

## New Research Trends in Designing E-Government Architecture Based on Blockchain Technology

Raed Abduljabbar Falih<sup>1,\*</sup>, Yusmadi Yah Bt Jusoh<sup>2</sup>, Dheyaa Jasim Kadhim<sup>3</sup>

<sup>1,2</sup>Department of Information System, College of Computer Science and Information Technology, University of Putra Malaysia, Kuala Lumpur, Malaysia

<sup>3</sup>Department of Electrical Engineering, College of Engineering, University of Baghdad, Baghdad, Iraq  
[GS60034@student.upm.edu.my](mailto:GS60034@student.upm.edu.my)<sup>1</sup>, [yusmadi@upm.edu.my](mailto:yusmadi@upm.edu.my)<sup>2</sup>, [dheyaa@coeng.uobaghdad.edu.iq](mailto:dheyaa@coeng.uobaghdad.edu.iq)<sup>3</sup>

### ABSTRACT

Blockchain has garnered the most attention as the most important new technology that supports recent digital transactions via e-government. The most critical challenge for public e-government systems is reducing bureaucracy and increasing the efficiency and performance of administrative processes in these systems since blockchain technology can play a role in a decentralized environment and execute a high level of security transactions and transparency. So, the main objectives of this work are to survey different proposed models for e-government system architecture based on blockchain technology implementation and how these models are validated. This work studies and analyzes some research trends focused on blockchain and the future of e-governance for connecting citizens and smart cities, such as Using Blockchain in the Notarial Office (NO), using blockchain technology in the management of police complaints, exploring blockchain-enabled end-to-end security e-voting, using blockchain and smart contract technology for trusted and safe property registration and record management, and using a blockchain-enabled Vehicle Certification (BVC) framework. Finally, this work has proven that the issue of transforming governments from the traditional system to electronic governments based on blockchain technology has become an inevitable matter of time.

**Keywords:** E-Government, Blockchain, Security, Peer-to-peer (P2P), E-voting, BVC, Notarial office (NO).

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\*Corresponding author

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## أبحاث بحثية جديدة في تصميم معمارية الحكومة الإلكترونية بالاعتماد على تقنية سلسلة الكتل

رائد عبد الجبار فليح<sup>1\*</sup>، يواسمدي ياهبات جوسه<sup>2</sup>، ضياء جاسم كاظم<sup>3</sup>

<sup>2,1</sup> كلية علوم الحاسوب وتكنولوجيا المعلومات، جامعة بوتر، ماليزيا

<sup>3</sup> قسم هندسة الكهرباء، كلية الهندسة، جامعة بغداد، بغداد، العراق

### الخلاصة

حظيت تقنية سلسلة الكتل بالاهتمام الكبير خاصة لانها تدعم المعاملات الرقمية الجديدة عبر الحكومة الإلكترونية. التحدي الأكبر بالنسبة لانتظمة الحكومة الإلكترونية العامة تتمثل في كيفية تقليل البيروقراطية وزيادة كفاءة وأداء العمليات الإدارية في هذه الأنظمة ، حيث يمكن لتقنية سلسلة الكتل أن تلعب دوراً في بيئة لامركزية وتنفيذ مستوى عالٍ من المعاملات الأمنية والشفافية. لذلك تتمثل الأهداف الرئيسية لهذا العمل في طرح نماذج مقترحة مختلفة لهندسة نظام الحكومة الإلكترونية بناءً على تنفيذ هذه التقنيات الجديدة، ثم كيفية التحقق من صحة هذه النماذج وملائمتها للعمل في الحكومة الإلكترونية. يدرس هذا العمل ويحلل بعض اتجاهات البحث التي تركز على سلسلة الكتل ومستقبل الحوكمة الإلكترونية لربط المواطنين والمدن الذكية مثل: استخدام سلسلة الكتل في دائرة كاتب العدل ، واستخدام تقنية سلسلة الكتل في إدارة مكتب شكاوى الشرطة، استكشاف استخدام تقنية سلسلة الكتل بدعم التصويت الإلكتروني الآمن الشامل ، استخدام تقنية سلسلة الكتل مع العقود الذكية لتسجيل الممتلكات وإدارة السجلات الموثوقة والأمنة ، واستخدام تقنية سلسلة الكتل في اصدار أجازات القيادة . أخيراً ، أثبت هذا العمل أن قضية تحويل الحكومات من النظام التقليدي إلى الحكومات الإلكترونية القائمة على تقنية سلسلة الكتل أصبحت مسألة حتمية ومسألة وقت فقط.

