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Review

Blockchain and a Technological Perspective for Public Administration: A Systematic Review

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Blockchain e a Perspectiva Tecnológica para a Administração Pública: Uma Revisão Sistemática

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ABSTRACT

Objective: the systematic review of this article aimed to present the applications and consequences of using Blockchain for public administration. **Method:** from researching articles in the Scopus, Web of Science, SSRN and Science Direct databases, and following the PRISMA method, 16 articles were selected that contain the following themes: Blockchain, direct government participation or as the main regulator, public policy. **Results:** the main applications used were related to: data processing and public data security, required new applications and institutional organization. As for the impacts, we highlight the improvement in data management, reduction of bureaucracy and the need for a relationship between the State, society, and market. **Conclusion:** blockchain is a technology capable of renewing management processes, creating new challenges for public administration.

Keywords: blockchain; public administration; e-government.

JEL Code: O14, H83, L86.

RESUMO

Objetivo: a revisão sistemática desenvolvida neste artigo teve como objetivo apresentar as potenciais aplicações e consequências do uso da *Blockchain* para a administração pública. **Método:** a partir da busca de artigos nas bases Scopus, Web of Science, SSRN e Science Direct, e seguindo o método PRISMA, foram selecionados 16 artigos que continham as temáticas: *Blockchain*, participação governamental direta ou como principal regulamentador, política pública. **Resultados:** as principais aplicações encontradas foram referentes a: processamento de dados e segurança de dados públicos, novas propostas de regulamentação estatal e de organização institucional. Quanto aos impactos, destacam-se a melhoria na gestão dos dados, diminuição da burocracia e necessidade de afinar a relação entre Estado, sociedade e mercado. **Conclusão:** a *Blockchain* apresenta-se como uma tecnologia capaz de renovar os processos de gestão, mas criando novos desafios à administração pública.

Palavras-chave: *blockchain*; administração pública; governo eletrônico.

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INTRODUCTION

Technology has been impacting the way government and society interact for decades. Following technological advancements, new management tools are incorporated into public and private organizations. In the Brazilian federal government, for example, e-Government introduced information technologies to optimize and streamline the services provided and to improve communication both internally (amongst different government bodies) as well as externally (society) (Chahin, 2004), enabling access to information and improving government transparency. Melati and Janissek-Muniz (2019), in a study on Intelligent Government scope, address the importance of recognizing and applying technology to organize public data and information, suggesting its relevance to the agility and quality of administrative practices. Cavalcante (2018) presents trends in Brazilian public management, such as accountability, participation and social engagement, e-Government and information and communication technologies.

Technological transformations challenge organizations to adapt to new forms of management, reflecting the adaptation of work and business to new technologies. Momo, Schiavi, Behr and Lucena (2019) witness this in the private sector, where the success of businesses is related not only to the introduction of new products and/or services, but to the innovation of business models. In the public sector, this logic is also true, encouraging the creation of laws and regulations that guide the implementation of public policies as well as administrative processes based on the introduction of technologies aimed at making public administration faster and more responsive, corresponding to new social demands and increasing democracy in the country (Vieira & Santos, 2010). It can also be noted that the government-citizen relationship has gradually shifted from government-centered to citizen-centered, thus enhancing the perspective of public value.

According to Cepik, Canabarro and Possamai (2014), Digital Age technologies such as the Internet "radically change the nature and way democracy, government and the State itself function" (p. 12). Thus, we note the importance of keeping updated studies and research of new technologies in public management, in order to offer a balanced reflection of the changes in evolution, seeking to support the agenda of government managers in the incorporation of aspects related to the use and application of new technologies.

This growing technological agenda has driven the acceleration of institutional changes. For Schwab (2016), a Fourth Industrial Revolution began at the turn of the century, based on the Digital Revolution, whose transformations are felt in the economy, society and governments. A remarkable technology is Blockchain, which has been pointed as a tool capable of giving reliability and security to data. The key point is in your programming chain, where with each transaction executed, a unique encrypted key is generated from a check network of code acceptability, making the transaction secure and irreversible (Swan, 2015).

Blockchain, which is already a technology under development in various private sectors (Momo, Schiavi, Behr, & Lucena, 2019), will also influence public institutions and the ways in which they manage. In this perspective, information management and the reliability of government data are essential for a more prosperous and constructive dialogue between society and the State (Cavalcante, 2018), and this technology is fundamental for providing data reliability. This brings challenges to public administration, such as those related to social welfare, the corporate sector and governments themselves. Public managers need to adapt governance style to new technologies, in order to making the public sector structures more efficient and processes more transparent, keeping governments globally competitive (Shava & Hofisi, 2017).

According to Bindu, Sankar, and Kumar (2019), e-government studies raise questions about open data, online social platforms, participatory governance, and Web 2.0 (information transaction) applications, demonstrating that the government-society correlation has been heading towards a democracy based on electronic decision-making and information exchange processes. Blockchain is a technology that can provide security in the storage and management of public data, thus enabling the justification of its adoption. Przeybilovicz, Cunha and Meirelles (2018), when dealing with the use of Information and Communication Technologies (ICT) for the development of e-Government, identified that it is needed to consider the legal and socioeconomic context in which this implementation is being carried out, considering the actors involved and the institutional capacity of the participating bodies. Also, the need to educate citizens in the use of technologies must be considered, facilitating practices of digital democracy.

The need to pursue the implementation of e-Government by introducing technology into public processes aims to improve the efficiency of public service provision along with the segmentation of

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users of these services to better respond to demands, more accurately measure the effectiveness of public policies, respond to economic demands of the country and engage its citizens in public decisions and policies generated from the trust in the sector due to its use of technology (Al-Jenaibi, 2015).

