Systematic Literature Review: Exploring Blockchain Technology in E-Government Systems: Challenges, Adoption, and Perspectives

Student paper

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Abstract—**The modern era demands the development of new technologies. Recently, a lot of attention has been directed towards the implementation of blockchain technology within the e-government sector. It has features that can have a significant impact on various sectors, including the public sector. To understand the possibilities of blockchain technology, as well as its impact on the public sector, this research analyzes the advantages and disadvantages of blockchain technology, as well as the extent of its adoption. Therefore, the current study determined that numerous challenges exist, and it is imperative to implement measures to mitigate potential risks associated with the adoption of blockchain technology. Furthermore, researchers unanimously emphasize the continuing relevance of the subject for continued research and the creation of more precise results.**

Keywords-blockchain, e-government, public sector, challenges for blockchain, blockchain initiatives, adoption, decentralization, transparency, privacy, systematic literature review

I. INTRODUCTION

The e-government can be identified as the introduction and use of ICT in administrative processes, with the aim of providing services that more efficiently meet the new needs, which over time change at the same pace as the evolution of society, in terms of organization and lifestyles [4]. By integrating blockchain, artificial intelligence, and big data technologies in their processes, governments are moving towards data-driven and evidence-based decisions and policy making [5]. Among these, Blockchain technology has attracted attention as the most important new technology. The inception of blockchain technology occurred in October 2008 with the introduction of the Bitcoin digital currency platform by its creator, Satoshi Nakamoto [6]. Blockchains could be defined as a direct peer-to-peer (P2P) distributed ledger technology for transactional applications that enables safe transactions without centralized supervision when there is a lack of trust among users. [2]. Blockchain technology, as in many other fields, has been explored by e-government to promote public administration transformation and facilitate the provision of transparent and secure public services [7]. Blockchain is a combination of many existing technologies,

but it constitutes an efficient, decentralized and informational infrastructure that is reshaping the way in which governments and citizens interact with each other [8]. Many efforts have been made by governments to adopt and implement blockchain technology in some of their public services, although the majority of them are still at an early stage [5]. The main aim of this paper is to uncover the challenges that e-government faces when attempting to adopt blockchain technology and to propose potential solutions.

This study is organized as follows and uses a systematic literature review by Kitchenham to examine different ways of measuring the success of the implementation of blockchain technology in the context of e-government [9]. The next section contains background information about both e-government and blockchain technology. The Methodology, as well as the systematic literature review (SLR) are presented in Section 3. Following that, in Section 3 are reported the SLR results, and their discussion is given in Section 4. Section 5 concludes the study, its limitations, and suggestions for future researches.

II. BACKGROUND

"E-government presents a tremendous impetus to move forward in the 21st century with higher quality, cost-effective, government services and a better relationship between citizens and government" [10]. E-government is increasingly a global phenomenon that is consuming the attention of politicians, policymakers, and even ordinary citizens [11]. The initial focus of e-government to provide and maintain a technological environment in government has evolved into transforming the government business model and organization, and is expanded to also cover the transformation of the relationships between government and citizens, businesses and other non-state actors [12], [13]. The inception of e-government opens avenues for citizens to actively partake in decision-making processes that directly or indirectly shape their circumstances. Consequently, citizens are no longer relegated to a passive role but become active contributors to these processes. The advent of e-government, which is an endeavor by governments to leverage Information and Communications Technology (ICT) for the

automation of public services, seeks to enhance their accessibility for citizens, businesses and intergovernmental entities [14], [15]. E-Government strives to ensure equal availability of all necessary services, providing a secure and private environment while enhancing efficiency in delivery. Additionally, it fosters improved communication and citizen engagement, achieves organizational missions and objectives, and contributes to heightened economic competitiveness, managerial effectiveness, and citizen satisfaction [16], [17]. Compared with the traditional e-government, the government has made a qualitative leap in the degree of automation of control, the intelligence of service and decision, the remote supportability, and the space-time scope that the government can control [18]. To ensure ongoing advancements in these and emerging domains, one of the information and communication technologies and tools employed by governments is blockchain technology.

Blockchain Technologies or BCT are capable of solving the problems that countries seeking to integrate them into e-government have had to face over the years [19]. Blockchain is the cryptographically-secure, distributed ledger protocol, best known as the technology underpinning digital currencies, like Bitcoin and Zcash, and smart contract platforms like Ethereum [20]. Block describes the way this ledger organizes transactions into blocks of data, which are then organized in a chain that links to other blocks [21], [22]. Each digital event or transaction within the public ledger requires validation through a consensus mechanism endorsed by the majority of participating nodes in the network. Upon reaching an agreement, the transaction is then documented within a fresh block. A timestamp is affixed to the new block, alongside a hash pointer linking to the preceding block and a nonce — a randomly generated number for hash verification [9]. Subsequently, the newly formed block becomes part of the existing chain of blocks and is disseminated across the network. In this way, blockchain establishes a transaction platform that is secure, decentralized, persistent, fault-tolerant, and auditable [23]. This framework enables transactions to occur in a decentralized manner without relying on a central intermediary.

