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Blockchain and Artificial Intelligence Integration in Public Sector Services: A Literature Review and Bibliometric Analysis

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Abstract: This study provides a comprehensive literature review and bibliometric analysis on the integration of blockchain and artificial intelligence (AI) within public sector services. By systematically examining academic publications and research trends, we identify key themes, influential papers, and prominent researchers contributing to this emerging field. Our analysis highlights the potential of blockchain to enhance transparency, security, and efficiency in public services, while AI offers advanced data analytics and decision-making capabilities. The co-occurrence network and thematic mapping reveal strong interconnections between blockchain, e-government, electronic voting, and AI applications. Furthermore, the global collaboration network underscores the extensive international cooperation driving innovation in this area. This study offers valuable insights into the current state of research, identifies gaps, and suggests future directions for integrating blockchain and AI to improve public sector services.

***Keywords:** Blockchain, Artificial Intelligence, Public Sector, E-Government, Bibliometric Analysis.*

1. Introduction

In recent years, there has been a growing interest in exploring the synergies between blockchain technology and artificial intelligence (AI). Despite this, the literature lacks comprehensive evaluations or extensive research on the combined role of blockchain and AI, particularly in the context of public sector services. Researchers have predominantly investigated blockchain and AI in isolation, focusing on their individual applications across various sectors and enterprises (Baltrušaitis et al., 2018; Fioretto et al., 2016; Yeow et al., 2018; Salman et al., 2018). However, only a few studies have examined the integration of AI with blockchain and the significant implications this convergence has on the ways we live, work, interact, and transact (Lopes and Alexandre, 2018).

Blockchain technology, since its inception in 2008, has been at the forefront of technological innovation, touted as one of the most transformative technologies of our time. Initially conceptualized as the underlying technology for Bitcoin, blockchain has evolved into a versatile and horizontal technology applicable across various sectors. It is revolutionizing how individuals and organizations automate payments, trace and track transactions, and ensure transparency and security in data exchanges (Ahmed and Ten Broek, 2017; Baynham-Herd, 2017).

One of blockchain's key advantages lies in its ability to eliminate the need for intermediaries in financial and data transactions. Traditionally, intermediaries are responsible for ensuring secure exchanges and are held accountable for any failures or breaches. Blockchain, with its incorruptible, irreversible, and decentralized public ledger, offers a paradigm shift by removing the necessity for central authorities among multiple parties (Luu et al., 2016). This technology inherently provides data immutability, integrity, authentication, validation, decentralization, and transparency, thereby ensuring robust security across distributed systems.

Moreover, blockchain's immutable nature and its use of public and private keys ensure the anonymity of transaction participants, adding an extra layer of security. The integration of blockchain with AI has the potential to enhance these security features while also leveraging AI's capabilities to process and analyze vast amounts of data, leading to more intelligent and automated systems.

While previous studies have explored blockchain and AI individually, as well as their applications across various sectors, they have largely done so in isolation (Baltrušaitis et al., 2018; Fioretto et al., 2016; Yeow et al., 2018; Salman et al., 2018). Few studies have delved into the integration of these two technologies and the transformative potential this convergence holds (Lopes and Alexandre, 2018). This research paper distinguishes itself by conducting a comprehensive bibliometric analysis and literature review specifically focused on the integration of blockchain and AI within public sector services. Unlike earlier works, this study systematically examines the intersection of these technologies, identifying key trends, influential publications, and potential future research directions. Additionally, by

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employing bibliometrix::biblioshiny() for the bibliometric analysis, this paper offers a robust and interactive approach to understanding the evolving landscape of blockchain and AI integration, providing new insights into how these technologies can jointly enhance public sector services.

This paper aims to bridge the gap in existing literature by providing a comprehensive bibliometric analysis and literature review on the integration of blockchain and AI in public sector services. Through this analysis, we seek to uncover current trends, key research areas, and potential future directions for the deployment of these technologies in enhancing public sector services by discussing the following three broad research questions (RQs)***: RQ1.*** What is the present status of the research on blockchain and AI integration in public sector services? ***RQ2***.What research contexts and themes in this domain have been explored in the existing literature? ***RQ3.*** What paths or themes can be addressed in future research?

2. Blockchain and AI Integration in Public Sector Services

2.1 Blockchain

Blockchain is a linked-list data structure that records transactions in a chronological sequence of blocks, forming a distributed database replicated across several nodes. This structure enables secure data transport without centralized control (Zheng et al., 2018; Kim, 2018). Each block comprises a header and a body, containing elements such as block version, parent hash, Merkle tree hash, timestamp, nBits, and Nonce, which are crucial for validation and security (Zheng et al., 2018).

Blockchain's security relies on asymmetric cryptographic algorithms, allowing users to perform transactions directly without intermediaries, using consensus methods to validate transactions peer-to-peer. There are three main types of blockchain systems: public, private, and consortium. Public blockchains are fully decentralized, private blockchains are controlled by a single organization, and consortium blockchains are semi-decentralized (Buterin, 2015).

Key features of blockchain systems include a distributed ledger, digital signatures, smart contracts, consensus mechanisms, and cryptography. The distributed ledger is a tamper-proof, cryptographically secure, and irreversible public ledger accessible to all network participants, where transactions are grouped into blocks and linked in chronological order, ensuring data integrity and reducing the risk of information loss (Bailis et al., 2018; Scriber, 2018; Puthal et al., 2018). Each user has a private key for signing transactions and a public key for verification, ensuring secure and transparent transaction broadcasting across the network (Peck & Moore, 2017). Smart contracts, which are self-executing contracts with the terms of the agreement directly written into code, facilitate automated and trustworthy transactions. Decentralized validation of transactions is achieved through consensus mechanisms, often using Proof of Work (PoW), which requires significant computational effort to solve cryptographic puzzles for transaction validation and block creation (Dinh et al., 2018; Nakamoto, 2008). Furthermore, asymmetric cryptography ensures transaction authentication, with participants validating blocks through cryptographic hashes like SHA-256. The longest chain of blocks is considered the most reliable and is used to maintain the blockchain's integrity (Gilpin, 2018).

Blockchain technology, initially prevalent in the financial sector, is now finding applications across various fields, extending beyond traditional financial and business services (Peters and Panayi, 2015). Real-world applications, such as collateralization of financial derivatives, show promise in reducing costs and risks (Morini, 2016). Blockchain has the potential to assist traditional businesses in their enterprise transformations, as seen in the case of postal operators (POs) expanding their services to include new financial and non-financial services, identity services, device control, and supply chain management (Jaag et al., 2016). Blockchain technology holds promise in developing safe and dependable peer-to-peer financial markets (Noyes, 2016b). Combining risk management frameworks with blockchain enhances performance and facilitates swift decision-making in investment and collateral selection (Pilkington, 2016).

Blockchain's applications span various domains including Internet of Things (IoT), Smart Contracts, Financial Services, E-Business, security and privacy, Public, and Social Services (Sukheja et al., 2019). The decentralized nature of blockchain networks ensures accuracy, prevents unauthorized access, and offers high reliability, trust, safety, security, and effectiveness. Blockchain transforms transaction records from closed and centralized documents to open and decentralized ones, ensuring the network's operation remains unaffected by a single node failure. This significantly enhances reliability and trust. Blockchain networks also serve as new trust bearers for decentralized documents, disseminating them through modified node networks. Additionally, blockchain employs a one-way hash function, making it difficult to reverse the process, ensuring the strict linear sequencing of newly created blocks. Moreover, blockchain technology has the potential to reduce labor costs and increase efficiency by processing all data using a predetermined set of procedures. By minimizing the number of intermediaries involved and streamlining the compromise process, blockchain accelerates the clearing and settlement of certain transactions.

