Bangladesh Journal of MIS
2024, Vol.10, No.02
https://doi.org/10.61606/BJMIS.V10N2.A2
ISSN:2073-9737 (Print), 2410-7077 (Online)

OPEN ACCESS

Integration of Blockchain in e-government system: Systematic literature review with Bibliometric visualization

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ABSTRACT

Government systems in different countries have experienced a vital evolution, particularly in public service delivery. Blockchain introduced innovation in the e-government system by emphasizing the transparency of transactions, immutability, and identity management. This study uses a systematic literature review and bibliometric analysis to address the benefits and challenges of adopting blockchain in e-government systems. The results encourage government officials and citizens to adopt blockchain to accomplish government activities. A total of 249 papers from the primary databases, i.e., IEEE Xplore, Scopus, and ACM, were scrutinized to be selected into 21 appropriate publications for full-text reporting using the PRISMA flowchart. Bibliographic data were accumulated and investigated consequently to develop network visualization using VOSviewer 1.6.19. Blockchain provides two-fold benefits to the e-government system, i.e., benefits to citizens and benefits to government bodies. Blockchain engages citizens in the service delivery process, ensures trust, enables access to government facilities easily, and maintains self-sovereign identity and secure data. Blockchain provides transparency and accountability among the agencies and ministries of government and facilitates cross-border activities. Having enormous benefits, governments face various challenges in using blockchain in the public sector. Based on the full-text analysis, blockchain implementation challenges are classified as technological, organizational, and environmental challenges. Government bodies should adopt blockchain to reap the benefits and address the challenges of implementing blockchain.

KEYWORDS: blockchain, e-government, PRISMA, VOSviewer

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ARTICLE HISTORY: ***Received:*** **20 Nov 2023;** ***Revised:*** **05 Nov 2024;** ***Accepted:*** **06 Nov 2024;** ***Published:*** **30 June 2025**

1. Introduction

Blockchain, a popular term in today's technologically developed world (Habib et al., 2022), ensures the transparency of information and its flow among parties involved with its advanced and distributed database applications (Akgiray, 2019). It can be considered a game changer for its revolutionary impact. Blockchain is used to manage, transfer, and share different types of data with the help of computer networks' nodes.

Blockchain has been introduced to cryptocurrency applications since 2008. The emergence of Bitcoin and other cryptocurrencies enhanced the popularity of this technology (Khanna et al., 2021). Blockchain is currently being used for different purposes in different sectors (Foroglou & Tsilidou, 2015), including supply chain management, healthcare, retail business, manufacturing processes, land registration, copyright and royalties' protection assurance, voting, administration of assets, advertising and so on. As in many other fields, this disruptive technology provides the government with numerous benefits such as reliability, transparency, efficiency, interoperability, data security, and trust (Xie et al., 2019; Phadke et al., 2022, Yaga, 2018). Therefore, there has been a surge of research efforts and government initiatives to integrate this cutting-edge technology into their e-government systems. Blockchain offers new opportunities to fulfill the aim of e-government, i.e., to improve governance quality and efficiency in service delivery to its citizens and other stakeholders. E-government can streamline administrative processes, improve transparency, and secure public services by leveraging blockchain's inherent features.

Many countries have developed blockchain for its numerous advantages. They provide different facilities based on different communities, such as industry communities, investment communities, user communities, and so on. Estonia tested blockchain in its e-governance in 2008 to reap the benefits of distributed database technology and decentralization of the service delivery process (Khatib et al., 2022). The country also applies blockchain in its financial, medical, public, and other sectors (Rahimi et al., 2021). Blockchain helps Estonia's government get many advantages from the technology and facilitates the country by fulfilling its ultimate goals and objectives.

The government of Dubai plays a vital role in transforming the country into an innovative country with the help of the entity "Smart Dubai" (Salem, 2016). This entity works for the betterment of Dubai with the help of both the public and private sectors. They also work on technological development and use blockchain technologies to enhance the efficiency and effectiveness of their financial services (Khan et al., 2022). It also facilitates the country's ensuring transparency. The technology was also implemented in other sectors of Dubai's governance activities. It helps the country to get the maximum benefit from blockchain (Bishr, 2019). Saudi Arabia is also using blockchain in its e-governance activities. The government must ensure the needs of the different communities, and this technology helps the Saudi government achieve its goals (Assiri et al., 2022). Abu Dhabi has the advantages of blockchain when applied in its e-governance sector, and this technology is used to ensure effective communication among different stakeholders (Wehbe et al., 2018). The authority developed blockchain to safeguard a solid, secure data management and exchange system. Georgia, Singapore, Japan, China, Sweden, India, the USA, and the United Kingdom are some countries that widely use blockchain in different sectors and e-government systems (Khanna et al., 2021). Blockchain reduces the ultimate cost and increases the efficiency of the government service delivery process. China adopted the technology to ensure the modernization of its governance system (Hou, 2017; Alexopoulos et al., 2019).

Blockchain is an emerging area for e-government systems. Many research studies have been conducted on the applications of blockchain in different sectors, and most of them have focused on any area of government service, i.e., e-voting, land registry systems, and identity management systems. (Elisa et al.,

2019; Lykidis, Drosatos, & Rantos, 2021). However, none focused on the recent trends of blockchain in e-government systems using bibliometric visualization. This study intends to fill the gap in conducting secondary data-based research on the integration of blockchain in the e-government sector. The benefits and challenges of adopting blockchain in e-government will be discussed based on the scholarly documents published in different countries to fill the gap of scarcity of secondary research combining systematic literature review and bibliometric analysis (Alexopoulos et al., 2019; Batubara et al., 2018; Elisa et al., 2018).

The development of a country mostly depends on the efficiency of the public sector. Blockchain-enabled government system makes public services more convenient for the government, people in business, policymakers, mass people, different professionals, foreign trade parties, and other country stakeholders. Blockchain has added a new dimension to this system (Petkova & Jekov, 2018). Knowing the benefits and limitations of this technology is a must to ensure its best outcomes. Therefore, Ølnes, Ubacht, & Janssen (2017) suggested the implementation of blockchain in the e-government system of countries. Therefore, this study aims to address the following research questions:

RQ 1: What are the benefits of adopting blockchain in an e-government system?

RQ 2: What are the challenges of adopting blockchain in an e-government system?

2. Research Methods and Procedures

A four-step process is used to search, evaluate, synthesize, and analyze (McCoy et al., 2020; Nguyen & Singh, 2018; Selçuk, 2019) the previously published documents in the respective research databases.

2.1 Literature Search

A rigorous search process has been applied for the literature search, and the search process is limited to the Scopus, IEEE Xplore, and ACM databases only. The reason for selecting the Scopus database for this study is that Scopus contains lots of peer-reviewed research documents from approximately all research disciplines. Moreover, the Scopus database provides advanced and proper search and analysis options, which makes this database effective for systematic literature review (AlRyalat et al., 2019; Harzing & Alakangas, 2016; Pranckutė, 2021). IEEE Xplore and ACM have been considered for searching literature as these databases integrate research works on emerging and recent technologies and topics.

Table 1. Search procedures

Keyword used for searching literature	Search within	Research database	Period	Query string	Sort by	Documents found
Block Chain or Blockchain or distributed ledger in e-government or e-government system	Title, Abstract, Keywords	Scopus, IEEE Xplore, and ACM	2015 to 2024	TITLE-ABS-KEY ("Blockchain" OR Blockchain OR "distributed ledger" AND "e-government system" OR "e-government") AND PUBYEAR > 2014 AND PUBYEAR < 2025	Relevance	249

Literature published from 2015 to May 2024 has been considered, where 2015 is the starting year and 2024 is the ending year for the literature search from the selected databases. An advanced search tool with two-level titles and abstract keywords has been used to search the literature, with level one containing Blockchain, Blockchain, and distributed ledger. In contrast, level two consists of e-government and e-government systems (Topic = (("Block chain" OR blockchain OR "distributed ledger") AND ("e-government system" OR e-government)). Table 1 exhibits the database search results for this study.

