

Investigative success factors concerning adoption of blockchain technology on behalf of e-government improvement

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ABSTRACT

The ability of blockchain technology to record transactions on distributed ledgers offers new opportunities for governments to improve transparency, prevent fraud, and establish trust in the public sector. However, blockchain adoption and use in the context of e-Government is rather unexplored in academic literature. In this paper we systematically review relevant research to understand the current research topics, challenges and future directions regarding blockchain adoption for e-Government. The results show that the adoption of blockchain based applications in e-Government is still very limited and there is a lack of empirical evidence. The main challenges faced in blockchain adoption are predominantly presented as technological aspects such as security, scalability and flexibility. From an organizational point of view the issues of acceptability and the need of new governance models are presented as the main barriers to adoption. Moreover, the lack of law and regulatory support is identified as the main environmental barrier of adoption. Based on the challenges presented in the literature, we propose future research questions that need to be addressed to inform the best approach in blockchain adoption for e-Government systems.

KEYWORDS: Blockchain; adoption; government; public service; literature review

1.0 INTRODUCTION

Innovations and transformations across many aspects of the public sector can be driven by the use of new technologies by governments. The use of information technologies (IT) to improve the public sector is often captured by the label of e-Government [1-11]. 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. Hence, the adoption of new technology to improve public services delivery has become more critical for government organizations [12-19]. Blockchain technologies, that are (amongst others) at the core of cryptocurrencies such as Bitcoin, are presented as a major breakthrough with great potential in public sectors. Blockchain has the potential to make government operations more efficient by improving the delivery of public services and increasing trust in public sectors. Also blockchain applications can be transformative, as it can change the way transactions are recorded [20-28]. Basically, blockchain is a distributed ledger that is shared among participating parties in a network, used to record transactions that are verified by a consensus mechanism that creates trust in the network. The majority of the participants in the network have to agree to approve the transaction. Once a record is created and accepted by the blockchain, it can never be altered. In this way, the distributed ledger provides an immutable record and ensures traceability of transactions. Governments around the world are starting to explore the potential benefits and concerns of integrating blockchain based applications into the public-private sector [29-37]. 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. These potential benefits attracted the attention of governments in many countries to improve transparency and to eliminate corruption. Several countries such as the USA, the United Kingdom, the Netherlands, the United Arab Emirates, Estonia, Sweden and China announced blockchain initiatives to actively explore its uses in the public sector [38-44]. Some of the potential benefits such as trust and transparency can be especially beneficial for developing countries since they are more vulnerable to corruption, fraud, and lack of trust than developed countries. However, most of the current research related to blockchain is focusing on its application for cryptocurrencies, such as Bitcoin, and only a limited number of research is

targeted at exploring the utilization of blockchain in other environment [45-50]. The importance of interdisciplinary research in the potential use of blockchain technology for government was suggested. They argue for more research into the possibilities of using Blockchain in the public sector to improve public services and to solve some of public sector governance problems such as inefficiency, fraud and corruption. In this article we analyze the state of the art in blockchain adoption in the public sector by performing a systematic study of peer-reviewed scientific literature. With this literature review we provide an overview of challenges in blockchain adoption in the public sector that serves as insight for both practitioners and researchers in order to suggest areas for further research. The structure of this article is as follows: Section 2 lays the theoretical foundations concerning blockchain technology for government by exploring the potential benefits of blockchain for government as well as presenting its implications. In section 3 we present our research methodology for the literature review, followed by section 4 in which we present the challenges for blockchain adoption based on the literature review. In section 5 we translate these challenges into future research topics. We finalize with a discussion of the practical implications and limitations of our literature review in section 6.