Blockchain technology, despite its significant potential, faces various challenges that impede its widespread adoption. One of the critical challenges is scalability. As the blockchain grows in size, so does the list of data and transactions, necessitating additional storage capacity. To address this, strategies have been proposed, including storage optimization and redesigning blockchain (Zheng et al., 2017; Bruce, 2014; Eyal et al., 2016). Another challenge is privacy leakage, as blockchain does not ensure transactional privacy, raising concerns about user information disclosure. Various strategies, such as mixing services and solutions like Zerocash, have been proposed to enhance blockchain anonymity (Johnson et al., 2001; Möser, 2013; Sasson et al., 2014). Furthermore, selfish mining poses a threat to the blockchain network, with selfish miners exploiting their mined blocks for personal gain. Techniques have been suggested to mitigate selfish mining, such as incorporating random beacons and timestamps (Eyal and Sirer, 2014; Billah, 2015; Solat and Potop-Butucaru, 2016).

Artificial Intelligence (AI) technology is another area of significant interest and development. AI systems, which allow machines to learn, infer, and adapt based on collected data, are gaining traction. These systems range from specialized expert systems to those capable of truly intelligent decision-making processes. Emerging AI themes include explainable AI, digital twins, automated machine learning, hybrid learning models, and lean and enhanced data learning, which are expected to synergize with the benefits of blockchain technology (Salah et al., 2018). The origin of AI research dates back to the 1940s and has continued into the 2010s and beyond, with AI systems capable of independent operation, pattern recognition, learning, and logical decision-making. While the public sector has been a late adopter of AI, several governments are now embracing its potential (Boyd & Wilson, 2017).

2.2 Artificial Intelligence

Artificial intelligence (AI) is rapidly gaining interest as it allows machines to learn, infer, and adapt based on collected data. While many current AI systems are specialized expert systems making decisions from a knowledge database, researchers are advancing toward truly intelligent decision-making processes. Emerging AI themes include explainable AI, digital twins, automated machine learning, hybrid learning models, and lean and enhanced data learning, which are expected to complement the benefits of blockchain technology (Salah et al., 2018). Originating in the 1940s and extending into the 2010s and beyond, AI systems operate independently, recognizing patterns, learning, and making logical decisions without human intervention. The public sector, though a late adopter, is increasingly recognizing AI's potential and beginning to employ AI technologies across various fields (Boyd & Wilson, 2017).

Recent decades have witnessed the development of new AI methods focused on data, allowing AI to process and interpret data at increasingly faster rates, as well as perform routine and non-routine activities (Brynjolfsson & Mitchell, 2017). AI has emerged as a versatile tool for service innovation across various industries, with tailored methodologies such as machine learning (ML), artificial neural networks (ANN), genetic algorithms (GA), multi-agent systems (MAS), and natural language processing (NLP) (Stone et al., 2016).

Despite the advancements in AI methodologies, understanding the impact of AI on the workforce, organizational structures, economy, government, and society remains insufficient. The adoption and dissemination of technology take time to influence production processes, organizational performance, and present legal and cultural challenges. Ethical concerns regarding data privacy, decision-making, and potential human job displacement by autonomous machines need to be addressed (Butterworth, 2018). Although various governmental sectors in several countries have initiated AI initiatives, there's still a lack of systematic knowledge regarding the motivations, processes, outputs, and outcomes of AI applications in the public sector.

Innovative tools like AI are being employed to enhance the management of public goods and services (Liu & Kim, 2018). Liu & Kim's research, while comprehensive, identified eight types of ICTs adopted in governance domains between 2008-2017 but lacks detailed insights on their impact on governance processes, state-citizen relationships, efficiency, effectiveness, and citizen satisfaction. Governments allocate their activities and expenditures towards socioeconomic objectives using the Classification of Functions of Government (COFOG), providing insight into which parts of the public sector AI solutions are being implemented or researched (IMF, 2001; OECD, 2011).

2.3 Integration of Blockchain with AI in Public Services

AI and blockchain technologies are gaining traction at an incredible rate. Both technologies have varying degrees of technological complexity as well as multi-faceted business ramifications. Blockchain technology has the ability to automate bitcoin payments and give decentralized, secure, and trusted access to a shared ledger of data, transactions, and records. Blockchain also offers the power to control interactions among members without the use of an intermediary or a trusted third party, thanks to smart contracts. However, a popular misconception regarding the blockchain concept in general is that "a blockchain is decentralized, hence no one controls it." The creation of a blockchain system, however, is still assigned to a group of core developers. As an example, a smart contract is a collection of codes (or functions) and data (or states) that are developed and published on a blockchain (say, Ethereum) by various human programmers. As a result, it is less likely to be free of defects and loopholes.

AI, on the other hand, provides intelligence and decision-making capabilities to computers that are human-like. We to emphasize that the blockchain implementation can be assisted or enhanced via various AI techniques. The alliance of AI and blockchain is expected to create numerous possibilities. Furthermore, AI might profit from the abundance of blockchain platforms for executing machine learning algorithms and tracing data saved on decentralized P2P storage systems. These data are often generated by smart linked products, which can include IoT devices, swarm robots, smart cities, buildings, and automobiles, among other sources. Off-chain machine learning analytics and intelligent decision making, as well as data visualization, can all benefit from cloud features and services.

Some of the key benefits of using blockchain for AI can be summarized as indicated in Table 2.3 (Panarello et al., 2018; Salah et al., 2018).

Table 1: Key features and benefits of Blockchain integration with AI

Benefits	Description	References
Data Integrity and Trust	Blockchain ensures data integrity and trust by providing a tamper-proof and transparent ledger, enhancing the reliability of AI-generated insights.	(Li et al., 2018; Haghighatdoost et al., 2020)
Decentralized Data Marketplaces	Blockchain facilitates decentralized data marketplaces, enabling secure and transparent transactions between AI developers and data providers.	(Kuo et al., 2019; Maesa & Lucherini, 2021)
Immutable Data Records	The immutability of blockchain ensures that AI-generated data records cannot be altered or manipulated, enhancing the credibility of AI models.	(Zhang et al., 2020; Gipp et al., 2021)
Enhanced Data Privacy and Security	Utilizing blockchain for AI enhances data privacy and security through encrypted and decentralized data storage and transmission mechanisms.	(Dai et al., 2019; Kim et al., 2021)
Transparent and Auditable AI Processes	Blockchain provides transparency and auditability to AI processes, enabling stakeholders to track and verify the origin and usage of AI-generated data.	(Valladares-Rendón et al., 2018; Suryanto et al., 2020)
Incentivized Data Sharing	Blockchain-based incentive mechanisms encourage data sharing among participants, fostering collaborative AI development while preserving data ownership.	(Hu et al., 2019; Chakraborty et al., 2021)
Improved Model Training and Validation	Blockchain enables secure and auditable model training and validation processes, ensuring the integrity and reproducibility of AI model development.	(Dinh et al., 2018; Tomašev et al., 2020)

Literature provides that we can use AI to assist us in implementing blockchain technology. As a result, the elements depicted in table (2) serve for combining AI with blockchain.

