DIGITALIZATION: THE USE OF BLOCKCHAIN IN PUBLIC SECTOR

Nemer Aburumman*, Jihad Fraij, Róbert Szilágyi
University of Debrecen, Doctoral School of Management and Business, Department of Business Informatics, Debrecen, Hungary
nemer.aburumman@econ.unideb.hu
fraij.jihad@econ.unideb.hu
szilagyi.robert@econ.unideb.hu

Abstract: *In a world of nonstop developing technology, Blockchain has become a trusted tool to apply transparency in the public sector. The consensus mechanism provides trusted data that can support clear and adjusted as well as well-structured procedures. Nowadays, the public sector can increase trust by adapting Blockchain applications in the services offered to be e-government portals. In this paper, the researchers review the literature to identify the potential use cases and application of Blockchain in e-government services. This new technology along with its related applications will be discussed and defined. Moreover, the possibilities of using Blockchain in the public sector and its impact on organizational transformation, financial management, and performance are increasing.*
The study concluded that the use of blockchain technologies and applications is still limited in the public sector. Obstacles and barriers are related mostly to (security and privacy) and law and by-laws support. This paper will provide a useful reference for researchers in blockchain applications and their impact on e-government and propose future research questions that need to be addressed to inform how the public sector should approach the blockchain technology adoption.

Keywords: Blockchain, E-Government, Public sector, electronic government

JEL classification: D73, H83

1. Introduction

Nowadays, the world is witnessing the adoption of a wide of new technologies within several sectors, for instance public, energy, industrial as well as the service sector, and Blockchain Technology (BCT) is considered to be one among the foremost recent technologies.
BCT is considered to be one of the most important technology which will influence society and business in the future (Webb 2016). BCT stores identical information but in different nodes, in which information can be added only when the nodes reached consensus. Furthermore, when new transactions are added, the previous information con is not removed, which will enable the nodes to trace the history. Consequently, BCT emerges as innovative tools that prove to be useful in several application scenarios. Some of the highest-ranked worldwide private companies, which are associated with the industrial sector, like IBM, Microsoft, Intel, and NEC, are currently investing and capitalizing in BCT, to enrich their portfolio of products (Karame 2016). Moreover, Companies that are producing services as well as dealing with the final customer are applying BCT to extend their consumer trust. FedEx, Marks & Spencer (M&S), and even the fast-food restaurants started using BCT. Burger King of Russia has launched its cryptocurrency token in Russia, called WhopperCoin.

* Corresponding author: Nemer Aburumman

Also, innovation and imbalance driven by blockchain provide an excellent opportunity for the public sector.
Moreover, BCT can store equivalent data at different nodes, in which data will only be added when the nodes have reached consensus. New transactions are often added, but previous information cannot be removed, enabling all nodes to trace the history. Thus, BCT emerges as an innovative tool that proves to be useful during several application scenarios. A number of the highest-ranked worldwide private companies, which are associated with the economic sector, like IBM, Microsoft, Intel, and NEC, are currently investing and capitalizing in BCT, to complement their portfolio of products (Karame, 2016). Moreover, Companies that are producing services also as handling the ultimate customer are applying BCT to extend their consumer trust. FedEx, Marks & Spencer (M&S), and even the nutriment restaurants started using BCT. Burger King of Russia has launched its cryptocurrency token in Russia, called Whopper Coin. Additionally, innovation and imbalance driven by blockchain provide an excellent opportunity for the general public sector.
The label of e-Government contributes to the enhancement of the public sector by using data technologies (Rumman et al. 2018). Adopting the e-Government trend aimed to maintain and provide a technological environment inside the government. The government will experience a business model transformation, changing the atmosphere of the public organization and was expanded to reach a point of transforming the relationships between citizens and government., businesses and other non-state actors (Janowski 2015). Hence, adopting the latest technologies to enhance the public sector services delivery has become even more critical for government organizations.
Blockchain is presented as a serious enhancement and development player with great potential in public sectors (Casey et al. 2016). In other words, BCT has the potential in forming government operations more effectively and dynamically by improving the public services delivery and increasing trust in public sectors (Konashevych 2017). As a result, governments around the world have started exploring the potential concerns and benefits of blockchain-based applications integrated into the public sector (Hancock 2016).
Even though various sectors have become more interested in using Blockchain technology, a few studies examined the use of Blockchain technology in the public sector. This research will try to answer questions such as What is this technology? And what are the related technologies to the public sector? What is the impact of these technologies on the organization itself? Moreover, what are the challenges and the benefits and the best practices of using this technology in the public sector? Furthermore, this research will try to find the appropriate solutions to mitigate threats as a challenge that faces the public sector.

