Data and Metadata. 2024; 3:.537
doi: 10.56294/dm2024.537

REVIEW

Blockchain for Managing Citizens' Data: Bibliometric Analysis and Systematic Literature Review

Blockchain para la gestión de los datos de los ciudadanos: Análisis bibliométrico y revisión sistemática de la literatura

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Cite as: Piantari E, Husaeni DNA, Nugroho EP, Anisyah A, Afrianto I, Jundurrahman I, et al. Blockchain for Managing Citizens' Data: Bibliometric Analysis and Systematic Literature Review. Data and Metadata. 2024;3:.537. https://doi.org/10.56294/dm2024.537

Submitted: 23-04-2024 **Revised:** 27-08-2024 **Accepted:** 21-12-2024 **Published:** 22-12-2024

Editor: Adrián Alejandro Vitón-Castillo

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ABSTRACT

Introduction: blockchain is an advanced technology that ensures a high level of data transparency and security by utilizing a distributed mechanism in storing and managing data. While currently blockchain is mostly utilized to facilitate cryptocurrency transactions due to its capability in securing data, blockchain also has the potential to store and manage various data, including government data. This research aims to reflect in the literature on trends in the application of blockchain technology in citizen data management and e-Government systems, focusing on trends, architectural design and the sector of the implementation of this technology. This research will also investigate data integrity and population accountability. This study seeks to provide insight into the challenges and application of blockchain technology in governance systems through several research questions.
Method: the PRISM method is used as a guide for conducting literature review analysis starting from defining literature eligibility criteria, defining information sources, conducting filtering, and data analysis.
Results: based on the results of the literature review, several previous studies have integrated Blockchain with IoT to increase supply chain transparency. Meanwhile, in e-government systems, several Blockchain implementations are used for decentralized identity verification to ensure the integrity and privacy of demographic data.
Conclusions: previous research shows that Blockchain technology has the potential to improve efficiency, security and transparency in various fields, especially in data management and governance.

Keywords: Blockchain; Data Management; Data Security; E-Government; SLR.

RESUMEN

Introducción: blockchain es una tecnología avanzada que garantiza un alto nivel de transparencia y seguridad de los datos utilizando un mecanismo distribuido para almacenarlos y gestionarlos. Aunque actualmente blockchain se utiliza sobre todo para facilitar las transacciones de criptomoneda debido a su capacidad para proteger los datos, blockchain también tiene potencial para almacenar y gestionar diversos datos, incluidos los datos gubernamentales. Esta investigación pretende reflejar en la literatura las tendencias en la aplicación de la tecnología blockchain en la gestión de datos de los ciudadanos y los sistemas de administración electrónica, centrándose en las tendencias, el diseño arquitectónico y el sector de la aplicación de esta tecnología. Esta investigación también indagará sobre la integridad de los datos y la rendición de cuentas de

la población. Este estudio pretende aportar información sobre los retos y la aplicación de la tecnología blockchain en los sistemas de gobernanza a través de varias preguntas de investigación.
Método: se utiliza el método PRISMA como guía para llevar a cabo el análisis de la revisión de la literatura, comenzando por la definición de los criterios de elegibilidad de la literatura, la definición de las fuentes de información, la realización del filtrado y el análisis de los datos.
Resultados: en base a los resultados de la revisión de la literatura, varios estudios previos han integrado Blockchain con IoT para aumentar la transparencia de la cadena de suministro. Mientras tanto, en los sistemas de gobierno electrónico, varias implementaciones de Blockchain se utilizan para la verificación de identidad descentralizada para garantizar la integridad y privacidad de los datos demográficos.
Conclusiones: la investigación previa muestra que la tecnología Blockchain tiene el potencial de mejorar la eficiencia, la seguridad y la transparencia en varios campos, especialmente en la gestión de datos y la gobernanza.

Palabras clave: Blockchain; Gestión de Datos; Seguridad de Datos; Administración Electrónica; SLR.

INTRODUCTION

The growth of digital technology has driven the need for systems that can store and manage data effectively and efficiently, without neglecting data security and accountability of the data. In the concept of smart city, the most primary data is population data. The data plays a crucial role in developing technology to realize the real concept of smart city. Data population is a core of an e-government system as it is used for various policies and public services, such as infrastructure planning, healthcare and educational services. Therefore, It is important to ensure that data is managed securely, transparently and accountably.

Blockchain technology has great potential to support the implementation of smart city by ensuring the integrity and accountability of the data through the distributed storing of data mechanism. Since it was first introduced in 2008, blockchain was originally designed to enable a trustless cryptocurrency—Bitcoin. However, more and more sectors and stakeholders see this technology as an attractive option to solve existing business problems and disrupt traditional industries.[1] Blockchain is a method of recording and managing data that makes the system difficult to change, hack, or manipulate by illegal parties. A public “block” or “chain” is a collection that keeps a record of transactions connected via peer-to-peer nodes.[2] Consensus mechanisms are used in blockchain to ensure that all network users agree and verify the validity of transactions. A consensus algorithm is used to authenticate and verify each block containing encrypted data.

With recent advancements, blockchain technology is now being applied across various industries, including government,[4] education,[5,6] and aviation.[7,8,9] In the government sector, blockchain’s use for data storage can help reduce data breaches, theft, and manipulation of population data, while also cutting down on unnecessary bureaucracy. By eliminating the need for third-party intermediaries, blockchain allows users to store and retrieve data securely. In the public sector, this technology has the potential to transform e-Government systems by improving data security, integrity, and transparency in various sectors.[9]

Blockchain technology leverages a decentralized approach for storing data instead of the traditional centralized model.[10] In this concept, the data will be distributed and stored across multiple nodes. This mechanism can improve data quality in terms of its authenticity and vulnerability to security breaches or server disruption.[11] Additionally, it strengthens data integrity, as any attempt to manipulate data in a specific node would disrupt the entire blockchain which makes it easier to detect tampering.[12] The use of smart contracts in blockchain technology further supports this by providing modules for contract agreements, verifying user information through logical operations and smart protocols, and integrating these with access control models and digital signature technology. This creates a robust system for user identity authentication and data verification.

The application of blockchain technology has been widely studied, with some previous research focusing on explaining the blockchain concept and its potential in securing, providing integrity, and transparency data, particular in public blockchains within the education sector.[13,14,15] For example, there are some studies discussing the use of blockchain technology for secure storage and efficient sharing of high-quality educational resources, by leveraging blockchain and IPFS.[16] In addition, there is also research that develops blockchain application prototypes for academic credential verification models, which utilize the security features of blockchain and IPFS.[17] Other research examines how blockchain enhances interoperability and trust within the Government 3.0 framework,[18] as well as the application of smart contracts in the transportation sector.[19]

Despite the previous research that has been discussed, there is a lack of study addressing the application of blockchain technology in e-government, especially in managing population data. In order to comprehend in depth about how blockchain technology has been implemented in this domain, it is essential to analyze the trends of blockchain research bibliometrics analysis combined with the systematic literature review (SLR)

method. Additionally, we have to figure out how blockchain architectural design is implemented to support e-government systems, as well as how blockchain technology affects the accountability and integrity of data, particularly within storing and managing population data processes. Thus, this study will examine to address the following questions:

RQ 1: What are the trends of blockchain technology in supporting e-Government systems, particularly in managing population data?