Table 2:AI and Blockchain Working Together

Ways	Description	References
Smart Contract Development	Utilize AI to automate smart contract development by analyzing legal and business documents to translate clauses into smart contract codes.	(Bailis et al., 2017; Boettiger & Deterding, 2018)
Security Enhancement	Employ AI algorithms to monitor blockchain networks for anomalies and potential threats, enhancing real-time threat detection and response.	(Salah et al., 2019; Zhang et al., 2019)
Data Validation and Consensus Mechanisms	AI can validate and verify data within the blockchain network, improving consensus mechanisms for accurate and valid	(Mikhaylov et al., 2018; Li et al., 2020)

	transactions.	
Optimizing Blockchain Performance	Use AI-based predictive analytics to optimize blockchain performance by analyzing network traffic and adjusting parameters for scalability.	(Baltrusaitis et al., 2018; Meng et al., 2021)
Identity Verification and Authentication	Integrate AI-powered biometric authentication systems with blockchain technology to enhance identity verification and authentication processes.	(Zheng et al., 2017; Zhang et al., 2020)
Data Privacy and Confidentiality	Leverage AI for advanced encryption and privacy-preserving algorithms to ensure the security and confidentiality of sensitive data in blockchain.	(Salman et al., 2018; Li et al., 2019)
Regulatory Compliance and Governance	Utilize AI-driven compliance solutions to monitor regulatory changes, identify compliance risks, and ensure adherence to relevant regulations.	(Bettoni et al., 2021; Piantadosi et al., 2022)

Governments are increasingly delivering public services through multiple channels to enhance value creation. As citizens demand greater efficiency and personalization, governments worldwide continue to invest in new technologies across sectors such as education, healthcare, and policing. These services aim to be both cost-effective and high-quality, which is crucial for achieving desired outcomes. Within the e-government framework, researchers have classified public values into three categories: duty-oriented (e.g., citizen responsibility), service-oriented (e.g., effectiveness), and social-oriented (justice). Additionally, four value positions for e-government are identified: professionalism, efficiency, service, and engagement. Other researchers have outlined three dimensions of public value: enhanced public services, improved administration, and improved social value, further dividing them into six forms based on these categories (Wang et al., 2021).

Although research on AI and blockchain in the public sector is limited, these technologies offer potential benefits such as increased efficiency, faster service delivery, and more informed decision-making. However, numerous barriers to adoption and implementation exist. For instance, AI systems can inadvertently introduce bias, reinforce past discrimination, favor specific political stances, or perpetuate undesirable practices. Key applications of AI in government include general public service, economic affairs, and environmental protection. More research is needed, particularly on value creation in the public sector (lnes & Jansen, 2018).

Blockchain, though still an emerging technology, shows promise for digital ID management, secure record-keeping, and document handling, all of which are crucial governmental functions. Blockchain can provide a secure, verifiable record of every transaction, whether financial or procedural, such as recording and time-stamping public documents. This capability has the potential to enhance secure document management in the public sector.

The integration of AI and blockchain technologies in the public sector holds significant promise but also faces numerous challenges. These challenges span various dimensions, including privacy, scalability, security, vulnerabilities in smart contracts, emerging consensus protocols, fog computing, governance, and expertise. Below, we summarize the key obstacles identified by various researchers.

Table 3: Challenges of integrating AI and Blockchain

Challenge	Description	References
Privacy	Private blockchain systems restrict access and exposure to large datasets needed by AI for accurate decision-making and analytics.	Wirtz et al., 2018; Zheng et al., 2020
Side Chains and Scalability	Blockchain networks struggle with scalability. For instance, Bitcoin handles 4 transactions per second, and Ethereum handles 12, which is far below the millions processed by platforms like Facebook.	Nguyen et al., 2020; Conti et al., 2019
Security	Security concerns include information security and preventing AI from learning harmful behaviors. AI technology must be resistant to manipulation, and misuse of blockchain's decentralized power must be mitigated.	Singh et al., 2020; Xie et al., 2019
Vulnerabilities in Smart Contracts	Ensuring smart contracts are free of defects and vulnerabilities is critical. AI-based decision-making algorithms in smart contracts must be secure against attacks, as their execution can be random and unpredictable.	Wirtz et al., 2018; Atzei et al., 2017
Emerging Consensus	Research is needed to develop application-level consensus protocols based	Liang et al., 2020;

Protocols for AI	on the quality of learning models, search algorithms, data quality, and optimization.	Shrestha et al., 2020
Fog Computing Paradigm	Fog computing allows localized computation and storage near data sources. Future fog nodes need AI, machine learning capabilities, and a blockchain interface for localized data management, access, and control.	Mukherjee et al., 2020; Gupta et al., 2020
Governance	Deploying and managing a blockchain platform with multiple stakeholders is complex and time-consuming. Issues arise even with private or consortium blockchains regarding the type of blockchain to use.	Ølnes et al., 2020; Alketbi et al., 2018
Expertise and Specialization	There is a growing demand for AI specialists and experts, but a shortage of qualified individuals hinders AI deployment and development. This poses a significant obstacle for implementing AI in the public sector.	Dwivedi et al., 2021; Gagné, 2018

Implementing blockchain and AI in the public sector requires a strategic approach to leverage the significant opportunities these technologies offer. Despite various global initiatives by government organizations to develop and apply blockchain and AI, the public sector faces challenges in implementation. Scholars have proposed several frameworks and models to support the adoption and deployment of these technologies, assessing the digital maturity of organizations and providing guidelines for effective integration. This summary reviews and evaluates these models to highlight their strengths, weaknesses, and practical implications.

Table 4: Frameworks and Models for Blockchain and AI Adoption in the Public Sector

Framework/Model	Description	Strengths	Weaknesses	Citations
Capability Maturity Model Index (CMMI)	A model to classify e-government maturity, ranging from ad hoc (low) to structured (high). It links higher maturity levels with achieving efficiency-related goals under diagnostic control.	Standardizes processes to achieve efficiency, widely recognized and used in e-government.	May not address all aspects of digital transformation, focuses mainly on process standardization.	Gerald, 2017
AI Readiness Model for SMEs	A model for SMEs to self-assess their AI maturity level, focusing on five pillars: Digital and smart factory, Data strategy, Human resources, Organizational structure, and Organization's culture.	Provides a structured approach for SMEs to evaluate AI readiness, based on literature review and interviews.	Limited sample size (only two interviews), lacks depth and clarity in pillar definitions, external validation needed.	Bettoni et al., 2021
AI-Readiness Framework	Assesses an organization's ability to deploy AI technologies, focusing on technologies, activities, boundaries, and goals. Provides a score range (0-4) to visualize AI readiness.	Helps organizations identify skills and capabilities required for digital transformation, applied in workshop settings.	Lacks empirical validation, unclear how dimensions interact and influence each other.	Holmstrom, 2022
Blockchain Readiness Assessment Framework	Assesses the regulatory readiness of organizations to deploy blockchain in the healthcare sector. Focuses on motivational, structural, engagement, and technological readiness.	Considers key stakeholders and regulatory issues, adaptable to various sectors, based on literature review.	No empirical validation, unclear mechanisms for selecting key dimensions and stakeholders, lacks customization suggestions for other sectors.	Sanda, Pavlidis, Polatidis, 2022