Blockchain technologies can be classified based on their prerequisites for data access and control. Effectively integrating and utilizing these technologies within the governmental sector signifies a noteworthy stride towards automated governance [24], [25]. Governments around the world are starting the explore the potential benefits and concerns of integrating blockchain based applications into the public-private sector [26]. It is believed that blockchain has great potential benefits for the government such as data integrity, data quality, transparency, avoidance of fraud and manipulation, reducing corruption, and enhancing trust, security, and privacy [27]. The prospect of these potential advantages has captured the attention of governments worldwide, prompting initiatives aimed at bolstering transparency and eradicating corruption [28]. Notably, countries including the USA, the United Kingdom, the Netherlands, the United Arab Emirates, Estonia, Sweden, and China have declared blockchain initiatives, actively exploring its applications in the public sector [29], [30]. Despite the

increasing interest, existing research predominantly concentrates on blockchain's role in cryptocurrencies like Bitcoin, with limited attention given to its broader applications [39]. Recognizing the interdisciplinary nature of blockchain research for government applications, Ølnes et al. [31] advocate for further exploration. They emphasize the need for comprehensive research to unlock blockchain's potential in addressing public sector governance challenges, such as inefficiency, fraud, and corruption [32], [33].

III. METHODOLOGY

To conduct the literature review, the guidelines outlined by Kitchenham, B. were followed [9]. According to Kitchenham, a systematic literature review involves three key phases: planning the review, conducting the review, and reporting the findings. The review is centered on a set of research questions, along with established inclusion and exclusion criteria.

A. Planning the Review

The research goal was to gather insightful information about models assessing the success of e-government systems, particularly exploring the application of blockchain technology in enhancing their efficiency and transparency.

Based on the guidelines from Kitchenham [9], the following research questions are formulated:

RQ1: What are the main benefits and obstacles associated with adopting blockchain technology in e-government?

RQ2: What is the current extent of adoption and prevalence of blockchain technology in e-governments worldwide?

RQ3: What problems in the context of e-government can blockchain technology provide solutions for?

For this literature review the Scopus database was searched. Scopus is a multidisciplinary abstract and citation database with comprehensive coverage of scientific, technical, medical and social sciences literature [34].

Search terms defined for search in this database are presented below:

("Blockchain Technology"

 AND

 "e-government")

 OR

 ("Blockchain applications"

 AND

 "Government services")

 OR

 ("Blockchain implementation" AND "Public administration")

 AND

 PUBYEAR>2017

AND

PUBYEAR<2024

AND (LIMIT-TO (DOCTYPE, "ar"))

OR (LIMIT-TO (DOCTYPE, "cp"))

The inclusion criteria defined for this review are:

IC1: The paper includes both keywords, namely "blockchain" and "e-government".

IC2: Only papers written in English will be in the review.

IC3: The study has to present a feasible approach, applicable in real-life situations.

IC4: The approach should include detailed information about the developed procedure.

Exclusion criteria defined for the review are:

EC1: If a paper is not related to the benefits or challenges of implementing blockchain in the context of e-government, the paper should be removed.

EC2: If a paper discusses the features of blockchain without a specific application in e-government.

EC3: The access to this paper is not freely available on the Internet.

B. Conducting the Review

The primary studies that met the inclusion and exclusion criteria in the literature review phase are presented in Table 1.

TABLE I.   FLOW OF THE EXCLUSION AND INCLUSION PROCESS

Results found	Rejected by title	Rejected by abstract	Rejected by content	Un-available	Final selection
112	40	37	10	2	23

Figuire 1 summarizes quantitative evidence of the inclusion/exclusion process in an appropriate flow diagram.
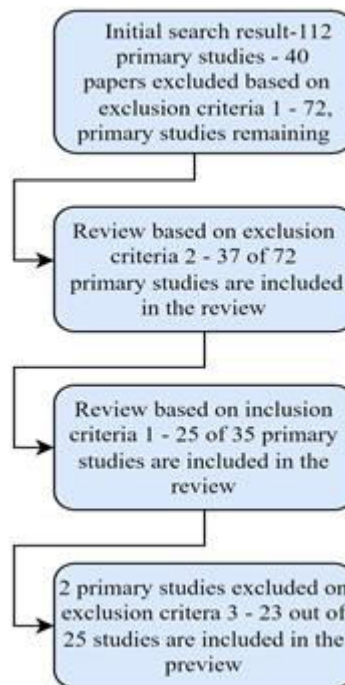

Figure 1.   Flow diagram of the exclusion and inclusion process

Searching through data sources with previously defined search terms led to the discovery of 113 primary studies. During the screening phase, the initial step involved excluding publications whose titles did not meet the criteria. Papers lacking relevance to the benefits or challenges of implementing blockchain in the context of e-government were rejected. At the conclusion of this stage, a total of 41 papers were excluded. In the next stage, 37 publications were excluded by their abstract. After reviewing the remaining papers, 10 were excluded due to their content and were not considered for further research. Furthermore, were identified as inaccessible for reading and removed. Finally, 23 primary studies are included in the literature review.

