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The Potential Use of Blockchain Technology in Public Service: A Systematic Literature Review

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Abstract: Blockchain is considered a technological trend with a unique and unprecedented foundation of ways of working, and has the potential to fundamentally change society in conducting activities related to the public or private sector. Although the academic literature on blockchain is generally focused on cryptocurrencies, in recent years, literature with different perspectives has begun to emerge regarding the use of blockchain in the context of the public sector. The unique characteristics of how blockchain technology works make it an innovation that is expected to change many activities, structures, and processes related to the implementation of public sector activities, especially in public services such as administrative processes, welfare provision, and regulatory practices. This article discusses through a systematic literature review about the potential use of blockchain in public services. This literature review identifies the types of public services most likely affected by the introduction of blockchain. In addition, this article highlights the benefits, potentials, and challenges and risks of blockchain for governments and citizens/society in general. Governments, in general, can optimize efficiency and tracking through the use of blockchain, but regulatory uncertainty and scalability capabilities being major challenges,   which are still poorly researched in the literature, can benefit from reduced bureaucracy and improved coordination through blockchain adoption, despite the lack of blockchain knowledge and skills being significant barriers to its implementation. For citizens or the public, security and transparency are key benefits, while the main risk lies in data security concerns. The article closes by noting a number of limitations in the existing literature and providing suggestions and recommendations for future research.

Keywords: blockchain; public service; governance approach; technology

1. Introduction

Public services are the main focus in the era of digital transformation, increasing efficiency and effectiveness is a priority. In this context, blockchain technology is emerging as an innovative solution that has the potential to profoundly change the paradigm of public service delivery. More than just a foundation for *cryptocurrencies*, blockchain offers revolutionary potential in the way we conduct transactions and the process of delivering modern public services. The high level of security and transparency offered by blockchain makes it a highly effective tool in solving public service delivery challenges, ensuring that the process not only becomes more efficient but also more adaptive to the changing needs of society.

Blockchain is considered a breakthrough in the foundation of the latest technology   because it is one   of the technological innovations that is considered to have disruptive consequences for certain groups and economic systems in the form of digital applications in the future. This blockchain technology is considered disruptive because it is claimed that after the use of blockchain-based systems in some simple applications in the economic field, blockchain continues to grow rapidly, eventually replacing the previous technology, and producing fundamental changes in many ways and processes. Of course, the initial goal was to reduce costs and improve performance significantly. Therefore, a thorough understanding of how blockchain should be optimized to benefit(Christensen et al., 2006; Lee et al., 2020) and not   radically disrupt the interests of many parties   is essential in the adoption process.

This technology offers a high level of security and transparency, so it has the potential to overcome challenges in the delivery of fast, reliable, and reliable public services. As a concrete

representation of Distributed *Ledger* Technology (DLT   ), blockchain uses DLT to store cryptographically secured information among a group of users through predefined network rules. This is done in the absence of control from a single entity or centralized authority. In other words, blockchain allows information to be stored and accessed in a secure and open way, without any one party with a specific authority being able to control everything (Berryhill et al., n.d.).

Blockchain is considered a potential asset for governments to keep up with future technological trends, with claims that blockchain technology will undergo transformation in many of its systems in the process of delivering and distributing public services. However, expectations of the positive impact of innovative technologies may result in overly optimistic implementation and judgments that may not be objective. Thus, anticipatory and preventive measures are needed in managing expectations for the potential changes brought by blockchain in the delivery of public services (Radziwill, 2018; Atzori, 2017; Ølnes, 2016)).

Search results using the Scopus scientific database found that at the end of 2019, about two-thirds (61.2%) of the total publications discussing blockchain were actually more focused on its relation to cryptocurrencies, especially Bitcoin. However, in recent times, there has emerged a number of studies on how blockchain can be utilized for the public sector. This literature is also expected to be one of the understandings of how to optimize the potential use of blockchain in the delivery of modern public services. Today, this understanding is still fragmented and comes from various fields of science, linking between Science and Social Sciences. As of now, there has not been a thorough review of the benefits, costs, and risks of blockchain in public services that combines all insights from different disciplines. This article aims to fill this gap through (Cagigas et al., 2021) *systematic literature review*.

However, along with the development of discussions about blockchain, there has been an increase in the number of blockchain projects/programs and applications that have begun to enter the early development stage and are initiated by governments and public administration institutions in many countries. Such projects and applications have the main objective of increasing efficiency in transactions, transparency, and accountability in bureaucratic processes. There are three main uses of blockchain in public services. First, the establishment of blockchain-based international public infrastructure aims to improve coordination and information sharing between governments, businesses, and citizens of different countries. An example is the European Blockchain Service Infrastructure (EBSI) being developed by the European Union. EBSI aims to create a publicly licensed blockchain infrastructure for services such as sovereign digital identity, notarization, diplomas, and trusted data sharing. Second, there are further development efforts in the concept of "(Cunha et al., 2021) *Smart City*". In this context, blockchain is expected to be an element that supports the integration of *Artificial Intelligence* (AI), *Internet of Things* (IoT), Big Data, and Cloud Computing technologies. Blockchain characteristics such as immutable and traceability, along with its decentralized structure, are expected to help ensure progress towards a more efficient, secure, and transparent way of managing services and data. Third, blockchain is used in supply chain management. According to the Alliance of Global Trade Facilities, supply network costs account for two-thirds of the total cost of products traded, and seven percent of the total value is the cost of the documentation process alone. Blockchain is used to overcome logistical complexity by breaking down information silos, automating transaction processes and bureaucracy, increasing transparency, and guaranteeing authenticity along the supply chain. In addition, it certainly bridges the relationship between the public and private sectors oriented towards public welfare, as has been done by a blockchain network called Etherium (Queiroz et al., 2020; Niforos, 2017).

The use of blockchain technology in the delivery of public services is expected to have a major impact in economic, socio-political, and environmental aspects. Blockchain has the potential to improve sustainability in various fields, defined as a balance between three main pillars: environmental, economic, and social. Blockchain technology can increase access and transparency in public management, as well as provide access to energy and water resources. In addition, this technology can also serve as a tool for community participation to collaborate internationally. Therefore, the adoption of blockchain can have a significant positive impact on a number of goals of

the (Paliwal et al., 2020) *Sustainable Development Goals* (SDGs): reducing inequality (Goal 10), sustainable development of cities and communities (Goal 11), and creating peace, justice, and strong institutions (Goal 16). Nonetheless, the use of blockchain still needs to be managed wisely to avoid potential risks or negative impacts that may arise in certain situations (Rocamora &; Amellina, 2018).

The purpose of writing this article is to collect, process and analyze scientific literature regarding the use of blockchain technology and its correlation with public services. To achieve this goal, a *systematic literature review is* conducted that thoroughly collects theoretically and empirically known information on the potential benefits, costs, and risks of using blockchain in public services. The contribution of this article is expected to provide a concrete systematic review by drawing on the latest scientific literature, as far as the author's knowledge, regarding specific literature related to the use of blockchain in public services. The results of this systematic review are expected to be useful and help enrich the wealth of knowledge and for policymakers to understand, implement, and convey the potential of blockchain technology.

The role of public services is very important in the formation of the modern state and society because it contributes to the consolidation of territory, social coherence, and the stability of governmental and political organizations. The author defines public services from a functional approach, referring to services provided for the public or public interest. The author chooses to focus on "public services" rather than "public sector" based on the fact that many public services are hosted by non-governmental entities and the private sector, or through mixed-ownership partnerships, such as service and service provider companies, cross-sector, third-party, or public-private partnerships. Thus, "public service" encompasses all these activities, regardless of direct ownership or control by the state as the ultimate authority. Based on the results of the analysis and findings from this systematic review, this article provides an understanding of whether the use of blockchain is indeed feasible and feasible, as well as something that is expected to be adopted by the delivery of public services (Clifton et al., 2016; Clifton et al., 2021).

The introduction of innovations such as blockchain involves complex processes with opportunities and barriers in the technological, socio-economic, legal, and cultural realms. The potential impact of these technologies will vary depending on the type of public service discussed. In addition, the implications of using blockchain in public services will depend largely on the community groups involved. For example, the impact of blockchain on governments that manage public services can be different from its impact on public servants responsible for the process of providing and distributing services, as well as on society as users of public services.

