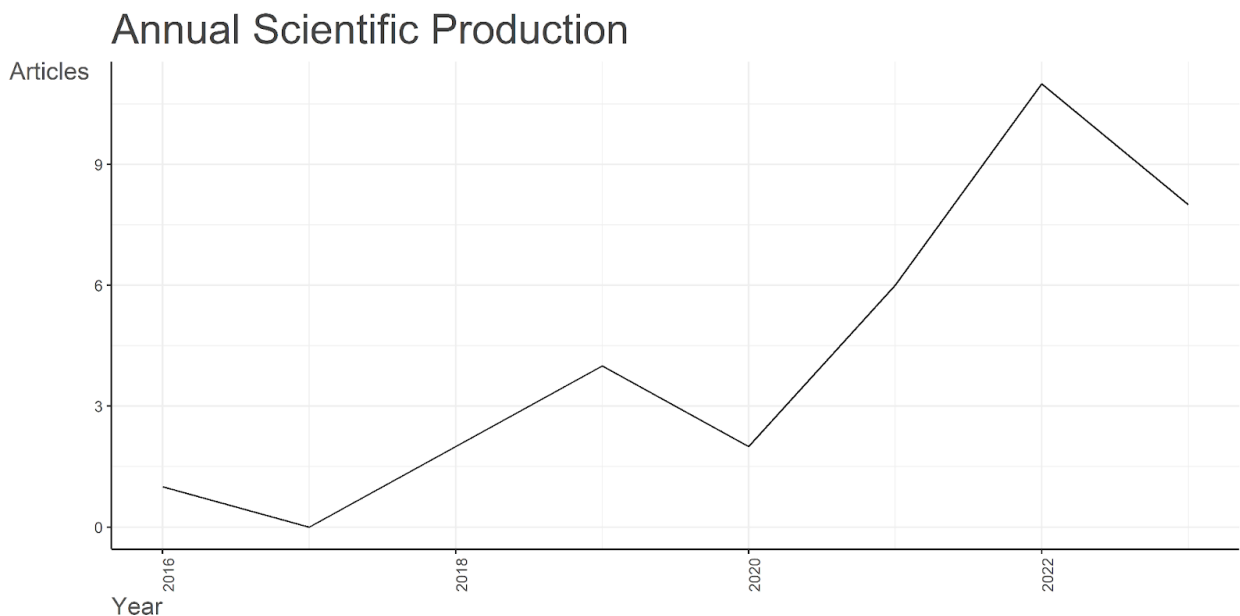


Fig. 4: Research on the financial blockchain in Indonesia

4.1.2. Bibliometric analysis overview

Relevant affiliation analysis

The most relevant affiliation analysis in Figure 5 refers to the process of identifying and evaluating the

most relevant or important affiliations (institutions or organizations) in relation to the academic work being analyzed. It assesses the contributions and impact of various affiliations in a specific research context. This can be useful for evaluating scientific collaborations, identifying centers of excellence, or directing research resources to the most relevant places. There were 81 institutions in total that produced content on blockchain in Indonesia, and 8 of them, which were dominated by universities in Indonesia, published more than five articles. Bina Nusantara University ($n = 22$) was the top-ranking organization in terms of publications among Indonesian universities. The second-placed institution was Telkom University ($n = 15$), followed by Universitas Sumatera Utara ($n = 13$), IPB University ($n = 12$) and University of Raharja ($n = 12$), Universitas Indonesia ($n = 11$), Institut Teknologi Sepuluh Nopember ($n = 7$), and Universitas Muhammadiyah Magelang ($n = 6$). This shows that government institutions in Indonesia are still lacking in research on blockchain.