249 scholarly documents were found in those databases, as displayed in Table 1. These include conference reviews, articles, book chapters, conference papers, reviews, and editorials.

2.2 Procedure for Assessing Literature

Relevant literature selected for this study through literature search has been evaluated and assessed using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) data flow diagram (Page et al., 2022), as shown in Figure 1.

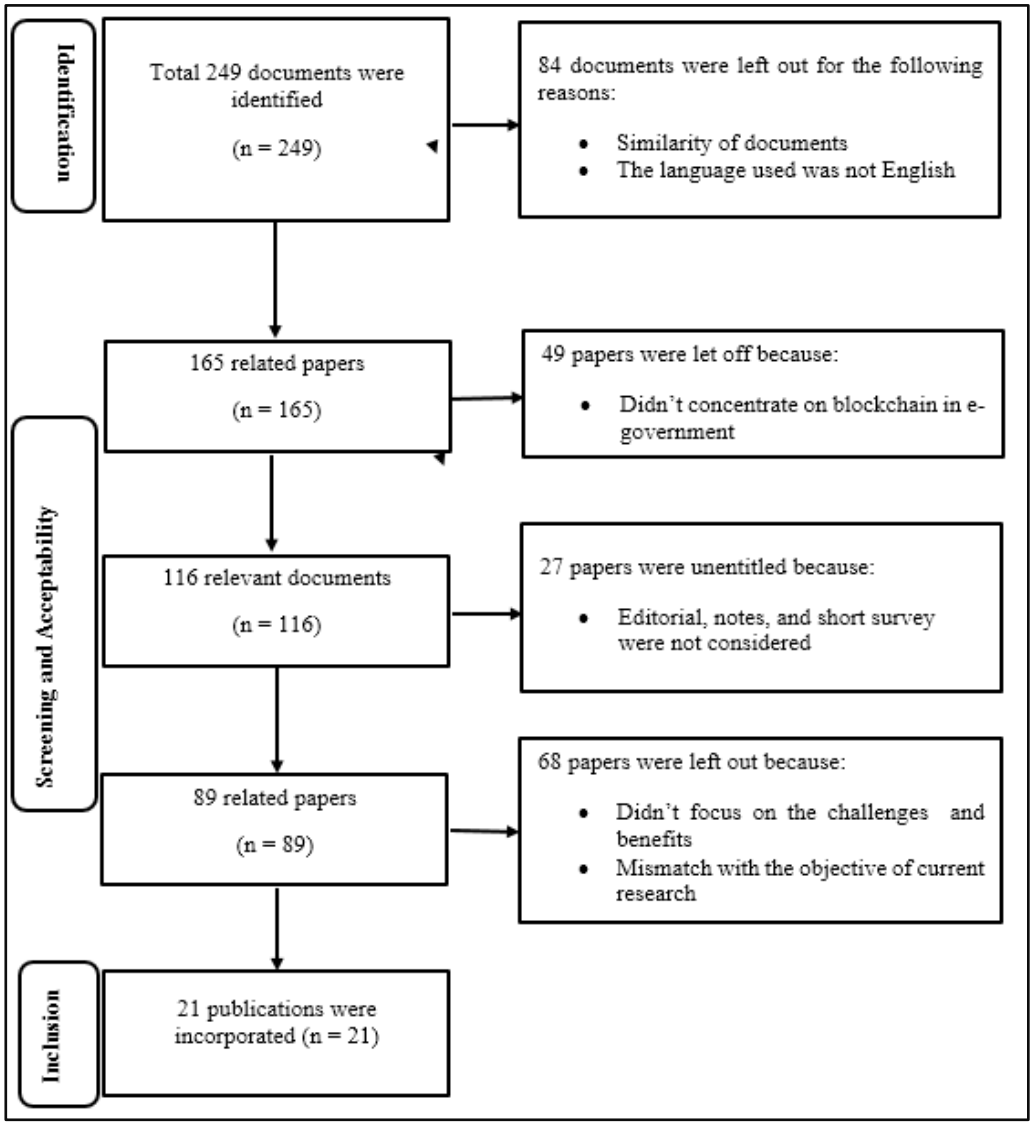

Figure 1. PRISMA Flow Diagram

2.3 Literature Synthesis

21 relevant documents have been selected and fixed up for reporting bibliographic data, and relevant information from them has been displayed in a table. The bibliometric information from several documents has been reviewed as recommended by Phulwani, Kumar, and Goyal (2020) and Xiao & Watson (2019). Therefore, the chosen research works have been downloaded in CSV and RIS format for further exploration and reporting as findings.

2.4 Analysis and Reporting Procedures

Bibliographic information has been analyzed and represented through different figures summarizing the findings and research trends. Bibliographic maps and networks have been produced using a bibliometric data representation software named VOSviewer version 1.6.19 (Eck & Waltman, 2017).

Finally, the 21 papers explicitly studied have identified the benefits and challenges of adopting blockchain in e-government.

3. Results

3.1 Conceptual Framework and Measures

Figure 2 represents published scholarly documents on blockchain in e-government by the top 10 countries from 2015 to 2024. China published the maximum number of documents in this discipline, revealing its enduring concerns about blockchain application in an e-government system. India produced 27 papers, the highest number in this respect, while the UK and the USA contributed 13 documents each.

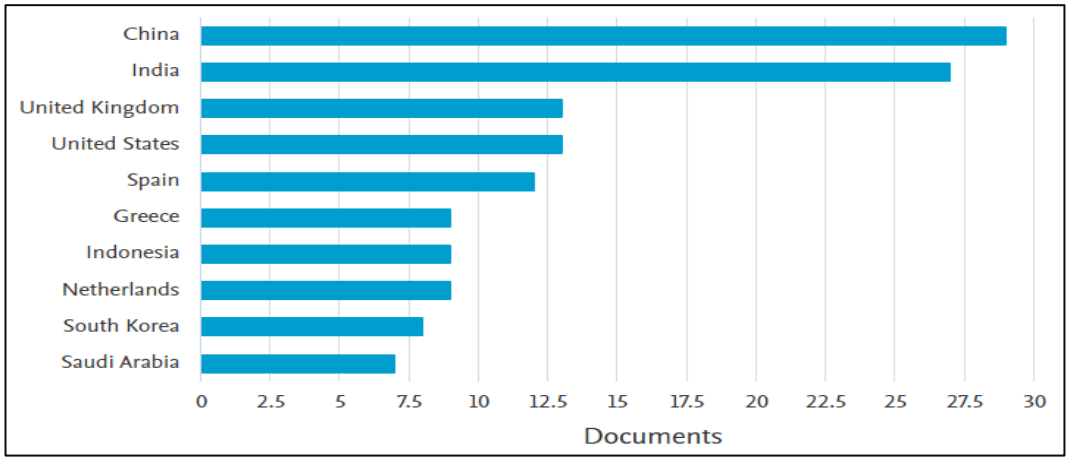

Figure 2. Country-wise Publications from 2015 to 2024

Figure 3 depicts the documents articulated by the top 10 diverse authors from 2015 to 2024. From 2015 to 2024, Ubacht published the maximum number of documents, which is 6. Elisa, Janssen, Yang, and Ølnes put 4 documents each in print, while the rest of the five authors circulated three research works each.