2. Method

To answer the questions in the introduction, the authors conducted a *systematic literature review*, adopting and following the guidelines *of Preferred Reporting Items for Systematic Reviews and Meta-Analyses* or PRISMA. This procedure includes a review of clearly formulated questions, following a systematic and explicit method. It includes clearly formulated objectives, a systematic search to identify all studies that meet the feasibility criteria, and a systematic presentation of findings. A (Moher et al., 2009)*checklist* for each step is attached.

The author applies a three-step walkthrough to identify related literature on blockchain in public services. First, the author's main focus is on the leading international repository, Scopus. The author began searching for literature containing the word "blockchain" in the title, abstract, or keyword. Literature must be in English and published as journal articles in the field of Social Sciences. Author searches include multidisciplinary publications that also fall into other fields such as Computer Science or Engineering. The authors found that relevant and interesting literature includes the word "public" ("public services", "public sector", "public administration", "public organization", "public managementc"), and/or the word "governance". As an effort, the author conducts further searches where the search results include the word "public" in any combination or the word "governance" in the title, abstract, or keywords.

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Second, the literature studies that the author includes in this *systematic literature review* must meet the criteria *(eligible)* (Cagigas et al., 2021)   with the following conditions:

- **Type of Study:** The notes considered should address the social impact (on government, civil servants, and society/citizens) of the application of blockchain technology in public services.
- **Topic:** The included notes must be related to the use of blockchain technology in public services. The author defines public services in functional terms, referring to those services provided for the public or public interest. In other words, following the literature and the main objectives on this topic, public services are services for and oriented to the interests and needs of the public, regardless of ownership or authority, either by the public or private sector.
- **Type of Participant:** The systematic scope of   this *literature review* involves the implications of blockchain for three types of participants that may be involved: I. Government, defined as a public body/entity that is directly or ultimately responsible for the provision of public services; II. Public servant, defined as an employee responsible for the provision and/or regulation of public services; III. Citizen, defined as an individual who has the potential to be a recipient of services.
- **Study Design**: The author's interest in conducting *a systematic literature review* covers the theoretical and empirical implications of the use of blockchain in public services.
- **Language:** The author limits the search for literature results to only those written in English.
- **Publication Status:** The author includes journal articles that have been reviewed by other academic colleagues, as well as those that have been created in the form of books and book chapters that have been published.

Finally, from the overall total search the author produced 353 literature. The selection process is described in Figure 1. At the first stage, the literature is filtered by title, abstract, and keywords. The author excludes duplicate keywords, as well as literature that does not meet all the necessary criteria for example, that is not written in English, not published as a journal article, restricted by Publication year 2019-2023. In the second stage, the remaining literature is filtered by reading abstracts. The author specifically follows the first two principles, eligibility criteria regarding the type of study and topic. Literature that does not address the social and societal impacts of blockchain use in public services is excluded. For example, some studies analyze blockchain applications from the point of view of business or the trade sector only, and other examples include only computer modeling of blockchain. As well as most literature with which the center and beginning of the emergence of blockchain systems itself is cryptocurrency, is also excluded. In the end, the selection of sorted literature resulted in inclusion from 132 studies in this systematic literature review.
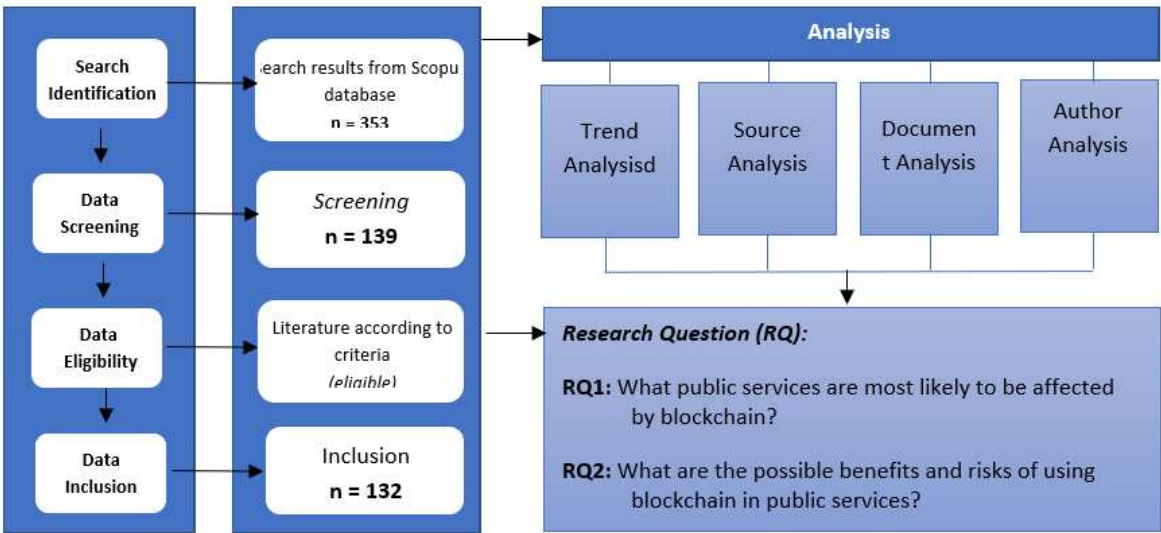

Figure 1. PRISMA Diagram for Research Design and Selection

The research method used by the author involves VOS Viewer and Biblioshiny applications in the process of processing data from *systematic literature review* (Moral-Muí±oz et al., 2020). VOS Viewer is a visualization tool used to analyze and describe relationships between elements in a dataset, while Biblioshiny serves as an interactive tool to detail and present literature findings in more detail. The first step in this process involves using VOS Viewer to identify patterns and relationships among keywords, authors, and literature sources related to the use of blockchain technology in public services. This application allows visualization of networks that make it easier for researchers to understand the structure and significance of the related literature. Furthermore, by using Biblioshiny, authors can conduct a more in-depth analysis of the literature findings that have been identified. With an interactive interface, researchers can filter and explore literature based on specific criteria, such as the year of publication, research category, or research method used. The combination of VOS Viewer and Biblioshiny provides a holistic and integrated approach in analyzing and presenting findings from (Guleria &; Kaur, 2021; Guleria &; Kaur, 2021; Patil, 2020) *systematic literature reviews*. The use of these tools not only enriches the data analysis process but also increases the involvement of researchers in detailing the literature findings in greater depth (Radha &; Arumugam, 2021).

Based on the explanation and description of the background and methods, this systematic literature review focused on the following research questions (RQ):

RQ1: What public services are most likely to be affected by blockchain?

RQ2: What are the possible benefits and risks of using blockchain in public services?

3. Results and Discussion

This *systematic literature review* reflects a careful framework for evaluating existing scientific knowledge regarding the use of blockchain technology in public services. The systematic steps carried out involve a meticulous search based on previously presented methods. This discussion focuses on key research questions *or research questions (RQ).* The results of this search show that there are 353 articles processed by inclusion and exclusion methods and explained through visualization in Figure 1. The selection was done meticulously, eliminating duplicates and ensuring that only certain literature that met the eligibility criteria were included in the study.

The *systematic literature review* (SLR) process includes data from 2019 to 2023, with total inclusion after processing to 132 documents. The annual growth rate of literature on the selected topic is 25.74%, indicating a significant increase in the production of research on this topic. The average age of the documents was 1.61, indicating that the literature is relatively new. The average citation per document is 13.05, indicating a moderate level of impact and relevance. In addition, there are 656 Keyword Plus (ID) and 492 Author Keywords (DE), reflecting the breadth and depth of topics covered. The review involved 376 authors, with 24 of them single-authored, and a collaboration rate of 2.99 co-authors per document, with 19.08% international collaboration. Document types include articles, conference papers, editorials, errata, notes, retractions, reviews, and short surveys, showing a wide variety of literature sources and formats.
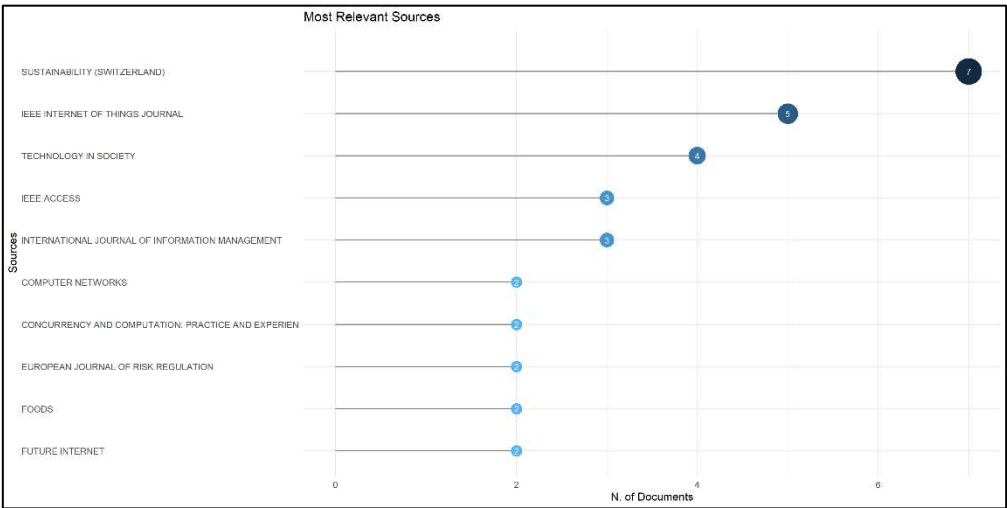
Figure 2. Most Relevance Sources