2.0 LITERATURE REVIEW

Blockchain was first proposed in 2008. Blockchain is essentially a public ledger, in which all transactions are stored in a chain of data packages (blocks) and distributed across a peer-to-peer network. All involved nodes in the network hold a copy of the blocks [1-9]. Every transaction or digital event in the public ledger has to be validated using a consensus mechanism by the majority of those participating nodes in the network. If agreed, then the transaction is recorded in a new block. A timestamp is applied to the new block along with a hash pointer as a link to the previous block and a nonce, which is a random number for verifying the hash [10-17]. After that, the new block is added to the previous chain of blocks and distributed across the network. In this way, blockchain provides a secure, decentralized, persistent, fault-tolerant and auditable transaction platform which allows a transaction to take place in a decentralized fashion without the need of a central intermediary [18-26]. In general, blockchain has the following key characteristics: Decentralization. Unlike a traditional transaction which is validated through a central trusted agency, every node in the network can validate transactions and has an identical copy of the ledger. This mechanism causes transactions in a blockchain to have advantages in fault tolerance, data consistency, higher user control, attack resistance, transparency and it also enables the removal of third-party intermediaries, such as a notary or financial institutions; Persistency [27-36]. The use of a consensus mechanism, a timestamp, and a cryptographic seal mean that invalid transactions will not be admitted and it becomes impossible to edit, delete or copy transactions that are already recorded in the blockchain. These blockchain features provide for data consistency, fraud protection, ownership assurance and immutable records of the transactions; Anonymity. Interactions based on blockchain technologies take place between two individuals using public-key cryptography, by which their identities are covered by pseudonyms. In this way, user privacy will be better protected than in classic electronic transactions; Auditability [37-43]. All transactions in a blockchain are stored in a chronological order, including the previous block's hash and storage of the hash of the current transaction which is meant to connect the next block when added. With this mechanism, transactions can be easily verified and tracked. These key characteristics of blockchain technology provide some potential benefits to be utilized in the public sector to improve public services. Some of the benefits such as the distributed architecture, the immutability and transparency may be useful to eradicate fraud and corruption in public sector. With the use of the technology, every transaction in public services can be recorded without manipulation and enables better transparency and subsequently can improve trust in public services [44-50]. If the promised benefits of blockchain technology could be proved, it is possible that the technology could reach an inflection point and start gaining widespread acceptance by governments around the world in the near future. However, point out that those potential benefits have not been proven by empirical evidence as of yet. Consequently, further interdisciplinary research in broader aspects of blockchain such as governance models, design variables, impact and risk are needed. Therefore, we used a literature review to map the challenges of blockchain adoption in the domain of government, but first we present the method that we followed for finding the literature in the next section.

3.0 RESEARCH METHODOLOGY

Given the importance of the potential use of blockchain in the public sector, we carried out a systematic literature review to identify current research and potential use of blockchain technologies in e-government applications. To achieve this aim, we formulated the following research question: What is the current state of the art in research and which are the main challenges faced in adopting blockchain technologies in the domain of e-Government? In this work, the guidelines for a systematic literature review provided by Kitchenham and Charters are followed. We used the following search terms, derived from the major terms in our main research question, are: Challenges of Blockchain Technology Adoption for e-Government: A Systematic Literature Review (blockchain OR “block chain” OR “distributed ledger”) AND (government OR “public service” OR “public sector”) We used three electronic database resources to find research articles: Scopus, ScienceDirect, and SpringerLink. Title, abstract and keywords were used to conduct a search for published journals papers, conference proceedings, workshops, and symposiums. The literature search resulted in 354 articles up to 30 December 2017 (see Figure 1).

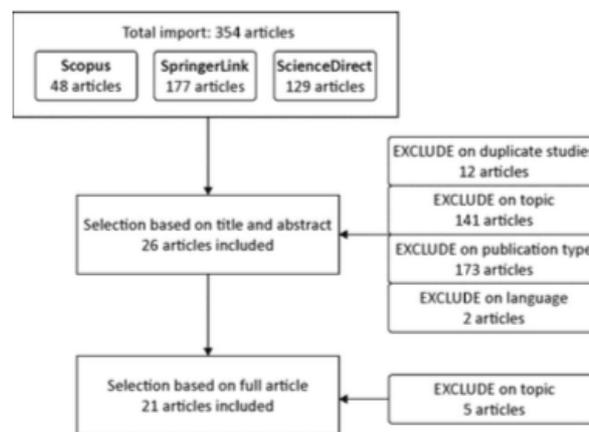


Figure 1: Search and study selection

A number of additional criteria were determined to select appropriate studies for inclusion in the review. To be included in the review, articles should: (a) be published in a peer-reviewed journal or conference proceedings, (b) present research about the use of blockchain technology in e-government, (c) be presented in English, (d) be accessible in full-text, (e) not duplicate with articles from other databases. After filtering, the article set was narrowed down to 26 articles. All 26 eligible publications were manually read to check the relevance for this research. An evaluation based on the full-text reading reduced the number of articles to 21 articles. The search and selection processes of this review are illustrated in Figure 1, and the full list of the selected articles is presented in Table 1. In the next section we present a description of these articles and analyze them to find the challenges they present for blockchain adoption in government.