3. Bibliometric Analyses

Bibliometric analysis, initially introduced by Pritchard (1969), has emerged as a robust scientific method for comprehensively understanding the temporal evolution of research fields from a multi-disciplinary perspective. This technique aids in mapping the boundaries of a research area, identifying influential authors, and indicating new directions for future investigations. Scholars have employed bibliometric analysis across various domains, including manufacturing, arts-based management, marketing, social media, finance, and technology and innovation. The choice of bibliometric techniques is driven by its ability to establish the intellectual structure of a field without subjective bias. It serves as a cross-disciplinary method, effectively mapping the directions and themes addressed during the development of a research field (Moral-Muñoz et al., 2020). Therefore, our study focuses on understanding how research oriented toward understanding the application of blockchain and artificial intelligence integration in public sector services has evolved since the origin of this technology.\

In this study, we employ the bibliometrix package in R, specifically biblioshiny, to conduct a comprehensive bibliometric analysis of the research landscape in the field of Blockchain and AI. By leveraging this powerful tool, we aim to explore the intellectual structure, evolution, and impact of research in this rapidly evolving domain. Biblioshiny provides a wide range of analyses that enable us to gain insights into the structure, dynamics, and impact of the research field. With biblioshiny, we can perform analyses such as bibliographic coupling, co-occurrence, co-authorship, citation, and co-citation analyses. Additionally, we can conduct keyword analysis, mapping, and visualization, temporal analysis, performance analysis, comparison, and benchmarking, clustering and classification, as well as content analysis (Ab Rashid, 2023). Through these analyses, we aim to uncover emerging trends, identify key research topics, and understand the collaborative networks and impact of researchers and institutions in the field of Blockchain and AI. This study contributes to a deeper understanding of the current state and future directions of research in this interdisciplinary area.

4. Method

The focus of this study is to review the literature of blockchain and artificial intelligence integration in public sector services, and perform a bibliometric analysis. Following a methodological approach similar to that of Khanra et al. (2021, 2020), and Ferreira (2018), this study has scanned, analyzed, and curated articles exploring the field of blockchain application in the aforementioned domains to compile an appropriate dataset.

4.1 Database Building

To achieve the objectives of this study, we adopted a two-step approach for identifying and reviewing the articles. In the first step, we defined appropriate search terms to mine the Scopus database for relevant articles. Scopus was selected due to its comprehensive coverage of peer-reviewed research in reputable journals and its widespread use within the academic community (Caviggioli and Ughetto, 2019; Donthu et al., 2020; Fahimnia et al., 2015). In the second step, specific criteria (Query) were applied to determine the inclusion of articles in our database for the bibliometric analysis and literature review of timespan (2015-2024). The used keywords for searching Scopus database was based in the following:

Query:

(TITLE-ABS-KEY
(blockchain AND artificial AND intelligence AND publi
c AND sector) OR TITLE-ABS-KEY
(blockchain AND artificial AND intelligence AND publi
c AND services) OR TITLE-ABS-KEY
(blockchain AND artificial AND intelligence AND egove
rnments) OR TITLE-ABS-
KEY(integration AND blockchain AND artificial AND i
ntelligence AND public AND sector) OR TITLE-ABS-
KEY (blockchain AND e-government) OR TITLE-ABS-
KEY (blockchain AND e-voting) OR TITLE-ABS-KEY
(artificial AND intelligence AND e-government)) AND
PUBYEAR > 2008 AND PUBYEAR < 2025

Total of 1,415 documents published (2009-2024), with different types, were retrieved once running the above search query as shown in Figure1.

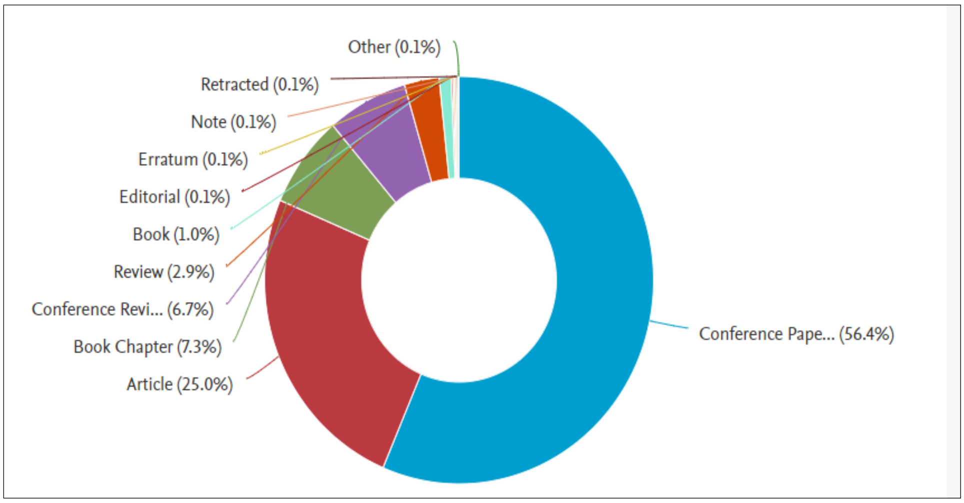

Fig 1. Percentage of Document Types

4.2 Initial Database Statistics

The bibliometric analysis conducted through biblioshiny in R provides a comprehensive overview of scholarly publications spanning from 2009 to 2024. Figure 2 shows basic statistics for retrieved documents.

Fig 2 Initial Database Statistics

The analysis encompasses a total of 1415 documents authored by 3691 individuals, with an average of approximately 3.15 co-authors per document. Among these, 125 documents were single-authored, showcasing a significant collaborative trend in scholarly research. The dataset comprises a diverse range of sources, with 719 unique publications identified. International collaboration is evident, with approximately 17.6% of the documents involving co-authors from different countries. The average age of the documents is 3.62 years, indicating a relatively mature body of work. The annual growth rate of these publications stands at 9.68%, suggesting a steady increase in scholarly output over time. On average, each document receives 10.96 citations, underscoring the impact and relevance of the research within the scholarly community. These statistics collectively offer valuable insights into the dynamics and trends within the analyzed scholarly domain.

The annual scientific production was analyzed to figure out the importance of the research topics. Figure 3 shows the annual publication for the timespan (2009-2024).

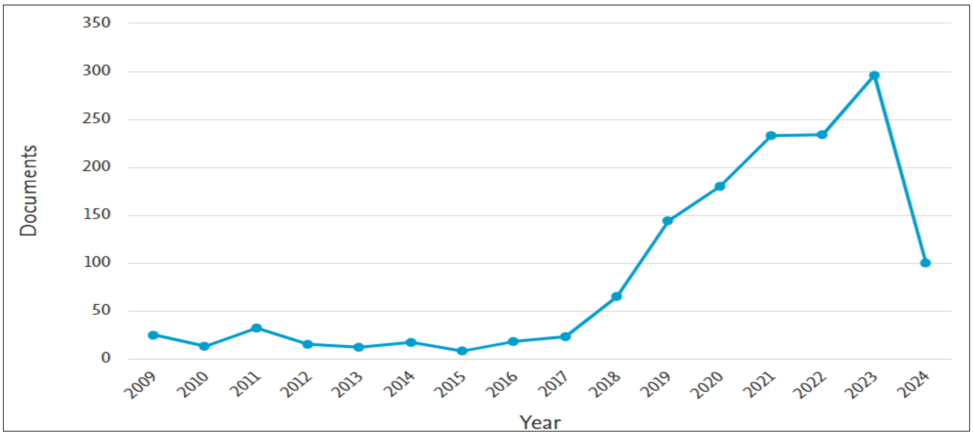

Fig 3. Annual Scientific Production

Scopus analyzer provides basic statistics about the published paper including the subject in which the research conducted. In this study, the blockchain and artificial intelligence integration in public sector services serves in various subjects as shown in figure 4.