The distribution of data processing results shows a number of interesting patterns in blockchain research in the context of public services, with a focus on scientific fields and publication journals. In the Social Sciences category, there are a number of journals that contribute a small percentage of the total record, such as the South Asian Journal of Business Studies, Thesis Eleven, and Transforming Government: People, Process, and Policy, each of which contributes 1%. This reflects the diversity of literature sources and the broad approach to the use of blockchain in public services in this area.

Meanwhile, in the Computer Science and Technology category, relevant literature is spread across various journals such as IEEE Transactions on Cloud Computing, IEEE Transactions on Emerging Topics in Computing, and IEEE Transactions on Services Computing. These journals, along with others, show strong involvement and significant contributions to blockchain-related literature. As such, this category reflects extensive interdisciplinary engagement with blockchain topics in the context of public services. The overall analysis shows a balanced distribution between the two disciplines, characterizing a thorough exploration of the use of blockchain across multiple disciplines. Inclusion in diverse journals signifies a comprehensive approach to understanding the impact and implications of blockchain technology in the context of public services.

Unlike 2019 and below where the direction of discussion about blockchain is dominated by cryptocurrency. The discussion on blockchain technology from Scopus between 2019-2023 tends to discuss topics related to governance, information technology, decision making, smart city development, authentication, data sharing, public key cryptography, network security, and decentralized networks. These themes show a focus on the technological, governance, and security aspects of blockchain technology, as well as its application in the decision-making process and smart city development. The likelihood of discussion and correlation between blockchain and public services, the general public, or governance is very high, as indicated by intermediate scores from relevant nodes such as "governance approach" and "e-government".
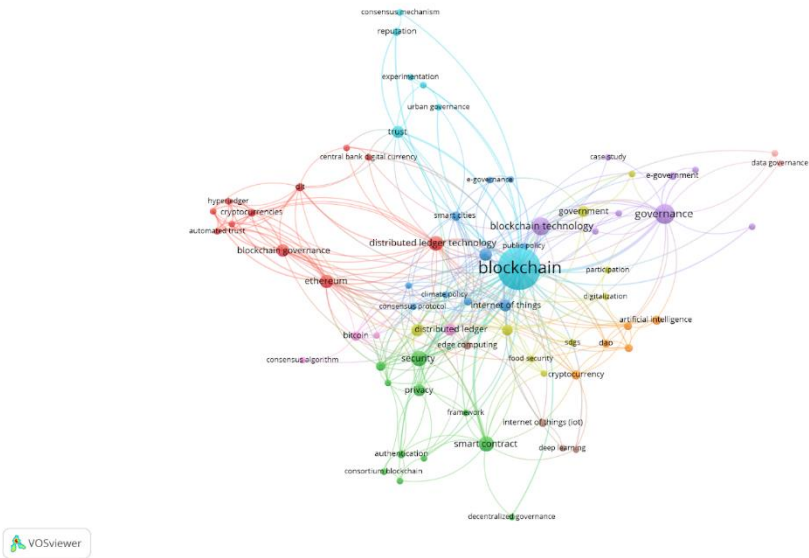
Figure 3. Network Vizualization

Each word has coordinates in clusters and is categorized into specific groups, reflecting different aspects of the topic. The explanation explains that words related to technology and security, such as "cloud computing," "distributed computer systems," "network security," and "smart contracts," form groups close to each other in two-dimensional space. This suggests a semantic interrelationship between these words in the context of technology and security. In addition, words related to public sector governance and management, such as "governance," "public services," "e-government," and "public policy," also form a separate group. This indicates that these words are closely related to the concept of governance and management of the public sector. In the context of privacy and security, words such as "privacy preserving techniques," "privacy preservation," and "security of data" are also clustered together, indicating semantic proximity in the context of privacy and security.

These nodes demonstrate a strong link between blockchain technology and governance or public services, reflecting a significant focus on the application of blockchain in public sector management and governance. An intermediate score of "governance approach", indicating a high likelihood of discussion and correlation between blockchain and governance. In addition, the existence of nodes such as "e-government" and "public sector" further supports strong associations between blockchain and public services or governance in the network structure.

This word mapping also provides insight into the semantic relationships and associations between technology, governance, and privacy-related words in the dataset. The mapping can also be linked to the concept of public services or governance, highlighting how technology plays a key role in the efficiency and transparency of public service distribution as well as the importance of privacy and security aspects in this context. This reflects evolving trends illustrating increased reliance on technology and the need for privacy protection in public service delivery and governance effectiveness.

Further understanding of the topic map, in the results of the text data that has been processed in Figure 4, identifies several key topics such as blockchain, governance, decentralized networks, artificial intelligence, and data security and privacy. These topics are associated with a variety of subtopics, including interoperability, privacy by design, privacy preservation, public institutions, smart contracts, waste management, social aspects, supply chain management, urban environments, distributed computer systems, distributed databases, hyperledger fabric, peer to peer networks, privacy preservation techniques, proof of work, reputation, citizen participation, fees, electronic data exchange, environmental technology, governance, information technology and communication, edge computing, information dissemination, network architecture, privacy, and accountability.
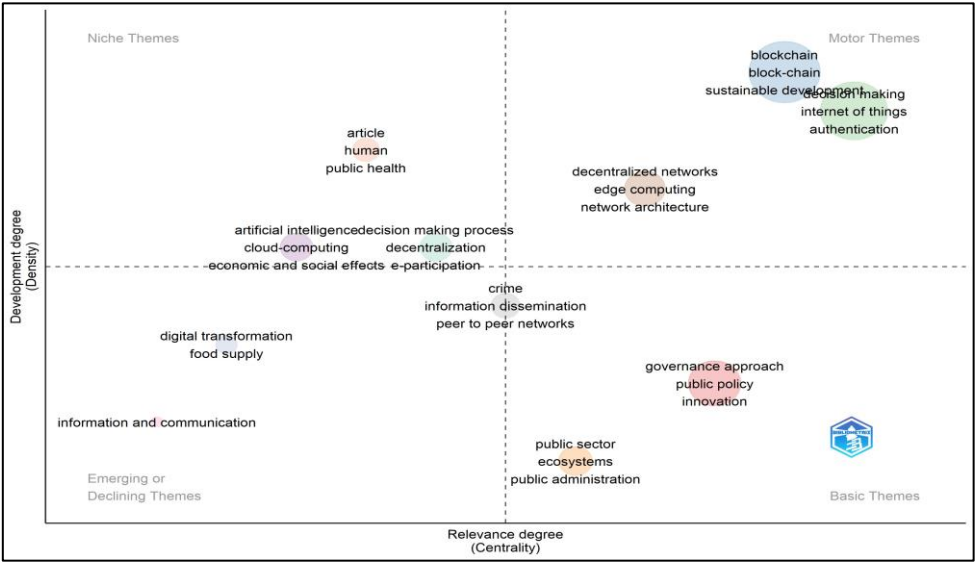
Figure 4. Thematic Map

In further analysis, the authors involved frequency and measures of centrality for each occurrence and words related to groups and group labels. The group labels and groups are determined based on the frequency and centrality of events and words in the dataset. For example, in group 1 labeled "blockchain," the word "blockchain" has a high centrality of betweenness, centrality of closeness, and centrality of pagerank, indicating its importance and influence within the group. Likewise, in group 3 labeled "interoperability," words such as "interoperability," "privacy by design," and "privacy preservation" had a measure of high centrality, demonstrating their significance within the group.