RQ 2: How has the architecture of blockchain been implemented to store and manage population data?

RQ 3: In which sectors has blockchain technology been applied within society?

RQ 4: How can blockchain technology enhance the accountability and integrity of the data population ?

Previous Research

Several researchers have performed reviews of blockchain technologies.[20,21,22,23,24] Di Vaio et al.[20] examine how blockchain technology promoting gender equality through a corporate governance framework oriented towards innovative technology. According to Di Vaio et al.[20], the research in this area has primarily concentrated on blockchain's commercial and financial qualities, with little attention given to its social potential. Falwadiya and Dhingra[21] identify 72 factors impacting blockchain technology adoption in government enterprises which are favorable conditions, social influence, trust in effort and performance, expectations, transparency, costs, and security. Alexopoulos et al.[22] discovered the use of BCT in e-Government in Europe can inform policymakers and practitioners about the technology's grey regions. Zhang et al.[23] research highlighted blockchain technology can be a solution to overcome the problem of lack of openness and flexibility in government information sharing systems (GIS). Additionally, Zhang et al.[23] discussed the benefits and drawbacks of blockchain technology within government sectors. They concluded that, while this technology can enhance the efficiency of government services and improve data security, challenges remain regarding throughput and monitoring. To address these challenges, the researchers proposed a system utilizing three distinct data exchange models: government-to-government, government-to-enterprise, and government-to-individual. Razzaq et al.[24] discovered that blockchain components can assist in resolving governance challenges. They also highlighted that the key to addressing these issues lies in implementing suitable laws and regulations, along with blockchain technology tailored specifically for governance purposes.

METHOD

The stages of this systematic literature review are illustrated in figure 1. This study began with the article gathering stage as the first step. After the data gathering procedure is completed, the following stage is data identification, which involves filtering and selecting the articles obtained. The final stage involves bibliometric analysis and visualization of the analysis' findings.

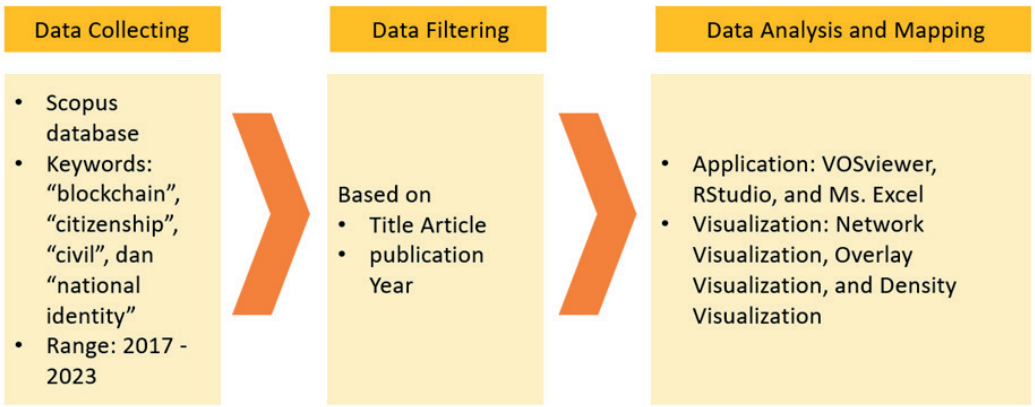

Figure 1. Research stages

In this study, 146 articles from the Scopus database were retrieved using the keywords "Blockchain" AND "citizenship" OR "Blockchain" AND "civil" OR "Blockchain" AND "national identity". The selection process begins with the article year and title of publication as the starting point. The articles were then screened to determine which were relevant. R Studio, Microsoft Excel, and VOSViewer will be used to conduct a bibliometric analysis of the selected articles. The following part will provide a more extensive explanation of this strategy.

Article collection

Collecting article data is the first step in conducting literature research using bibliometric analysis. Articles

published on the official Scopus website between 2017 and 2023 on the topics "blockchain", "citizenship", "civil rights", and "national identity" were collected at this stage. A total of 146 articles relevant to this topic were found. The articles gathered were then chosen depending on their type of publishing. Only journal or conference articles containing the word "Blockchain" are considered for further screening. The document identification method yielded 106 articles suitable for study in order to answer the research questions.

Identify the articles

During the data collecting stage, articles will be chosen via a document screening procedure. At this point, filtering is done based on the article's title and the year it was published. Articles that are not relevant to the issue of blockchain technology, both in terms of title and publishing date, will be removed. The filtered data will be uploaded to a file in .xlsx format for further analysis using bibliometric methods.

Data analysis and mapping

The analysis was carried out to answer RQ 1, RQ2, RQ3, and RQ4. To address RQ1, a bibliometric study was performed by looking at the number of publications by year, author, and country. The network, overlay, and density visualizations exhibited also represent research trends in the usage of blockchain technology to assist e-Government. The findings of this analysis are provided in subsection 4.1. Other analyses conducted to address RQ2, RQ3, and RQ4 are described in subsections 4.2, 4.3, 4.4, and 4.5.

RESULTS

Bibliometric Analysis

Development of Scopus-indexed blockchain publication

Figure 2 shows that there were 146 publications between 2017 and 2023 that included the terms "blockchain," "citizenship," "civil," and "national identity". A screening process was performed on all 146 publications, and 106 articles were selected as related to the keywords utilized. However, not all of the articles identified by this screening are used to answer RQs 4 since RQ4 specifically refers to articles that address the use of blockchain technology in government settings. There are 23 articles about this subject. This study's data is limited to Scopus-indexed publications from journals and conferences.

The growth of publications in the field using these five keywords between 2017 and 2023 shows fluctuation. According to Figure 3, articles about "blockchain", "citizenship", "civic", and "national identity" increased significantly between 2017 and 2021. In 2017, there were five papers published on these topics (3,42 %). This figure climbs year after year, reaching 9 articles (6,16 %) in 2018, 22 articles (15,07 %) in 2019, 29 articles (19,86 %) in 2020, and 34 articles (23,29 %) in 2021. The number of articles on "blockchain", "citizenship", "civic", and "national identity" peaked in 2021. However, this increase in articles did not endure long. The calculation of the number of publications in 2023 is based on data as of July 15, 2023.