**الكلمات المفتاحية:** الحكومة الإلكترونية، سلسلة الكتل، الأمن، النظر للنظير، التصويت الإلكتروني، أجازة القيادة باستخدام سلسلة الكتل، دائرة كاتب العدل.

## 1. INTRODUCTION

With the sudden turmoil of the web and its widespread availability, many countries worldwide have examined electronic switching to share and assist in the transfer between individuals and other subsidiaries (Elisa, 2020). While the government continues incorporating technology into its day-to-day processes to pursue "digital transformation," something else is happening behind the scenes: interpreting what digital government means (Draheim, 2020). The optimization of bureaucratic procedures in government systems is one of the current priorities of governments. (Mezquita, 2021). Nevertheless, the rapid development of technology, particularly in public service, has kept many countries behind, which runs counter to the United Nations' vision of e-government (AL-Musawi, 2020). Nowadays, e-governance is very popular (Goswami, 2020). Several definitions of e-government have been since its inception in the 1990s, all regularly revised as practice changes (Chen, 2021). E-government refers to incorporating information technology into



business to provide public services online and increase government efficiency (**Assiri, 2021**).

The goals and objectives of e-governance are to provide citizens with more precisely perceived services to accomplish overall social and economic leverage with elevated performance and efficiency obtainable in the significant escalating points (**ALMendah, 2021**).

To increase the quality of government services rendered and encourage widespread people involvement, it aims to improve efficiency, fiscal limitations, the effectiveness of government programs, knowledge-based choice of decision, increase government transparency, and establish efficiency between the government's cooperation, social, societal, and citizen relations (**Chen, 2021**). Consumers who participate in e-government use the internet at home rather than waiting in long lines at government desks, conserving money and time on commuting expenditures. Service providers can also assist more efficiently. (**Ranjith Kumar, 2021**). The fourth industrial revolution, which is extremely significant, includes several national efforts to take advantage of next-generation innovations in various industries, such as (IoT), machine learning, a network of remote servers hosted, and blockchain technology.

Among these, blockchain has received the greatest attention as the most crucial new technology (**Myeong, 2019**). Blockchain has promising application potential and piqued stakeholders' interest from academia to industry (**ALMendah, 2021**). Since then, blockchain methodologies have spawned a plethora of other applications that have been successfully adopted in various fields (**ALMendah, 2021**). The technology has been termed the most inventive and disruptive information technology of the twenty-first century for these and other reasons (**Ahmad, 2021; Joodi, 2023**). The technology allows for the establishment of private connections between the parties involved without the use of intermediaries (**Jagrat, 2020**). It is simply a virtual series of blocks; when we use the terms "block" and "chain" in this context, we mean digital information (the "block") that is stored in a public database (the "chain") (**Lykidis, 2021**). It can be distributed across multiple sites, geographies, or institutional networks. As a result, blockchain may be considered an information system or a free, decentralized Internet server (**Jagrat, 2020; Hasan, 2022**). Using blockchain technology, records are stored in blocks or chains under no solitary person's authority, so everyone involved can see what is flowing (**Lykidis, 2021; Jabbar, 2018**). Everyone in the network can see the data, and once it is fed, it is difficult to alter or even change it, making it tamper-proof. The technology ensures the security of every transaction because the user provides a signature as proof of authenticity, after which the data is encrypted, further enhancing its security (**Lykidis, 2021; Joodi, 2023**). Systems must be trusted to be confidently available to users and perform all their services over the internet. This also necessitates the involvement of trusted third parties.