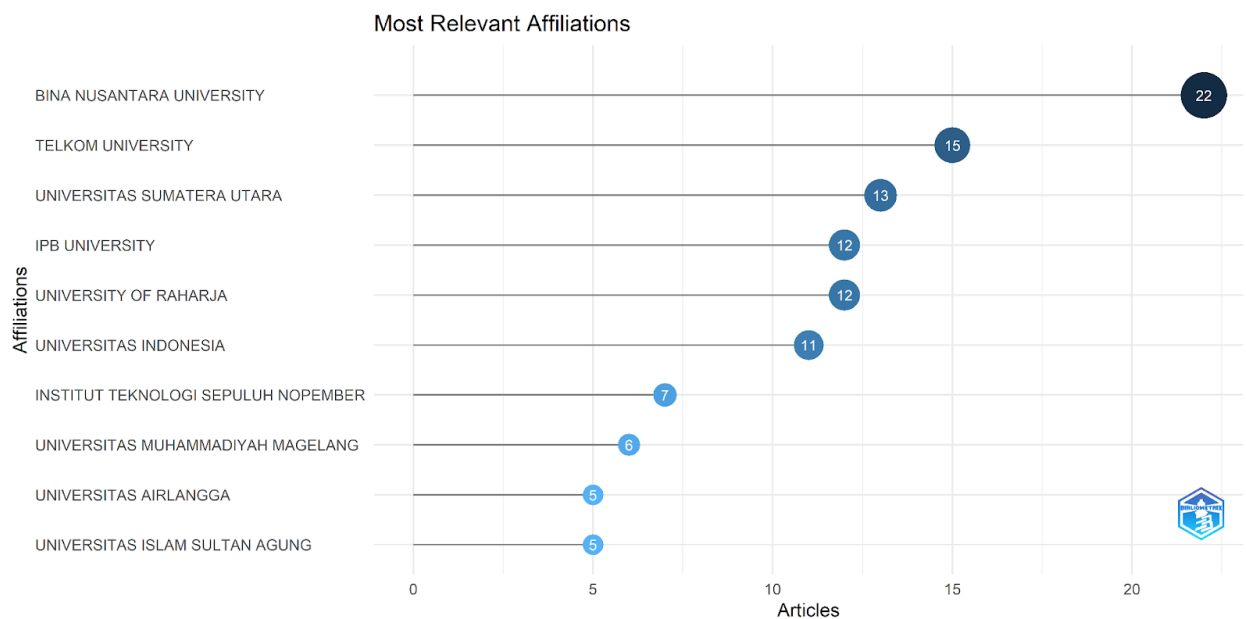


Fig. 5: Most relevant affiliation analysis on blockchain in Indonesia

Relevant sources analysis

The most relevant sources analysis in Figure 6 describes of the procedure for determining and assessing the most relevant publications. The 10 most published sources are dominated by conference proceedings, while journals are in the top 10-20 positions as shown in Table 4.