2. Blockchain Technology (BCT)

Blockchain's origin goes back to 2008 when it had been introduced as computer science design to secure direct trading of assets between peers who may not have sufficient confidence in each other. A distributed append-only ledger is the essential core innovation that blockchain introduces in which messages could be irrevocably recorded. Maintaining central intermediaries was eliminated right after this new concept was introduced, which has potentially large political and economic implications. Obviously, electronic ledgers became a universal way of record-keeping. Thus, blockchain technology started to expand rapidly beyond the original payment system applications. Today, BCT is being more explored growing developer community, as they are seeing it as a general-purpose technology (Brynjolfsson et al. 2000), which will transform both the public sector and the industry (Smith, Stirling, and Berkhout, 2005).
Blockchain is one of the most well-known and used distributed technological ledger. Blockchain is a technological ledger in which value-exchange transactions (in the form of

cryptocurrencies, tokens, or information) are sequentially grouped in the shape of blocks. Each block must contain a signature that contains precise data (a string of data) of that block. Next and previous blocks are linked with that signature as well up until the primary block. The recording of blocks cannot be changed, and data cannot be deleted across a peer to peer network, using cryptographic trust and assurance mechanisms. Cryptocurrencies can be defined as a decentralized subset of digital currencies, based on a set of algorithms and protocols. These algorithms and protocols enable a peer-to-peer, cryptographically based payment mechanism, a medium of exchange, and a store of value, the best-known example being bitcoin (Allessie et al. 2019). Moreover, a token is a digital item that represents neither a physical object of value nor the right to perform some operation.

Blockchain finds its origin when being mentioned in a paper that was published by an anonymous (group of) author(s) called Satoshi Nakamoto. Within this paper, Bitcoin was introduced and presented as a purely peer-to-peer (P2P) electronic transaction network. This network allows financial transactions to be directly transferred without the need for a financial institution (Nakamoto 2008). In other words, blockchain technology makes it possible for two identified actors (called nodes) to make transactions in a peer-to-peer (P2P) network and store these transactions in a distributed way across the network (Back et al. 2014). This operation registers all transactions along with the owners of the assets being interacted. Blockchain has 3 types of networks: (a) Public; (b) Consortium; and (c) Private (Figure 1).

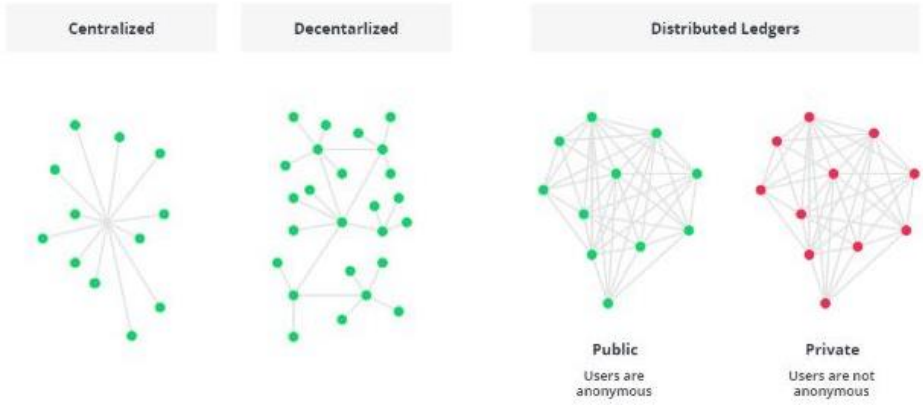

Figure 1: Blockchain networks types
Source: (Lastovetska 2019)