Thus, considering that the debate between Blockchain and public administration is still in phase of maturation, this article seeks to answer: What are the possible applications and impacts that the use of Blockchain can offer to public administration?. From this question, and aiming to contribute to the debate of the transformation of Public Management in the Fourth Industrial Revolution, the intent is to understand what are the possible applications and consequences of the use of Blockchain for public administration, opting for a Systematic Review (SR) as the methodological procedure, following the PRISMA model (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2015) for its execution. After this introduction, section 2 presents the concept of Blockchain, followed by section 3 which shows the SR steps and results. Section 4 presents a critical analysis of the results, followed by the conclusion.

BLOCKCHAIN

Blockchain is a technology that has the potential to transform the ways in which markets and governments operate. Considering its characteristics of reliability, immutability, authenticity and auditability, from the generation of encrypted data that goes through a horizontal validation network (Han, 2017), the technology has inspired a variety of researches that propose its use in various fields of knowledge. Launched in 2015 by the UK government, the report called 'Distributed Ledger Technology: beyond blockchain' highlights the importance of technology and considers it a possibility for the improvement of services provided by government, industry and services such as: financial services, real estate investments, health and identity management (Government Office for Science, 2016).

Blockchain is based on a mathematical algorithm that, through a chain of blocks, identifies a transaction executed online. The chain of blocks formed after the operation is registered and replicated in several servers responsible for validating, by consensus, the registration. This makes this encryption secure because with multiple scattered copies it becomes difficult to alter blocks through a cyberattack (Government Office for Science, 2016). This technology is based on the Distributed Ledger Technology (DLT) concept. Swan (2015) defines Blockchain:

> The blockchain is a worldwide decentralized public ledger for the registration, acknowledgement, and transfer of all assets and societal interaction, a society's public records bank, an organizing mechanism to facilitate large-scale human progress in previously unimagined ways. ... The blockchain is a consensus model at scale, and possibly the mechanism we have been waiting for that could help to usher in an era of friendly machine intelligence (Swan, 2015, p. 94).

This technology has become popular through its implementation in a global financial transaction system realized through the digital cryptocurrency Bitcoin, conceived by Nakamoto (2008). With each financial transaction, an encrypted key is generated, making the transaction secure. For validation, this code goes through a series of servers, which will validate it through mining. This procedure aims to solve the value of the new algorithm created when a new transaction is requested (Oberhaus, 2017), providing the creation of a unique, tamper-proof, immutable and resilient encrypted code capable of promoting a secure, fast and intermediary-free financial transaction (Zachariadis, Hileman, & Scott, 2019).

The popularity of Bitcoin is in the way that Blockchain was applied, enabling versatile and innovative features. It is an encrypted key-based technology, a sequence of blocks where each has a predefined number and its union with other blocks is based on mathematical logic. Thus, the sequence is not randomly created, ensuring reliability to the process. Each block represents an operation, secured by encrypted digital signatures, meaning that the issuer and recipient of the transaction are protected, as well as the record, giving transparency and accountability to transactions (Formigoni Filho, Braga, & Leal, 2017; Government Office for Science, 2016; Swan, 2015; Zachariadis et al., 2019).

Blockchain also has a distributed network for verifying the authenticity of the operation and there is a public copy registered on each server that executes the operation for each fact performed (Zachariadis et al., 2019). Additionally, the transaction amongst peers streamlines several types of processes, eliminating process intermediaries (Formigoni Filho et al., 2017).

Considering the mentioned attributes, one notes derived features, such as security in the storage of the records, allowing the immutability of the data and, thus, integrity and reliability; decentralization of operations, creating a validation network that makes fraud difficult; possibility of more accurate and

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accessible accountability, with transactions recorded in an unchanged and encrypted distributed ledger (Nofer, Gomber, Hinz, & Schiereck, 2017; Swan, 2015; Zachariadis et al., 2019). However, it is worth noting that not all Blockchain's operation is necessarily similar to Bitcoin.

Blockchain networks can differ in public (permissionless) or private (permissioned) networks. The first has its own rules, operating independently of legal or regulatory aspects - as is the case with Bitcoin; transaction validators are anonymous and admission to participate in the network of miners is freely accessible. On the other hand, private networks follow regulations and participants are pre-selected, applications are restricted to closed corporations only (Formigoni Filho et al., 2017; Yermak, 2017). That is, encrypted access keys for operations on an open network are widely accessible and anonymous, while on a permissioned network, access keys are controlled and permission for transactions must be requested (Blockgeeks, 2019).

According to Pilkington (2016), one can think of the essence of Blockchain as informational and procedural, and not simply related to the monetary realm. Thus, considering that Blockchain can be applied beyond financial transactions, for example, the Ethereum[1] platform, which uses Blockchain, allows for a secure ledger to enable decentralized and generalized transactions (Wood, 2014). In this concept, various types of transactions can be executed, from the creation of tokens or currencies for each venture to making smart contracts, more complex transactions secured by Blockchain properties.

Smart contracts are programs that combine user interface computational protocols to execute contract terms (Szabo, 1997). With Blockchain, the process becomes simplified compared to existing technology at the time the concept of smart contracts was conceived (Blockgeeks, 2017). This innovation may eventually replace the need for lawyers and banks involved in asset contracts, as the terms of business between both parties are presented; you can also control property owners, tangible (houses, cars) or intangible (data sharing, access permission) (Nofer et al., 2017). All possibilities become viable based on the lack of need of a third party to confirm or expedite the process.

Beck, Avital, Rossi and Thatcher (2017) indicate likely Blockchain-related topics of study, such as payment platforms, legal issues, organizational implications, the Internet of Things (IoT), sustainable social and environmental development, energy efficiency, as well as new currencies and actors involved in future organizational models derived from the new technology. Colchester (2019) foresees Blockchain-driven trends such as more flexible government regulatory agencies and ready-to-work initiatives led by more transparent governments and consortia, considering governance models based on shared data as well as distributed systems.