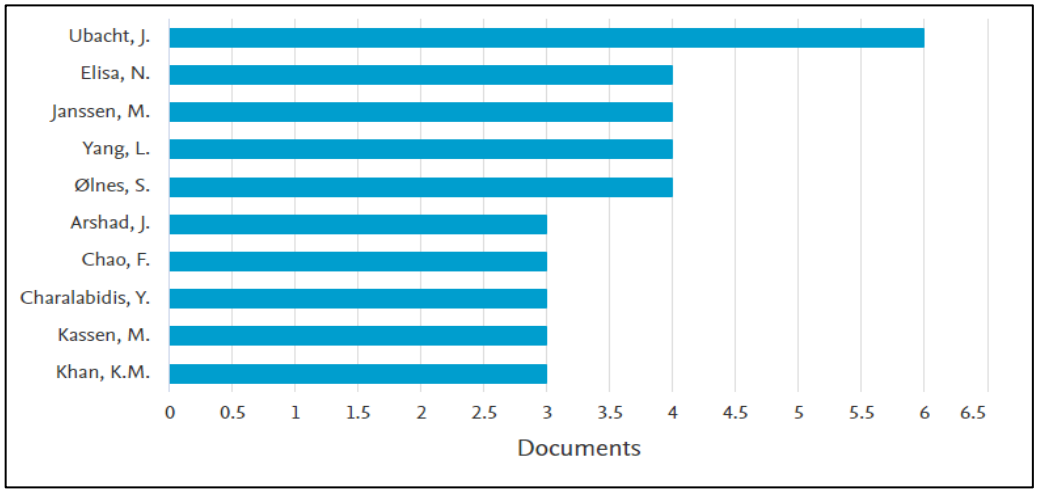

Figure 3. Documents by Author from 2015 to 2024

Figure 4 expresses the countries' co-authorship network. In this network, every node represents a country, while the line connecting the countries depicts the relationship between the countries' co-authorship. This map shows that there is only one cluster consisting of four countries, and the UK has the most substantial co-authorship network, which consists of Saudi Arabia, China, and Bangladesh.

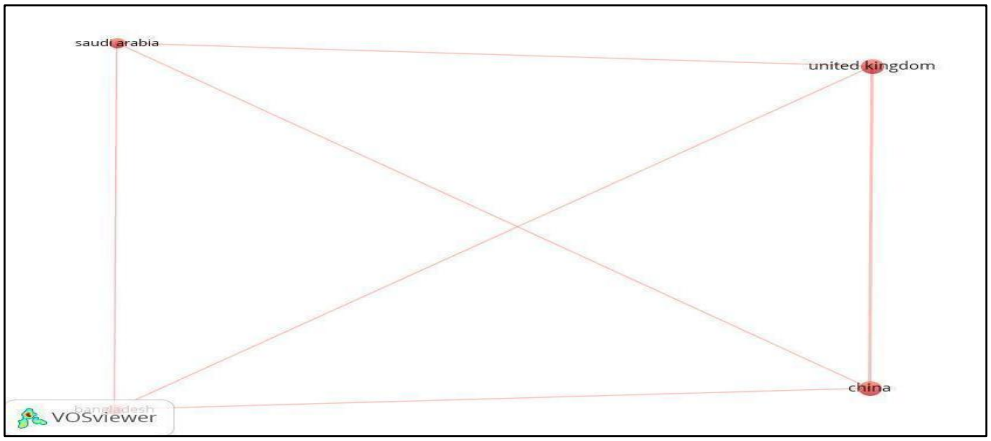

Figure 4. Co-authorship network of countries

Figure 5 exhibits a co-authorship network of authors, each node representing various authors and each color depicting different clusters. There are five groups, with Chen having the largest network consisting of Peng, Dong, and Hao. Lin and Gao co-authored and created their network, whereas Zhang has a strong co-authorship network with Mao, An, and Ma.

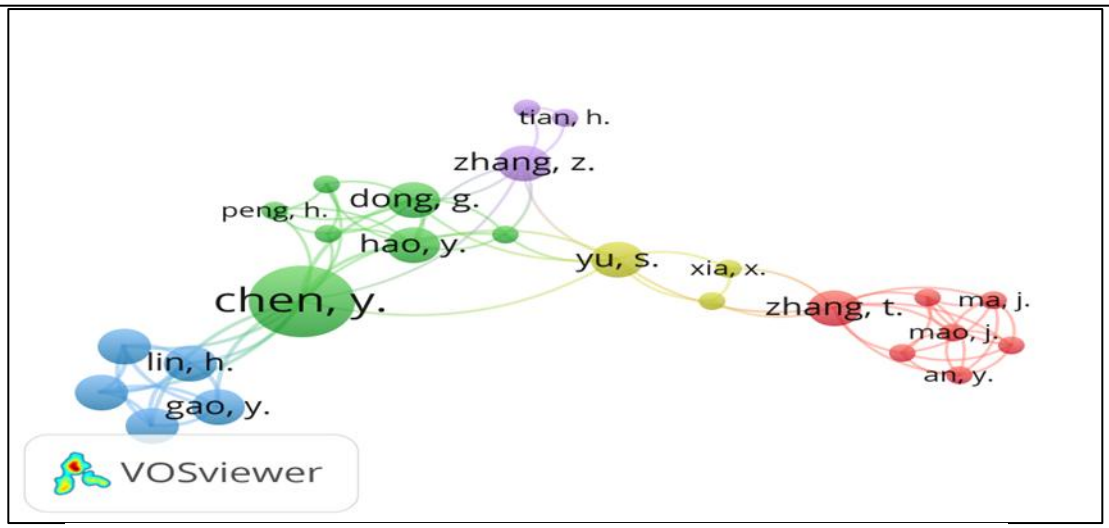

Figure 5. Co-authorship network of authors

According to Figure 6, the majority (50%) of the documents were published as conference papers, whereas 29% were published as articles. Conference reviews, book chapters, reviews, and editorials accounted for 10%, 6%, 4%, and 1%, respectively.

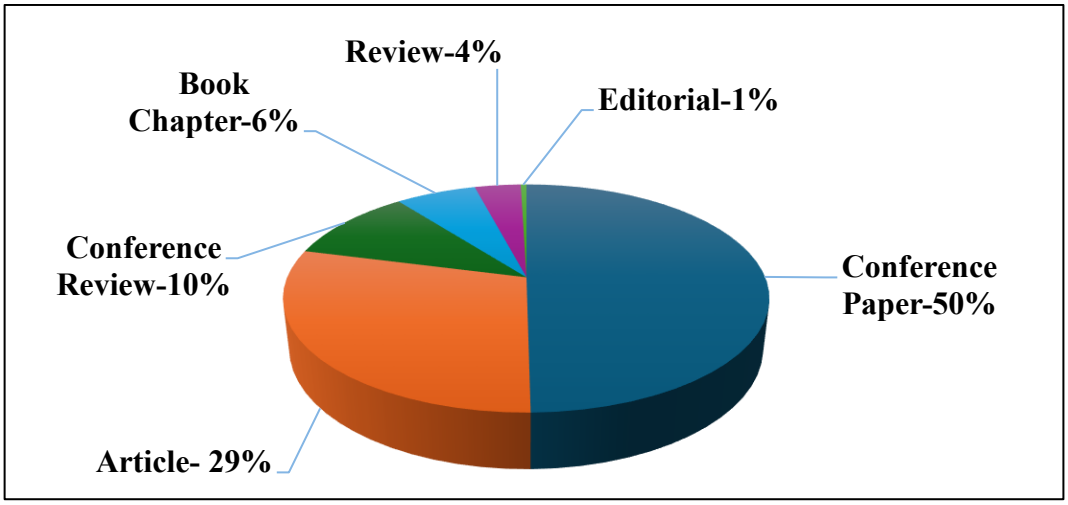

Figure 6. Documents by type from 2015 to 2024

Figure 7 displays documents published in different subject areas on blockchain and e-government. Computer science is the prominent field that contributed most to this respect, accounting for 40.4 percent. Engineering, decision science, mathematics, and social science are responsible for 13.0 percent, 9.1 percent, 10.9 percent, and 8.0 percent, respectively. Business, management, and accounting accounted for 7.4 percent.