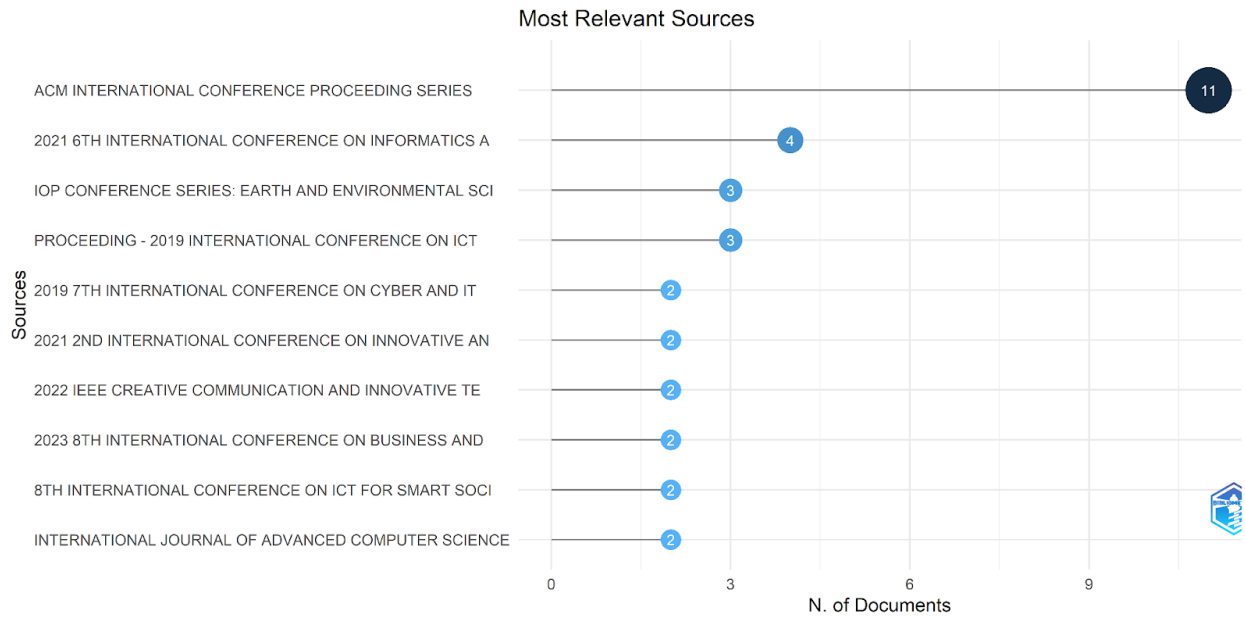


Fig. 6: Most relevant sources on blockchain in Indonesia

Table 4. Most relevant sources on blockchain in Indonesia

Sources	Articles
ACM INTERNATIONAL CONFERENCE PROCEEDING SERIES	11
2021 6TH INTERNATIONAL CONFERENCE ON INFORMATICS AND COMPUTING, ICIC 2021	4
IOP CONFERENCE SERIES: EARTH AND ENVIRONMENTAL SCIENCE	3
PROCEEDING - 2019 INTERNATIONAL CONFERENCE ON ICT FOR SMART SOCIETY: INNOVATION AND TRANSFORMATION TOWARD SMART REGION, ICISS 2019	3
2019 7TH INTERNATIONAL CONFERENCE ON CYBER AND IT SERVICE MANAGEMENT, CITSM 2019	2
2021 2ND INTERNATIONAL CONFERENCE ON INNOVATIVE AND CREATIVE INFORMATION TECHNOLOGY, ICITECH 2021	2
2022 IEEE CREATIVE COMMUNICATION AND INNOVATIVE TECHNOLOGY, ICCIT 2022	2
2023 8TH INTERNATIONAL CONFERENCE ON BUSINESS AND INDUSTRIAL RESEARCH, ICBIR 2023 - PROCEEDINGS	2
8TH INTERNATIONAL CONFERENCE ON ICT FOR SMART SOCIETY: DIGITAL TWIN FOR SMART SOCIETY, ICISS 2021 - PROCEEDING	2
INTERNATIONAL JOURNAL OF ADVANCED COMPUTER SCIENCE AND APPLICATIONS	2
INTERNATIONAL JOURNAL OF SUPPLY CHAIN MANAGEMENT	2
JOURNAL OF ADVANCED RESEARCH IN DYNAMICAL AND CONTROL SYSTEMS	2
JOURNAL OF LEGAL, ETHICAL AND REGULATORY ISSUES	2
JOURNAL OF MONEY LAUNDERING CONTROL	2
JOURNAL OF OPEN INNOVATION: TECHNOLOGY, MARKET, AND COMPLEXITY	2
JOURNAL OF PHYSICS: CONFERENCE SERIES	2
JOURNAL OF THEORETICAL AND APPLIED INFORMATION TECHNOLOGY	2
LECTURE NOTES IN NETWORKS AND SYSTEMS	2

Trend topic analysis

Trend topic analysis is a crucial mapping technique that aids in illustrating the prior stream's origin of the trend integration. The year is shown on the X-axis, and the cumulative keyword occurrences are shown on the Y-axis. Figure 7 displays the research's trending subjects. Except for the words "blockchain" and "indonesia", keywords such as "electronic money" and "bitcoin" had the longest

duration of 4 and 2 years, respectively. Both have cumulated occurrences of higher frequency of 7, as shown in Figure 8.