Alcantara, Rodrigues, Lima and Nunes (2019) highlights Blockchain government-level initiatives such as the establishment of a healthcare platform in the Estonian government, the Dubai Blockchain Strategy initiative, which aims to enable financial transactions through Blockchain, as well as strives to make Dubai a world reference in the use of this technology. Also, the author highlights the Dutch initiative Dutch Blockchain Action, an agenda for the development of Blockchain that has as its pillars “digital identification”, “conditions for the use of blockchain technology” and “enabling the development and use of technology” (Alcantara, Rodrigues, Lima, & Nunes, 2019, p. 14).

Allessie, Sobolewski, Vaccari and Pignatelli (2019) present a survey of Blockchain application projects in European public administration, involving use in notarial services, distributed bases and smart contracts for land registration and transfer, academic certificates, government payments, decentralized system of identities. The authors identified that the majority of the projects are still in the testing phase, not providing conclusive results on impacts on public management. The authors pointed out that projects that involve a smaller variety of stakeholders and more centralized governance have less complexity, such as projects with notary application. On the other hand, projects with more disruptive solutions involving distributed bases and smart contracts, for example, face more implementation challenges, usually related to incompatibility with operating administrative processes and non-compliance with current regulations.

Also in Brazil, several initiatives have been accomplished to appreciate the technology and its applications. Still following smart contracts, Luciano (2018) proposed their use for the automation of contract management in the Brazilian natural gas commercialization process, showing the potential improvements in the control of contracts related to state-owned companies.

In January 2019, at the international seminar Disruptive Technologies for Financial and Public Services at the Banco Nacional de Desenvolvimento (BNDES; The Brazilian National Development Bank), the importance of data transparency and integrity

was highlighted and Blockchain was presented as one of the key technologies for such transformation. Gladstone Arantes (systems analyst and technical leader of the BNDES Blockchain Initiative) perceives this technology as the possibility of achieving the United Nations Sustainable Development Goals (Agência BNDES de Notícias, 2019). One of the projects is to use Blockchain to track public money used to finance projects through the use of token (Leal, 2017).

SERPRO launched in 2017 a Blockchain platform to solve Treasury Direct (TD) issues, in order to facilitate any citizen's access to investment in government bonds without having to have their own bank account (Serviço Federal de Gerenciamento de Dados [SERPRO], 2017).

In academic spaces, was found the example of the Universidade Federal da Paraíba, which in February 2019 delivered the first Blockchain-based digital diplomas. This initiative was encouraged in view of the high rate of denunciations of counterfeit diplomas and the lack of proof of the authenticity of higher education certificates. The expectation is that the technology will be passed on to other Brazilian higher education institutions (Rede Nacional de Ensino e Pesquisa, 2019).

Despite the optimism with regards to the development of this new technology, it is important to note that the implementation of Blockchain presents challenges and technical limitations, such as the low information transfer capacity per second, the lead time to generate a safe transfer, the size of the data created, security, the waste of energy resources used for mining, the difficulty of creating programs using Blockchain due to its complicated application programming interface and the use of simpler versions of cryptographic keys, which may be more vulnerable to cyber attack (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016).

From the above, we note that Blockchain and public administration have a positive and constructive relationship. Also, it is possible to infer that this technology affects social, productive and organizational dynamics through new tools created to solve contemporary problems. In the next section, by performing an RSL using the Prisma method, we will explore and present this relationship.

SYSTEMATIC REVIEW: BLOCKCHAIN IN PUBLIC ADMINISTRATION

The research developed made use of the Systematic Review. This method was chosen because it aims to summarize a large amount of existing information about a phenomenon. According to Sampaio and Mancini (2007), "systematic reviews allow incorporating a broader spectrum of relevant results, rather than limiting the conclusions to reading only a few articles" (p. 84). For Mendes-da-Silva (2019), "it is understood that the publication of revisions may constitute a channel for continued publication of relevant contributions" (p. 4). In this way, from the SR performed, collaborate with the study of Blockchain and potential applications in the public sector. To operationalize this review, the main assumptions of the PRISMA method - Preferred Reporting Items for Systematic Reviews and Meta-Analyze (Moher et al., 2015) will be applied as follows.

The steps of SR

In this research, the activities performed for SR are based on the PRISMA method guidelines (Moher et al., 2015). To summarize the literature on the topic of the article, as well as to contribute to a future research agenda (Mendes-Da-Silva, 2019), some aspects recommended by the PRISMA method were adopted (Moher et al., 2015), especially the eligibility criteria, analysis and communication of research applicable to systematic reviews.

The SR started by (1) formulating the question, followed by (2) the location of the studies and search detailing. Subsequently, we proceed to (3) critical evaluation of the studies, with the modeling of filters to select the relevant works and later (4) data collection. Finally, we run an (5) analysis and presentation of data, extracting the most relevant information for (6) interpretation of data and afterwards (7) critical analysis, source of debate on the topic.

The guiding question (1) of the SR was 'What are the possible applications and impacts that the use of Blockchain technology can provide to the public administration?'. To answer the question, the study search strategy (2) used the definition of the search string, with keywords that can submit articles matching the search. A test was performed to verify the amount of returns of each elaborated string. Table 1 brings the results obtained in the first step. Concurrently with the definition of the strings, the search sources were chosen: Web of Science, Scopus, Science Direct and Social Science Research Network (SSRN).

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Table 1. Search strings and quantity obtained.