The use of measures of centrality, such as centrality betweenness, centrality closeness, and centrality pagerank, provides insight into the importance, influence, and prominence of words in groups and group labels. This information helps identify key words and understand their key role in connecting, influencing, and centralizing content within the group. In addition, these measures help understand the prominence and impact of specific words in the context of the topic covered in the data in a more understandable manner.

The trend of using the term "blockchain" in the academic literature shows a significant increase from year to year. In 2021, the frequency reached 54, but then dropped to 29 in 2022 and further decreased to 6 in 2023, signaling a fairly noticeable decline. Analysis of the overall literature growth rate shows a negative figure of -50%, indicating a decrease in the frequency of literature on this topic from 2019 to 2023. This could indicate a shift in research focus or a decrease in interest in the topic in the 2019-2023 time period.
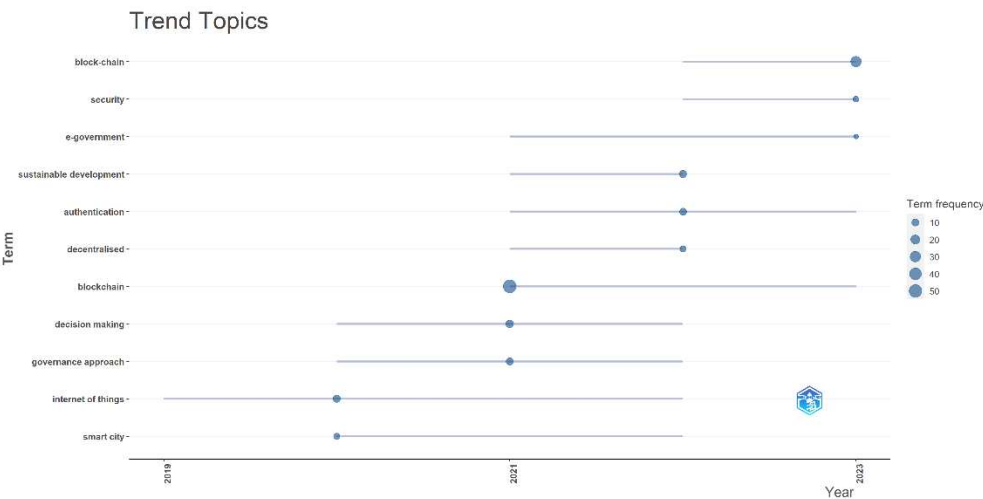
As a difference, the use of the term "*decision making*" fluctuated from 12 in 2020 to 2021 , then decreased to 10 in 2022. These fluctuations highlight the dynamics in the frequency of terms over the past few years. In addition, observations of terms such as   "*e-government*"   and   "*security*" show a decrease in frequency in the academic literature in recent years. This decline may be due to a shift in research focus to new areas that dominate the attention of researchers in this field.

Based on the data, words related to "public service," "public," or "governance" can be identified. The terms "governance approach" and "e-government" are directly related to governance and public services, while "sustainable development" may also include aspects of public governance and service delivery. These terms reflect a focus on governance and public service within the selected/inclusive field of study.

In addition, the analysis in this section also highlights the average age of documents, which can give an idea of the extent to which the literature in this field is still relevant. With an average document age of about 1 year, it indicates that the literature is relatively new and reflects the emphasis on current research. The estuary of this analysis can guide the author to identify trends and areas of research that require further exploration. There may be changes in research focus and dynamics of interest that can be an impetus for further research to fill knowledge gaps and enrich the literature on this topic.

The data presented in the visualization of Figure 6 shows that several key topics, such as Authentication, Blockchain, Internet of Things, Governance approach, and Sustainable Development, experienced a significant increase in the number of discussions from 2019 to 2023. From these four topics, it can be seen that Blockchain is in the main spotlight with a very striking growth from 5 *keywords* in 2019 to 54 in 2023. This shows the growing interest in Blockchain. Although other topics, such as Decision Making, Internet of Things, and Sustainable Development, have also seen an increase in mentions over time, the growth in mentions for Blockchain looks more special.
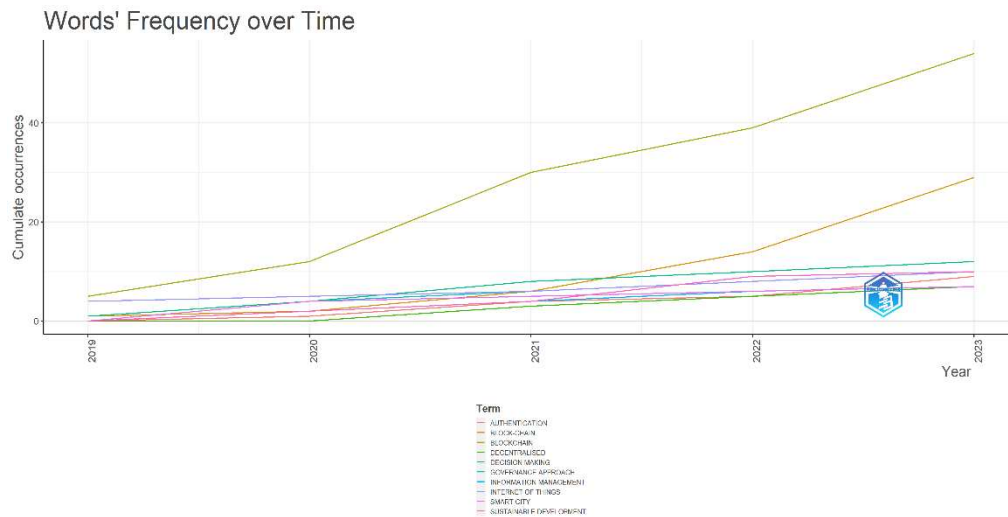
10

Figure 6. Dominant Word Frequency from the 2019-2023 period

Meanwhile, the increase in mentions for the topics of Decision Making, Internet of Things, and Sustainable Development also reflects issues that are increasingly relevant in the context of public services. Effective decisions, the use of technology to improve services, and environmental resilience are increasingly becoming key focuses in designing public service policies and practices. Thus, this analysis provides a strong view of the evolution of topics related to public services. This increased interest can provide guidance for policymakers and researchers to better understand emerging trends and needs in improving the effectiveness and quality of public services.

To reinforce word usage trends in this topic, the word cloud arrangement will visually represent the terms that appear most often in larger, more prominent fonts, while the terms that appear less frequently will appear smaller. In this case, word cloud will likely feature "blockchain" and "block-chain" as the most prominent terms, followed by "decision making," "governance approach," "internet of things," "sustainable development," "authentication," "decentralised," "information management," and "smart city" in sizes that vary based on frequency. This visualization will provide a quick and intuitive understanding of the most common concepts in the data.
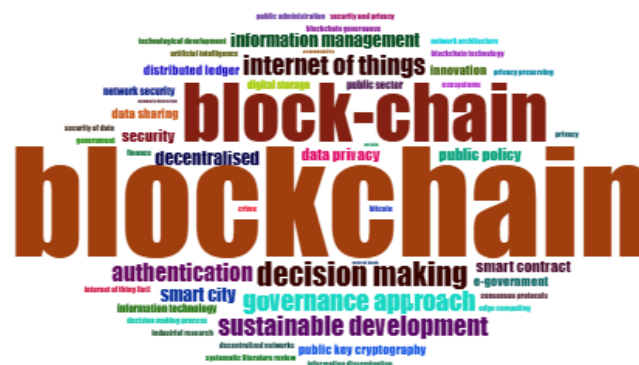

Figure 7. Word Cloud

In this regard, "blockchain" or "block-chain" are the most prominent words, indicating the significance of blockchain technology in the context of public services. This is in line with the growing interest in leveraging blockchain for public service applications, such as governance, authentication, and information management. The prominence of the words "decision making" and "smart city" also indicates a focus on using blockchain to improve decision-making processes and develop sustainable urban environments, which are key aspects of public services. In addition, words such as "decentralised" and "internet of things" indicate an increasing emphasis on decentralized and connected systems, which are relevant to the modernization of public services. Overall, the makeup of word clouds reflects the relevance of blockchain technology in the context of public services and its potential to transform governance, decision-making, and urban development.

Overall, this pattern indicates that the interest and relevance of these topics is increasing year by year. There is a correlation between the change in years and the increase in mentions for all of these topics, suggesting that the longer it takes, the more significant these topics are. From this data, it can be concluded that changes in the technological, business, and sustainability landscape are contributing to a growing focus on issues such as Blockchain, Decision Making, Internet of Things, and Sustainable Development. This analysis provides a solid basis for further research and provides a potential snapshot of the future direction of development of this topic.