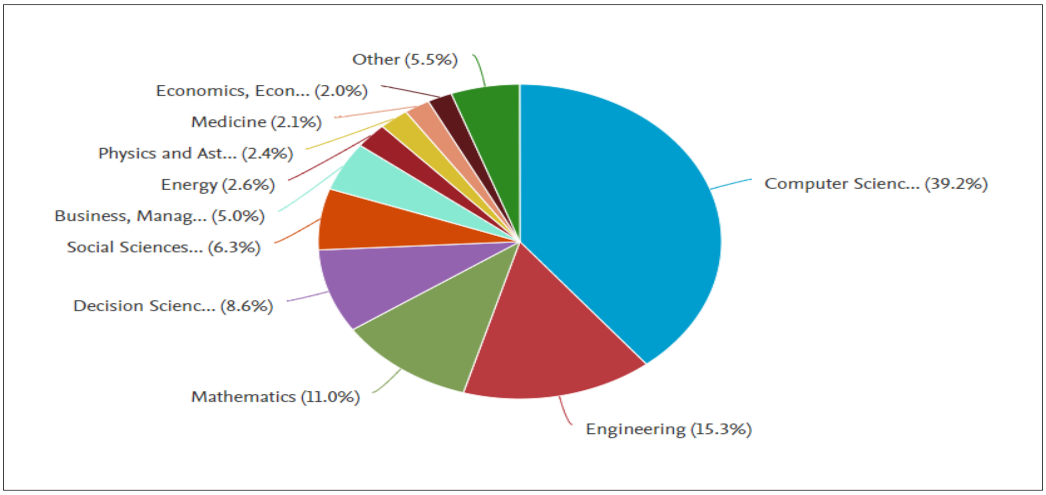

Figure 4. Documents by subject area

Figure 5 shows the published documents related to the blockchain and artificial intelligence integration in public sector services by source during the timespan (2009-2024).

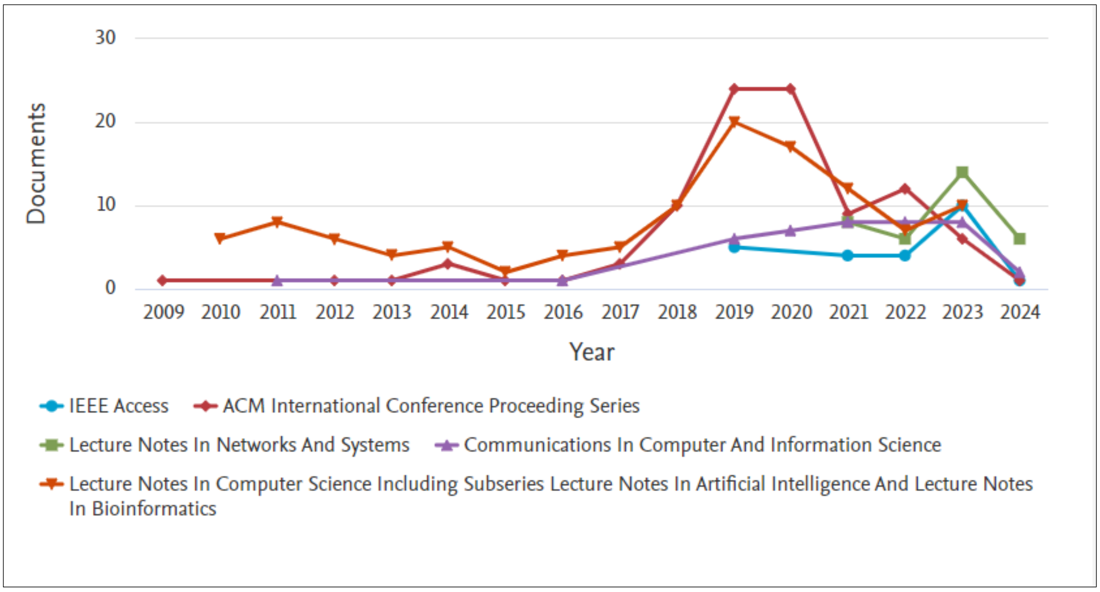

Fig 5. Documents per source per year

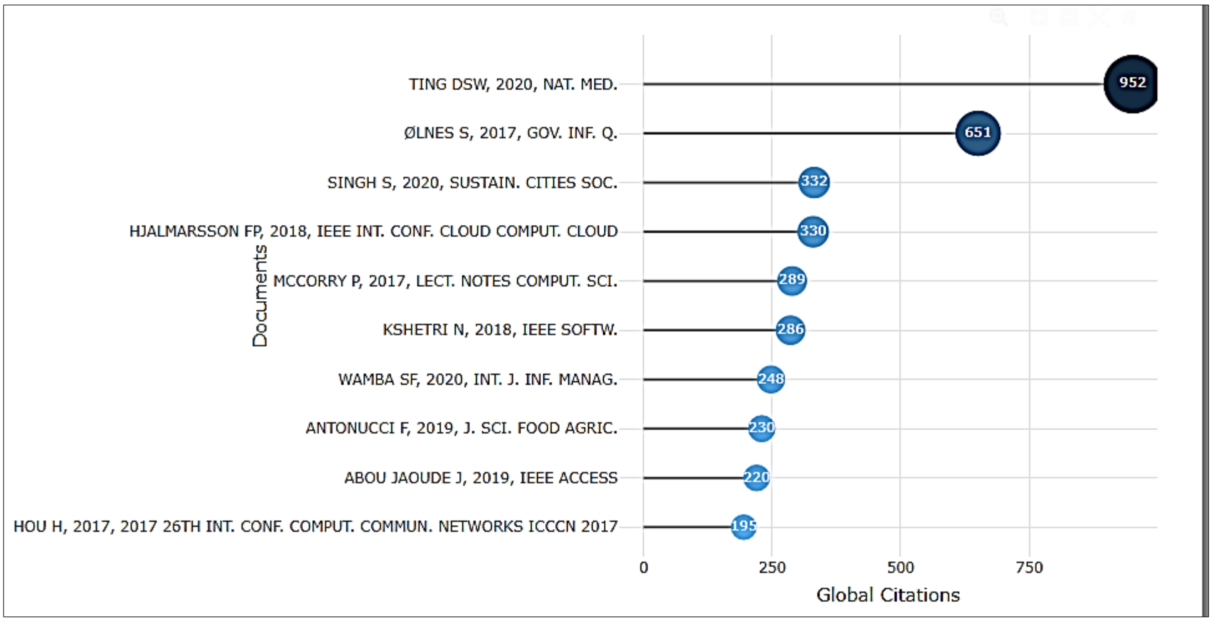

Fig 6. Most Global Cited Documents

In figure 6, the provided publications showcase a spectrum of citation metrics that reflect different aspects of scholarly impact and interest. The highest-cited papers demonstrate substantial impact and ongoing relevance, aligning with the deep exploration of emerging technologies like blockchain and artificial intelligence (AI) within public sector services. These papers likely contribute foundational insights or innovative approaches that resonate across academic and practical domains. Conversely, publications with lower citation metrics may underscore specific niche topics or emerging areas within the broader theme of blockchain-AI integration in public services, highlighting evolving trends and potential areas for further exploration. Overall, these citation insights provide a nuanced view of the landscape your paper aims to analyze, emphasizing both established knowledge and emerging research trajectories in this rapidly evolving field.