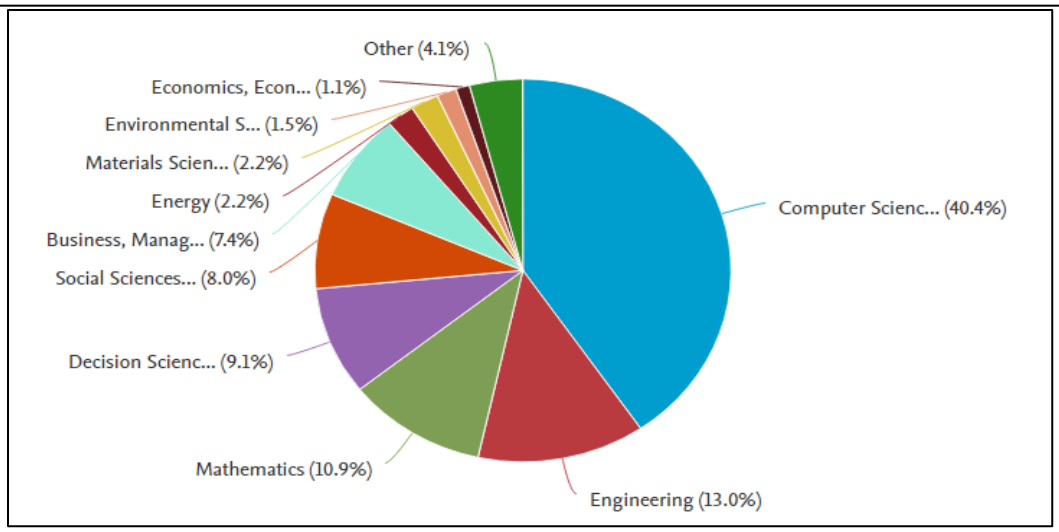

Figure 7. Documents by subject areas from 2015 to 2024

Figure 8 shows the number of documents published each year from 2015 to 2024. Although there was a single document in 2015, the number of published documents continuously increased until 2021. In that particular year, there were 51 documents, which is the highest number during the stated period. After that, there was a slight decrease in the following years. By May 2024, it became higher. Therefore, it is assumed that by the end of 2024, the number could exceed the highest.

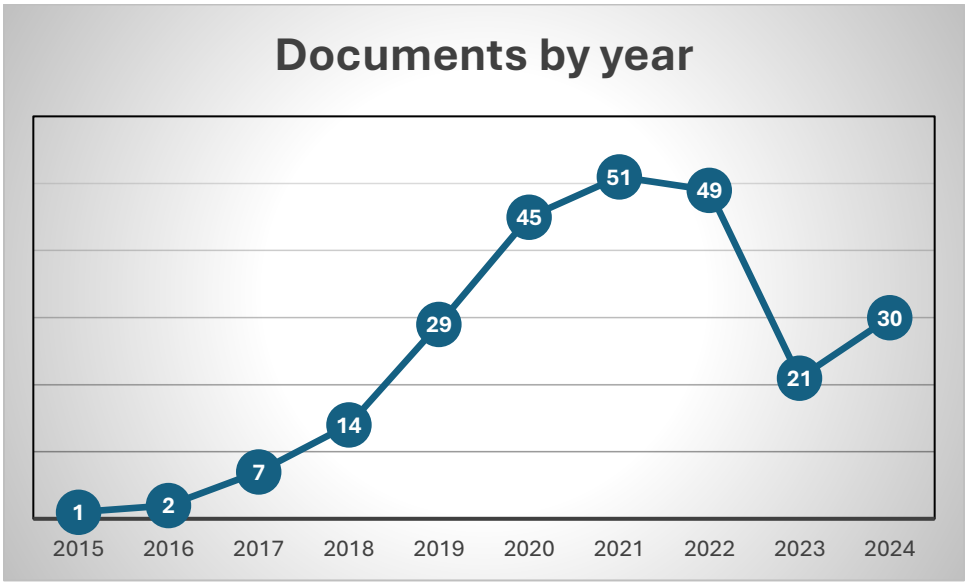

Figure 8. Documents by year from 2015 to 2024

The top ten affiliated organizations' contribution to scholarly works has been shown in figure 9. Delft University of Technology circulated the highest number of documents (7 publications). The University of Northumbria contributed the second-highest number of publications. Universitat d'Alacant, Vestlandsforsking, and the University of the Aegean produced 4 papers each, while the rest of the organizations contributed 3 documents each.

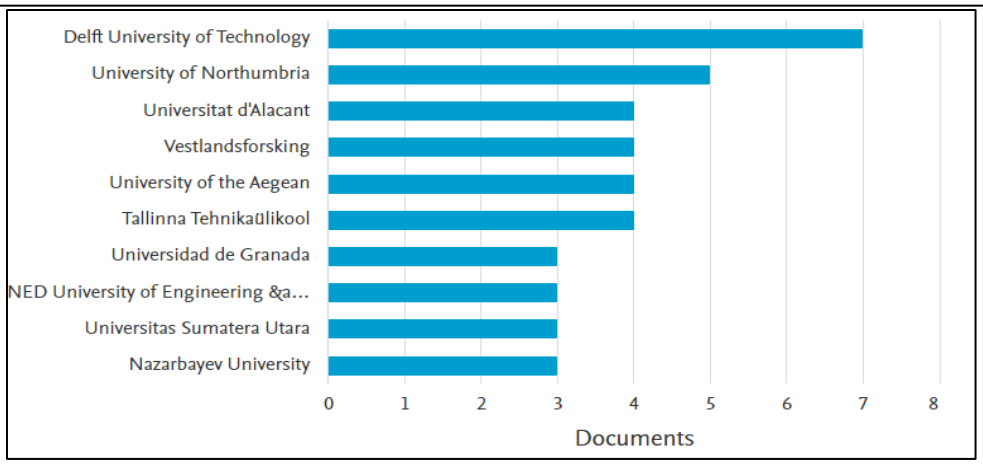

Figure 9. Publication by affiliation

The top five funding sponsors' publications have be presented in figure 10.. Among them, the National Natural Science Foundation of China funded the maximum number of documents (six). The Commonwealth Scholarship Commission and the National Key Research and Development Program of China published two documents each.

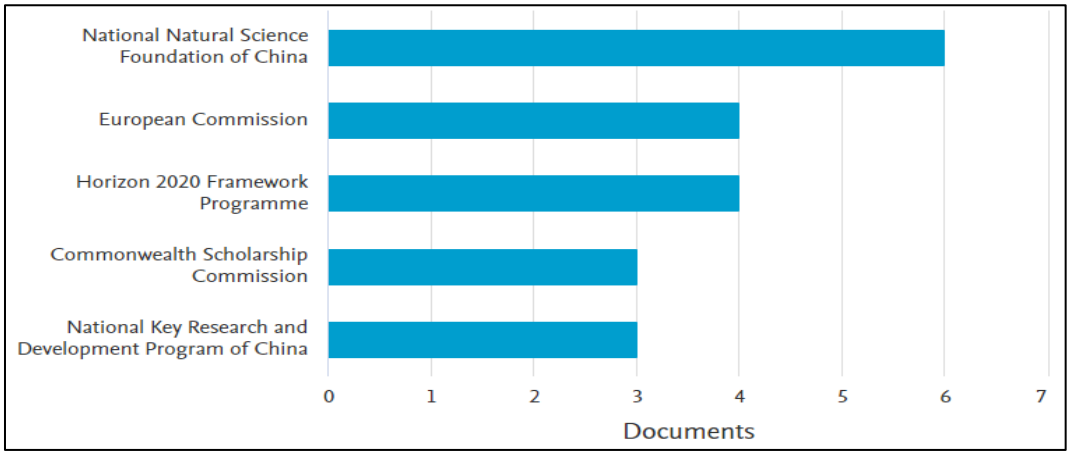

Figure 10: publications by top 5 funding sponsors

The co-citation network of cited authors, shown in Figure 11, demonstrates links between two or more