In this context, understanding the geographical distribution of research contributions is essential to gain insight into the global landscape within the thematic field under study. To achieve this, the authors transformed the raw data into percentage-based representations, allowing a more in-depth examination of each country's relative impact on the subject of this *systematic literature review*.
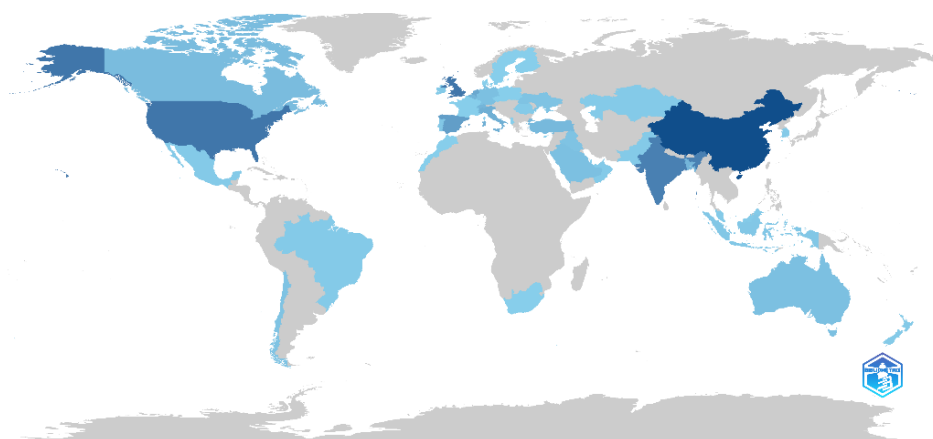

Figure 8. Production of Scientific Literature by Country

Upon analysis, it was revealed that China emerged as a major contributor, accounting for 40% of the total documents. The United Kingdom (UK) and the United States (US) have similar positions, each representing 27% of the literature. India also showed significant participation, accounting for 24% of the documents. The four countries, namely China, the UK, the US, and India, together play a central role in shaping the discourse on the theme under study. followedby Spain, the Netherlands, and Italy showed significant contributions, with percentages ranging from 10% to 15%. Countries such as Bangladesh, Belgium, and Switzerland showed comparable impact, each contributing 8% to the overall literature. Other countries, including Turkey, Canada, and Australia, show varying degrees of influence. This percentage-based analysis not only provides a clear picture of the major contributing countries, but also allows a comprehensive evaluation of the relative significance of each country in the thematic domain of *systematic literature review*. Insights like these about the geographic distribution of research contributions contribute to a more holistic understanding of the global landscape as it relates to the topic under study.
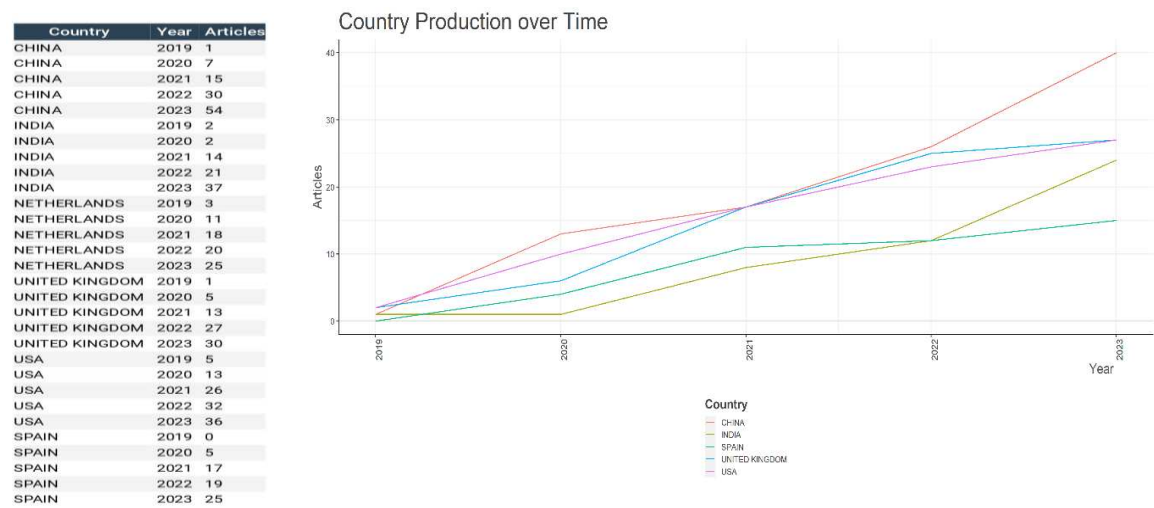
Country	Year	Articles
CHINA	2019	1
CHINA	2020	7
CHINA	2021	15
CHINA	2022	30
CHINA	2023	54
INDIA	2019	2
INDIA	2020	2
INDIA	2021	14
INDIA	2022	21
INDIA	2023	37
NETHERLANDS	2019	3
NETHERLANDS	2020	11
NETHERLANDS	2021	18
NETHERLANDS	2022	20
NETHERLANDS	2023	25
UNITED KINGDOM	2019	1
UNITED KINGDOM	2020	5
UNITED KINGDOM	2021	13
UNITED KINGDOM	2022	27
UNITED KINGDOM	2023	30
USA	2019	5
USA	2020	13
USA	2021	26
USA	2022	32
USA	2023	36
SPAIN	2019	0
SPAIN	2020	5
SPAIN	2021	17
SPAIN	2022	19
SPAIN	2023	25

Figure 9. Article Production by Country from Year to Year: Trend of Increasing Academic Activity

Article production from 2019 to 2023, a general pattern of research output growth is seen among selected countries. Notably, China, India, the Netherlands, the United Kingdom, the United States, and Spain all showed a trend of increasing the number of articles published during the specified period. This increase reflects positive trends in scientific and research activity across these countries.

China is showing significant growth, from just 1 article in 2019 to 54 articles in 2023. Similarly, India has seen an increase in the number of articles from 2 in 2019 to 37 in 2023. Other countries have also contributed to this increase. For example, the Netherlands increased article production from 3 in 2019 to 25 in 2023, while the UK rose from 1 article in 2019 to 30 in 2023. The United States also showed significant growth, jumping from 5 articles in 2019 to 36 in 2023. However, it should be noted that Spain has decreased from 0 articles in 2019 to 25 in 2023. Overall, however, this trend reflects an increase in research activity and academic contributions from different countries during the period studied.

Further analysis of the data showed variations in growth rates among these countries. Notably, China and India experienced a significant increase in the number of articles during the specified period, indicating a possible growing influence in academia and research. Overall, the distribution of articles among these countries shows a positive trend of increased research and scientific activity. The varying degrees of growth also emphasise the dynamic nature of academic contribution, with some countries showing faster progress compared to others.

Although looking at the production of articles from various countries over a certain period of time gives an idea of academic activity, we should not miss another aspect that is no less important, namely the impact or number of citations on published documents. Further discussion needs to be done to gauge the extent to which these articles contribute to the knowledge and sustainability of research. The large number of articles produced by a country is not always proportional to its impact in the scientific world. Therefore, measuring the number of citations or impact on the resulting document is a critical step to evaluate the real contribution to the development of knowledge in a field or discipline.