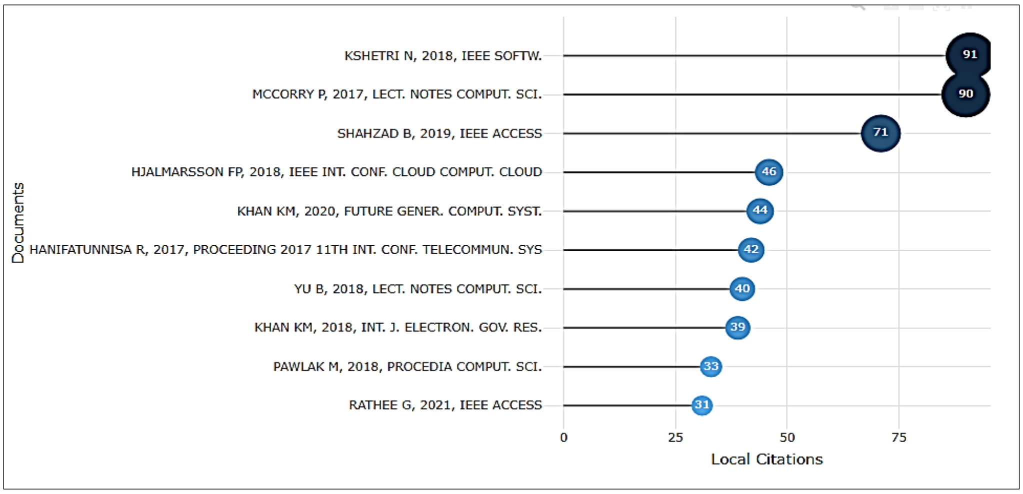

Fig 7. Most Local Cited Documents

Figure 7. shows the locally cited documents identified, which reflect varying levels of impact and recognition within their respective fields of research. Leading the list is research by KSHETRI N and MCCORRY P, both of which have garnered substantial local citations, indicating their significant influence and relevance. These papers, alongside contributions from SHAHZAD B and KHAN KM, underscore the growing interest and depth of scholarship in integrating blockchain and artificial intelligence (AI) in public sector services. Despite differences in global citation counts and LC/GC ratios, each document contributes uniquely to the discourse, highlighting emerging trends, innovative approaches, and critical insights that shape current understanding and future directions in this evolving interdisciplinary domain. Their local citations signify strong community recognition and engagement, crucial for advancing theoretical frameworks and practical applications in public service innovation.

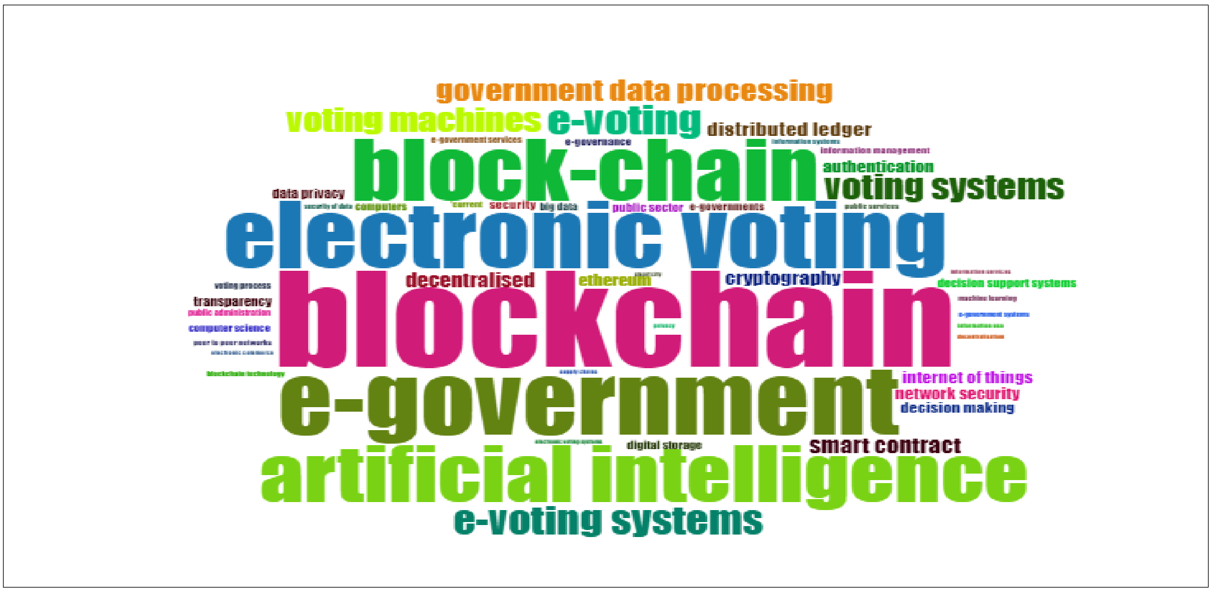

Fig 8. Keywords Count

The word frequency analysis highlights key terms central to the study of blockchain and artificial intelligence integration in public sector services. Prominent terms include "blockchain," emphasizing its foundational role in digital transformation efforts. "E-government" and "electronic voting" underscore the focus on enhancing governmental processes through digitalization and secure voting systems. Terms like "artificial intelligence" and "government data processing" reflect the growing synergy between advanced technologies and public service innovation. This analysis underscores the critical intersections shaping discussions and research in leveraging technology for effective governance and service delivery.