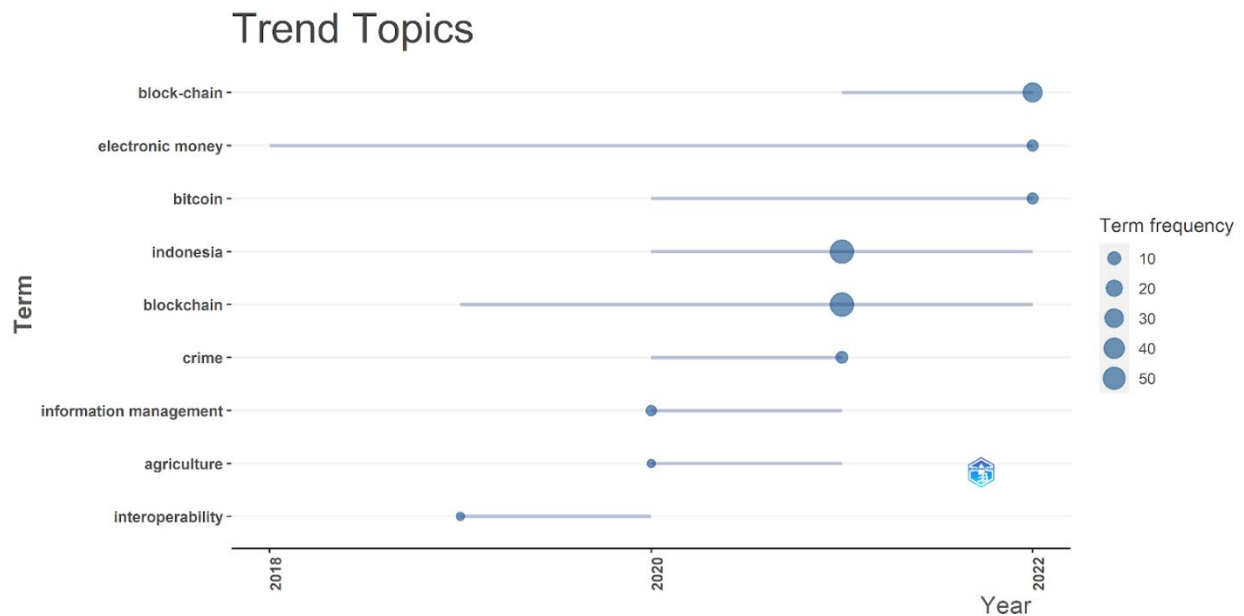


Fig. 7: Trend topics analysis of blockchain in Indonesia

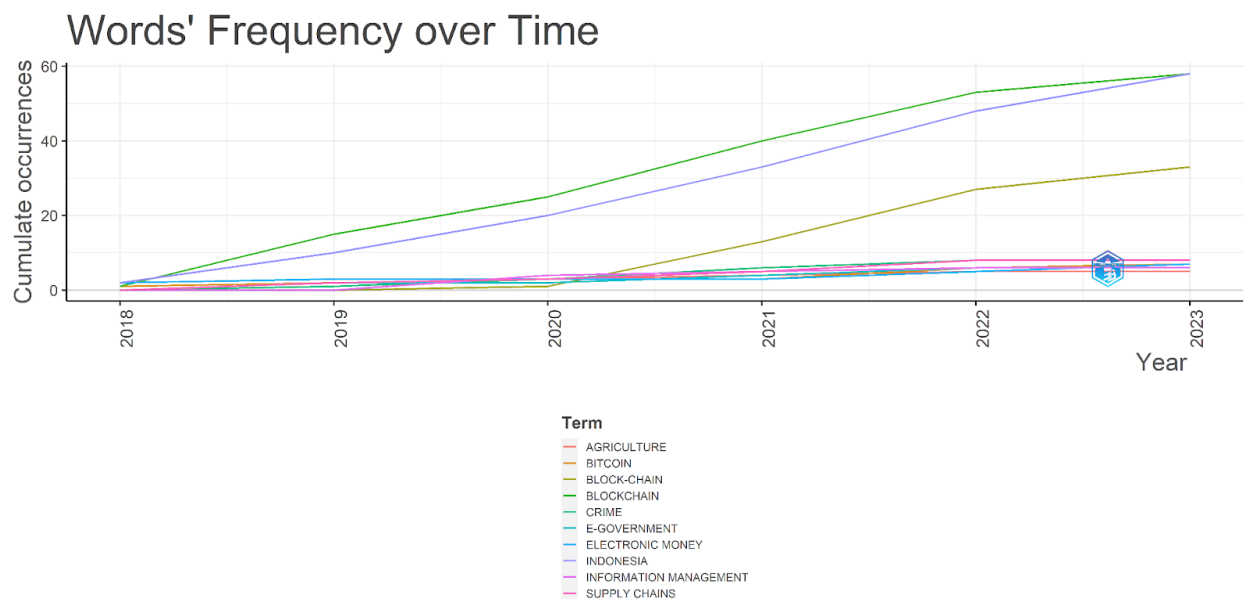


Fig. 8: Words' frequency over time on blockchain in Indonesia

Thematic map

A thematic map is a classification of themes based on their respective quadrants, with the upper right quadrant being the "motor themes" with the highest density and centrality. In the motor themes quadrant, the most advanced and relevant research areas are located based on the chosen themes. The upper left quadrant represents specialized topics that are developed but isolated from other research areas. The lower left quadrant highlights themes that occasionally emerge and have high centrality but low density. The lower right quadrant represents basic research areas with high centrality but low density.

The thematic map in Figure 9 is the result of visualizing the network analysis within different thematic areas. In the lower right, electronic money, investments, and behavioral intention are

fundamental cross-cutting themes. This demonstrates that blockchain technology has the potential to change electronic money systems, investments, and individual behavioral intentions by providing increased security, transparency, and accessibility. There is a group that overlaps with the lower left quadrant, namely e-learning, payment systems, and payment transactions.

The upper right quadrant displays six clusters. Cluster 1 encompasses research on blockchain in Indonesia. Cluster 2 is related to information management, interoperability, and big data. This cluster overlaps with the cluster on blockchain in Indonesia. Blockchain technology can enhance information management by ensuring data integrity and security. It promotes interoperability by providing a standardized platform for data exchange and transactions. When combined with big data, blockchain can offer improved data storage, analysis, and auditing capabilities, making it a valuable tool in various sectors that rely on data-driven decision-making. Cluster 3 consists of agriculture, supply chain management, and blockchain technology, and overlaps with Cluster 1. Cluster 4 encompasses digital storage, e-government, and transparency, while Cluster 5 focuses on bitcoin, cost, and the financial market. Clusters 4 and 5 overlap, indicating that these topics are interconnected. The connection between Clusters 4 and 5 reflects how blockchain technology impacts not only data management and transparency but also economic and financial changes. The use of blockchain in e-government can enhance transparency and data security in government administration, while blockchain's use in finance, such as Bitcoin, can transform the way transactions and investments are conducted. Thus, they play different yet interconnected roles within the broader blockchain ecosystem. Cluster 6 consists of data integration, data manipulations, and group discussions.