Users within the P2P network can verify transactions by a ‘consensus mechanism’. This mechanism lets the users of the same network validate and update the registry within the entire network (Allessie, Sobolewski, and Vaccari, 2019). In centralized systems, the accuracy of the system in a traditional way, in which an intermediary or an administrator. Whereas the BTC processes will determine trust and accuracy of the information within the system.. A consensus mechanism may be considered a process in which nodes agree on the proposed transactions during a distributed network. Moreover, this mechanism presents the recording information in the ledger by a manner that ensures data integrity, immutability, and consistency. There are certain conditions, protocols, and rules which govern and enable this distributed mechanism to network the recording, completion and execution of data. In other words, the consensus is often built with regards to the previous transaction, forming transactions sequence, sort of a ledger. In blockchains, transactions are clustered and shaped into a block in which this block must contain numerical data that refers to the

previous block. Within the case of Bitcoin, after a registering new transaction, a replacement block is made with the occurrence not only of the new data but also linked to the previous block data, afterwords, the data will be validated across the network. This process forms a sequence of blocks: hence the name 'blockchain'.

Blockchain technology can be seen as a complex process; however, few individuals can fully describe or even understand with certainty the basic elements of blockchain technology. This most likely true especially for cross-disciplinary researchers from non-technical disciplines. Reasons might be the complex interplay of blockchain elements and resulting properties that are hard to grasp in detail and the lack of a solid shared knowledge (Holotescu 2018) the main building blocks or components of Blockchain that were found:

- Cryptography: This technology is mainly based on encryption and electronic signature operations that take place within multiple processes, through which the identity of the user and the permission of those who have the right to access information are identified, and this process contains three main elements Hash (unique code for each transaction), Public Key Cryptography, and Digital Signature.
- Consensus Mechanism: The technique is based on what is known as synchronizing the records from the users of the network to ensure that the new process added to the chain is intact and does not contain contradictory information. This process is called "mining" in Bitcoin. Examples are: Proof-of-Work (PoW), Proof of Stake (PoS).
- Data Store: It is an electronic ledger in which all unconfirmed operations are combined with blocks using the consensus algorithm, and each new block is linked to the previous and ready to like to the new blocks.
- P2p Network: It is the network through which information transfers and exchanges are carried out in blockchain technology exchanging and transferring information and transactions done without the need of a third party as in traditional exchanges. For example, in bitcoin, the sender creates a transaction in which the information about the recipient and a digital signature to prove the authenticity of the message and the value of money (Nakamoto 2008), this information is transmitted over the network from users so that the information is validated via a "mining" process and then stored in the digital ledger (Swan 2015).
- Node: User or computer within the blockchain.

2.1. Blockchain Technology Applications

At the present time, many sectors are seeking to use blockchain technology to improve their services or even reduce costs in general, Goyal Indicated in his study that the applications that use blockchain technology are divided into four main categories: currency, smart contracts, securities and record-keeping (Figure 2)(Goyal 2018).

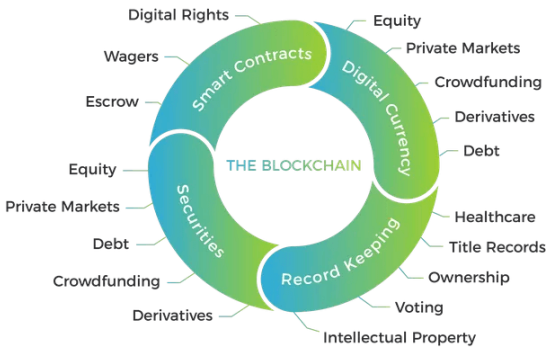

Figure 2: Blockchain Applications
Source: (Goyal 2018)

The expansion of the Blockchain applications was developed in four stages as per the following:

- **Currency**: One of the first sectors that used the blockchain is (the cryptocurrency), where Satoshi Nakomoto pointed to this technology by applying an electronic cryptocurrency called the "Bitcoin" where payment and exchange of money are made through the network using the blockchain technology without the need for intermediaries such as banks or financial institutions (Nakamoto 2008).
- **Open Source**: The blockchain technology was developed as an open-source, and this made many electronic currencies to join bitcoin, such as (ether (ETH), stellar (XLM), and USD Digital (USD-D) to use blockchain and take advantages of the effectiveness and potential of the new technology.
- **Transaction Records and Records of Right**s: In this stage, the use of the blockchain has moved to a new stage, which is the management of goods and services, not just the information used in electronic currencies.
  Examples of this phase include the use of a blockchain as a repository of property rights records, land records, document storage, and even casting votes.
- **Automatization**: This stage seeks to automate all transactions and information in the future so that this technology is used in all aspects of life and in various sectors, now the blockchain is used to implement smart contracts and analysis of transactions by other devices such as cases used in the Internet of things.

2.2. Examples of the Use of BCT In Public Sector

There are many applications of BCT used by governments around the world and here in table 3, the researchers summarized the most use cases and applications of Blockchain technology in the government services and public sector identified from the literature.

Table 3: Blockchain applications

BCT application	Country	Descriptions
ID management	Estonia	The government uses the blockchain technology to store individuals 'identities and manage them electronically over the network, and thus use this electronic identity in various other government transactions. This application allows individuals to access their data and share it with other parties without the need for a third party.(Shrier, Wu, and Pentland, 2016)
Payments and Taxation	United Kingdom, Ukraine, Switzerland	A number of countries use blockchain to verify transactions and track them in the payment and tax process, and these processes via blockchain are faster and more transparent than the traditional method that requires a third party to perform verification and tracking operations.
Record store	UAE, Estonia, United States, China, Russia	Each user on the blockchain receives a "gold copy" of the record contains the information as a block. If the record changes, a new block is added and the revised file is synchronized across the network, all this process usually performs in only a few seconds. with more and more changes are made, new blocks are added, to form a chain.
Voting systems	Ukraine, Estonia, and Australia.	The tendency of many countries to use the blockchain technology to conduct electronic voting operations, because this technology has proven the ability to maintain confidentiality, transparency, and safety of users, and through this technology, the application

		of voting freely and more democratic is more possible (Swan 2015).
Healthcare	United States, Estonia	The entry of blockchain technology into the health sector considered a major revolution, as this technology helps in preserving patients' information and health history, and this information can be accessed by other health service providers such as doctors, pharmacists, even insurance companies. In addition, this technology allows researchers to support their researches in the health field, as it provides a huge database that can be accessed at any time (Swan), and this increases transparency and the costs associated with it. Finally, blockchain technology enables governments to track health records and that increase accountability, and even provide support and advice to make better decisions in this area (Swan 2015).
Ownership transfer (land title)	Ghana, Georgia, Sweden, Honduras	According to (EVRY's Innovation Lab 2015) the use of the blockchain started with the Assets registry in 2013 and it was called the blockchain 2.0, the validation of transactions before the blockchain was a challenge requiring a central authority, but the blockchain technology changed that and now that does not require a central authority or a third party to verify or validate the transactions and users can store the information with the digital signature and timestamp which can be verified by other users on the network.

3. Characteristics of BCT

Blockchain has 4 key characteristics (Nielson 2018)and these characteristics can provide the governments the opportunities to gain more benefits from these technologies. Here you can see the main characteristics that we found in previous literature in Table 4 and after that the potential benefits that governments may get from this technology.