Blockchain technology has been discovered by e-governance services to provide secure and transparent transactions or any value exchange, whether money, gold, information, legal documents, or data (**ALMendah, 2021; Jabbar, 2021**). Blockchain quickly becomes necessary in everyday life because it can potentially solve some of the world's most pressing problems (**Lykidis, 2021; Kadhim, 2023**). The government's blockchain-based digital transformation plan is crucial for altering information participation openness, and there is a level of trust between the government and its constituents. (**Chen, 2021**). Governments may employ blockchain as a smart decentralized technology with the most security, is more diaphanous, is distributed orderly, and is cheap and inexpensive for databases, transparent,



distributed, open, and affordable database technology. Efficiency, enhanced services, greater accessibility of public services, and more openness and accountability are all advantages of e-government **(Rani et al., 2020)**. Blockchain technology is gaining popularity among the numerous technologies under development because of its benefits **(Myeong, 2019)**.

This work aims to survey the new research trends of transforming governments from traditional systems to electronic ones based on blockchain technology. These trends include creating a decentralized and secure e-government system using blockchain consortium technologies, proposing a framework for a blockchain-based tendering mechanism, proposing a Blockchain-enabled Vehicle Certification (BVC) system, proposing a framework for a decentralized e-government peer-to-peer (p2p) system and so on. The following two subsections show the two main issues related to using blockchain technology to support the e-government system.

### 1.1 Securing E-Government-based Blockchain

Many studies are on designing and implementing a secure e-government network using blockchain architecture technology. Yet they differ in the scale of the implementation or the areas of that implementation and the type of research that was done. Some studies focused on blockchain and the future of e-governance in smart cities **(Khanna, 2021)**, along with addressing the challenges of connecting citizens and smart cities **(Oliveira, 2020)**. Others focused on the automation of public information processes **(Kassen, 2022)**, using blockchain for preserving privacy in e-governance systems **(Ranjith Kumar, 2021)**, using and implementing blockchain-based land registry systems **(Mezquita, 2021)**, a blockchain-based e-governance framework for transport stakeholders **(Das, 2020)**, a data storage system based on blockchain for e-government applications. A confirmatory experiment was conducted in several research using e-government documents from the blockchain. **(Thoppae, 2021)**, Propose privacy-preserving and security in e-government programs or debate using blockchain as a next-generation technology for e-government information infrastructure **(Rani et al., 2020)**.

Moreover, a blockchain-based system was created in the Notarial Office (NO) to supply various important certificates. The smart electronic contracts that replaced the old ones organized by hand were encrypted, and ledgers were created to work with different types. **(Gao, 2021)**.

The use of blockchain technology in managing police complaints was also investigated **(Hingorani, 2021)**. The implementation of blockchain technologies in the context of business and government information sharing was also found **(van Engelenburg, 2020)**, but also the challenges and benefits of using a blockchain for e-government **(Lykidis, 2021)**. The current issues (security and privacy) of blockchain applications and identifying promising solutions for a blockchain revolution in e-government services were also examined **(Almendah, 2021)**. The studies also looked into the shortcomings of prior assaults, proposed a remedy based on an innovative consensus algorithm devised, and analyzed different issues with present government information sharing **(Zhang, 2019)**. Studies also investigated using a strong supervision algorithm model based on blockchain. In e-government **(Lin, 2020)** looking at the factors influencing blockchain administration and their importance **(Myeong, 2019)**. Research on the topic looked into the recent progress of blockchain initiatives in government **(Haneem, 2020)**, demonstrated blockchain-based government infrastructure information, and illustrated how governments can use it



worldwide (**Jagrat, 2020**). Blockchain and smart contract technology are proposed for trusted and safe property registration and record management (**Soner, 2021**). Identifying key narratives in the field of e-government (**Draheim, 2020**) are used for Exploring blockchain-enabled end-to-end secure e-voting (**Gupta, 2021**) and investigating tendering system based on blockchain with active citizen participation and tracking of funds (**Goswami, 2020**). As for the type of studies that dealt with the topic of blockchain and e-government, they varied between providing an overview or survey as an excellent example for practitioners who want to undertake studies on this issue by, for example, using Blockchain technology in the public sector identifying the challenges that come with adopting.