C. Data extraction and summarization

Through data extraction, the studies chosen in the preceding stages of a systematic literature review were examined and subsequently outlined in the following section. Tables and graphs offer a visual representation of the selected primary papers, based on the criteria for data extraction. All reviewed baseline studies were conducted from 2018 to 2023.

TABLE II.   DISTRIBUTION OF PRIMARY STUDIES PER YEAR

Year	Primary studies	Number of studies	%
2018	[26], [27]	2	8,70
2019	[1], [25], [24], [21]	4	17,39
2020	[22], [23], [5], [20]	4	17,39
2021	[17], [18], [19]	3	13,04
2022	[8], [11], [12], [7], [15], [16], [14]	7	30,43
2023	[28], [13], [6]	3	13,04

As shown in Table 2, the largest number of papers was published in the year 2022. The year 2022 also represents the year when the most papers were published. These data are also visually presented in Figure. 2
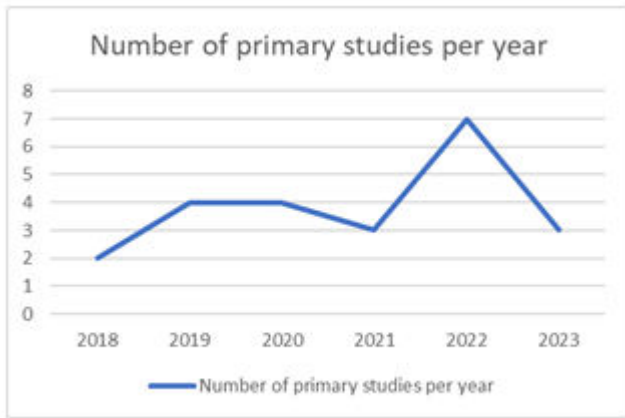

Figure 2. Visual representation of the distribution of primary studies per year

Table 3 displays the types of sources for the primary studies. The majority, 52,17%, were published as journal articles, with the remaining 47,83% being conference papers.

TABLE III. SOURCE TYPES OF PRIMARY STUDIES

Source type	Primary studies	Number of studies	%
Journal article	[20], [24], [8], [26], [14], [33], [42], [13], [1], [26], [39]	11	47,83
Conference paper	[23], [5], [32], [28], [19], [41], [25], [37], [22], [21], [38], [39]	12	52,17

Table 4 outlines the primary studies focusing on the e-government context. Results reveal that 21,74% of the studies discuss the advantages of implementing modern technologies in public sector services, while another 13,04% address challenges and potential issues related to the use of blockchain technology in e-government. It's important to highlight that a substantial 65,22% of the texts discuss both the benefits and obstacles of this approach.

TABLE IV. DISTRIBUTION OF PRIMARY STUDIES BASED ON ASPECT MENTIONED IN THE CONTEXT OF E-GOVERNMENT

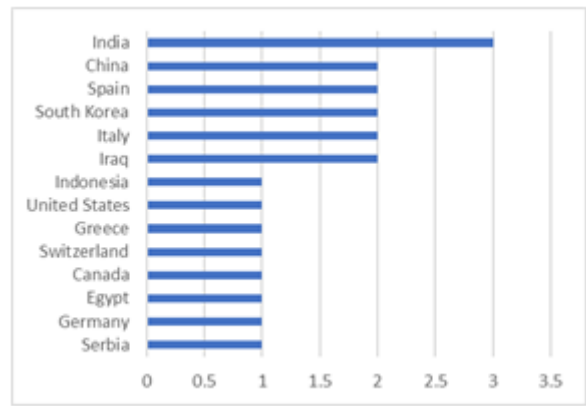| Aspect mentioned in the context of e-government	Primary studies	%
Benefits	[8], [32], [41], [13], [28]	21,74
Obstacles	[22], [42], [40]	13,04
Mixed	[37], [19], [20], [24], [5], [25], [14], [26], [39], [33], [26], [1], [23], [40], [38]	65,22

Figure 3. Review based on countries

Table 5 presents the primary studies showing problems associated with blockchain implementation in e-government. Results reveal that the most of the studies are focused on problems with privacy (65%). These data are visually presented in Figure 4.