Test	String	Web of Science	Scopus	Science Direct	SSRN
1	"administration" + "blockchain"	24	59	289	19
2	"public administration" + "blockchain"	8	18	43	6
3	"public administration" + "blockchain" + "electronic government"	1	1	4	0
4	"blockchain" + "electronic government"	11	2	5	11
5	"public administration" + "blockchain" + "applications"	4	6	37	1
6	"public administration" + "blockchain" + "e-government"	1	3	10	4
7	"blockchain" + "government" + "public management or administration"	6	6	109	5

The selected string was "blockchain" + "government" + "public management or administration", because, despite not always returning the highest quantitative return results, the results obtained were more accurate and loyal to the research theme, i.e. the application of Blockchain in or related to public administration. Table 2 presents the way the search was performed on each platform.

Table 2. Terms used to search on each platform.

Platform	Terms used
Scopus	Blockchain *and* government *and* public (management or administration)
Web of Science	TS=(blockchain AND government AND public AND (administration OR management))
SSRN	blockchain government public*
Science Direct	Blockchain AND government AND public AND (management OR administration)

Note. * After the main search was completed, the search with the words management or administration was refined.

Filters were created to select the articles (3) that would bring more relevant information to the study (Table 3). The articles prior to 2013 were initially excluded, as it was noticed that previous works brought more technological and conceptual discussions of Blockchain. In comparison, articles published from 2013 brought information of applications and more consolidated views of use, more in line with the purpose of this research. The second filter was the selection by language (English and Spanish) and the third by literary production. Only scientific articles, including review articles, were selected; book chapters and other textual forms have been disregarded.

Table 3. Filters used for the selection of RSL articles and their justification.

Order	Filter	Justification
1st	Publication Date	Blockchain's study beyond financial transactions is a novelty. In previous years, the articles were about the technology itself. From 2013, the industry began to consolidate and some case studies were reported.
2nd	Language	The searches were performed with strings with English terms. Papers with abstracts in English that were published in Spanish were also accepted.
3rd	Material Selection	Only scientific articles were selected; books and book chapters have been excluded as well as repeated articles.
4th	Summary Analysis	From the summaries, the word Blockchain was identified. If the abstract had this term in its body, then it was searched for: Public Administration, Public Politics, Electronic Government and E-Government.
5th	Reading of Articles	At the end of the process, 28 articles remained, which were fully read and selected only those that specifically dealt with Public Administration as well as Blockchain.

In the fourth filter, the articles were selected. Eligibility criteria were (i) the identification of the word Blockchain explicit in the abstract and (ii) terms that refer to the space encompassing public administration, such as: policy, public policy, government, e-government, politics, public. Also, the relevance that the public administration had in relation to the suggested use of Blockchain.

In the end, according to Figure 1, 28 articles remained, which were read to verify if they covered the chosen theme: Blockchain and public administration. Of these, 16 articles remained for analysis. Steps 4, 5, 6 and 7 - data collection, data analysis and presentation, data interpretation and critical analysis, respectively - will be presented and discussed in the following sections. Items 5 and 6 were performed in the Nvivo 12 Pro software.

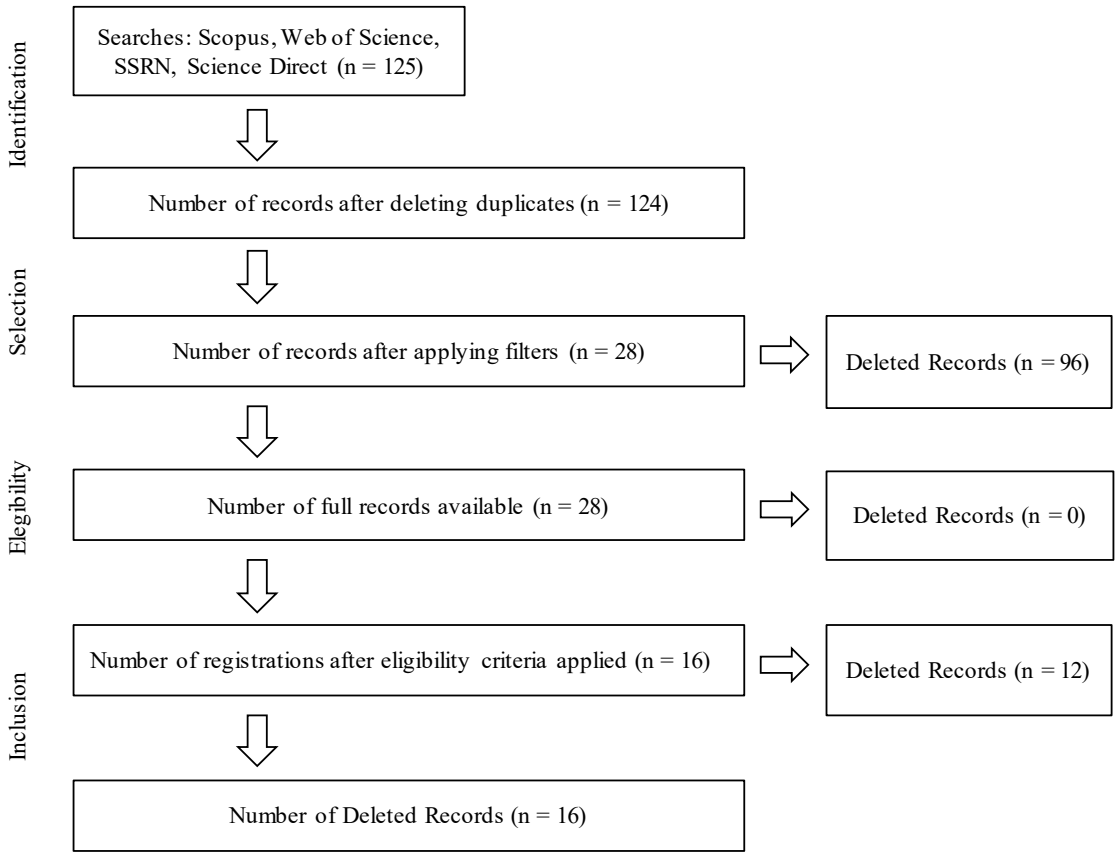

Figure 1. Flow of the Selection Process.