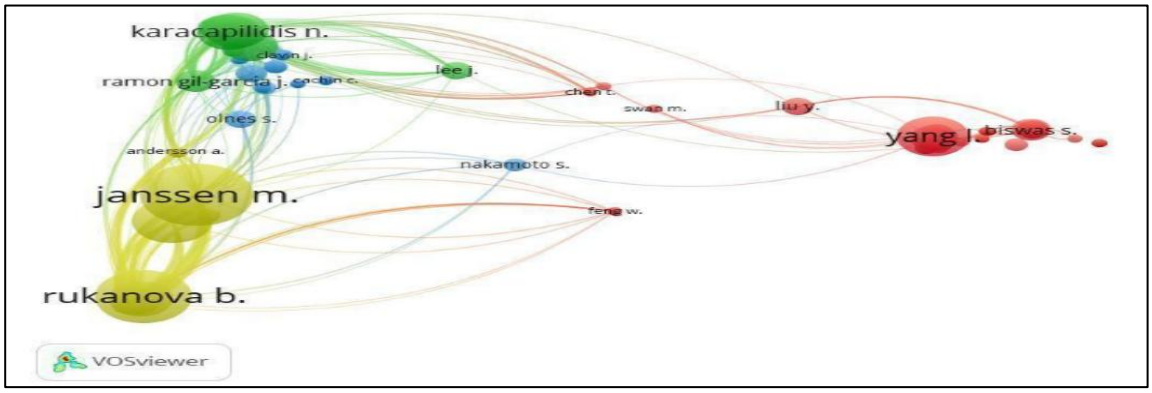

Figure 11. Co-citation network of cited authors

documents of authors that are cited by authors(s) in their document(s). Janssen and Rukonova have a strong co-citation network, while Karacapilidis, Lee, and Remon have their own co-citation network. It is also evident that Yang is mostly co-cited by Biswas, Liu, Chen, and Swan.

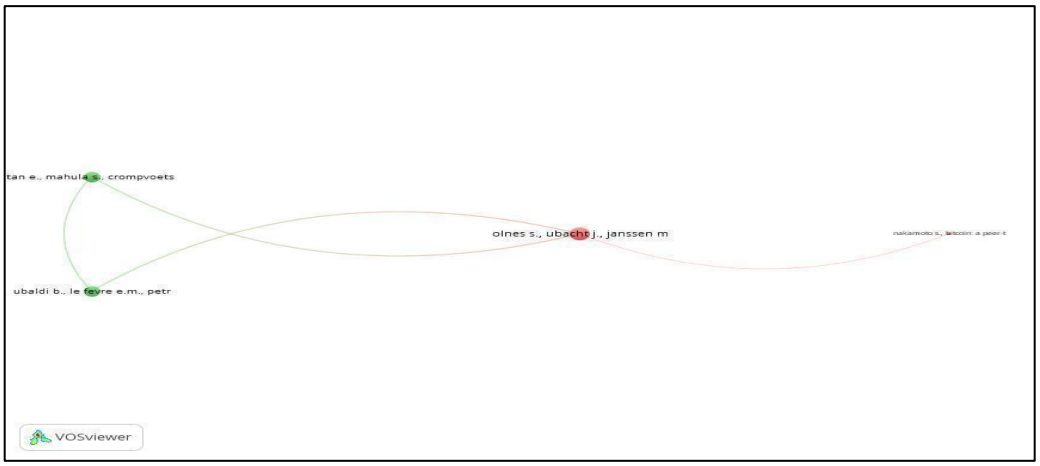

Figure 12. Co-citation network of cited references

Figure 12 shows a co-citation network of cited references representing the web of references that are co-referred by other documents or authors. Only two clusters denote the infancy or evolution stage of blockchain in the e-government system. Therefore, there is ample scope for further research.

The bibliographic coupling of countries represents a web of countries that cite each other's scholarly works. There are only two groups—one consisting of five countries and another having only three nations, as depicted in Figure 13. China and the UK have the strongest bibliographically coupled networks, whereas Bangladesh has links with the UK, China, and Saudi Arabia. Greece has the weakest network, having connections with China and the United Kingdom.

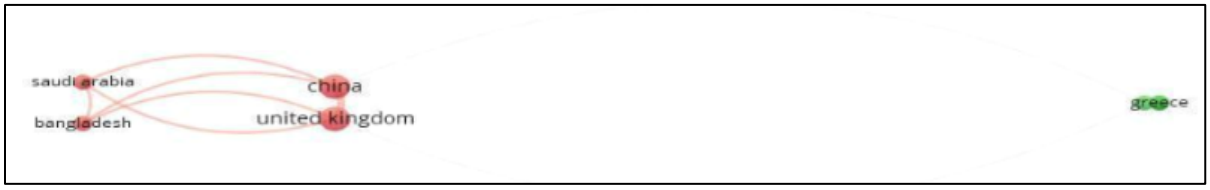

Figure 13. Bibliographic coupling of countries

Figure 14 reveals the bibliographic coupling of documents by different authors. Elisa, Yang, and Chao have the largest number of bibliographically coupled documents. Rukonova and Engelenburg have substantial numbers of bibliographically coupled documents.

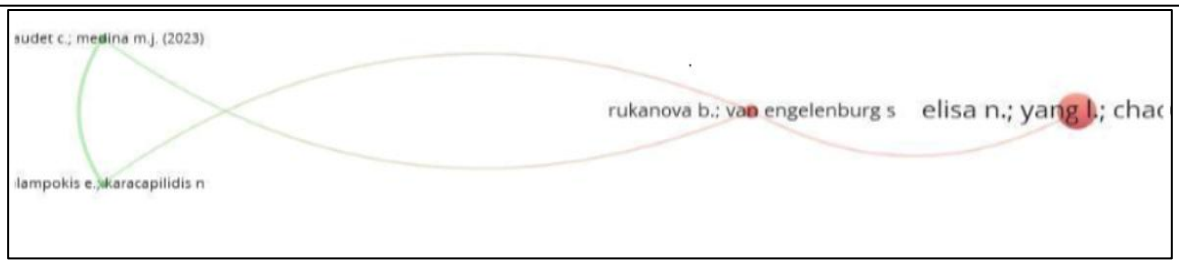

Figure 14. Bibliographic coupling of documents

The keywords of the relevant documents, as shown in Figure 15, have been used to build a bibliographic Network Map. The map is a network of recurrent and significant terms, with blockchain and e-government at its center, linked to another term on the map. Among 90 linked terms, e-voting, public sector, e-government applications, government, government sectors, blockchain, government information, and digital storage are the most occurring terms.