Citation analysis provides an overview of the influence of research results from various countries. In particular, the United Arab Emirates stands out with the highest average citation per article, at 77.00, indicating the substantial influence of its research contributions. On the other hand, the United States, with the highest total citations of 287, demonstrated a significant and far-reaching contribution to the global scientific community. Germany is also conspicuous with its high average citations per article, confirming its influential role in research results.
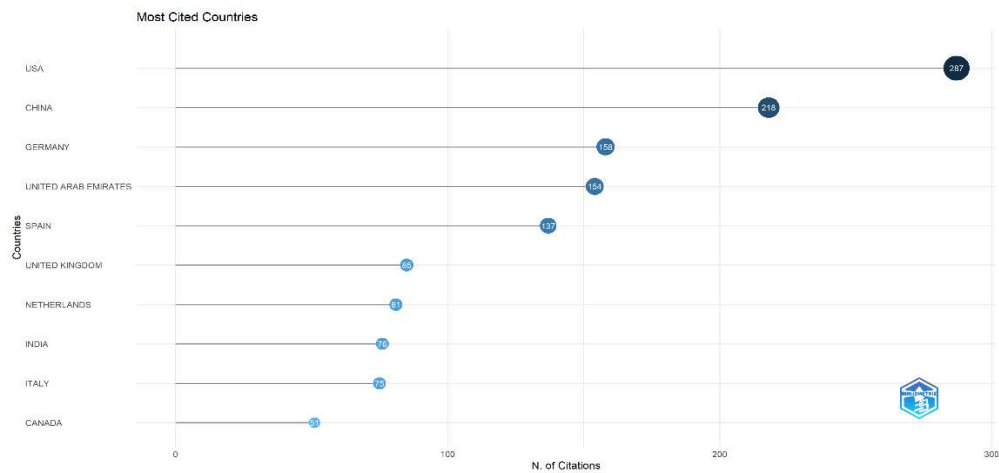
Figure 9. Countries with the　Highest Citations/Citations

These findings show the varying degree of influence of different countries on the global scientific landscape, as reflected in each country's citation metrics. The United States, with a significant number of citations, is strengthening its leadership in scientific research in the field of blockchain and innovation globally. Moreover, the tremendous impact of the United Arab Emirates, Germany, and other countries such as Qatar, as shown by the average citations per article, highlights the complex dynamics in the influence of global research.

In conducting *a systematic literature review*, understanding the impact and contribution of the authors is one of the keys to gain deep insight into the development of research in the scientific field. Authors of scientific papers bring unique experience and expertise to the literature corpus, and the impact of their articles can be reflected through various evaluation metrics such as h-index, g-index, m-index, total citations, and average citations per author. In the context of this SLR, we will explore and analyze the impact of the authors based on existing data, in hopes of gaining a better understanding of their individual contributions to knowledge development in the context of blockchain utilization.

The H-index, proposed by , is a measure of the productivity and impact of a researcher's work. It is calculated based on the number of publications by an author and the number of citations each publication receives. An author has an h-index of h if the h of his publication has at least h citations each. The H-index is widely used to compare the impact of researchers in the same field. These metrics are used to assess the impact and influence of researchers' work, often in conjunction with other factors such as total citations and average citations per publication to provide a comprehensive evaluation of a researcher's contribution to the field (Hirsch, 2005).

Based on the dataset processed in this SLR, we can see variations in author impact from the metrics of total citations, average citations per author, and number of publications. Some, such as KUD and KUMAR S, stand out with an h-index of 1, signifying at least one publication with at least one citation. On the other hand, authors like LEEWIS S show lower impact. Overall, the dataset reflects the divergence of author impact, showing diverse contributions in academia related to blockchain in the context of public service or government.
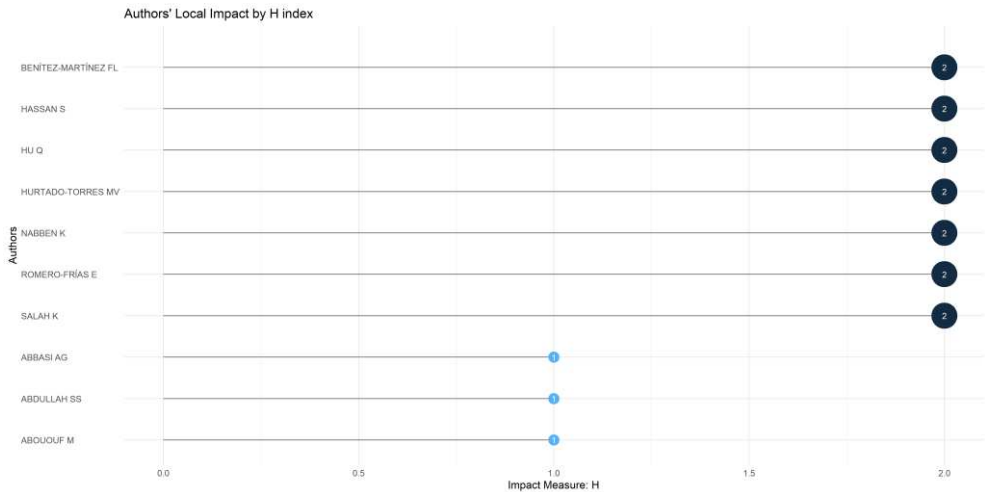
Figure 10. Authors Local Impact by High Index

The following authors have an h-index of 2: Benítez-Martínez FL, Hassan S, Hu Q, Hurtado-Torres MV, and Nabben K. These authors have at least two publications with at least two citations per publication, contributing to an h-index of 2. The H-index is a measure of an author's publication productivity and impact, and achieving an h-index of 2 indicates that these authors have made significant contributions that have been cited at least twice each publication, indicating a striking level of impact in their respective fields.

In addition, based on the data, it can be seen that Benítez-Martínez FL, Hassan S, Hu Q, Hurtado-Torres MV, and Nabben K also have relatively high total citations (TC) and average citations per author (Average), indicating that their work is not only productive but also has a significant impact, which is reflected in the number of citations received by their publications. The presence of a high total citation indicates that their works are frequently cited by other researchers, adding to the prominence of their impact in the scientific community.

RQ1: What public services are most likely to be affected by blockchain?

In exploring the challenges and opportunities of applying blockchain technology in the context of public services, the first research question (RQ1) we will discuss is, "What public services are most likely to be affected by blockchain?" This question prompted the authors to investigate the extent to which blockchain technology can play a key role in transforming or disrupting the various services provided by the public sector. By detailing the impact of blockchain on specific services can gain a deeper understanding of the potential and constraints of this technology in improving the efficiency, transparency, and reliability of public services.

Let's further discuss the findings in the data that has been processed and visualized in this article . Based on these data, it can be seen that several public services have a significant impact and are candidates for transformation or disruption through the use of blockchain technology. The distribution of data shows wide variation across different public services (see Figures 3, 5, 6).

For example, in public service management, blockchain can facilitate access to those public services, reducing or eliminating delays in activities that previously took time. Other advantages include reduced fees for registering information and updating records in near *real-time* for all parties involved in the blockchain. Some governments around the world, such as Dubai and Georgia, have already started transforming their public (Baroudi &; Benghida, 2022; Muhammad & Adil, n.d.)service and management systems using blockchain technology. While the benefits are real, regulatory uncertainty remains a major problem. Therefore, there needs to be adequate regulatory conditions so that the application of blockchain can be considered legitimate as a clear regulatory establishment before it is implemented.

Public Health

Public health is also a public sector that has the potential to be disrupted by blockchain. Improved tracking through blockchain allows each health item to have a unique code to check its authenticity and composition. This can reduce prescription fraud and increase supervision of health product production. Blockchain can also help in the storage of employee data related to absenteeism, performance evaluations, and security measures for medical personnel. While offering solutions to increase citizens' personal control over their health data, as well as improve patient-doctor communication, blockchain implementation in healthcare requires technical training, especially for elderly patients.

Public Revenue (Tax)

The use of blockchain in the tax system and cooperation between tax authorities and customs agencies can also provide significant benefits to governments. The tracking and transparency nature of blockchain enables faster and effective detection of fraud and errors in tax activities. In the context of customs, blockchain can improve coordination between agencies and more efficient management. However, challenges remain, including international standardization of blockchain legal requirements and clarification of jurisdictions applicable to international blockchains (Faccia &; Mosteanu, 2019).

In the context of decision-making of public organizations, blockchain technology offers a variety of significant advantages. By providing a transparent and immutable record of transactions, blockchain helps improve the decision-making process by providing equal access to all parties. The existence of (Novak, 2020) *smart contracts* also allows automation in some decision-making processes, reducing the potential for *human error* and increasing efficiency. Security and authentication are becoming important aspects, and the use of blockchain can improve both. With enhanced security, an immutable track record, and decentralized verification, the risk of fraud and unauthorized access can be reduced. Blockchain authentication systems can also simplify the identity verification process by reducing the need for logins and double passwords. Although these benefits seem promising, there are some considerations to consider. Scalability challenges may arise as blockchain technology is still in its developmental stage. Technology complexity and regulatory issues can also be barriers to widespread adoption. Therefore, organizations need to consider carefully before adopting blockchain for decision making and authentication (Lai & Chuen, 2018; Novak, 2020).