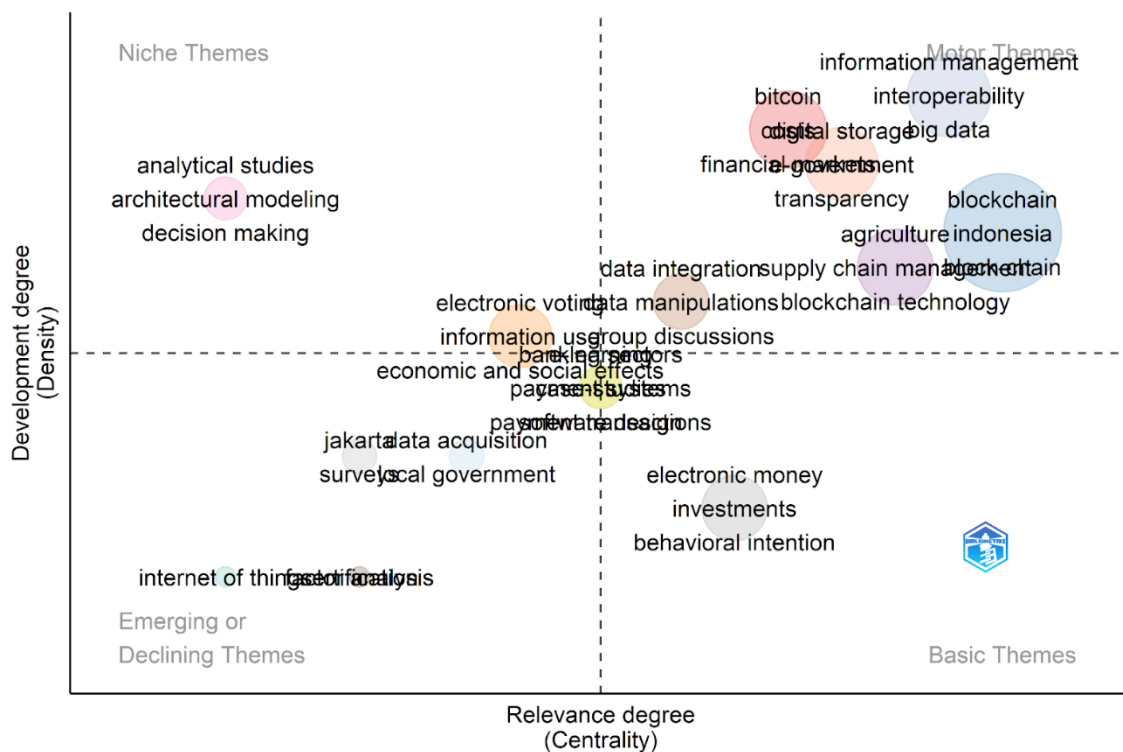


Fig 9: Thematic map analysis of blockchain in Indonesia

The upper left quadrant includes 2 groups: electronic voting, information use, and economic and social; analytical studies, architectural modeling, and decision making. Electronic voting, information use, and economic and social aspects overlap with the lower left quadrant, indicating a significant connection or relevance between the use of electronic technology in elections (electronic voting), information use, and economic and social aspects within the academic literature. Related studies explain how the use of electronic voting technology affects information use and its impact on economic and social aspects of society.

Special topics in the lower left quadrant include 6 clusters, with 2 clusters overlapping with the lower right and upper left quadrants. There are groups related to e-learning, payment systems, and payment transactions; data acquisition and local government; Jakarta and surveys; certification; and the internet of things.

4.2. Discussion

This section explains the research question based on the bibliometric analysis results.

4.2.1. Question 1

How far is the research on financial blockchain in Indonesia?

Blockchain technology is gaining traction in Indonesia, with numerous research and development initiatives, collaborations, and projects in progress. We have compiled data on the state of blockchain research in Indonesia using Scopus data, which is presented in Table 5. The results of blockchain research in Indonesia from 2016 to 2023 indicate 141 research documents. Specifically, there were 34 research documents related to blockchain research in the financial sector in Indonesia during the same period and three research documents related to blockchain in the government sector in Indonesia. These figures suggest a growing interest in blockchain technology research in Indonesia. This version provides a smoother flow and clarifies the presentation of the data and results.