According to the PRISMA Model, by Moher D., Liberati A., Tetzlaff, J., Altman D. G., & The PRISMA Group (2015). Principais itens para relatar revisões sistemáticas e meta-análises: A recomendação PRISMA. *Epidemiologia e Serviços de Saúde*, *24*(2), pp. 355-342. Retrieved from http://www.scielo.br/pdf/ress/v24n2/2237-9622-ress-24-02-00335.pdf

RSL Results

The results obtained corroborated with the perception that Blockchain studies related to public administration are still incipient within the academic sphere. However, a satisfactory set of Blockchain's main application suggestionswas obtained, as well as the potential impacts they could generate (Table 4). Albeit the technology applications are not mature enough and widely tested, the findings were convincing with the research proposal.

Table 4. Data collection: summary of the main applications and potential impacts found in the analyzed articles.

Article	Author/Year	Journal	Suggested Application	Potential Impacts
Algorithmic Government: Automating Public Services and Supporting Civil Servants in using Data Science Technologies	Engin & Treleavenm (2019)	The Computer Journal	Smart contracts; Contract management; Identity management; Government data storage	Fostering a technological government by fostering startups, transforming public services
Beyond the Hype: Distributed ledger technology in the field of public administration	Kossow & Dykes (2018)	Research Gate	Data security; Data processing; Execution of government pay-ments; Digital identity; Voting	Security in the storage and processing of data; traceability of information; government transparency
Blockchain Governance and The Role of Trust Service Providers: The TrustedChain Network	Atzori (2017)	Social Science Research Network (SSRN)	E-government; Public administration	Avoid duplicity of data; integrity of information; effectiveness in collecting government fees; workflow improvement
Blockchain in government: Benefits and implications of distributed ledger technology for information sharing	Ølnes, Ubacht & Janssen (2017)	Government Information Quarterly	Reorganization of organizational process so that the public service adapts to Blockchain use	Disappearance of sections or restructuring/adaptation of government intermediary bodies to ensure proper management of Blockchain operation
Blockchain in the built environment and construction industry: A systematic review, conceptual models and practical use cases	Li, Greenwood & Kassem (2019)	Automation in Construction	Utilize Blockchain within building processes to improve information sharing and contribute to the development of smart cities and governments	Reduction of bureaucracy and streamlining of financial transactions
Blockchain meets Genomics: governance considerations for promoting food safety and public health	Johnson (2019)	Journal of Food Law and Policy	Using Blockchain to control food supply chain for identifying pathogens	Public-private partnership in system management (data governance)
Blockchain = less government, more market	Berg, Markey-Towler & Novak (2018)	SSRN	*Smart Contracts, Voting, Payments, Financing*	From the use of Blockchain decrease dependence on government institutions
Blockchain Tracking and Cannabis Regulation: Developing a permissioned blockchain network to track Canada's cannabis supply chain	Abelseth (2018)	Dalhousie Journal of Interdisciplinary Management	Use Blockchain to store data related to government regulated production and distribution data on cannabis in Canada	Regulate and store data related to cannabis production to improve production control and decrease illegal drug sales
El auge de blockchain y sus possibilidades reales de aplicación en los registros de las administraciones públicas	Maza (2019)	Revista de Internet,Derecho y Política	Blockchain would be used for storing various government records.	Higher levels of data security and transparency as well as reduction of potential tampering
Governance on the Drug Supply Chain via Gcoin Blockchain	Tseng, Liao, Chong & Liao (2018)	International Jornal of Environmental Research and Public Administration	Use the Blockchain Gcoin system to enable transparent drug transactions	Improved control over drug distribution, decreasing counterfeit drug trade
Land records on Blockchain for an implementation of Land Titling in India	Thakur, Doja, Dwivedi, Ahmad & Khadanga (2019)	International Journal of Information Management	Use of Blockchain to record land properties and other related documents	Organization of structures and consequently of the process of property registration
Next Generation Government Service Bus: The Blockchain Landscape	Marchionni (2018)	SSRN	Use of Blockchain to improve communication between government service sectors	Each sector would be responsible for their data management and, through Blockchain, would exchange accurate and agile information.
Promoting public deliberation in low truste environments - Australian use cases	Lander & Cooper (2017)	SSRN	Use of Blockchain for online voting of public policy projects	Guaranteed transparency and reliability to the vote for data security provided by Blockchain
Regulation as both enabler of technology use and global competitive tool: The Gibraltar case	Scholl & Bolívar (2019)	Government Information Quarterly	Blockchain regulation deliberation from the stakeholders involved	Implementing Blockchain as a public policy that adds public value
The promisse of peer-to-peer? The potential impact of blockchain on the actor configuration in the Dutch eletricity system	Buth, Wieczorek & Verbong (2019)	Energy Research and Social Science	Use Blockchain to store small-scale power gen-eration data and allow it to be sold and pur-chased	Intelligently make viable the use/ implementation of a local energy market
The security and financial implications of Blockchain technologies: regulating emerging technologies in Canada	Ducas & Wilner (2017)	Canada's Journal of Global Policy Analysis	Possibility to use "sand-box regulation" so that Blockchain research can develop	Ensure legal certainty for ongoing testing using Blockchain, not restricted to government pilot projects only

Figure 2 presents the word cloud graph most found in the analyzed articles, with the word government in 5th place.