Digital Identity

Digital identity is the most fundamental public service that determines people's accessibility to use other public services, throughblockchain   other public sector activities that   can be changed and integrated in one system that is more efficient and can be accessed at any time and real-time. Blockchain can save conventional bureaucratic activities and   large sums of money on the operational costs of data centers, system management, and verification. (Hou et al., 2018a)In Estonia , blockchain   has changed the way citizens interact with governments and other stakeholders, as well as how administrations have found ways to promote(Kotka et al., 2015) modern public services. The same can also be adopted and become a vision of a sustainable modern government in the future (Tammpuu &; Masso, 2018).

In the context of developing countries, the adoption of blockchain technology in the provision of public services can be key to increasing efficiency, reducing bureaucracy, and providing easier access for citizens. For example, by using blockchain-based digital identities, governments can address bureaucratic challenges that often hinder citizens' access to healthcare, education, and social protection. In addition, the adoption of this technology can help reduce corruption and increase transparency in the delivery of public services. Nonetheless, implementation challenges, including the availability of infrastructure and technical skills, need to be noted in order for blockchain adoption to be successful and deliver significant benefits in developing countries.

Public Policy

Blockchain can also bring significant improvements in government regulatory practices and security standards. Real-time tracking systems, such as blockchain, will allow regulators to see all transactions and product history in near real-time. For example, it would allow the identification of each food product and provide it with data that cannot be manipulated, such as origin, organic attributes, and labor conditions. This will ensure that regulators can do their jobs more efficiently and effectively, guarantee the reliability of records as well as simplify access and processing processes. However, it remains unknown whether blockchain can efficiently manage information along the supply chain at scale (Howson, 2020; Allen et al., 2019; Sander et al., 2018). In the nature of social protection policy. Blockchain can be used to disintermediate government transfers to citizens. By providing secure, direct, and transparent transfers, these technologies can change the way social policies are implemented (Kundu, 2019).

In addition, Blockchain can also make the way environmental protection policies work is made. The amount of data recorded in blockchains in collaboration with the Internet of Things (IoT) can improve the ability to analyze and understand environmental problems. Governments can quickly trace the source of active substances that can affect the environment, enabling the implementation of more proactive measures in the face of climate change. Presenting public procurement data in blockchain can increase government transparency and accountability from the active participation of citizens or citizens. This technology can help address corruption and other concerns (Zhang et al., 2020; Jarrahi, 2018a).

In the case of public procurement by health systems, traceable systems such as blockchain will allow local hospitals to purchase health products in a decentralized manner, while at the same time centralizing information about quantity and price, and making it available to all. In addition, governments can present their expenditures on a public ledger, which is available and viewable by the public. This will not come at the expense of the privacy of the main agent, as a well-designed system in blockchain utilization will guarantee anonymity (Borole et al., 2019; Abelseth, 2018).

Blockchain in Sustainable Smart Cities

In the context of the continued development of smart cities, blockchain has an important role to play in managing urban infrastructure. By providing a secure and transparent platform, blockchain can be used to optimize energy distribution, waste management, and transportation systems. This leads to efficient energy use, reduced waste, and support for sustainability. Information management in smart cities can also be improved through blockchain technology. Data can be stored and shared securely among various systems and stakeholders, ensuring information integrity and privacy. Thus, urban services can become more efficient and reliable. Decision-making processes for city planners and administrators can also be improved through guaranteed information sustainability. However, along with the profit potential, there are some challenges to overcome. Blockchain scalability and regulatory complexity can be constraints. Therefore, while blockchain offers significant opportunities in the context of sustainable smart cities, its application needs to be carefully considered to address potential constraints and risks (Bhushan et al., 2020; Ibba et al., 2017; Xie et al., 2019a; Majeed et al., 2021).

RQ2: What are the possible benefits and risks of using blockchain in public services?

The author's approach discusses the implementation of blockchain technology in public services from the various points of view of two main parties in the process: the Government and its citizens/society or public. For each side, the authors identify the main benefits of blockchain in public services and then discuss the consequences of its application in the context of public services. Negative consequences are grouped into possibilities/opportunities, and challenges/risks, which may arise from the activity or process of their implementation.

Society/Public

The use of blockchain technology in public services has quite a significant impact on society. From the various literature that the author studied, it can be seen that there are great benefits that can be felt by the community, but cannot be separated from the costs and risks that need to be considered. Data security and transparency are two main aspects that provide positive benefits to society. Data security is obtained through a structure that cannot be unilaterally manipulated/changed, where every transaction is verified by consensus, increasing the level of trust in information management. However, there are also costs and risks associated with the potential security threats of blockchain data and the accessibility challenges of this technology, especially among people who do not yet have sufficient technical knowledge or internet access. As such, it is important to carefully consider the impact of blockchain implementation on people's daily lives.

Benefits to Society/Citizens

Blockchain transparency creates a new form of trust where the community can easily monitor every action within the network. The combination of this transparency with the security and traceability properties of the blockchain allows citizens to trace any (Rien Agustin &; Susilowati, 2019) changes incorporated into the blockchain back to its original inclusion, and is open to validation of authenticity. In addition, in transactions between citizens, it is very easy to verify whether one participant in the network has an exact and unaltered copy of historical data. Trust based on   the term (Jarrahi, 2018b; Abelseth, 2018) secure and transparent distributed ledger eliminates the need to hire, pay, and trust third-party entities to oversee transactions, allowing further disintermediation of data   processing (Abelseth, 2018).

The security generated by blockchain comes from its immutable nature or data structure by a single entity, where every transaction is verified through consensus between nodes, preventing one party   from authority from changing it. When new data is entered into the chain, it is almost impossible to modify it or delete it. In addition, the decentralized structure of the blockchain helps guarantee the integrity of information by avoiding vulnerability to a single security breach. The process is also transparent and accountable by every node. Therefore, in terms of technology, cyber security can be considered a key advantage for citizens in countries adopting blockchain technology (Karale & Khanuja, 2019 (Warkentin &; Orgeron, 2020; Myeong & Jung, 2019; Rien Agustin &; Susilowati, 2019).

Another benefit of blockchain is related to the idea that   individual communities   al can control greater authority over their personal data and privacy. Blockchain is designed to give data owners a unique ID to access it over the blockchain network and the ability to share certain parts (Kundu, 2019) (with the ID owner's permission) that they wish to share. In addition, all these personal data   can be maintained in the same system so that each individual will have a comprehensive digital identity, including all   their personal data, containing reliable and secure personal information. When used in this way, blockchain can facilitate the authentication of personal identities as well as, if needed, the provision of personal information, such as education certificates or health status. Data in the blockchain is encrypted in various ways, to ensure user privacy. Some data from government departments and public service providers are closely related to citizens' personal information. Merging data from multiple sources can be used to form a 'complete profile' of each citizen, which obviously affects privacy. By using blockchain, various protocols can be used to encrypt data and provide anonymity, to avoid this risk. As a result of trust in technology, nodes in the system can exchange data without knowing each other's identity and personal information, so the privacy of each participating node is protected (Potts et al., 2017; Hou et al., 2018b Fan et al., 2019; Potts et al., 2017; Potts et al., 2017).

Risks and Challenges of Society/Citizens

Security is indeed a major bargaining point on blockchains, but some literature mentions that it also carries significant challenges or risks. At least the main risks identified. Currently, consensus

mechanisms other than "*proof-of-work*" (relating to system performance) are adopted to reduce the energy consumption and computing resources of blockchain. However, this solution comes with risks because it can weaken network security, the alternative consensus rules are less stringent. Some *cyber* attacks   have also already occurred in blockchain systems. Hackers can exploit weaknesses caused by poor programming. There is a risk of blockchain system password theft or coordination attacks together on a particular point of the network. The possibility of password theft in these blockchain systems exists and may evolve as computing evolves in the future (Meiklejohn, 2018; Radanović &; Likić, 2018; Carvalho, 2019).

Another obstacle to the use of blockchain comes from its lack of flexibility in the early stages of development. While its immutable data structure is beneficial for some public services, it is also an obstacle for society. Blockchain data is difficult to delete or change. In addition, blockchain relies on data that has been validated by nodes, so it cannot be considered a trustworthy source of information because this technology only guarantees the accuracy of procedures, not the quality of information. The quality and usability of blockchain technology as good as or largely depends on the authenticity of its users. Therefore, replacing party (or multiple parties) oversight with blockchain in a process that requires a high degree of accuracy is quite a significant challenge. Although encryption is useful for improving the privacy of blockchain users, the risk of reidentification still exists. Although every user on the blockchain is connected to a public pseudonymous address, the transaction is publicly available, and the information is visible to all participants in the blockchain network (Dhagarra et al., 2019; Xie et al., 2019b).