Table 5. Document of the results of blockchain research in Indonesia

Year	Blockchain in Indonesia	Blockchain in Indonesia	Blockchain financial government in Indonesia
2023	27	8	1
2022	33	11	1
2021	30	6	0
2020	21	2	0
2019	23	4	1
2018	6	2	-
2017	0	0	-
2016	1	1	-
Total research	141	34	3

Indonesia is actively exploring and embracing blockchain technology, including in the financial sector. Figures 3 and 4 represent the curves of blockchain analysis results in Indonesia and financial blockchain in Indonesia. These curves are presented in Table 5 to track the research conducted each year. Research on blockchain in the Indonesian financial sector has already been widely conducted, accounting for 24% of the research related to blockchain in Indonesia. This indicates that the financial sector has become one of the primary focuses of blockchain-related research in Indonesia. This can encompass various aspects, such as the development of blockchain-based financial applications, research on the potential security and efficiency of blockchain technology in financial transactions, or the analysis of the broader impact of blockchain technology on the Indonesian financial sector. In Figure 5 shows, that research on blockchain in Indonesia is predominantly led by universities. Several universities in Indonesia have been actively engaged in blockchain-related research, with Bina Nusantara University being the most prolific in conducting research on blockchain. The lack of government level research poses a distinctive obstacle to promoting innovation and advancing blockchain technology in Indonesia.

Figure 6 and Table 4 show that research publications on blockchain in Indonesia are dominated by conference proceedings compared to publications in journals. Meanwhile, in Figure 7 and Figure 8 it

can be seen that the blockchain research subjects that are currently trending in Indonesia are "electronic money" and "bitcoin". The thematic map showcases the interconnectedness of blockchain-related research themes and clusters, as shown in Figure 9. It illustrates how blockchain technology influences various sectors, from finance and government to agriculture and data management, emphasizing its potential to bring about significant changes in these domains. The map also highlights areas of overlap, indicating research intersections and interdisciplinary connections within the academic literature.

4.2.2. Question 2

What is the potential for implementing blockchain in regional government finance?

Blockchain is a technology that has a lot of potential and is widely used. Blockchain has the advantage of the immortality of transaction records. Figure 2 shows the concept of data transaction on the blockchain, the transaction cannot change if the transaction has been confirmed on each network. Every transaction is recorded in one block after another and becomes a historical record that cannot be easily changed or even deleted. Transaction records on the blockchain can be used to oversee of regional government financial management so that transaction issues can be tracked. With these advantages of transparency, the implementation of blockchain can enhance accountability and efficiency.

The Indonesian Corruption Eradication Commission (KPK) data from 2017 to 2023 shows that there were 90 instances of criminal offenses in regional governments and 420 cases in city administrations (KPK, 2022). Criminal offenses related to budget misuse and procurement fraud are common types of corruption cases. The data from KPK show that the potential implementation of blockchain technology in regional government finance is highly suitable for addressing these criminal issues. Blockchain technology can bring several benefits, such as increased transparency, enhanced security, and improved efficiency in financial processes. By leveraging blockchain, regional governments can streamline budget allocation, track financial transactions, and ensure accountability in the use of funds. In addition, blockchain can facilitate faster and more secure cross-border transactions, enabling seamless financial interactions between regions. With proper implementation and adoption, blockchain can revolutionize regional government finance in Indonesia, leading to more effective financial management and greater trust in the system.

The potential adoption of blockchain technology in the financial operations of regional governments in Indonesia requires research support. As shown in Figure 3, the potential for blockchain in Indonesia appears promising. Research efforts in this area have been steadily increasing over the years, as indicated by the upward trend in the analysis curve. This indicates that the technology is likely to be used in the future. Originally recognized in the financial sector, the implementation of blockchain is now making inroads into various other industries. Table 1 outlines some research related issues about the use of blockchain in local government, such as transparency, efficiency, and accountability.

The adoption of blockchain technology in the management of finances and government services in Indonesia holds significant potential for enhancing transparency, efficiency, and accountability. Blockchain offers tamper-proof transparency and verifiable transaction records, thereby contributing to improved accountability and reduced fraud risks. Furthermore, it enables real-time monitoring of the use of public funds, including budget allocations, social assistance, and infrastructure projects, allowing regional governments to manage finances more effectively. However, implementing blockchain is not an instant solution and requires thorough planning, substantial investment, and full support from local governments. Challenges such as regulation, education, and technological integration must be addressed wisely to ensure the successful implementation of blockchain in the financial operations of regional governments in Indonesia.