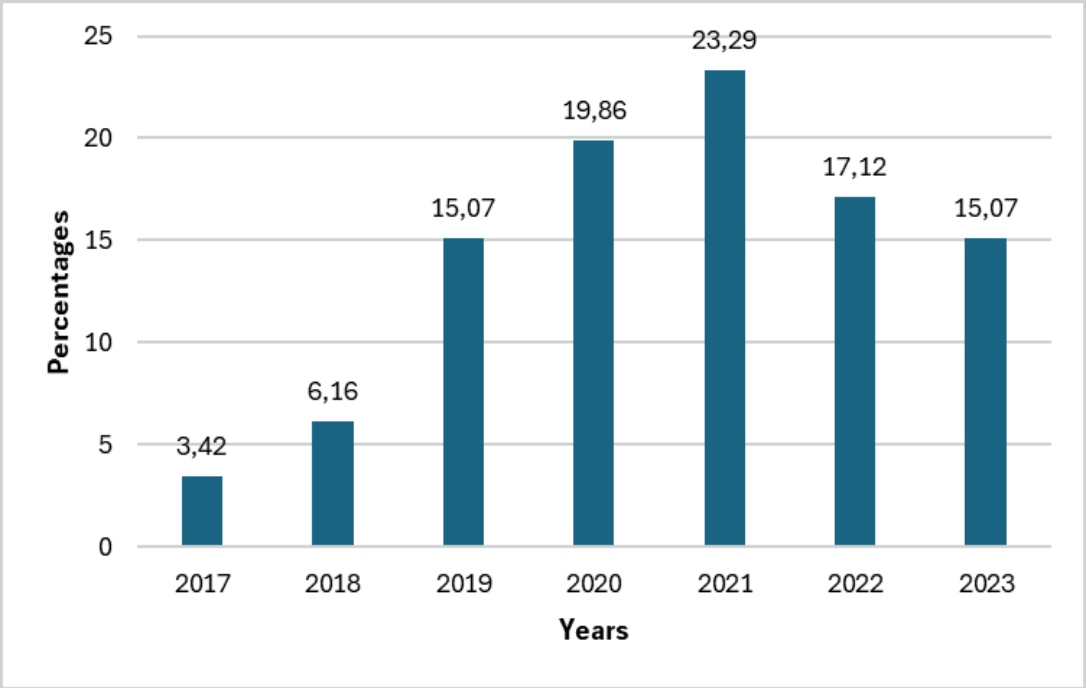

Figure 2. Percentages of publications in the blockchain field indexed by Scopus in 2017-2023

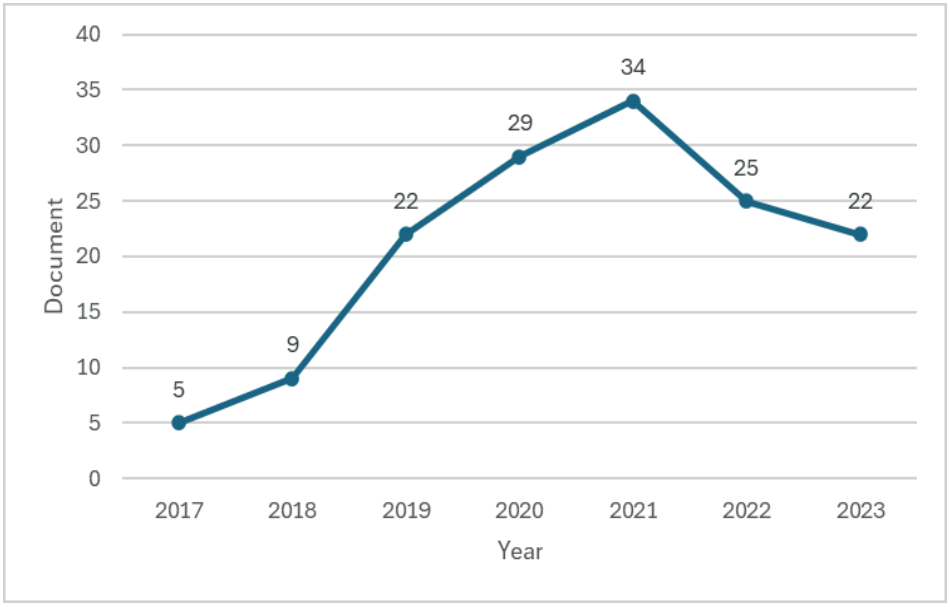

Figure 3. Development of the number of publications on blockchain topics indexed by Scopus in the 2017-2023 period

The most influential writer

Figure 4 displays the number of citations from articles authored by researchers who frequently do research on "blockchain", "citizenship", "civil", and "national identity" between 2017 and 2023. According to this table, Calzada, I. has the most citations.[36] Calzada researched these issues in 2018 and 2023. Calzada authored one article in 2018 that was cited by 24 authors, and two publications in 2023 that were each cited by 12 writers.

Figure 4 displays the ten authors with the most publications, as well as the authors with the most citations. Based on this data, Wu, Z. is in first place, with four articles published. Calzada, I., Jing, L., Xu, G., and Zhenzhen, P. all published three articles. Meanwhile, Campbell-Verduyn, M., Diniz, E.H., Fathiyana, R.Z., Fudong, Z., and Jokubauskas, R. all submitted two publications.

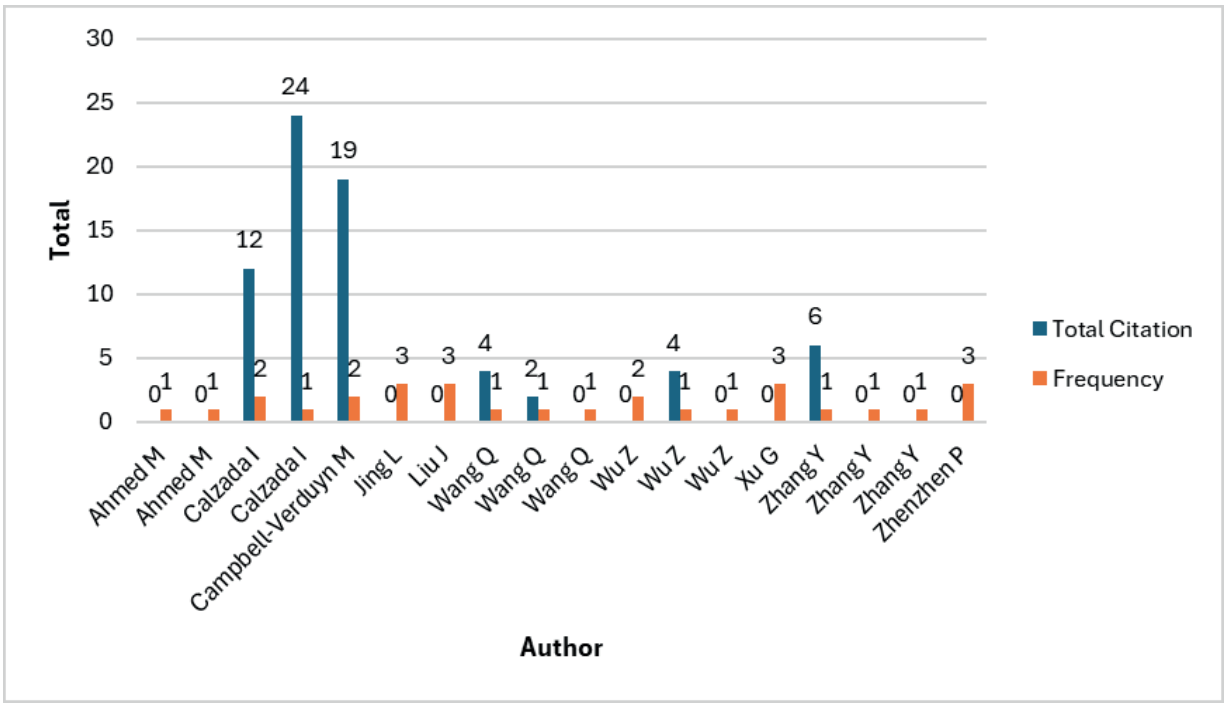

Figure 4. Author Production over Time

The most prolific institution in publishing research in the blockchain field

Figure 5 displays the top ten associations in research on "blockchain," "citizenship," "civic," and "national identity." According to the figure, Don State Technical University had the most publications compared to the other affiliates. From 2017 to 2023, this Russian university published a total of 18 papers. From 2018 to 2023,