Figure 2. **The 50 most found words in the articles analyzed.**

The main suggested applications were consolidated into four main points: data processing, data security, new state regulation models and institutional procedures (Figure 3). All possibilities are based on the secure mechanism of encrypted blocks that Blockchain has in its programming, besides having a system based on the validation by us of the system for the confirmation of each transaction made in the network, providing reliability to the information stored in it.

Given the distributed way data is stored in Blockchain, applications related to logistics, land properties, electricity, government payments and smart contracts turn out to be appropriate, since the different actors involved in each process would benefit from the distributed ledger (Atzori, 2018; Buth, Wieczorek, & Verbong, 2019; Engin & Treleaven, 2019; Kossow, 2019; Li, Greenwood, & Kassem, 2019; Marchionni, 2018; Maza, 2019; Ølnes, Ubacht, & Janssen, 2017; Thakur, Doja, Dwivedi, Ahmad, & Khadanga, 2019). Polls, Supply Chain, Digital Identity and Building Construction share Blockchain's data processing efficiency; the technology stands out for its security in storing data, as they are important information, be it for social control - elections and document maintenance - or for the control of buildings and food and/or medication, and the public administration must control or regulate these processes (Abelseth, 2018; Johnson, 2019; Kossow, 2019; Lander & Cooper, 2017; Li et al., 2019; Tseng, Liao, Chong, & Liao, 2018).

Dealing with a more structural issue, some findings point towards new models of state regulation when it comes to enterprises using the Blockchain as an instrument, making use of the concept of stakeholders for regulatory deliberation (Scholl & Bolívar, 2019) or the application of the sandboxes model, which eases current legislation for businesses to apply advanced technologies, such as Blockchain, without being inhibited by legal rigidity, but at the same time supervised by the government (Atzori, 2018). There are also proposals for more radical changes in institutional processes, especially state ones, removing from them the main control (Berg, Markey-Towler, &

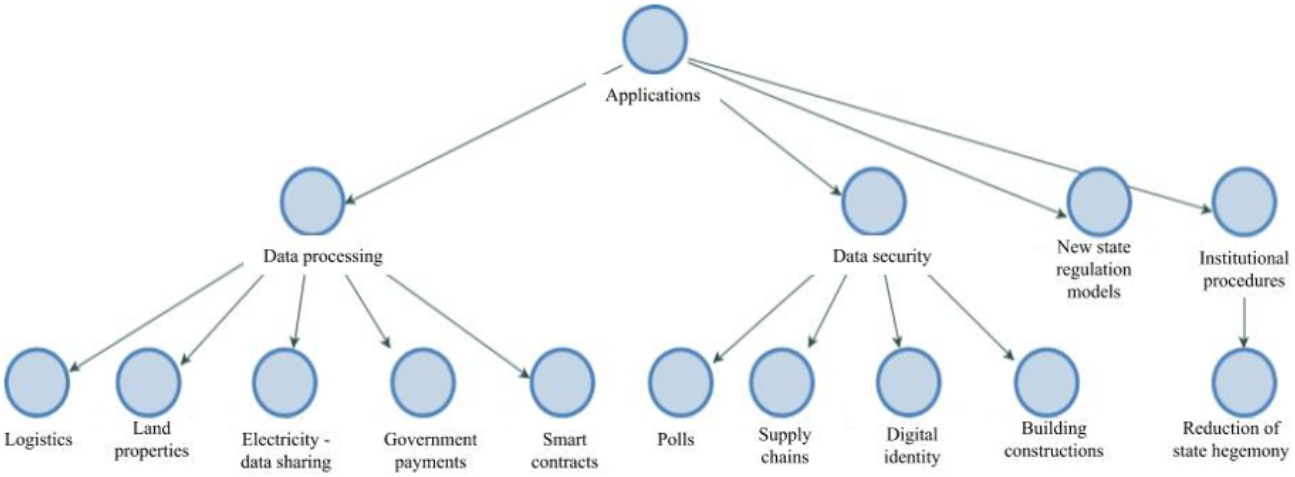

Figure 3. **Key findings about Blockchain applications in selected articles.**

Novak, 2018); however, this requires a more in-depth discussion.

Among the potential impacts from the results obtained (Figure 4), it is demonstrated that the use of Blockchain leads to improvements in data storage, which could result in the reduction of bureaucratic processes, speeding up data processing and allowing, for example, the use of smart contracts. Furthermore, Blockchain is an important tool for sharing information such as clinical pathological data, drug distribution and supply chain stages of a wide number of products, contributing to more efficient surveillance and control (Abelseth, 2018; Atzori, 2018; Berg et al., 2018; Buth et al., 2019; Engin & Treleaven, 2019; Johnson, 2019; Kossow, 2019; Li et al., 2019; Marchionni, 2018; Thakur et al., 2019; Tseng et al., 2018).