## 1.2 Blockchain Technology Application for E-Government

Blockchain technology in the government sector (**Chen, 2021**), performing a literature review on new property registration models based on blockchain technology that is now being developed as proof of concept by several countries. A systematic conceptual review of blockchain technology's application to e-government and the implications of the impact on blockchain based upon procedures' evolvement of e-government and the sector in general (**Rani et al., 2020**).

Reviewing the academic papers published on the challenges and benefits of using a blockchain for e-government in the Kingdom of Saudi Arabia's e-government (**Lykidis, 2021**) and researching blockchain efforts in Asia's top five countries development indicator of e-government (EGDI) countries: Cyprus, the United Arab Emirates, South Korea, Japan, Singapore, and Korea. (**Haneem, 2020**). Surveying the literature for information on the many solutions that governments throughout the globe have implemented for the successful use of Blockchain Technology in enhancing safe information flow between countries (**Jagrat, 2020**). Other research combined two kinds of information gathering or methodologies, as seen in the following examples of such research: with the help of a panel of experts and a qualitative review of the literature, Satoshi Nakamoto has seven blockchain discoveries that have been analyzed, developed, and explored, and investigated how and where can Thailand 4.0 be helped to implement the vision of the digital economy such as (**Thppae, 2021**). Another study (**AlMendah, 2021**) surveyed the literature on Blockchain technology and its developments, which span both the public and private sectors. It proposed a framework for integrating Blockchain into any e-government platform. Yet another study that mixed research methods was by (**Zhang, 2019; Abdulredah, 2020**) who analyzed current government information sharing problems, combined with literature research, proposing a theoretical framework based on blockchain technology applied to government information management and sharing, constructing a blockchain-based government information sharing model, and providing implementation strategies at the technical and management levels.

## 2. NEW RESEARCH TRENDS OF E-GOVERNMENT-BASED BLOCKCHAIN TECHNOLOGY

Other types of studies have the largest share of literature on the blockchain, and e-government is those studies that propose or develop a framework, system, or method. Examples of such studies in the literature are:



- Proposing a blockchain-based strategy for a regionally based peer-to-peer system, ensuring data authentication and personal privacy while also increasing public sector trust **(Ranjith Kumar, 2021)**.
- Proposing a Blockchain-enabled Vehicle Certification (BVC) system that connects government, drivers, automobile owners, and manufacturers through a secure channel. **(Das, 2020)**.
- Creating a low-cost blockchain data storage system for managing e-government data **(Chen, 2021)**.
- Proposing a framework for a decentralized e-government peer-to-peer (p2p) system based on blockchain technology to secure data security and privacy while also enhancing public sector confidence **(Elisa, 2020)**.
- Proposing a consortium blockchain-based electronic certificate-sharing system to tackle the challenges of cross-border government services, particularly in terms of transaction verification, efficiency, and data confidentiality **(Gao, 2021)**.
- Developing a framework to evaluate the alignment of stakeholders' interests, governance requirements, and blockchain design choices in business and government information sharing **(Van Elgelenburg, 2020)**.
- The proposed technology detects PKI attacks and distinguishes between mistakes and attacks, enabling accurate anomaly control. **(Talamo, 2020)**.
- Developed a blockchain supervision model based on the Threshold Ring Signature algorithm (TRS) **(Lin, 2020)**.
- Proposed a blockchain-based solution for handling complaints for both cognizable and non-cognizable offenses **(Hingorani, 2020)**.
- Developing a framework for automated registry paper maintenance **(Soner, 2021)**. Propose an end-to-end secure e-voting method based on blockchain **(Gupta, 2021)**.
- Creating a decentralized and secure e-government system using blockchain consortium technologies **(Talamo, 2020)** and proposing a framework for a blockchain-based tendering mechanism **(Goswami, 2020)**.