Don State Technical University continuously published three publications every year. In addition to Don State Technical University, there is another Chinese affiliate with a substantial number of publications: the Second Research Institute of the Civil Aviation Administration of China. This affiliate had a total of 16 publications, including one in 2020, five in 2021, five in 2022, and five in 2023. For more details, see figure 5.

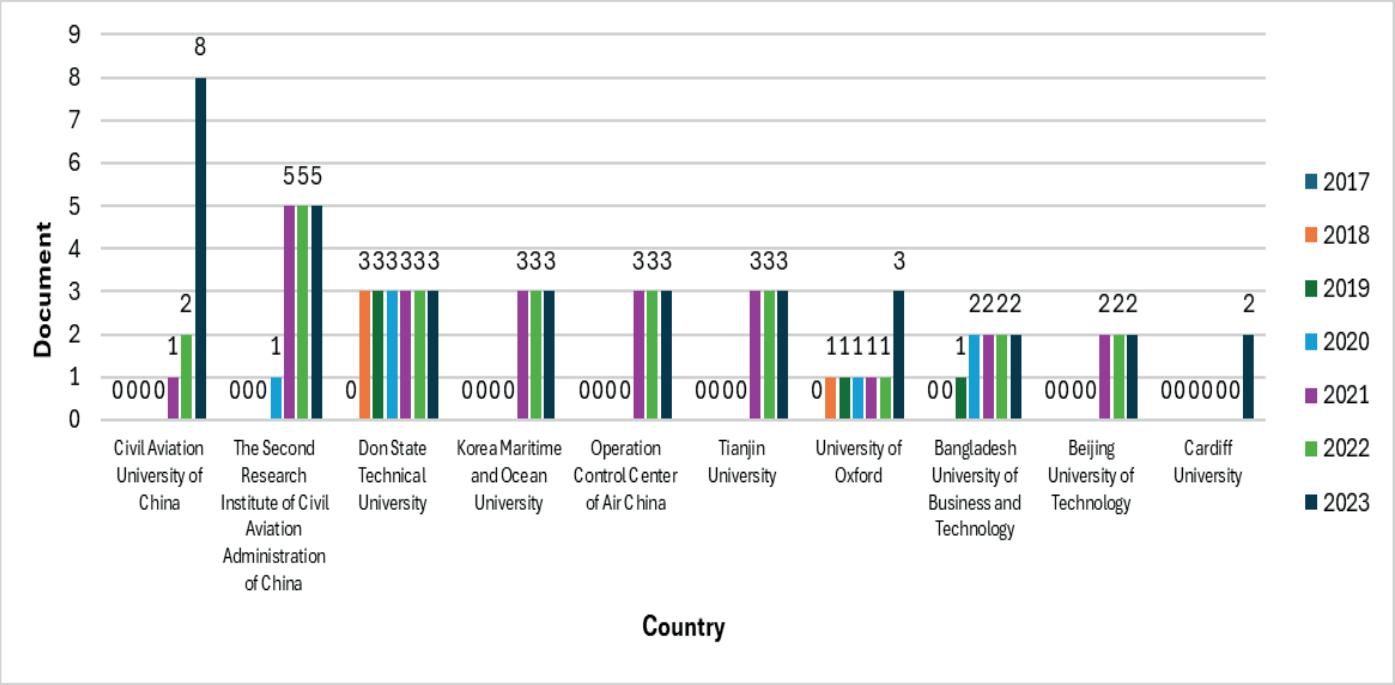

Figure 5. Top ten associations in research on "blockchain," "citizenship," "civic," and "national identity" by Scopus during the 2017-2023 period

Countries with the most blockchain publications

Researchers in China have widely written and explored "blockchain", "citizenship", and "national identity". According to figure 6, China had a total of 173 papers published between 2019 and 2023. In 2019, there was only one article published in Chinese. However, the number of publications climbed dramatically in subsequent years, with 11 papers in 2020, 42 in 2021, 57 in 2022, and 63 in 2023. Aside from China, several other countries are included in the ten countries with the most publications, namely India (53 publications), United States (82 publications), United Kingdom (30 publications), South Korea (26 publications), Australia (41 publications), Canada (29 publications), Germany (32 publications), Indonesia (16 publications), and Italy (13 publications).

Sources/publishers that publish a lot of research on blockchain

Figure 7 depicts the ten most numerous and relevant Scopus indexed journal and conference sources for publishing works on the topics "blockchain", "citizenship", "civil", and "national identity". One of the most important sources for studies on these themes is the ACM International Conference Proceedings Series, which released 34 pieces between 2017 and 2023. In contrast, the other nine outlets published an average of one to three items during the same time period. The same. For instance, AIAA IEEE Digital Avionics Systems Conference Proceedings, Actualidad Jurídica Iberoamericana, and Computer Law and Security Review all published three pieces. Other sites, such as Swiss Applied Science, Automation in Construction, Citizenship Studies, Global Networks, and Information and Communication Technology Law, published two publications over that time period, but AIP Conference Proceedings only published one. The emphasis on publications from the ACM International Conference Proceedings Series highlights the value of this resource in the research of blockchain technology, citizenship, and national identity. This also underlines the limited number of studies published by other sources, which may impact future academics' publication decisions on blockchain technology and related issues.

Analysis of publication data evaluation results using VOSviewer

During the data mapping process using VOSviewer, the bibliometric analysis uses a relationship limit between terms with a minimum value of 10. The goal of determining this number is to ensure that the term mapping procedure generated by VOSviewer covers all data with a 100 % completeness level. Additionally, in data mapping, the binary counting approach is used. The mapping findings yielded 63 words, which were derived

from the titles and abstracts of papers retrieved from the Scopus.com website. The 60 terms were then picked based on their relation to the study keywords. After the screening procedure, 60 phrases were found that were closely related to study topics that centered on “blockchain”, “citizenship”,”civic”, and “national identity”.