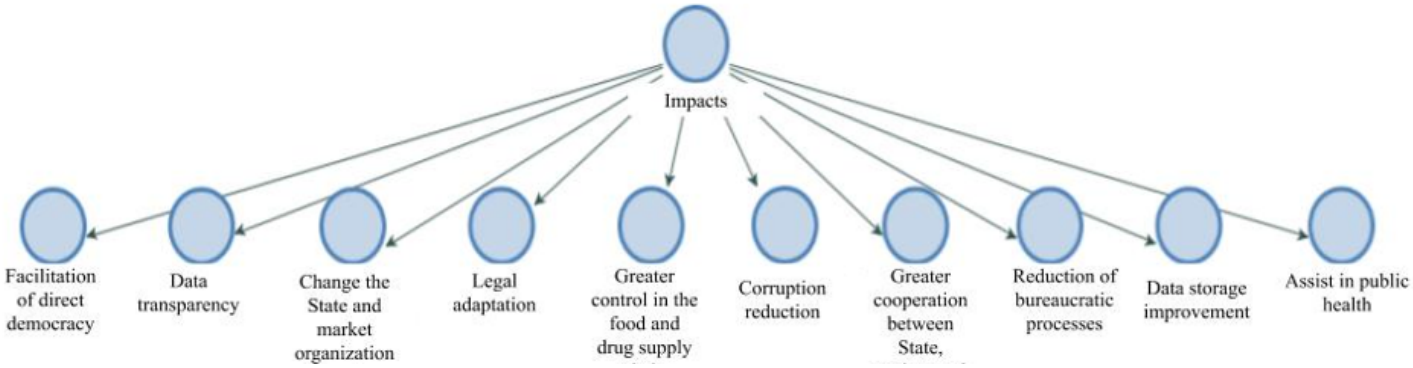

Figure 4. **Key findings on possible blockchain impacts on selected articles.**

The identification that Blockchain would impact on the facilitation of direct democracy and data transparency was verified based on the possibility of offering a new mechanism for the construction of public policies and social participation, considering the possibility of reliable electronic elections (Berg et al., 2018; Lander & Cooper, 2017). By making use the distributed network, it would be possible to improve the reliability and ease of communication between the actors involved, allowing a bottom-up model of organized and efficient public policy making (Ducas & Wilner, 2017). Also, this new technology, due to its characteristics, would help fight corruption, bringing more speed to public administration and reliability in the sector.

Another impact was the possible need to change the State and market organizational structures in relation to it. This change would begin with the reorganization of public administrative structures and could lead to a state reform because, with the new operating dynamics being provided by Blockchain - such as efficiency in data management - institutions, government bodies or sectors may become obsolete, needing to alter their activity or functionality (Berg et al., 2018; Marchionni, 2018; Ølnes et al., 2017). It should also be considered that the use of Blockchain technology requires greater cooperation between State, society and market, given that technology has its core in sharing the database, generating transparency and accountability, making it necessary to build permanent dialogue structures among actors (Abelseth, 2018; Buth et al., 2019; Scholl & Bolívar, 2019). However, for the implementation of Blockchain in the current context, the legal adaptation of this technology to existing structures is imperative (Abelseth, 2018; Engin & Treleaven, 2019; Kossow, 2019; Scholl & Bolívar, 2019; Ølnes et al., 2017), given that modern states have as their fundamental characteristic the legitimacy of law enforcement.

From the results, we note that there is a low incidence of studies exploring Blockchain applications in public administration; most of them identified as pilot studies presenting the potential areas of application for Blockchain application in this sector. Thus, after analysis and presentation of the data obtained (step 5), these will be further discussed in section 4.

BLOCKCHAIN APPLICATIONS AND POTENTIAL CONSEQUENCES

There are several possible applications and consequences that Blockchain technology can bring to the public sphere, both in government structures and processes, as well as in the society-State relationship for the formulation of public policies and social participation. Table 5 presents a comparative overview between the Blockchain applications found in the RSL and the benefits of its use for public administration.

Table 5. Comparison between the results obtained and their application in public administration.

Blockchain applications	Benefits in public administration	Principles
Data processing	Combating corruption and transparency	Storage of distributed databases, improving the security of public data, providing better management, transparency and immutability
	Fraud-free notary services	Applied to real estate property registration industry, avoiding tampering
Data security	Increasing citizen participation mechanisms	Supported Blockchain elections and/or voting for process reliability
New models of state regulation	Safe decentralization of civil records and other data used by public administration	Blockchain data processing and storage for better management, transparency and immutability
New institutional procedures	Efficiency, updating and modernization of public sector processes and regulations	Restructuring of public institutions to adapt to Blockchain implementation, bringing efficiency to the sector

From the work explained above, Blockchain presents data security as one of the main attributes and can be used in voting and data processing efficiently, avoiding fraud and duplication, ensuring storage in several immutable copies scattered around the network, guaranteeing accountability and transparency of information. Thus, Blockchain could also help in the fight against corruption, considering the difficulty of implementing and disseminating fraudulent data on platforms using this technology. From this, it is concluded that Blockchain could be a tool capable of working for the benefit of society, bringing information security and ensuring compliance with the legislation, through the encrypted government data storage model and distributed ledgers. According to the analysis presented in section 3.2, it appears that Blockchain is a tensioned model for the storage of data dealing with land ownership and its demarcation, allowing the facilitation of the process of purchase and registration of real estate and/or land, as well as more transparency (Maza, 2019; Thakur et al., 2019). Land ownership or land demarcation disputes, whether agrarian, quilombola, indigenous or urban and not yet implemented in land reform (Reis, 2012), could be simplified by using the Blockchain to define land tenure and immutability, reducing conflicts.

Another key point is citizen participation. According to Teixeira (2008), a major challenge to provide participation has been access to information. To tackle that, Blockchain can be a strong ally in promoting tools that provide this access. For example, at the end of public policy council meetings, their deliberations could be voted anonymously, inhibiting forms of internal coercion, and the result could be aligned directly with the council's financial sector, generating concrete evidence of the public need and budgetary viability. Besides, these decisions could be made by the population, or part of it, through a voting process on a Blockchain platform, contributing to the increase of democracy.

In addition to security, Blockchain is an important tool for storing data and facilitating data management. Under this perspective, the technology also contributes to the improvement of data openness and availability, contributing to transparency, one of the needs pointed out by FGV's Diretoria de Análise de Políticas Públicas, (DAPP; Directorate of Public Policy Analysis), and Open Knowledge Brazil (OKBR), which found inadequacy related to the opening of government data. According to Albuquerque (2017), one of the main problems found was the difficulty in working

with data and the lack of its complete availability for download.