4.2.3. Question 3

What are the features of the blockchain that are very important for use in finance?

Financial issues in regional governments are not significantly different from general financial issues.

On the Table. 1 shows several constraints to regional government finance in Indonesia. The constraints experienced include issues with reporting system control, transparency, and efficiency. Each constraint has its impact, ranging from loss of potential income to corruption. The constraint regarding reporting system control issues, every transaction is recorded permanently and cannot be altered or deleted. It creates a complete trail that can be used to verify the authenticity of transactions and financial reporting. With this audit trail, control and supervision over the reporting system can be enhanced, thereby reducing the risk of data manipulation or incorrect reporting. Regarding transparency constraints, blockchain is a decentralized and distributed technology where all network participants have identical copies of transaction data. It allows for real-time monitoring, enhances data integrity, and minimizes the risk of fraud. Regarding efficiency, transactions can be executed directly and automatically between the involved parties without intermediaries. It reduces the time required to settle transactions and associated costs, thereby improving operational efficiency.

Through the use of smart contracts, automated processing and the removal of intermediaries in business operations can be accomplished. Smart contracts on the blockchain can perform transactions according to the agreement of both parties. Smart contracts ensure the validity of the contract, and the procedure can be executed automatically if all conditions are appropriate (Chu et al., 2023). On the basis of the advantages of smart contracts, this feature is quite important to use in regional government finance. Smart contract technology can be considered a solution to increase efficiency by speeding up and securing every transaction. From a security perspective, the decentralized structure of the blockchain makes smart contract transactions difficult to hack. A hacker would need control over at least half of the computing power in the blockchain network to compromise its transactions. This makes the use of smart contracts indispensable for every transaction in regional government finance. Several blockchain platforms are commonly used, as shown on Table 6.

Table 6. Blockchain platform

Blockchain platform	Advantage	Characteristic of blockchain
Ethereum (Chu et al., 2023)	Ethereum can easily integrate blockchain and smart contracts.	Public, every node can execute smart contracts, and everyone can issue smart contracts of Ethereum.
Hyperledger Fabric (Zhao et al., 2022)	Blockchain with a modular architecture with a high levels of scalability, flexibility, confidentiality, and resilience that supports programming and execution in a standard language.	Private, a network of allowed participants in a transaction that must have an identity certificate. Each node performs transactions that correspond to the chain code above it.
Corda (Brown, 2018)	Corda was built with the purpose of recording and enforcing business agreements and agreements between trading partners because it can reliably execute smart contracts.	Private, open-source private networks, and permissions that create the Corda network.

Table 6 provides a description of blockchain platforms that includes their advantages and characteristics. Considering the network structure and inherent characteristics, a private blockchain is a better fit for implementation in regional government finance. There is no central entity that can control a network on a public blockchain, it is decentralized and everyone can participate. Financial transactions require secure transaction processing with more granular controls on each network. Administrators as access control are needed to make the process more transparent, even though data transactions between parties cannot be changed and can still be traced. In this case, Ethereum is not recommended for regional government finance because it is a public blockchain. Therefore, blockchain has the potential to improve control over reporting systems, increase transparency, and enhance efficiency by maintaining

unalterable transaction records and ensuring high levels of transparency. Additionally, the network structure of blockchain, especially in a private context, contributes to control, and security in regional government finance.

5. Conclusion

This bibliometric study makes a relevant contribution by analyzing blockchain research trends in Indonesia and assessing the potential for blockchain implementation in regional government finance. Research questions help align bibliometric analysis with specific research objectives. The results reveal increasing research activity, suggesting that blockchain adoption could grow. Blockchain's immutability, transparency, and automation features demonstrate strong potential for enhancing financial management and controls in regional governments. These insights can inform blockchain deployment plans and future research directions. In the future, further exploration will be conducted to find a suitable blockchain platform for regional government finance. The need for mapping specific requirements by conducting case studies in its implementation to produce architectural designs.

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