4.0 RESULT

Some pioneering works were published in efforts to explore blockchain adoption for e-Government systems and services. There were 21 scientific articles published proposing blockchain integration within e-Government, in which 15 articles were published in conference proceedings and only 6 articles appeared in scientific journals. Furthermore, of the 21 articles 3 of them were published in 2016 and 18 articles appeared in 2017. This suggests that efforts to utilize blockchain technology in the public sector have only just begun. This comes not as a surprise as noted, who shows that the potential use of blockchain in the public sector has not been widely realized and reported upon so far. When looking into the application domain, most of the research (7 articles) discuss the application of blockchain for e-Government in general, discuss the idea, potential benefits, current issues, potential

use, approach and evaluation of blockchain adoption. Blockchain applications in public healthcare received the highest attention, with four articles looking into the possible use of blockchain to improve patient medical records integrity. Meanwhile, three articles examined the use of blockchain in education services to overcome lack of data integration and integrity in the public education sector. Moreover, blockchain adoption is proposed in the context of smart cities in other 3 articles, two articles look into in the context of government to business supply chains, and single articles are dedicated to digital identity, e-voting, and the tax system. The state of the art in literature shows that the utilization of blockchain in the e-Government domain is still very limited. It is likely that not all typical applications to record transactional data such as ownership, important information and document records such as land and vehicle registry, certificates (birth, marriage, education), (business) licenses and others, as suggested, have been explored. This descriptive overview indicates that applications based on blockchain technologies have not yet materialized in full in the public sector. There is much work that is rather conceptual and does not link to actual implementations or evaluations in the empirical work. We therefore carried out another analysis of the literature by looking into the research process stages that are represented by the literature. This will yield an extra indicator for the state of the art in the academic literature on blockchain adoption in the public sector. In order to classify the research process stages presented in the selected articles, we use the categorization of the systems development research process which are: conceptual framework, system architecture, system analysis and design, system (prototype) development and system evaluation. After reading all the selected articles, we identified 11 articles that are focused on providing conceptual frameworks of blockchain utilization in e-Government applications. Some of the articles discuss current issues, the potential benefits, the importance and general vision of adopting blockchain technology to improve public services delivery, and e-voting. Furthermore, we analyzed the influence of blockchain technology on the smart city

5.0 CONCLUSION

In this article we present the findings of a systematic literature review on the current state of affairs in research and the challenges faced in the adoption of blockchain technologies in the domain of e-Government. Our findings show that academic research in this area has only just started and issues discussed in the selected literatures are still very limited. Consequently, more intensive research in this area is still necessary to advance the maturity of this field of research. Particularly, empirical studies using rigorous research protocols should be enforced in government context to study the various potential benefits of blockchain adoption. Empirical studies will increase the reliability and clarify the validity and limitations of the advantages and potential benefits of blockchain technology. This is relevant for the government practice as well as the academic research. The contemporary literature shows that the main challenges in blockchain adoption are rooted in the technology aspects such as security, scalability and flexibility. Meanwhile, the need of new governance models and acceptability of this technology are the major challenges from the organizational perspective. Moreover, from the environmental aspect, laws and regulations support is the biggest problem that needs to be addressed. In order to resolve the technological challenges, we propose research into blockchain technology standards and a reference architecture for e-Government applications. Also a systemic approach to study the transformational consequences with more emphasis on the organizational context in developing blockchain based applications is needed. Moreover, an approach to find a balance between regulatory and legal frameworks and the applications of innovative blockchain technologies is needed. Finally, a shared, secure and scalable infrastructure to stimulate the development and diffusion of new blockchain-based technology is important to advance large-scale adoption. The limitations of our literature review are linked to the choice of the search terms used, the journals included and the time period of the publication of the selected articles. Some important facts from publications that fall into the realm of grey literature might be missed since we did not include grey literature in our review. However, the articles discussed in this review provide an overview of the state of the art in academic research in blockchain technology adoption for the e-Government system. Annual repetition of the literature review will allow us to track and map the developments in this research area. To conclude, the review in this study offers a useful starting point for future research themes for the development of blockchain-based e-Government systems for practitioners and researchers.

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