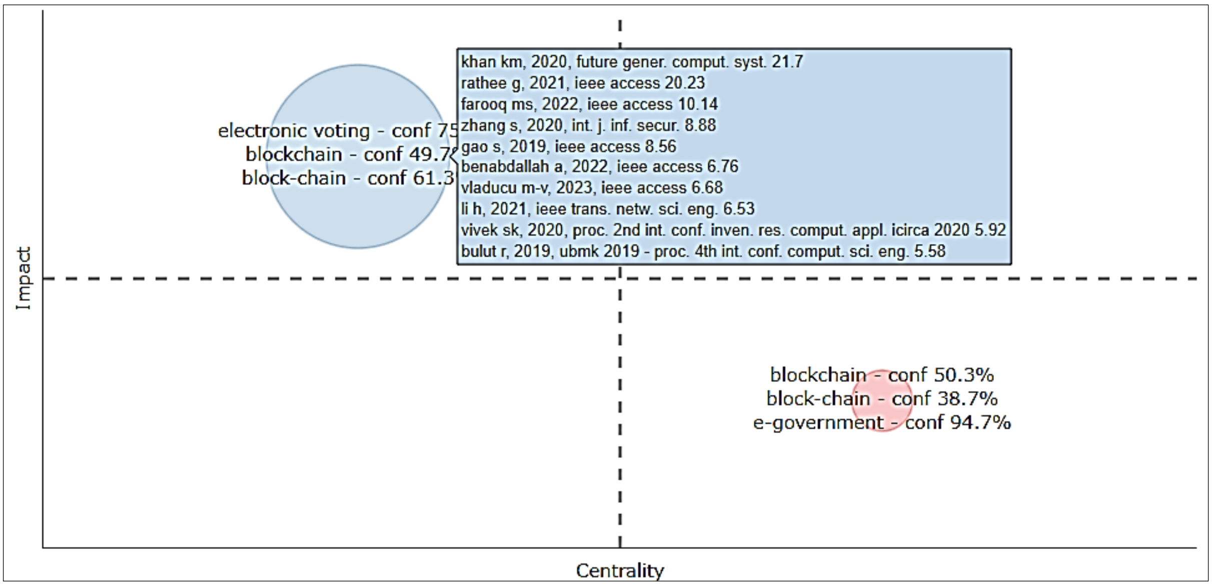

Fig 9. Clustering Analysis by Coupling

Based on the clustering analysis by coupling and the provided normalized local citation scores, the documents are grouped into a single cluster (Cluster 1). This cluster is characterized by a range of normalized local citation scores, reflecting varying degrees of impact and citation within their respective fields of study related to blockchain and artificial intelligence integration in public sector services.

The document by MCCORRY P, published in 2017, stands out with the highest normalized local citation score of 11.76, indicating significant recognition within its research context. Following closely are documents by YANG Y, LI M, GAO Y, and others, each contributing to the cluster's cohesion in terms of scholarly impact and relevance.

This clustering suggests that these documents share common themes or research interests, potentially focusing on similar aspects of technological integration, security, and computational systems within the public sector. The cluster analysis provides a structured view of the interconnectedness and collaborative potential among these works, highlighting their collective influence on advancing knowledge in this specialized area of study.

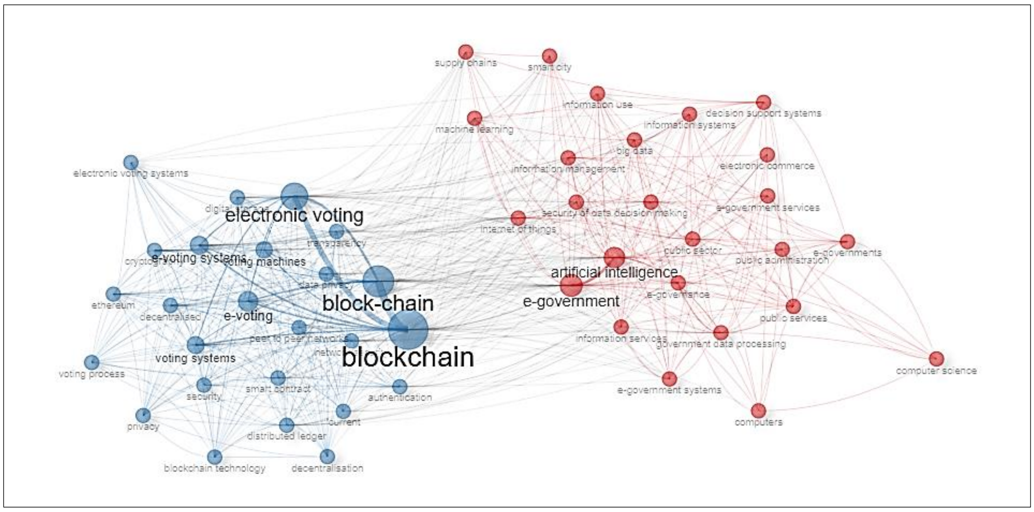

Fig 10. Co-Occurrence Network Analysis

Based on the co-occurrence network analysis of terms related to blockchain and artificial intelligence integration in public sector services, the following insights can be derived from the data provided:

1. **e-government**: This term has the highest betweenness centrality (94.984), indicating it serves as a critical connector or bridge between other terms within the network. It also has a relatively high PageRank (0.054), suggesting it is highly influential and frequently referenced in the context of blockchain and AI integration in public sector services.

2. **artificial intelligence**: Similarly, artificial intelligence exhibits significant betweenness centrality (70.337) and PageRank (0.051), highlighting its pivotal role and widespread discussion in relation to e-government and other related concepts.

3. **government data processing**: While less central compared to e-government and artificial intelligence, government data processing still maintains a moderate betweenness centrality (8.059) and PageRank (0.025), indicating its relevance and connection within the network.

4. **internet of things**, **decision making**, **decision support systems**, **public sector**, **e-governments**, **computers**, and **e-governance**: These terms also contribute to the network, each with varying levels of betweenness centrality, closeness centrality, and PageRank. They collectively represent interconnected themes and technologies within the broader context of digital transformation and governance.

Overall, the co-occurrence network analysis reveals how these terms interact and are discussed in scholarly literature, highlighting their interdependencies and thematic cohesion in the discourse on blockchain and artificial intelligence integration in enhancing public sector services.

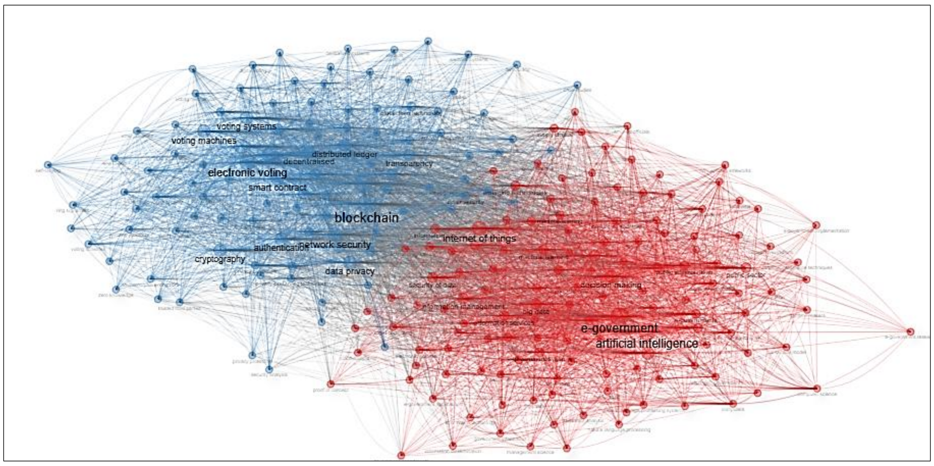

Fig 11. Thematic Network

Based on the thematic network data provided, which includes occurrences, words, cluster assignments, and centrality measures, it appears that all terms are clustered under Cluster 1 labeled as "e-government". Here are some observations based on the data:

1. **Occurrences**: The term "e-government" appears most frequently with 373 occurrences, indicating its prominence and central role in the thematic map.

2. **Cluster and Cluster_Label**: All terms, including "artificial intelligence", "government data processing", "internet of things", "decision making", "decision support systems", "public sector", "e-governments", "computers", and "e-governance", are grouped under Cluster 1, which is labeled as "e-government". This suggests a strong thematic coherence around the concept of e-government within the analyzed documents.