Other studies looked at blockchain's potential to mechanize particular organizational processes, functional domains, and transactions in government organizations from an explanatory and discursive perspective to advance the theoretical discussion of blockchain's ability to spur administrative reforms **(Kassen, 2022)**. Using an analytic-hierarchy process (AHP) analysis to investigate determinants of blockchain administration and their priorities **(Myeong, 2019)**. There are even fewer studies that used quantitative research methods (i.e., descriptive, correlational) in addressing the topic of the blockchain and e-government, such as that of **(Al-Musawi, 2020)** examining the mediating role of digital ID system and Blockchain technology in the effective application in One-Stop Service of Blockchain technology, and how the technology increases e-government applications quality better than normal ICT.

### 3. PROBLEMS ADDRESSED BY STUDIES ON BLOCKCHAIN AND E-GOVERNMENT

Studies on blockchain and e-government have attempted to address many diverse e-government architectures based on blockchain technology, which are often related to the services of public institutions that governments provide to their citizens. The following



studies dealt with the problems of designing and implementing a secured e-government network using blockchain architecture technology. These problems have differed in the scale of the implementation of the areas of that implementation and the type of research that was done:

- **(Elisa, 2019)** According to the research, e-government is one of the platforms that maintains sensitive information on individuals, companies, and other affiliations, making it a target for cyber-attacks. The current state of e-government systems is centralized, resulting in a single point of failure.
- According to **(Myeong, 2019)**, reforming government management is not only a technical problem, as evidenced by the knowledge and information society and the e-government development process. Demonstrating the fundamental blockchain technology and how much research has attempted to use it to avoid hacking in various industries **(Myeong, 2019)**.
- Moreover, the governance requirements for systems that facilitate information sharing between businesses and government organizations (B&G) are decided by many stakeholders, many of whom have competing interests **(Van Elgelenburg, 2020)**. These competing interests can stymie implementing and expanding ICT innovations that alter their roles and powers.
- As **(Jagrat, 2020)** highlighted, the problems of current systems in terms of Departmentalism, inefficiency in administrative processes, and a lack of faith in public records are all issues that need to be addressed, and demonstrated how blockchain has the potential to transform traditional business operations and deliver considerable value to citizens.
- **(Talamo, 2020)** demonstrated how public key infrastructures (PKIs) are hierarchical, but Their employment in non-hierarchical situations has resulted in many criticisms. PKI is vulnerable to hazards due to probable failures of certificate authorities (CAs), which might be utilized to issue unauthorized certificates to end users. Many recent breaches demonstrate that if a CA's security is compromised, the security of the relevant end-users is jeopardized. Besides, there have been numerous instances when unauthorized certificates have been issued due to a CA's faults or breaches **(Talamo, 2020)**.
- As per **(Elisa, 2020)**, e-government should be of more security, encrypted, and highly private systems because failure would be very costly economically and socially. Many servers and databases house the majority of current e-government technologies, such as websites and electronic identity management systems (eIDs). A centralized management and verification system with a single point of failure is subject to cyber attacks such as malware, Denial of Service (DoS), and Distributed Denial of Service (DDoS) **(Elisa, 2020)**. According to **(Elisa, 2020)**, until improved security technologies and remedies are invented and made available to combat these threats in the future, every e-government structure remains unprotected from hackers of privacy and security.
- Furthermore, another problem highlighted by **(Geneiatakis, 2020)** regarding transparency and transaction security is critical in e-government services in trust building in the services offered and urgent options, particularly for G2G applications, to ensure security, use over public networks of secure protocols or secret communications because they are legally permitted. However, as numerous studies have highlighted, they do not guarantee information security according to the designs, i.e., that are typical throughout the information process and may pose security problems. They might, however, oppose nonrepudiation and liability services. Moreover, since administrative



and legal criteria must be met initially, contemporary e-government services have data synchronization difficulties **(Geneiatakis, 2020)**. This work has also pointed out that, presently, the bulk of e-government services rely on a single point of failure, which results in a single point of failure.