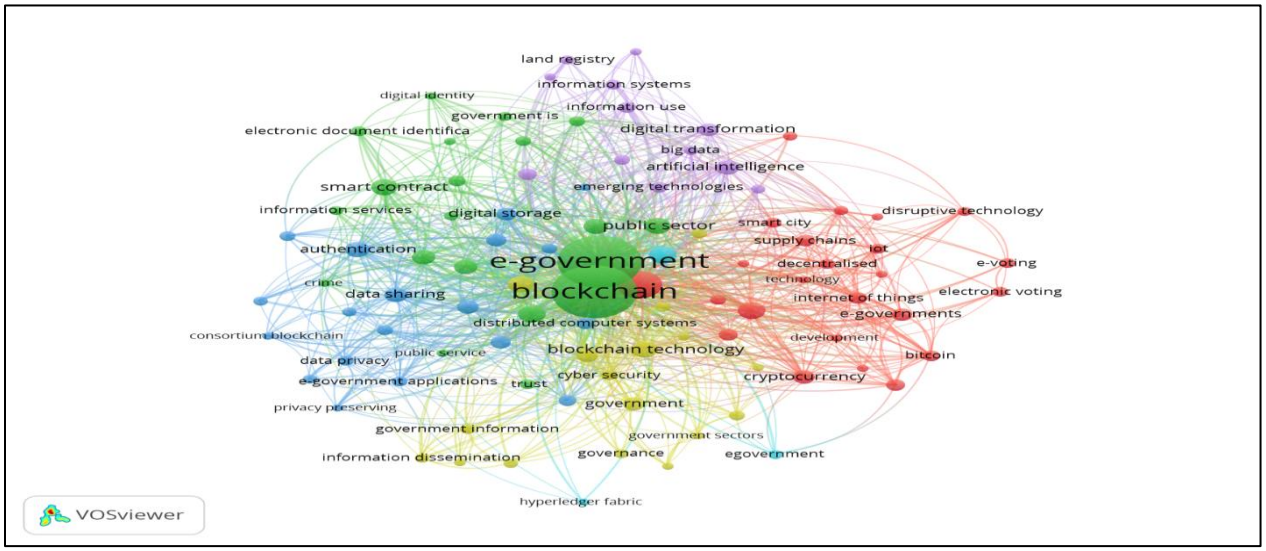

Figure 15. Bibliographic data-driven network map of keywords

4. Analysis

4.1 Full Test Reporting of Selected Papers

At this point, the authors have reviewed and reported previous publications pertinent to adopting blockchain in e-government systems. In this sense, emphasis has been given to the reporting criteria, necessities, and recommendations recognized by Saif and Islam (2022).

Table 2. Reporting the identified documents

No	Author(s) & Year	Objective(s) of study	Methods used	Findings
1.	Sharma et al. (2024)	The study's major focus is on investigating the challenges of blockchain adoption in government service delivery.	Mixed method	**Challenges:** Degradation of transaction performance speed due to complex consensus protocol, implementation cost, and developing an integrated system with all capacities are the major challenges of blockchain in government systems.
2.	Anomah et al., (2024)	This study assesses the benefits and challenges of introducing a Blockchain-based taxation system in Ghana.	Mixed method	**Benefits:** It improved the pellucidity and efficiency of the taxation system. It also decreases fraudulent activities in tax collection and management. **Challenges:** Users' lack of awareness, resistance to change, lack of technological support, and inflexible institutional policies are the major hurdles to adopting blockchain in Ghana's taxation.
3.	Phadke, Medrano, & Ustymenko, (2022)	The study aims to gauge the adoption of blockchain in different areas of e-government systems and the consequences of adopting blockchain in e-government.	Qualitative	Blockchain has significant potential for use in different sectors of government systems, such as education, elections, healthcare, citizen identity management, asset management, etc. **Benefits:** Blockchain reduces cost fraud and increases data efficiency, trust, security, and privacy. **Challenges:** Blockchain has obstacles in terms of having standard regulations, scalability, security, and flexibility.
4.	Wang & Wang, (2022).	The study aims to investigate the impact of integrating blockchain into the e-government system of Kyrgyzstan.	Pilot project-based qualitative study	**Benefits:** Based on pilot project analysis, blockchain improves credibility, transparency, and efficiency in public sectors.

No	Author(s) & Year	Objective(s) of study	Methods used	Findings
5.	Kassen, (2024)	This study determines the blockchain designers' perceptions of integrating the blockchain public service delivery system.	Qualitative	**Benefits:** Blockchain improves the integrity of data management, the efficiency of service delivery, and the reliability of storing citizens' data.
6.	Batubara et al. (2022)	The study aims to conduct a stakeholder analysis and assess the influence and interest of various stakeholders in blockchain in e-government.	Qualitative	**Benefits:** Stakeholders are classified as citizens, governments (national and local), and businesses that have diversified interests and influence on government systems. The authors suggested that determining stakeholders' needs and interests facilitates the easy implementation of blockchain in e-government.
7.	Supriyadi, Sensuse, & Sucahyo (2021)	This study measures the factors that drive different nations to adopt the blockchain in government systems.	Qualitative	**Benefits:** Dominating factors of blockchain in e-government have been categorized as technological, organizational, governmental, and environmental. Governance, platform, and expertise are the technological factors, while commitment, support, availability of funds, and proper planning are the organizational factors in implementing blockchain. Moreover, standardization rules, cooperation and knowledge among stakeholders, and socioeconomic factors are environmental drivers of blockchain in government.
8.	Alexopoulos et al. (2019)	The paper aims to critically assess the advantages and roadblocks to implementing	Qualitative	**Benefits:** Streamlining service delivery processes, reduced cost, easy access to vast amounts of data, and data privacy and integrity are the vital drivers that motivate governments to

No	Author(s) & Year	Objective(s) of study	Methods used	Findings
		blockchain in government sectors.		implement blockchain. **Challenges:** Latency in completing transactions, hacking through owning 51% of the total nodes, and violation of data partition law due to publicly sharing private data are the significant challenges of blockchain in e-government transactions.
9.	Abdullah, & Jusoh, (2022).	This study highlights the importance of assessing the benefits and hurdles of blockchain implications in e-government sectors.	Qualitative	**Benefits:** Blockchain's major contribution to e-government is improving the quality and quantity of data, as well as data integrity and validity. **Challenges:** Blockchain poses technological, environmental, and organizational challenges.
10.	Allessie, Sobolewski, & Vaccari (2018).	The study's purpose is to offer insights into the economic restrictions and effects of Blockchain (BC) on the public sector by analyzing the cost and benefits of blockchain.	Qualitative	Blockchain facilitates arranging public services in a more direct and distributed manner, and it offers more advantages to the financial sector. **Benefits:** The technology helps to reduce complexities in inter-organizational information exchange. **Challenges:** Lack of focus on empirical evidence of BC projects in the public sector can be a problem in implementing blockchain.
11.	Ølnes, Ubacht, & Janssen (2017)	The study aims to determine the prospective benefits and ascertain novel roles for the government in implementing blockchain.	Qualitative	**Benefits:** Blockchain's potential benefits in the government system include transparency, corruption reduction, increased trust, reduced costs, data integrity, and higher data quality and reliability. **Challenges:** BC implementation for e-government raises issues related to experimentation, the need for standardization and flexibility, auditing

No	Author(s) & Year	Objective(s) of study	Methods used	Findings
				blockchain applications, and data stewardship and accountability.
12.	Hou (2017).	This paper's objective is to investigate the application of blockchain in e-government in Chinese context.	Qualitative	**Benefits:** Blockchain facilitates the Chinese government by strengthening credibility, promoting resource collaboration, improving government service quality, and developing the Individual Credit System. **Challenges:** The Chinese government faces several difficulties while implementing blockchain, including the high cost of establishing a new blockchain-based platform, security issues, management issues, and the long-term preservation of blockchain platform records.
13.	Warkentin & Orgeron (2020).	The focus of the study is to explore the impact of blockchain on the public sector.	Qualitative	**Benefits:** The study provides insights on the way to harness blockchain better To improve outcomes and productivity of e-government. It also highlights the opportunities for BC to transform public service delivery.
14.	Khan et al. (2022)	The study's purpose is to explore blockchain's capabilities and influence on the public sector.	Qualitative	**Benefits:** Blockchain benefits governments by reducing regulatory reporting costs and improving efficiency, data integrity, and accountability. **Challenges:** Lack of necessary infrastructure, support, expertise, privacy and security issues, and governance issues.
15.	Goldsmith et al. (2022)	The paper aims to analyze problems relevant to Blockchain-based e-governance to assess the potential	Both qualitative and quantitative	Implementing blockchain can manage issues like public healthcare, corruption, employment, taxation, fraud and document attestation, elections, and e-participation. Oman will gain several advantages from being an early mover into blockchain-based e-