3. **Centrality Measures**:

○ **Betweenness Centrality**: This measures the extent to which a term acts as a bridge connecting other terms in the thematic network. Terms like "government data processing" and "decision making" show relatively high betweenness centrality, indicating their role as important connectors within the thematic map.

○ **Closeness Centrality**: This metric measures how quickly a term can interact with other terms in the network. While all terms have very low closeness centrality (0.002), indicating they are relatively distant from each other in terms of direct connections, they are all tightly clustered under the overarching theme of e-government.

○ **PageRank Centrality**: This metric reflects the influence or importance of a term based on the number and quality of its connections. "e-government" and "artificial intelligence" have the highest PageRank centrality, suggesting they are highly influential and frequently referenced within the thematic context.

In summary, the thematic map illustrates a focused discussion around e-government as the central theme, with related concepts like artificial intelligence, government data processing, and others contributing to a coherent discourse on digital governance and technological integration in public sector services.

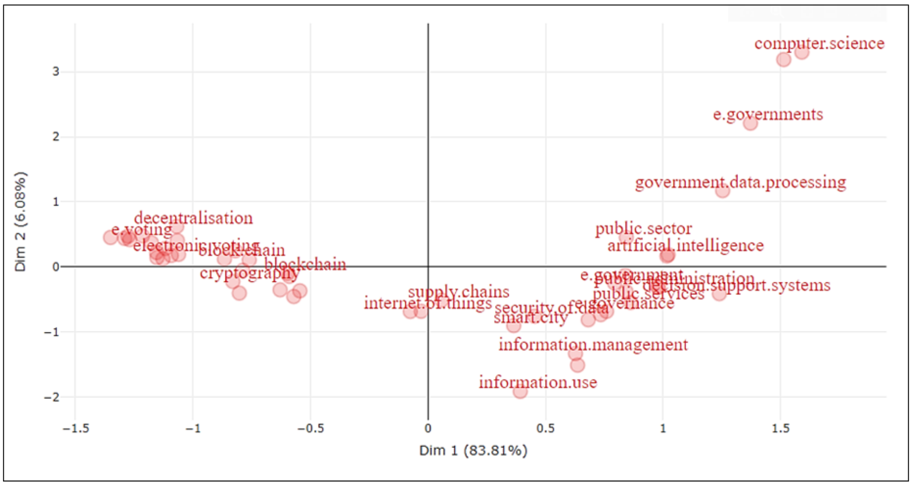

Fig 12. Factorial Analysis Of The Word Map

Based on the factorial analysis of the word map provided, the words are positioned in a two-dimensional space (Dim1 and Dim2) based on their relationships and clustering. Here's an interpretation based on the data:

1. **Cluster 1 Interpretation**:

○ **Blockchain**: Positioned negatively on Dim1, suggesting it shares less correlation with other terms in the cluster.

○ **E-government**: Strongly positively correlated with Dim1, indicating it is central and closely associated with other terms in the cluster.

○ **Electronic voting, Block-chain, Artificial intelligence, E-voting, E-voting systems, voting systems, voting machines**: These terms are positioned negatively on Dim1 and show moderate correlations within the cluster.

○ **Government data processing**: Positioned positively on Dim1 and strongly positively on Dim2, indicating it is highly correlated and possibly a central theme within the cluster.

This factorial analysis suggests that the cluster (Cluster 1) predominantly revolves around topics related to e-government, electronic voting systems, blockchain, and artificial intelligence. "Government data processing" emerges as a significant theme within this cluster, possibly indicating its pivotal role in the context of digital governance and technological integration in public sector services.

The positioning of terms along Dim1 and Dim2 reflects their relative importance and associations within the analyzed documents, providing a structured view of thematic cohesion and interrelationships in the factorial space.

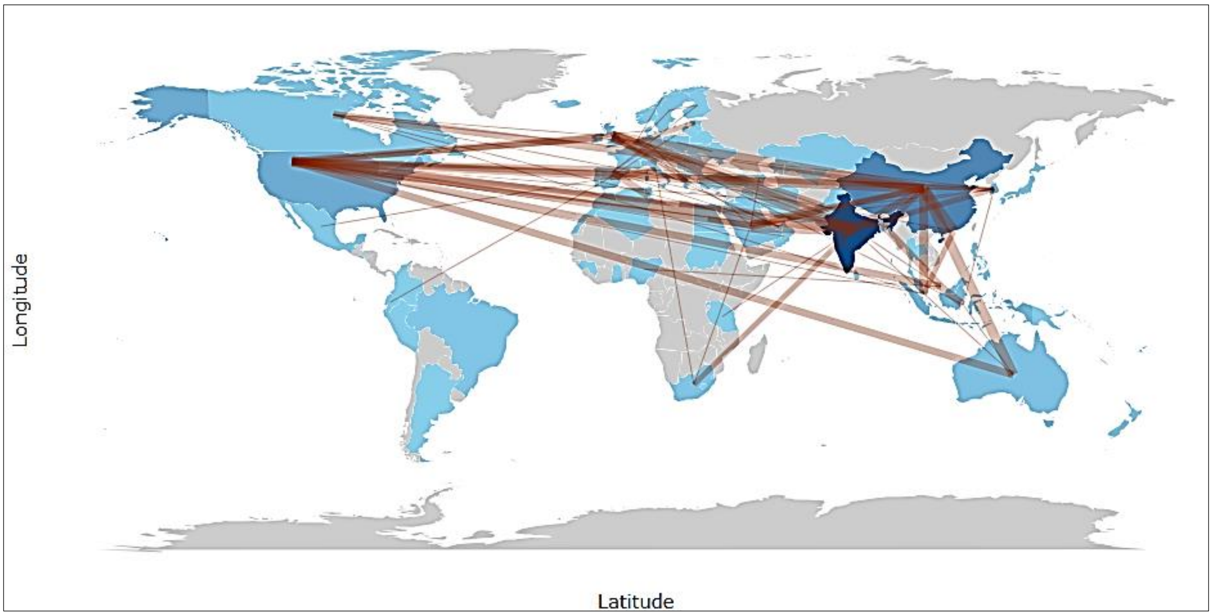

Fig 13. Collaboration World Map

This collaboration world map highlights diverse international partnerships across various countries, showcasing a range of bilateral collaborations from Australia to the United States. Each pair signifies a unique connection in academic, scientific, or economic domains, reflecting global networking efforts across continents and regions.

5. Conclusion

This study has explored the integration of blockchain and artificial intelligence (AI) in public sector services through a detailed literature review and bibliometric analysis. The findings underscore the transformative potential of these technologies in enhancing transparency, security, efficiency, and decision-making in public sector operations. Key themes such as e-government, electronic voting, and data analytics emerged as significant areas of research focus. The analysis also revealed strong international collaboration, indicating a global interest in leveraging blockchain and AI to innovate public services.

However, despite the promising prospects, the integration of these technologies is still in its nascent stages. Challenges such as technical complexities, regulatory hurdles, and the need for robust infrastructure must be addressed to fully realize their benefits. Future research should focus on developing scalable solutions, establishing standardized frameworks, and exploring the socio-economic impacts of these technologies on public administration.

Overall, this study provides valuable insights into current research trends, identifies critical gaps, and sets the stage for future explorations into the synergistic potential of blockchain and AI in the public sector. By continuing to advance this field, we can pave the way for more transparent, efficient, and intelligent public services, ultimately benefiting society as a whole.

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