- Besides, according to **(Das, 2020)**, the exponential growth of digitalization has offered numerous opportunities for e-governance, particularly for transportation stakeholders. However, the enormous obstacle. On the other side is the research opportunity for real-time large-scale data handling in a scalable, secure, and hidden style.
- Another challenge raised by **(Goswami, 2020)** concerning the manual approach of the manual bidding system for submitting bids for a specific contract to complete a certain developmental activity and selecting the best offer at the end is time-consuming and costly. as well as vulnerable to manipulation and corruption. As a result, the use of e-tendering is required. E-tendering is an internet-based tendering process that begins with the publication of an advertisement and ends with the winner's notification. The government and other firms have put it in place to guarantee that tendering is transparent. **(Goswami, 2020)**.
- Researchers have been considering the notion of blockchain in recent years. However, previous research has raised concerns about the blockchain's suitability for a secure e-voting procedure and the system's or actors' authentication **(Gupta, 2021)**. Yet another challenge was raised by **(Gupta, 2021)** concerning the voting process, which was deemed an insecure procedure where they conducted votes, and it should be authenticated for all types of vulnerabilities.
- **(Hingorani, 2020)** highlighted the increased number of criminals and how many of these occurrences go unnoticed. Even though the police have an online facility for keeping FIRs and NCRs, most FIRs are still written by hand in some countries. To register a cognizable offense, the complainant must usually be present at the police station.
- Similarly, **(Oliveira, 2020)** pointed out that the way residents engage with cities impacts their overall quality of life and that their engagement in social decisions is critical for influencing public policy decisions affecting government, regulation, and education.
- Similarly, **(Lykidis, 2021)** pointed out that conventionally, data was stored in paper files, which would then be saved in secure wardrobes; however, technology has developed to the extent where information can now be stored in computers and cloud systems that were previously thought to be secured. Nevertheless, the same technology allows malicious components to disturb systems and gain access to data, some of which are sensitive, resulting in financial loss.
- Nevertheless, contrary to the aforementioned literature on blockchain and e-government **(Franciscon, 2019)** asserted that blockchains in public utilities are an impediment that must be overcome to develop more effective blockchain architectures.
- According to **(Chen, 2021)**, a considerable amount of data (animation, text, graphics, video, and audio) is managed via systems maintained by network operators, who usually use a centralized architectural design in e-government application situations. This centralized design, on the other hand, may result in a single point of failure and data ownership difficulties. It is not easy to ensure data integrity and reliably measure data use.
- Along the same lines **(Thoppae, 2021)** emphasized the need for the government to improve security in an open architectural environment, executing functions, information storage, transaction execution, and establishing trust are all possible.