TABLE V. DISTRIBUTION OF PRIMARY STUDIES BASED ON THE PROBLEM MENTIONED IN THE CONTEXT OF E-GOVERNMENT

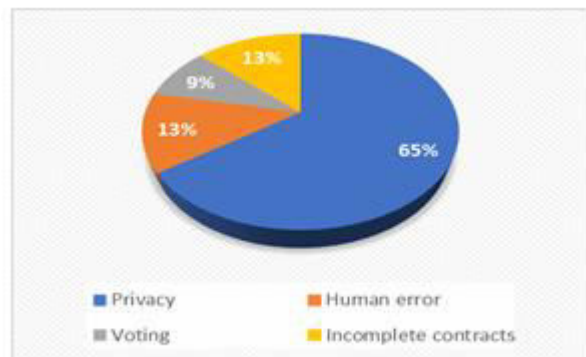| The problem mentioned in the context of e-government	Primary studies	%
Human error	[13], [22], [20]	13
Voting	[32], [42]	9
Privacy	[28], [19], [5], [24], [25], [26], [39], [8], [26], [21], [1], [23], [41], [39], [38]	65
Incomplete contracts	[37], [14], [33]	13

Figure 4. Review based on problems

IV. Discussion

In this section are discussed the results and the findings from the conducted systematic literature. The overall impression that can be obtained by considering the results is that the number of published works is decreasing from year to year, which is shown in Table 2 and Figure 2. This may indicate an evidently low level of interest in the topic of blockchain implementation within e-government compared to, for example, the year 2022. Nevertheless, this does not mean that the applications and possibilities of blockchain technology are not still being studied. In addition, although India lags far behind the so-called developed countries, the largest number of authors are from India and have chosen to cover a modern topic like Blockchain. The largest number of works originate from India, which is presented in Figure 3.

In response to RQ1, it can be concluded that implementing blockchain in e-government holds the potential for numerous innovations in the public sector. In Table 4, there is a higher percentage of benefits in primary studies compared to obstacles (21,74%). However, it is not a big difference to be able to establish that most of the obstacles have been resolved. By analyzing Table 4 it can also be seen that a majority of the papers a challenge corresponding to every benefit, which may have a negative effect (65,22%). For example, Transparency is a necessary, but not a sufficient condition for ensuring greater public accountability [35]. Data digitalization, transparency, and traceability have an important role in the adoption of technology, while human dissatisfaction and insecurity represent a real challenge [36].

As an answer to question RQ2, Figure 3 shows India's dominance as a country interested in Blockchain technology innovation. Perhaps it was expected that researchers from more developed countries, such as the United States and Germany, would pay more attention to this topic. The broader use of blockchain technology surely should be greater interest globally.

In the end, as the answer to the last question (RQ3), it has been established that there are a large number of problems for which the blockchain can find the right solution. The key problems are related to human errors, privacy, incomplete contracts and voting. By analyzing Table 5, it can be definitively confirmed that privacy is the most significant issue and challenge in the implementation of blockchain technology in e-government (65%). Following privacy, issues related to incomplete contracts, voting, and human errors arise. The Blockchain features that can address these issues include: security, decentralization, immutability, traceability, and smart contracts [37]. The ambition is to explore blockchain attributes that precisely address the challenges faced by the current governance structure [38].

V. CONCLUSION

With the expansion of blockchain technology into various domains, research efforts have significantly surged in recent years, particularly in exploring its impact on e-government [39]. Studies in this area have been reduced, which is why the main topics discussed in the selected literature are limited. Furthermore, there is still a need for more in-depth research in this domain to further enhance the maturity of this research field [5], [15]. The main purpose of this literature review is to study in detail and show the impact of blockchain technology in e-government. At the beginning of the paper, research questions were formulated, and answers were provided throughout. Contemporary literature indicates that there is a multitude of problems and challenges associated with the adoption of blockchain technology as a form of modernization.

Addressing these challenges certainly presents a difficult task, but blockchain technology includes functionalities that can have a significant impact. The theoretical and qualitative analysis of the framework's security and privacy reveals that cryptography, immutability, and the decentralized management and control provided by blockchain technology can ensure the necessary security and privacy in e-government systems [40], [41]. The proposed system also possesses the potential to address various challenges such as human errors, incomplete contracts and voting issues [42].

In conclusion, this research, despite limitations, provides a view on the challenges and issues arising in the context of blockchain and e-government. From the primary studies, it can be concluded that the researchers emphasize the insufficient number of sources for researching the features of blockchain technology, as well as hope that in the years to come, the wide range and perspective of blockchain technology can be more proven.

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