Government

This discussion will outline in detail the benefits that governments can gain by integrating blockchain in public services, with an emphasis on efficiency and effectiveness and an increased transparency footprint. The use of blockchain technology in public services has been a major focus of discussion, and a deep understanding of its benefits and risks is essential, especially for governments as stakeholders and providers of public services. However, along with these benefits, risk is also an important factor to note, especially in the context of data security and regulatory uncertainty. This discussion will provide an overview of the government in making informed and balanced decisions related to the adoption of blockchain technology in the context of public services.

Benefits to the Government

The use of blockchain technology in public services provides a number of significant benefits to governments. One of the main aspects is the innovative move in data processors in particular [there is information storage and sharing, which positively affects the efficiency of public service processes. For example, blockchain offers an automated solution for securely storing data in digital format, reducing unnecessary party involvement and, ultimately, saving costs. This advantage also has the potential to reduce (Fu et al., 2018) *human error* in public service distribution operations. Thus, public services that involve big data management and information exchange with citizens/society, businesses, and other sectors, have the potential to undergo transformation through blockchain integration, which in turn improves operational efficiency (Allessie et al., 2019; Chang et al., 2020).

The second and most important benefit of using blockchain, as explained in many references and literature, is its ability to perform tracking. Product characteristics and attributes, from location to application, can be traced in detail, providing benefits of authenticity, proprietary, origin, product and service safety, and accountability across multiple sectors. Each product data record is also capable of including details about production conditions, providing strong support for human rights guarantees and fair work practices (Saberi et al., 2019).

Other potential benefits for governments through blockchain adoption include decentralized structures, which improve data security by reducing reliance on information silos. The process of authenticating data by blockchain systems makes manipulation of information without detection by other nodes nearly impossible, reducing the risks associated with unilateral points of failure. Further, blockchain technology has the potential to reduce transaction time and costs by avoiding the

involvement of third-party intermediaries. The clarity of the resulting data also has the potential to increase the level of accountability for both governments (Fan et al., 2019).

Challenges and Risks for Government

Meanwhile, the main challenge and risk of using blockchain by governments is regulatory uncertainty. According to some literature review, the implementation of blockchain by governments brings a number of significant challenges and risks. One of those key risks is interoperability, that is, the ability to share information, operate, and transact easily across multiple systems. This is a fundamental challenge because it is expected that there will be several different public and private platforms rather than a single ledger (such as the Internet), requiring interoperability. A potential conflict also arises between blockchain technology and the laws in force in many countries. It is not yet clear how legal recognition will be given to data in the blockchain, and whether it will require additional conditions to be recognized as legal. Another potential risk is that with every possible blockchain node located in various locations in the world, it is impossible to establish consistent jurisdiction based on country location or specific conditions. More importantly, the immutable nature of blockchain data can be a legal issue with legal regulations, such as the 1995 Directive or GDPR in the European Union (Chang et al., 2020; Allen et al., 2019; De Filippi &; Hassan, 2018; Lemieux, 2019; De Filippi &; Hassan, 2018; Warkentin &; Orgeron, 2020).

The second significant challenge and risk in implementing blockchain is the scale limitation which is closely related to the effectiveness and efficiency of utilizing this technology. Challenges include the scale and speed of transactions within a blockchain network. This transaction speed affects the time it takes to insert a transaction into a block or reach an agreement between nodes. The more nodes involved in verifying a block, the slower the validation process will be. Further, the more data entered and the block size enlarged, the more difficult it is to generate and propagate blocks. Therefore, there is a trade-off between scalability and security. Blockchain technology is still immature in handling the amount of processing on a large scale (Dhagarra et al., 2019; Xie et al., 2019b; Saberi et al., 2019).

Blockchain also incurs social, economic, and political costs for governments. Some consensus mechanisms, such as 'proof-of-work', force each node to use expensive energy resources in the mining process, causing ever-increasing energy costs. Despite other mechanisms, many of the public service delivery systems of various governments are not mature enough to be widely implemented. Switching to a blockchain record-keeping system and scaling it to serve a large population can be costly and detrimental to the environment. The socio-economic costs also include the need for high capital investment, and research suggests that the cost of switching to blockchain may not be worth the increase in security. Estimates of total initial capital investment are difficult to determine. It is also inseparable from talking about regulatory factors, meaning that political interests and activities are also inevitable in legitimizing the blockchain implementation system in many public spheres and disturbing the interests of certain groups (Xie et al., 2019b; Gabison, 2016; Gabison, 2016; Xie et al., 2019b).

Ultimately, although blockchain is presented as a new innovation and hope in modern public services, the risks cannot be ignored. While it provides benefits to governments and society, blockchain is not a replacement for institutional trust and existing infrastructure. Countries with quality civil society tend to be more successful in adopting blockchain technology in other areas outside of government or public interest (Hyvärinen et al., 2017).

4. Conclusion

We are probably on the most disruptive footing of all time in a system, and that the presence of blockchain technology is becoming a major conversation in the context of cross-sector transformation. Although not yet fully mature, the impact and implications of using blockchain are increasingly receiving serious attention in an effort to understand how this technology can shape the future of public services and people's lives as a whole.

This conclusion section discusses the main contribution of writing this article, namely the presentation of *a systematic literature review* on the application of blockchain in public services. Using PRISMA criteria, this study identified 132 literature sources divided into theoretical, empirical, and systematic review articles. Blockchain applications are widespread in several public services, focusing on public management and administration, as a basis for decision-making and public policy with a focus on data structures in decision making, as well as financial services and health services.

The organizational approach is discussed with attention to the role of government, and citizen-society in blockchain innovation. Governments have an opportunity to increase efficiency and footprint through blockchain, but face regulatory challenges. Citizen-community assesses the benefits of blockchain's security and transparency, while taking into account possible risks.

Key implications include the need for clear regulatory standards and transformation within governments to effectively adopt blockchain in the context of administering public affairs. For citizens, blockchain adoption can provide greater data security, transparency, and personal control. However, keep in mind that blockchain's success depends on effective integration with other technologies in the strategy of digitizing public services.

Limitations

The main limitation in this discussion is due to the limited literature regarding the use of blockchain in public services. One of the major flaws in the literature is the lack of empirical analysis regarding the use of blockchain in public services. Since the use of blockchain in public services is still at an early stage, most of the analysis is abstract or theoretical framework. Most of the past research has focused on discussing the potential benefits, costs, or risks of blockchain in public services without touching on specific cases that have already been implemented, or focusing on case studies without providing sufficient empirical evidence.

Next regarding the writing of this article, although the search and screening process has been carried out in great detail, there is still a possibility that some high-quality works were missed. In addition, the process of inclusion and exclusion carries a certain amount of subjectivity. Therefore, potential bias in literature selection or information extraction can be maximally identified. Lastly, this article focuses on the use of blockchain applications from a social, economic and possibly political point of view, ignoring the more technical aspects of the main basic activity i.e. computational.

Suggestions and Recommendations

In this final section, the author aims to provide constructive and future recommendations in the context of implementing blockchain in public services. In evaluating the existing literature, the authors identified four specific issues that still lack adequate attention. It is described as follows:

1. From Theoretical Analysis to Empirical Analysis:
   - Research on the use of blockchain in public services needs to move from descriptive/theoretical studies to empirical analysis or real implementation.
   - Larger qualitative and quantitative data sets are needed to analyze the benefits, risks, and costs of blockchain in public services.
   - Internal and external evaluations of blockchain use cases need to be considered for a better understanding of blockchain's potential in the provision of public services.
2. Diversification of empirical methods:
   - Cross-sector design is needed to understand the differences in blockchain usage between private and public sector organizations, as well as between public policy sectors.
   - Cross-country research can provide insight into the introduction and requirements of public administration for blockchain adoption.
   - External research evaluation is necessary to prevent biased results.
3. Overcome Key Technical Barriers:
   - More research is needed in the technical field, especially regarding the scalability of blockchain for public services.

- Consensus algorithms that require lower computation need to be developed for blockchain management with a large number of users and data processing.
- Energy consumption needs to be reduced, and operational costs need to be low and predictable.

4. Distinguish Between Blockchain Types:
- Future studies will need to adopt a joint scheme to identify the preferred type of blockchain based on specific characteristics of public services.
- Focus on implementing blockchain infrastructure to achieve different policy goals.
- Special attention to the licensing and governance characteristics of blockchain infrastructure.

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