No	Author(s) & Year	Objective(s) of study	Methods used	Findings
		benefits, threats, and limitations in Oman.		government solutions. **Benefits:** Transparency, corruption reduction, ease of document verification.
16.	Ølnes & Jansen (2018).	The objective of this paper is to discuss how blockchain (BCT) can be used as an infrastructure for specific areas of government.	Qualitative	Inter-organizational applications must be built and, if possible, expanded globally so that they can maximize the benefits of BCT. Many legal, organizational, and technical factors may influence the successful implementation of BCT. **Benefits:** Blockchain improves information quality, operational aspects, governance, and control and provides several economic advantages.
17.	Ølnes (2016)	The paper highlights the potential for using blockchain in public sector services.	Qualitative	The study shows that Bitcoin meets most of the core requirements for information infrastructure, which is part of blockchain. This will impact future digital innovation, and blockchain also has great potential for use in the public sector. **Benefits:** Blockchain is a cost-effective and secure ledger of information.
18.	Mezquita et al. (2022)	The study aims to focus on the benefits of applying blockchain to the assets registry process.	Qualitative	The paper reflects on the potential benefits of blockchain. It emphasizes the natural evolutions of the e-government paradigm and the challenges of implementing blockchain. **Benefits:** Access to data and the reduction of corruption through distributed storage, data security, and economic cost reduction.
19.	Hjálmarsson et al. (2018)	This study aims to evaluate the application of blockchain as a	Qualitative	**Benefits:** Blockchain facilitates secure and cost-efficient elections while guaranteeing voters' privacy. It also offers a new possibility for

No	Author(s) & Year	Objective(s) of study	Methods used	Findings
		service to implement distributed electronic voting systems.		democratic countries by ensuring timely, secure, effective, and efficient ways of election with new possibilities of transparency.
20.	Clavin et al. (2020)	The study's purpose is to review the governmental applications of blockchain, focusing on the technical perspectives.	Qualitative	Blockchain is used in different sectors, including healthcare and energy. **Challenges:** The challenges of implementing blockchain include the cost of blockchain, data quality, correctness of the security system, scalability, privacy, and timing assumptions.
21.	Alexopoulos et al. (2019)	The objective of this paper is to identify the advantages and barriers to applying blockchain in government.	Qualitative	**Benefits:** The potential advantages of governments using blockchain include quality assurance, process simplification, information sharing, data safety, transparency, flexibility, standardization, and government credibility. **Challenges:** Privacy leakage, selfish mining, legal binding, and scalability.

5. Findings

5.1 Potential Benefits of Adopting Blockchain in E-Government System

Implementation of Blockchain in government sectors streamlines the government service delivery processes, improves trust and security of data, integrity, and transparency of sensitive data, and enhances cross-agency and cross-border data sharing. Besides, blockchain reduces corruption, fraud, and the cost of performing public service transactions and storing citizen information. Implementing blockchain in government systems provides advantages to various stakeholders of e-government systems. The benefits of blockchain in government systems are classified into two broad groups based on the stakeholders of such systems. Broad stakeholders of government are classified as two- 1) citizens consisting of service users, non-government organizations, and researchers, and 2) government bodies consisting of both national and local government and their administrators, ministries, and agencies (Sæbø et al., 2011).

5.1.1 Benefits of Blockchain in E-Government for Citizens

Citizens interact with the government system for different reasons, especially as service users (Sæbø et al., 2011) and share their sensitive data with e-government systems such as health records and payment systems as a central authority and the government is responsible for protecting the privacy and security of such data. Using blockchain in government systems ensures the privacy and security of sensitive data through its cryptographic and immutability characteristics (Jun 2018; Tshering & Gao, 2020). Data, once recorded, cannot be altered and reversed, which is a key to maintaining the integrity of stored data. Therefore, governments in different countries use blockchain to reap these benefits (Abdullah & Jusoh, 2022; Alexopoulos et al., 2019). Phadke, Medrano, and Ustymenko (2022) also identified that the security and privacy of data are vital drivers of the adoption of blockchain in public sectors.

Alexopoulos et al. (2019) emphasized another benefit of blockchain, which is citizens' decentralization of data and access to data. Through blockchain, anyone can access data shared in the chain (Sullivan & Burger, 2017) and manage their profile by providing up-to-date data, which is called Self-Sovereign Identity (SSI). Through SSI, people can selectively share their data publicly, whereas the government can reduce the cost of data collection, maintenance, and tracking of data in the long run. Therefore, as identity management systems (Gervais et al., 2016; Hou, 2017), most governments are using blockchain worldwide (Sullivan & Burger, 2019; Sung & Park, 2021). Transparency and accountability of governmental services, transactions, and policies are the determinants of establishing citizens' trust in governmental actions. Blockchain enhances the accountability of service providers and government agencies, which brings corruption down and surges citizens' confidence in the government (Kassen, 2022; Rizal et al., 2019; Hou, 2017). Blockchain in the government system promotes citizen participation in the service delivery process instead of being passive service receivers. Any changes in data and transactions remain visible across the chain. Consequently, fraudulent activities, corruption, and illegal manipulations of data and transactions can be eliminated (Cai & Zhu, 2016; Atzori, 2015; Kshetri, 2017; Tapscott & Tapscott, 2016). Furthermore, blockchain is a valuable tool through which citizens can provide their feedback and take part in decision-making processes, resulting in the empowerment of citizens.

Easy access to government services and welfare programs are the two intertwined benefits of blockchain use in government activities. Through blockchain platforms in government sectors, users can interact with public services with a unique identity instead of requiring multiple identities for separate service platforms. Consequently, the public service accessibility process becomes easier for citizens. Regarding social welfare programs, the government can ensure proper distribution of such funds and reliefs as blockchain maintains the temper-proofs of transactions. Maintaining a transparent financial ecosystem is possible with the help of blockchain. People need to pay for services or receive financial benefits from governments through various intermediaries. Blockchain reduces the presence of intermediaries in this regard as it ensures peer-to-peer communications, eliminating third parties, reducing costs, and delaying transactions.

5.1.2 Benefits of Blockchain in E-Government for Government Bodies

Like citizens, service providers, agencies, and governmental bodies benefit from blockchain by certifying citizen data's integrity, privacy, and security. It provides protection against data breaches and establishes trust in the system (Abdullah & Jusoh, 2022; Alexopoulos et al., 2019). Blockchain also confirms

transparency and accountability among the agencies and ministries while improving the accountability of the service providers in delivering legitimate services and properly using public funds. People can now observe how public funds are being utilized for the development of the country. Moreover, government bodies ascertain their internal auditing and compliance with regulations and standards, as every transaction has a temper-proof record visible to others.

Simplified intergovernmental and cross-border activity is another advantage of blockchain use for government bodies. Authorities and ministries frequently work with several agencies in collaboration to provide services or address complex problems; blockchain enables frictionless data exchange and interoperability across various entities, lowering administrative costs and duplicating tasks. Additionally, the decentralized structure of blockchain minimizes the necessity of intermediaries in cross-border collaboration, simplifying global trade and promoting seamless relationships between national governments and international organizations. Blockchain maintains unique identities for citizens, enabling them to update and manage the data, leading to easy access to public services. Digital badging triggers actions automatically if predefined conditions are met, which adds value in automating service processes, reduces the need for intermediaries, saves costs, and enhances efficiency (Hou, 2017; Gervais et al., 2016; Sullivan & Burger, 2017). Low latency time and self-control process are two other benefits of using blockchain in public service delivery.