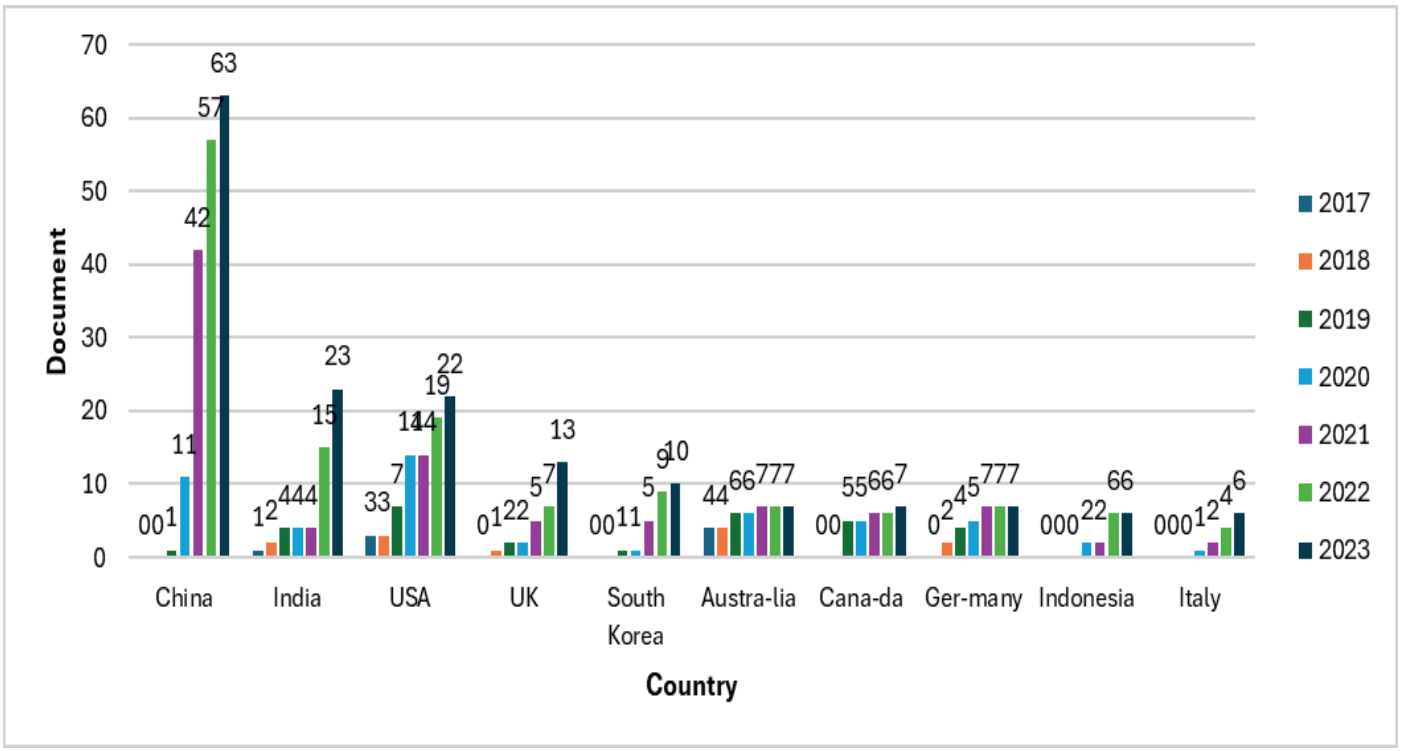

Figure 6. Ten countries with the highest levels of productivity in blockchain publications

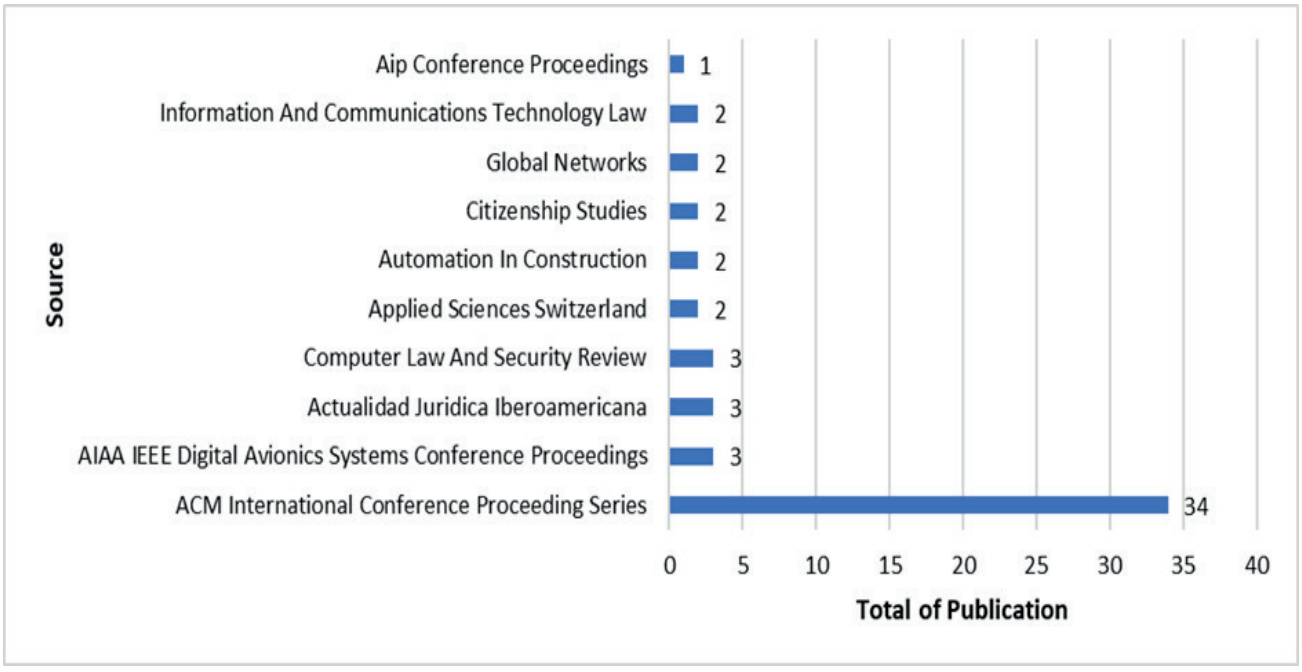

Figure 7. Growth of blockchain-related publications indexed in Scopus during the 2017-2023 period

Based on the mapping results from VOSviewer, four clusters were identified, each distinguished by color: red for Cluster 1, green for Cluster 2, blue for Cluster 3, and yellow for Cluster 4 (see table 1). Aside from that, the amount of elements in each cluster can vary. Cluster 1 has 21 items, Cluster 2 has 20, Cluster 3 has 18, and Cluster 4 has a single item. Each of these clusters describes the link between the investigated topics.[25]

Table 1. Cluster group by mapping results

Cluster	Items	Total items	Color
1	Organization, addition, blockchain, case, citizen, work, civil society, government, information, blockchain technology, need, paper, person, process, record, service, solution, system, data, transparency, and trust.	21	Red
2	Author, context, platform, country, creation, regulation, cryptocurrency, demand, analysis, example, issue, law, framework, order, smart contact, study, time, transaction, type, and development.	20	Green
3	Privacy, problem, research, security, application, approach, challenge, internet, IoT, model, network, , implementation, industry, technology, communication, concept, field, and things.	18	Blue
4	Operation	1	Yellow

Aside from creating 4 clusters, data mapping with VOSviewer generates 3 forms of visualization: network visualization (see figure 8) and overlay visualization (see Figure 9). Figure 5 depicts each component with a colored circle of varying sizes. The circle's size represents the frequency with which the item was used in the study; the wider the circle, the more frequently the item was utilized. Figure 8 shows that blockchain-related terms are in cluster 1, which is colored red.