Table 4: BCT characteristics

Characteristics	Descriptions
Decentralization	In traditional transactions you need a central authority or a third party to verify the authenticity of the transactions, whereas, blockchain technology does not need this central authority and the transactions are validated by the participating users in the network, moreover, they can keep an identical copy of the shared electronic ledger. This characteristic provides multiple advantages such as (fault tolerance, data consistency, higher user control, attack resistance, and transparency) and finally remove all third party agencies such as financial institutions, notary, or other intermediary institutions. (Kshetri 2017).
Persistency	Blockchain uses the "consensus process", which is a process to ensure the validity of transactions by users on the network and after this process the transactions stored in the digital ledger and it becomes impossible to modify, delete or even copy them. With this feature, blockchain technology provides fraud protection, ownership assurance, and consistent records of stored transactions (Morgen E. Peck, 2017).
Anonymity	Interactions in blockchain technology are directly between users without the need of intermediaries and by using pseudonyms far from their original identities and using public-key cryptography, and in this way, this technology provides greater privacy than traditional transactions that use the original identities of individuals (Kshetri 2017).
Auditability	Transactions are stored in a chain where the new transaction after verification is linked to an old transaction in the digital ledger and is ready to receive a new transaction. Therefore, in this way, the transactions are linked to a time

	series of the date of adding each transaction, therefore by using this mechanism these transactions can be tracked and easily verified.

4. Organizational, Financial and Performance impact

It is possible that the BCT reaches an inflection point and start getting a wide acceptance by governments around the world in the years to come if these benefits and challenges can be identified clearly. However, Ølnes, Ubacht and Janssen, (2017) expressed that, until now, those benefits have not been proven by empirical evidence. The main benefits found in previous literature of applying blockchain technology in governments are claimed to be:

4.1. BCT Impact on Organizational Transformation

Blockchain changed how the organization model is shaped. These technologies transformed the old organizational model into a more decentralized model using Telecommuting as a way of work to offer services or goods to active consumers. This transformation of a new organizational model might also establish a new generation of organizations (Shrier, D., Wu, W. and Pentland, A., 2016).. In other words, non-physical organizations could be the norm and the best future model. In this way, non-physical organizations will have no offices, physical assets, or even employees. Blockchain as technology came as a support to establish non-physical organizations to exchange value in a secure and decentralized way (Allessie et al. 2019).

4.2. BCT Impact on Financial Management

The advantages of blockchain technology can be determined in the financial markets as well. In that, it will play the role of mediator by creating a decentralized and secure record, which is a research block in itself that gives each party the ability to verify the validity of the deal and speed up the settlement process, and allow greater accuracy of trading, and can be completed Quite the fees of brokers, and it has changed from some circles by influencing the process of fixing the share price, as stated in the report of the British «Dieut» Foundation. Documenting financial transactions can also be conducted through personal keys that verify ownership of the assets, a variable used for digital signatures but can be stolen or lost in the same way that passwords are lost due to breaches or malware (Tan, B. S., & Low, K. Y., 2019). Developers have already come up with solutions to protect private key owners and blockchain technology assets. For example, all parties within a network can agree that most parties must sign before agreeing to a deal (Le, V. T., Pahl, C., El Ioini, N., & D'Atri, G., 2019). This will prevent hackers from changing ownership by stealing one key, and such multiple signature transactions can be programmed directly into asset trading applications.

Money market workers need to develop themselves to become an effective part of technological developments and this means hiring and training blockchain technology developers or partnering with them. Although this technology is still new and its capabilities are still being explored, companies must jump to unite forces with other parties in their operating environment.

One of the most important solutions that BT can offer in case of adoption is offering a real-time accounting system. The time lag can be fixed by using BT, in which it allows stakeholders to see all transactions in real-time status (Potekhina, A., & Riumkin, I., 2017). Throughout the studied literature, many pieces of research show that there are usually delay in the annual and quarterly financial reports. In some cases, an average of 1.96% market drop can be a result of these delays as well as sometimes a decline in the stock returns will be affected by late reporting (Bartov, DeFond, Konchitchki, 2015). A transparent blockchain accounting system can mitigate these delays and problems, especially since all financial transactions cannot be changed and used accurately.

4.3. BCT Impact on Performance

Performance comparison structures and management accounting overall considered to be a key position in generating decision-making facts and general performance warning signs for identifying and managing the overall performance of the place such structures (Jumah, A., & Alnsour, Y., 2019). For Instance, ERP, and corporate talent systems has become automated in general and thus enable entry to massive amounts of statistics (big data) very briefly a period.