5.2 Challenges of Adopting Blockchain in E-Government System

According to the TOE framework (Tornatzky et al., 1990), the challenges of adopting blockchain in e-government systems have been grouped into three categories. They are governmental, technological organizations for e-government systems and the environment (Ølnes & Jansen, 2018; Saif et al., 2022).

5.2.1 Technological Challenges

According to Rogers (2010), technological issues are associated with technical capability, complexity, expertise, and innovative solutions. Along with a surge in transactions in the government system, blockchain faces the problem of scalability and managing vast amounts of transactions (Alexopoulos et al., 2019; Clavin et al., 2020). Due to the decentralization of transactions, blockchain performs slowly, creating problems for activities requiring real-time response. Therefore, compromised performance is another pitfall of blockchain in the e-government system. With control of 51% of computing power, hackers attack systems, breaching the security of data stored in chains. Therefore, dealing with sensitive personal data like medical records is a challenge for governments (Khan et al., 2022; Ølnes et al., 2017).

Although blockchain eases intergovernmental data sharing and collaboration, it requires using a common platform and protocols. Therefore, the lack of a common platform among governments hinders interoperability among various governments. This problem is still severe as only a few nations have blockchain-based government systems (Ølnes & Jansen, 2018; Alexopoulos et al., 2019), as there is a lack of proper governance and standards. Lack of technological knowledge among stakeholders, sufficient IT infrastructure, data storage capacity, software and hardware failures and vulnerability, lacking IT experts, and technological complications are also considered major barriers to implementing blockchain in the public sector of a nation.

5.2.2 Organizational Challenges

Organizational challenges are strongly associated with the skills and expertise of government ministries and officials, their capabilities, and the nature of existing systems. Lack of a proper change management system, absence of coordination and cooperation among existing departments, agencies, and ministries, and having well-defined protocols, standards, and regulatory frameworks are the major organizational barriers for governments in adopting blockchain in their systems (Saheb & Mamaghani, 2021; Dutta et al., 2020). Lack of openness to change and proper strategic plans, fear of losing centralized decision-making power to a decentralized system, maintaining status quo, fitting existing regulations into the new blockchain-based system, and inability and unwillingness to incur adequate upfront expenses for developing blockchain infrastructure are also considered organizational challenges.

5.2.3 Environmental Challenges

Environment implies the ecosystem (Tornatzky et al., 1990) where governments operate their activities. Therefore, the lack of standard regulatory frameworks to monitor and control the ecological effects of the Blockchain-based e-government system is the major barrier to adopting blockchain in the e-government system. Consumption of high energy by blockchain has an adverse impact on the environment which raises questions regarding its implementation in public domains (Wang & Wang, 2022; Saif, 2022). PoW-based blockchain dependency on high computational power and energy consumption degrades environmental balances and contributes to an increment in carbon footprint. Lack of coordination among the public sector, private sector, practitioners, and academicians is another environmental barrier to successfully implementing blockchain in e-government systems.

6. Conclusion, Implications, and Limitations of the Study

6.1 Conclusion

The study focuses on revealing recent trends in blockchain applications in e-government systems and assessing the benefits and challenges of adopting blockchain in-government systems. Scopus, ACM, and IEEE Xplore databases have been used to search for relevant literature to address the research objectives. Among the relevant literature, 21 papers have been chosen for further review and reporting using PRISMA flow diagrams, and VOSviewer software has been used to represent bibliometric trends and maps.

The literature review and bibliometric representation of papers show that China and India are the leaders and have a substantial focus on blockchain in the e-government system, with China as the top funding sponsor for blockchain projects. Among the authors, Ubacht published the most research papers in this area. Most of the scholarly reports have been published as conference papers. During the stated periods, 2020, 2021, and 2022 had substantial surges in research work in this respect, and this trend will continue for 2024 also. This reveals the popularity of blockchain applications in the government or public sectors. Blockchain and e-government frequently co-occur, while cyber security, privacy, public sector, digital badge, and smart contact are also associated with these terms.

Bibliometric analysis and data review show that the government and its stakeholders may benefit substantially from blockchain implementations in government systems. These benefits are segregated into benefits for citizens and benefits for the government, its agencies, ministries, and officials. Citizens

look at the benefits from service users' perspectives, while the latter is from service providers' and authorities' perspectives. Therefore, blockchain use in government reduces inefficiencies, costs, and complexities in public service delivery. Moreover, reducing fraud, high security, privacy, transparency, and authenticity are also positive outcomes of implementing blockchain in the government system. Citizen empowerment is one of the vital benefits of blockchain in the government system. In a democratic governmental system, citizen empowerment and participation in decision-making enhanced decision-making enhance citizens' trust in government and government efficiency (Marsal-Llacuna, 2020; Hughes et al., 2018; Balcerzak et al., 2022). From the government side, blockchain provides government officials with hands-on tools to automate most of the processes and enables service users to self-control the processes, improving user experience and satisfaction as interdepartmental and inter-government data sharing becomes more accessible and more effective through blockchain platforms.

This study shows that technological, organizational, and environmental challenges hinder the widespread use of blockchain in government systems. Data leakages, system failure, lack of expertise and training on technology use, lack of standard rules and regulations, and infrastructures are significant technological barriers. Most of the governments who have started using blockchain in their system face significant challenges from technological grounds (Khan et al., 2022; Hou, 2017). Organizational barriers are also noteworthy, and they lack capacity, funds, resistance to change, and inappropriate action plans, which are supported by (Alexopoulos et al., 2019; Hou, 2017; Wang & Wang, 2022; Tseng et al., 2020; Clohessy et al., 2019). These challenges are addressed mainly by incorporating cooperation among different parts of the government and through proper planning and policies of the authorities. Finally, the environmental challenges of blockchain are reported by most of the scholars (Saif et al., 2022; Hou, 2017; Wang & Wang, 2022; Tseng et al., 2020; Clohessy et al., 2019; Mohammad & Vargas, 2022). Environmental challenges usually arise due to proof of work-based consensus systems. Although some of the challenges in this category cannot be overcome, the high energy consumption problem can be solved by looking for alternative consensus methods.

6.2 Implication

From this study, governments and policymakers get an insight into recent trends in blockchain in government sectors and understand the potential benefits and barriers of implementing blockchain in public sectors. This study enriches managers with the benefits of integrating blockchain into government systems. The benefits are grouped into two categories based on the perspectives of all government system stakeholders. Ultimately, the benefits are efficiency and flexibility in service delivery systems, reduced corruption, and ease of information exchange with various internal and external parties. Nations that want to incorporate blockchain and have already incorporated blockchain into their systems could learn about potential challenges and take proactive actions to mitigate them. On the other hand, citizens and other stakeholders realize its significance from its recent trends, which allure them to enhance their knowledge and understanding of this technology. Moreover, awareness of this cutting-edge technology will reduce the resistance to adopting blockchain in the public sector among citizens, managers, policymakers, system users, etc. It will subsequently facilitate the implementation of blockchain in the public sector.

6.3 Limitations

Although this study contributes significantly to the field of blockchain and government, the outcomes are grounded on only three databases. Therefore, other databases, i.e., ProQuest, EBSCO, and JSTOR, may be incorporated for further study in this field to add more to the outcomes of this study. This study is based only on secondary data, which is another vital limitation. Primary data may improve the conclusions of the current study. Furthermore, future studies can address the adoption of blockchain in specific areas of government systems, which will add significantly to the literature on blockchain.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Citation

Rupa, R. A., & Sultana, R. (2024). Integration of blockchain in e-government system: Systematic literature review with bibliometric visualization. *Bangladesh Journal of MIS, 10*(2), 16–42. https://doi.org/10.61606/BJMIS.V10N2.A2

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