Bids are a public service mechanism of hiring services and procurement of public administration that seeks to speed up the process of choosing companies, through a rigid administrative process of public notices (in Brazil governed mainly by Law no. 8666 of 1993) (Lei n. 8666, 1993). Even with all the regulations, bid frauds are still common. For that reason, smart contracts could be an innovative solution to the government procurement process. This type of contract, generated within the Blockchain system, is only executed once a series of criteria specified in the programming are validated by the network to effect the transaction. Thus, it would be feasible to verify if the company to be hired is suitable, if the budget is adequate for the purchase, among other issues that would guarantee greater efficiency and accountability to the public sector (Luciano, 2018).

Despite enabling transactions still considered slow for computer systems, Blockchain may be a more agile option when compared to what is currently offered for public management. Using Blockchain, the waiting time can be reduced for documents, such as ID and work card, driver's license, birth and marriage certificate, among others. Besides this, all these records could be stored under the same code, being easily accessible and reliable, given the data an immutability characteristic corroborating the prospect of using Blockchain for more efficient and transparent public records (Maza, 2019). Furthermore, experiments with ID cards and other electronically validated digital documents are already being tested at government level, which shows the importance of having a technology that supports this evolution (Allessie, Sobolewski, Vaccari, & Pignatelli, 2019).

There is also a possibility of better management in electoral processes, especially in the control of security and agility in the process. Blockchain could improve the reliability of the votes, since the generation of electoral data would be recorded on several servers in order to make any kind of tampering impossible. It would also allow for a more dynamic voting system and could facilitate the conduct of referendums and public consultations (Lander & Cooper, 2017). Thus, new ways of managing public assets could be considered, minimizing the direct and often unilateral influence of the State. However, it is important to remember that for a harmonious social organization, it is necessary to have relationship channels that include interested participants involved in public policy (Scholl & Bolívar, 2019). Examples of opportunities for new models of state regulation are in the logistics control of food, drugs and electricity, as seen earlier.

Based on what has been exposed above, it is concluded that, in order to make these changes and the implementation of these benefits doable, it would be necessary to reorganize government structures and remodel internal processes, beginning by the standardization of data storage and seeking greater integration between government bodies. Then there would be the possibility of establishing a truly integrated system and new regulations, significantly improving e-Government services and processes (Berg et al., 2018; Marchionni, 2018; Ølnes et al., 2017).

CONCLUSIONS

New technologies, typical of the Fourth Industrial Revolution, influence the way society, companies and governments relate to and maintain each other. Blockchain, technology considered disruptive, is already a reality. Understanding it is more than necessary to be prepared for the new directions that organizations and society will undertake.

In the public management context, the emergence of the e-Government and the Open Government Partnership have encouraged policies that seek to improve the relationship between public administrators and citizens, seeking to provide greater transparency and popular participation through government data exposure and electronic services improvement. Taking into consideration the new technologies developed in the 21st century, Blockchain impacts how processes are designed as well as data storage and the utility that intermediary institutions have within the organizational system.

This paper showed that the theme Blockchain and public administration has been gaining relevance and importance as the dissemination of this technology spreads, since it has been verified the increase in the occurrence of articles on the theme in recent years. In addition, with the RSL, it was possible to draw an overview of the main applications of Blockchain in public administration and their impacts. This research could be used to identify opportunities, as Blockchain is a hot research area, with opportunities for application in different sectors.

Based on the results obtained, it was observed that Blockchain can provide reliability and quality in the management of government data, as well as

agility in the execution of public administration contracts, helping to inhibit bid fraud, and tampering with documents, payment notes, among others. In addition, it would enable an efficient mechanism for decentralized electoral processes, corroborating a more participatory model in public policy decisions, with agility and anonymity. It would be also an important tool for logistics control of products that require state regulation. Even with results from Blockchain's government-led studies still being mostly at pilot and experimental levels, the expectation remains to deepen knowledge to identify solutions to problems that undermine democracy, such as corruption, bureaucratization and inefficiency.

Despite the demonstrated positive applications and impacts on the use of Blockchain in public administration, it should be noted that technology does not transform reality by itself but offers a new tool at the service of society. Blockchain, by providing data security, can improve efficiency in public administration services and strengthen the exercise of democratic participation. Such technology enables horizontality, transparency and reliability in information management, as long as its instrumentation is done in a way that serves social interests, becoming a means of achieving the development of constructive and participatory actions. To this end, dialogue and cooperation between the parties involved in building society - universities, citizens, businesses and government - is crucial.

Also, it is necessary to debate the inherent characteristics of the public sector, which responds slowly to institutional and technological changes. According to the analysis of Possamai (2014) based on Fountain's studies, it is necessary to think about ICT from the recognition of the existence of Institutional Stability Mechanisms, which are formed to provide security and continuity to the state management process, and of sociopolitical variables in construction of public policies of electronic government.

Thus, it is suggested for future research to deepen the studies on e-Government from the analysis of the pertinent legislation, seeking to appreciate the sociological and political variables that corroborate to the introduction of technological mechanisms in the government, as well as the expansion of search sources to create a more solid supporting framework on Blockchain technology, contributing to the debate on technologies in public administration.

Note

[1] Ethereum is a decentralized platform that executes smart contracts: applications that work exactly as scheduled, without any possibility of third party downtime, censorship, fraud or interference.

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1st author: main article writer. She made the theoretical framework, the collection, analysis and systematization of data, in addition to figures and tables. Creator of the theme.

2nd author: outlined the initial scope of the study and research method, assisting in the technological framework of the applications identified in the continuity of the research. Helped in the definition and support of the article review.

3rd author: conducted the adequacy of the article for the journal, including new references and reviewing analysis and discussion of results. First reviewer, responsible for article submission and correspondence with the journal.

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