If you do not return immediately "once records are entered in the useful ERP system, Business Intelligence may make management, records management and accounting management immediately available and publish them throughout the life of the organization, whether or not specific facts On CEO's dashboards or CEO's smartphones "There is a price to use the facts in this additional Open method that is potentially a loss of privacy, which raises challenges about how excellent governance ideas (such as accountability ownership of facts, a voice in questioning the integrity of records or Its privacy is about Criticisms of public performance and securing this data) seem crucial (Brennan, N. M., Subramaniam, N., & van Staden, C. J., 2019).

Challenges of Using BCT in Public Sector

In previous literature, challenges that face these technologies are described as many and different. For example, challenges related to the technology itself and others related to the regulations and policies and finally some challenges related to the technology infrastructure. Literature summary is shown in the below table.

Table 5: BCT challenges in previous literature

Challenge	**Previous literature**
Challenges related to the technology (Security and Scalability, Usability, Interoperability/Compatibility, Reliability, Flexibility, Cost-effectiveness, Computation efficiency, General application platform, Storage size, Immaturity, Design variables)	(Ahram et al. 2017; Angraal et al. 2017; Dübder et al. n.d.; Ølnes, Ubacht, et al. 2017; Lander et al. 2017; Sharples et al. 2016; Marsal-Llacuna 2018)
Regulations and infrastructure support	(Moura et al. 2017; Sullivan et al. 2017; Dübder et al. n.d.; Ølnes & Jansen 2017; Lander et al. 2017; Ahram et al. 2017; Batubara et al. 2018)
Organizational readiness, Acceptability, Implications, Trust, Auditing	(Ahram et al. 2017; Batubara et al. 2018; Lastovetska 2019; Ølnes, Ubacht, et al. 2017; Sharples et al. 2016)

One more challenge lies in the immaturity of the BCT itself, which is still evolving. Governments should do small scale BTC application experiments to materialize the potential and to avoid costly failures. Decision designing can determine how BCT can be beneficial. For large scale implementation, it is important to focus on a theme that should be (design for flexibility). This requires strong governance as the main characteristic of BCT has built-in mechanisms (consensus protocol and immutability of the records) that are at odds with the flexibility(Allessie et al. 2019).

5. Conclusion

Blockchain is a general-purpose technology that offers trending ways for private and public organizations to record transactions, ownership, certificates and events. BCT is a revolutionary technology in which it transformed the old mechanisms to serve its best in applying massive benefits on organizations, Financial Management and performance in the public sector. BCT is a distributed Ledger Technology (DLT) that provides a trusted, transparent, and decentralized data management in an auditable and immutable manner. This study explored the potential applications and used cases of Blockchain technology for public sector services. Furthermore, this study shows that there is a huge potential in the use of Blockchain for government services since it can deliver government services in a distributed, voluntary, and cheaper way. Moreover, this research tried to include a literature review to make it possible to identify the impact of using BCT in organizations especially in the public sector, as well as its identified challenges. Future research should focus more on the BCT solutions in how to overcome the mentioned challenges as well as using a critical assessment of potential benefits of the public sector adoption of BTC which can include stewardship and accountability role. Nonetheless, more research can discuss diverse ways of creating trust and several vocal points related to BCT challenges such as organizational transformation, dis- and re-intermediations, governance models, design variables, auditing and the effects on the benefits and limitations are needed.

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Bio-notes

Aburumman Nemer, is *a PhD student* in the *University of Debrecen / Applied Informatics and Logistics Institute* and member of the several research teams developed within the projects implemented by our Faculty. As a PhD student, Aburumman focused on the use of technology in the public sector administration (e-government, e-agriculture …etc.).
Fraij Jihad, is a *PhD student* in the *University of Debrecen / Applied Informatics and Logistics Institute*. As a PhD student, *Fraij* focused on the use of technology in the Human Resources Management (E-HRM, E-Recruitment, E-Management…etc.).
Robert Szilagyi is an associate professor in the *University of Debrecen / Applied Informatics and Logistics Institute* and leader of several research teams developed within the projects implemented by our Faculty. His research area is applied informatics in the field of business, agriculture and e-government.