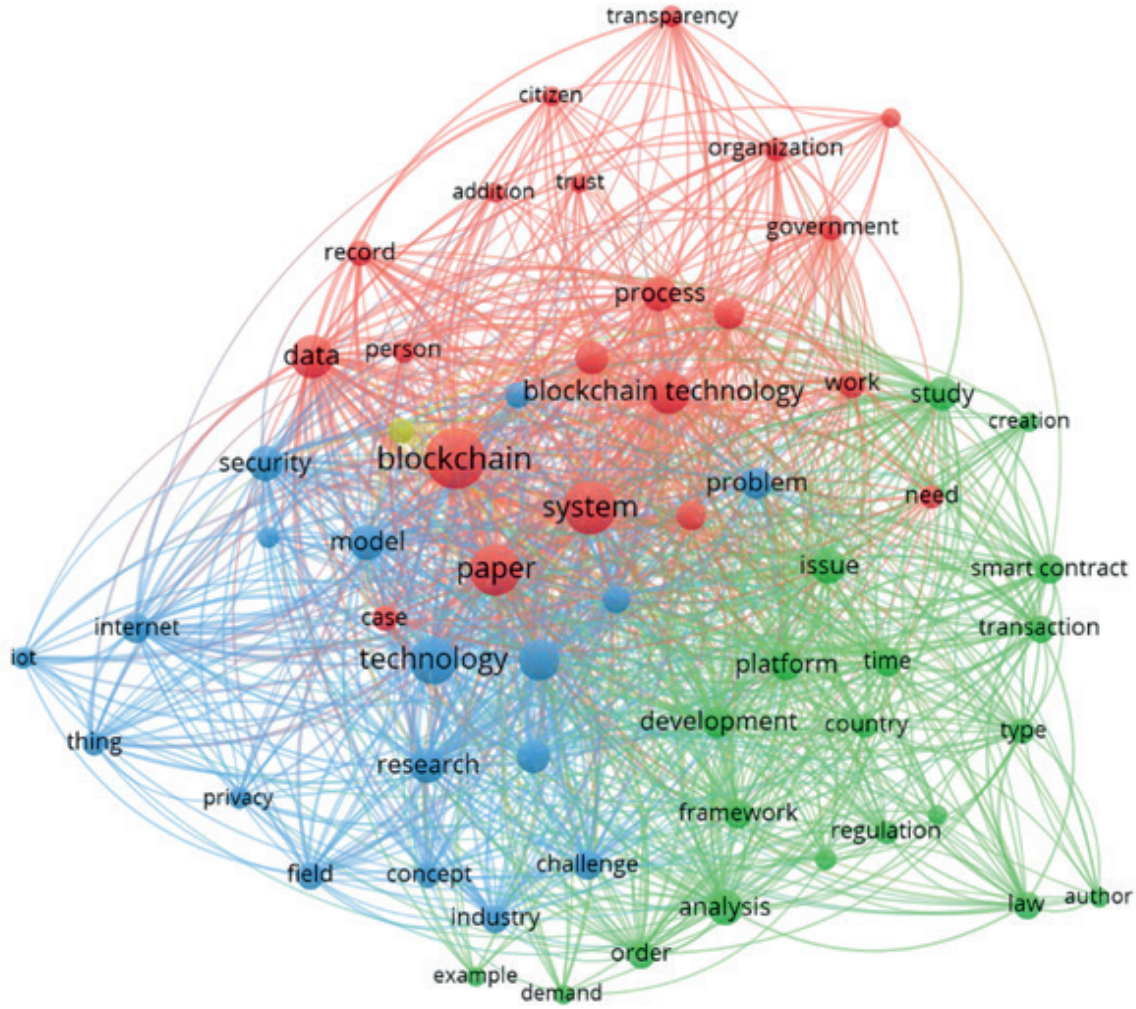

Figure 8. Network visualization based on keywords

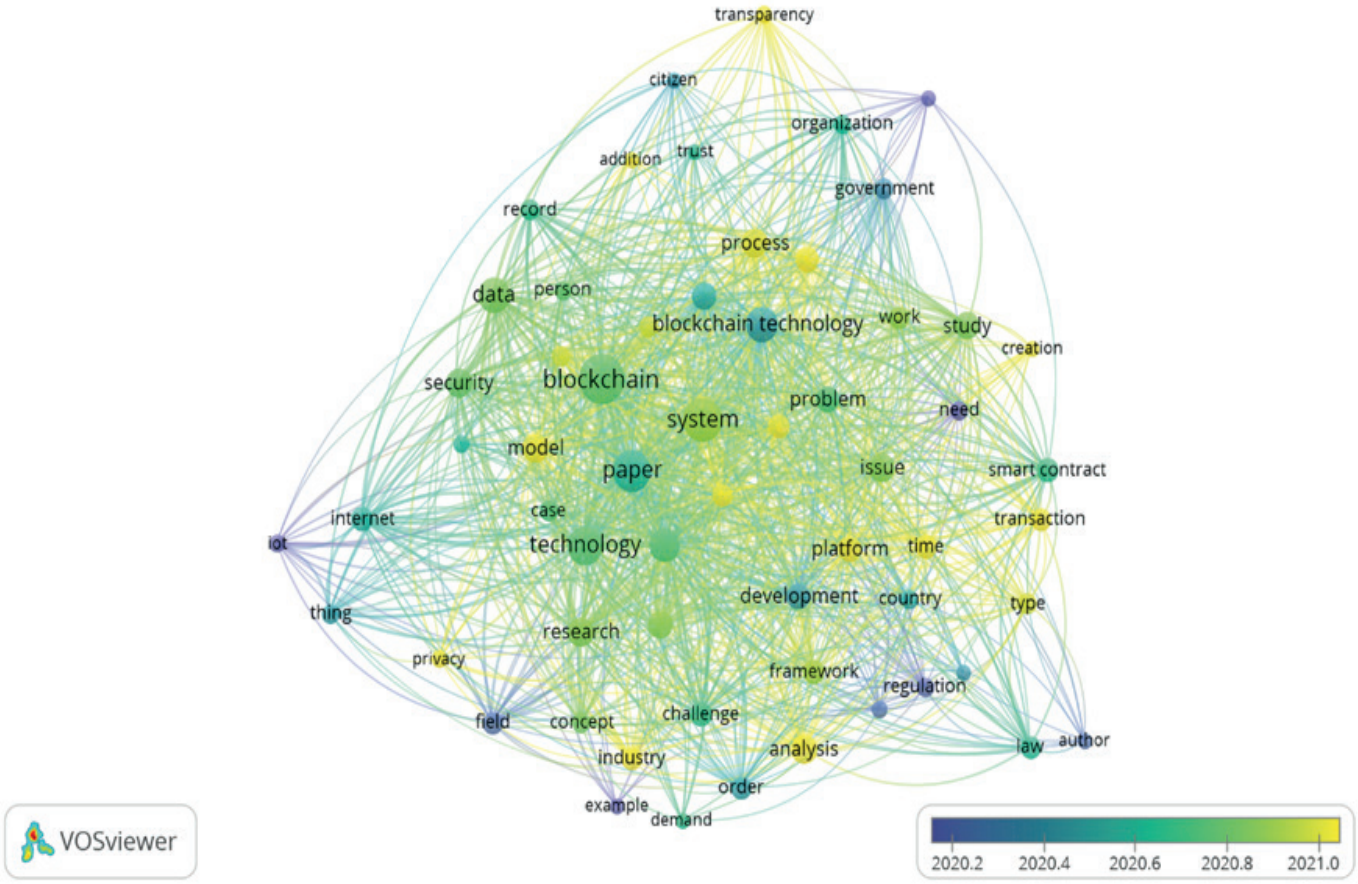

Figure 9. Overlay visualization based on keywords

Blockchain architecture that has been used to implement a citizenship system

Several prior studies explored blockchain-based systems for storing and managing demographic or citizenship data. Amrit Jha and colleagues[29] presented a decentralized public citizenship record model based on the blockchain concept. Maintaining data integrity is critical in their proposed model. The chosen system architecture is critical in protecting the correctness of the incoming data flow while also taking into account the data's interaction with pre-existing data sets. Aside from that, this system serves as a data storage warehouse. Simply defined, as new citizen data is added, the system meticulously records how it ties to current citizen information, boosting the data's transparency and validity. Overall, Amrit Jha and colleagues proposed three basic components in the model (figure 10).

a. Decentralized applications. Decentralized applications can run independently and use different data structures than traditional applications or webpages. This program operates by running all system logic and processes on a decentralized server using blockchain technology. This mechanism can make the system more transparent, particularly for parties with access rights to it.

b. User (User Agent). The public and government personnel have access to all existing data collections in the program and can add new data to them.

c. Backend powered by decentralized blockchain technology. Decentralized apps require decentralized servers to perform properly. This blockchain-based server, like other blockchain systems, operates as a global computer that stores data as a state system and monitors changes to that state using a block ledger. This renders the data in the system unchangeable.[29]

Other blockchain designs for smart city implementation with citizen participation have been proposed to improve transparency in government policy and implement smart city principles.[30] This approach is meant to allow the public to vote on the policies that are being implemented. Zaheer Khan and his colleagues presented three major components that comprise this architecture.

a. Ledger. The ledger serves as a container for people's feedback on certain regulations. This book also includes information provided to various electoral districts, as well as information on the history of voting. Apart from that, this ledger also includes authentication and validation processes carried out by administrators at the district level, which will then be passed on to admins at the city level.

b. District administrator. District administrator is a blockchain-based system that manages voting proposals, provides smart contract services, and facilitates voting proposals at the district level. At the district level, the implementation of decentralization allows the community to submit ideas regarding certain policies. These proposals will be recorded in the district ledger and then forwarded to the city government..

c. City administration. City administration is a blockchain-based system that stores population data for anyone who wish to submit vote collection plans. The process of approving community voting initiatives takes place at the city level.

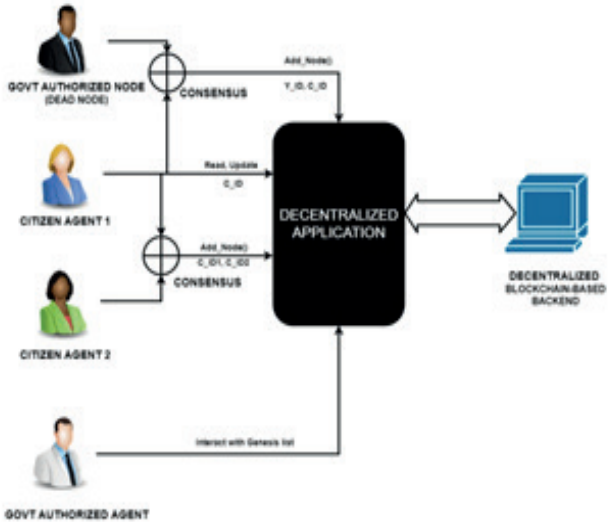

Figure 10. A high-level overview of the blockchain model for citizenship data system[29]