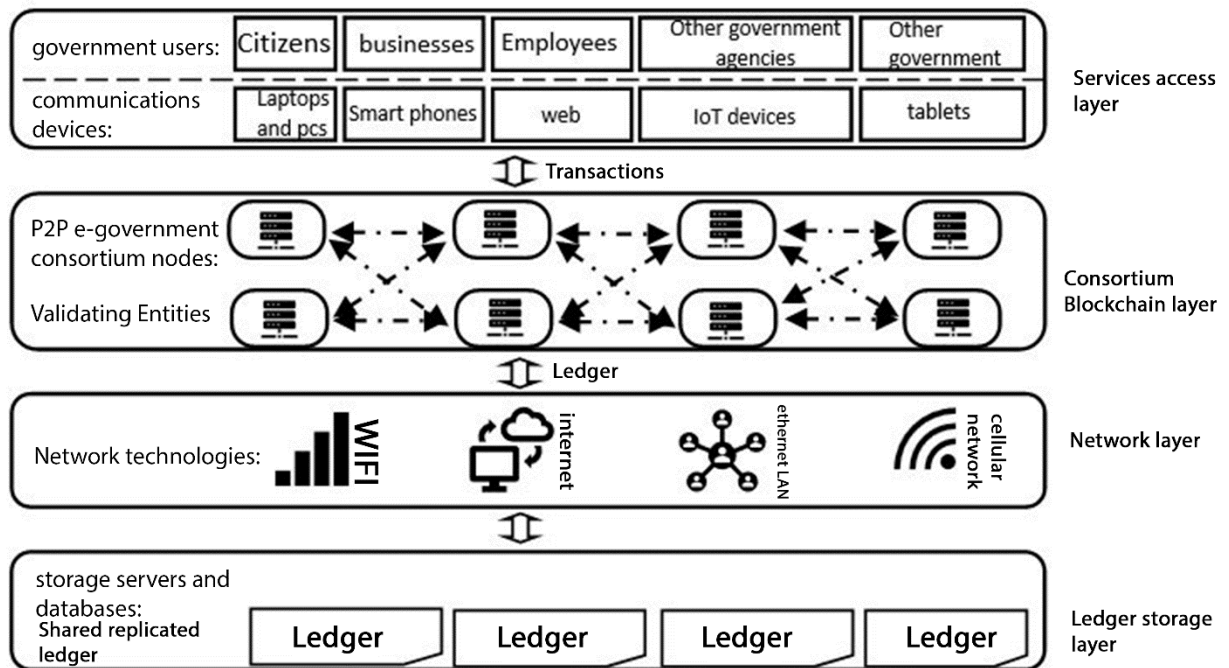


- Among those problems is that which was touched upon by **(Assiri, 2021)**, who addressed the vulnerability of the e-government system that uses information and communication technology (ICT) to security risks and cyber-attacks which made e-government systems raising worries about user privacy, as well as the confidentiality and integrity of data.
- Similarly, **(AlMendah, 2021)** highlighted major problems such as security and privacy concerns faced by systems using e-services that provide consumers and users with speed of implementation and comfort, as well as high-luxury features.
- Another challenge highlighted by **(Gao, 2021)** was concerning the Notarial Office (NO), which is responsible for issuing various essential certificates. One of the most important reasons for the interruption is the continued dependence on handling by hand, which requires paper materials from government agencies. Because non-local paper items have less credibility in the local environment, the Notarial Office cannot perform cross-border services **(Gao, 2021)**. Because copies of paper items are preserved, it can easily lead to critical information leaks.
- As per **(Ranjith Kumar, 2021)**, the information and communication technology used by the e-government to deliver governmental services to numerous entities and institutions is one of the most complex systems that require diversification, protection, and security. Any misstep might prove to be extremely costly, both prudently and collectively.
- One of the causes of cyber-attacks is major system failure, which leads to, for example, spyware, denial of service, and malware.
- Another challenge was pointed out **(Mezquita, 2021)** that the simplification of bureaucratic procedures in property registration operations, as well as the necessity for optimization to boost management's profitability, is one of the current difficulties facing governments, the speed with which procedures are performed, and decrease in the ambiguity that arises in the processing of data.
- According to **(Khanna, 2021)**, there is an urge for cities to become smart, and governments worldwide are challenged to transform due to the rise of urbanization and increasing citizen engagement.