Each component can communicate with one another via the internet via node identification, and each component is linked by a chain code.[30] Aside from the architecture that has been established, there have been a number of alternative architectures adopted in the population sector using blockchain technology. Things to consider while implementing blockchain architecture include features of its use in every government, such as bureaucracy and business procedures carried out by agencies or regions that will use blockchain technology.

The population sector has adopted blockchain technology.

Blockchain technology promises significant improvements in transparency, efficiency and security in the population administration process. This technology has been applied in various fields related to data populations, including:

1. Digital identity. The use of blockchain technology in digital identity systems improves security, transparency, and decentralization. As a result, each individual has complete control over his own identity, without the need to go via a third party.[31,32,33,34]
2. Landownership registration. Blockchain technology can strengthen trust and security in the process of recording and land ownership transactions. Apart from that, the application of this technology can also reduce the potential for corruption and its perpetuation.[31,32,33,34]
3. Election (Electronic Voting). Blockchain technology has been applied to record voter data and election results, especially in elections that are held boldly. Blockchain technology has the ability to eliminate fraud and data manipulation while also protecting voter privacy and anonymity.[31,32,33,34]
4. Data on the structures and means required to properly settle legal issues in order to achieve democratic citizenship rights and the core components of the rule of law.[35]

In addition to the sectors mentioned above, blockchain technology has been used or is being studied in a variety of additional areas. However, the use of this technology in the population sector is still in the experimental stage in many countries, including Indonesia. Implementing blockchain technology presents a number of problems, including technological, ethical, legal, and policy issues.

Accountability is implemented through blockchain technology

According to findings from article review studies, data transparency,[29,36,37,38,39,40] decentralized data[36,37,38]

and immutable records housed by blockchain technology can all improve data accountability.[36] Blockchain provides a safe, open, and decentralized mechanism for keeping citizen records, making it a potential means to holding society responsible. Population data stored on the blockchain will be protected by Certificate Authorization (CA)-based process control and cryptography tools.[41] Furthermore, blockchain technology provides a safe and transparent platform for ensuring population responsibility while maintaining data integrity and consistency.[39] Population accountability is maintained by keeping and preserving citizen information in systems known as nodes. Every transaction is recorded on the blockchain, creating an irrefutable audit trail. Therefore, population data stored on the blockchain becomes more open and reliable.[42]

Implementation of population data integrity using blockchain technology

According to the conclusion of the article's observational study, the integrity of population data applied in blockchain technology is as follows:

1. Blockchain technology can support population integration in two ways: through decentralized and non-easily changeable identity verification, which is very useful for integration purposes, as well as the implementation of blockchain-based voice isolation systems. The voting process can be made more secure, transparent and accessible by utilizing blockchain technology. This technology provides opportunities to protect and decentralize identity management, voting processes, and economic participation.[36]
2. Implementing a decentralized and transparent approach can boost population integrity. Population data can be recorded and validated using blockchain technology on a safe and impenetrable network. Blockchain technology can support population data acoustics by offering a secure, transparent, and decentralized platform for storing and verifying population information.[37]
3. Blockchain technology can help to protect population integrity by offering a secure and impenetrable method of storing and managing individuals' IDs. Because blockchain is decentralized, no single entity controls the data, making unwanted access or tampering difficult. The use of encryption also ensures that each characteristic is secured, and data may only be accessed with the identity holder's specific consent.[29]
4. Blockchain technology protects the population's integrity through encryption, hashing, and consensus methods. The blockchain's integrity is maintained by creating a chain of blocks using the previous block's hash value.[38]
5. Blockchain technology can ensure the integrity of data populations by providing a secure and immutable method for managing and storing information. Distributed ledgers can be used to store population data, with the information encrypted and linked to previous records using hash cryptography. Blockchain can improve the integrity of population data in several ways. First, due to its decentralized nature, the risk to the communications or data ecosystem is lower, as no one entity controls the data. Second, demographic data can be easily transparent thanks to the transparency and auditability of blockchain, which ensures its accuracy and accuracy. The decentralized and distributed structure of blockchain technology guarantees high data integrity and makes it almost impossible to modify. Thus, blockchain provides better functionality to maintain population integrity and protect sensitive data.[43]
6. The data contained in the blockchain is distributed among multiple nodes, making it impossible for attackers to modify it. This is what makes blockchain a viable security option for data sharing.[42]
7. Blockchain technology offers a secure and decentralized approach to identity verification and data management. In addition, this technology can support maintaining the integrity of population data. Blockchain allows access and storage of population data in a transparent and uninterrupted manner, which guarantees the authenticity and completeness of the information. By reducing the risk of identity theft and illegal access to personal data, this technology also improves the integrity of data populations.[40]
8. Consensus mechanisms and cryptographic techniques are used to ensure population integrity. Blockchain technology substantially enhances population integrity by utilizing cryptographic technologies. Blockchain ensures population integrity through the use of cryptographic techniques and consensus processes. This approach ensures data security, correctness, and consistency inside a blockchain network.[44]
9. Blockchain technology allows the private sector and governments to communicate data automatically and in real time.[39] Aside from that, blockchain ensures privacy and anonymity, preventing potential data fraud.[35]

DISCUSSION

All of the research shows that blockchain technology could provide answers for the system to improve transparency, security, and efficiency. China was a country that produced more blockchain-related articles. During the 2019-2023 period, the primary application of blockchain technology in both China and the United States will be to improve the security and reliability of air traffic management operations and supply chain management efforts. Specifically, in the field of supply chain management, IoT technologies play a critical

role in capturing and integrating innovative data sets into the blockchain infrastructure, hence increasing the supply chain network's transparency, traceability, and operational efficiency. Beyond its use in supply chain management and air traffic control, blockchain technology offers exciting opportunities for the administration of citizen data. Blockchain technology has the potential to improve the management and protection of sensitive citizen data by providing secure, immutable, decentralized, and auditable solutions. Prior studies have suggested models for using blockchain technology to secure demographic data, despite the fact that its application for storing and protecting such data is still relatively new. The initial authentication method of data kept on blockchain systems, for example, using smart contracts, has been shown to be reliable in terms of data authentication, according to research cited as.[29,30] Another study recommends a Blockchain-based system as a dependable and secure method of storing all of a nation's citizen records.[45,46,47] Another study provides a methodology for helping professionals create self-sustaining ecosystems with distributed ledger technology; important components of this framework include token engineering, governance modeling, value exchange mapping, and distributed ledger technology architecture.[48] Averin and Averina's research investigates and assesses current fixes, as well as their suitability for various blockchain architectures.[49]

Blockchain technology also has a big impact on data ownership and control in the context of data citizenship. It allows citizens to actively participate in the development and management of their personal records, such as when blockchain technology is integrated with digital identities. It can reduce privacy leaks by implementing granular access control mechanisms. The implementation of blockchain can result in independent and robust data management systems that assure data ownership and traceability, providing users authority over their data and encouraging the sharing of high-quality sensitive data.[48] Furthermore, blockchain technology, paired with selective encryption and smart contracts, enables data owners to trade their data while preserving control, guaranteeing that only authorized users have access to it.

According to research, there are a number of blockchain frameworks in development, but it is still difficult to emphasize the importance of prioritizing operational requirements, testing, deployment, exploration, and maintenance,[50] particularly for digital identity, land ownership, and the general election process. Other articles have investigated the legal challenges of applying current laws to decentralized digital technologies and advocated the adoption of regulatory sandboxes and new legislation.[51]

CONCLUSIONS

The analysis in this article focuses on investigating how blockchain technology might enhance data openness, security, and efficiency across a range of industries, particularly population governance and data management. According to the research, there is a growing trend of blockchain technology in China and the US. It is widely utilized to enhance security and dependability in the primary supply chain and air traffic control features. Furthermore, supply chain networks that are integrated with IoT technology are tracked and made transparent through the usage of blockchain technology.

Furthermore, although the use of blockchain technology to secure population data is still in its early stages, the proposed model and methods indicate the technology's ability to protect personal information. To protect the integrity of demographic data, blockchain technology employs decentralized identity verification and tamper-proof record keeping. Its consensus protocols and encryption algorithms provide secure data management, making it difficult for attackers to change the data. Because of its transparent ledger system and decentralized structure, blockchain reduces the risk of identity theft and unauthorized access to personal data while also providing effective solutions for data integrity and identity verification. Blockchain technology also has a significant impact on data ownership and control, particularly in digital identity management. It empowers individuals to manage their own personal data while guaranteeing privacy and traceability through fine-grained access control techniques. Smart contracts and selective encryption enable data owners to maintain control over their information while still enabling authorized access. However, there are also challenges in developing and implementing blockchain frameworks, notably in areas such as digital identification, property ownership, and election procedures, where operational specifications, testing, regulatory compliance, and maintenance must be carefully considered. Despite these challenges, blockchain technology offers promising prospects to improve data citizenship and governance, emphasizing the importance of more research, creativity, and collaboration in this emerging field. As a result, research and development efforts investigating blockchain's potential applications in strengthening data citizenship and governance should be continued, with funding initiatives and collaborative partnerships offering aid. In addition, legislators and regulators must develop precise regulatory frameworks and legal compliance measures suited to the unique features of blockchain technology in order to foster innovation while ensuring compliance with current legal standards and data protection laws.

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AKNOWLEDGMENT

The researcher would like to express his deepest thanks to the Deputy for Research and Development

Strengthening, Ministry of Research and Technology/National Research and Innovation Agency in accordance with the 2023 Fiscal Year Research Contract on the Higher Education Collaboration Research Grant for Fiscal Year 2023. The researchers also express they're thanks to the Population Service and the Cimahi City Informatics Service as research partners.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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