#### 4. DESIGNING E-GOVERNMENT ARCHITECTURE-BASED BLOCKCHAIN

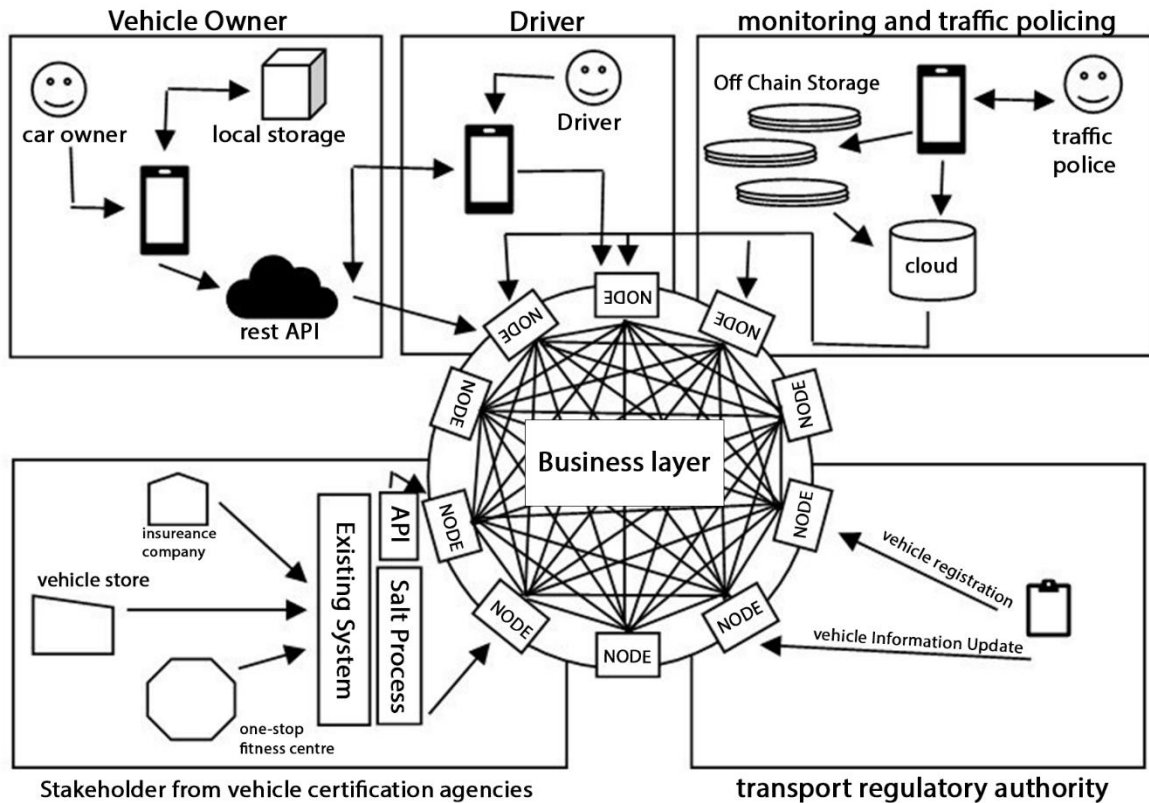
The previous studies submitted proposed solutions on blockchain and e-government that have reached many different conclusions. These problems have the following solutions:

- Dealing with cyber-attacks and centralizing existing e-government systems resulted in a single failure point. **(Elisa, 2019)** proposed a system appropriate for e-government system security and privacy guarantee, as shown in **Fig. 1**.
- **(Myeong, 2019)** investigated the essential value of blockchain was discussed, as well as its possible convergence with other administrative disciplines and development paths, to project its future contribution to society.
- To register a cognizable offense of criminal activities and find an alternative to a centralized system, **(Hingorani, 2020)** suggested that having a decentralized system is required to ensure that the system has no single point of failure and that complaints are processed safely and shielded from illegal access. **(Hingorani, 2020)** developed a blockchain-based framework for managing both cognizable and non-cognizable offense complaints.



**Figure 1.** The proposed e-government system by consortium blockchain (Elisa, 2019)

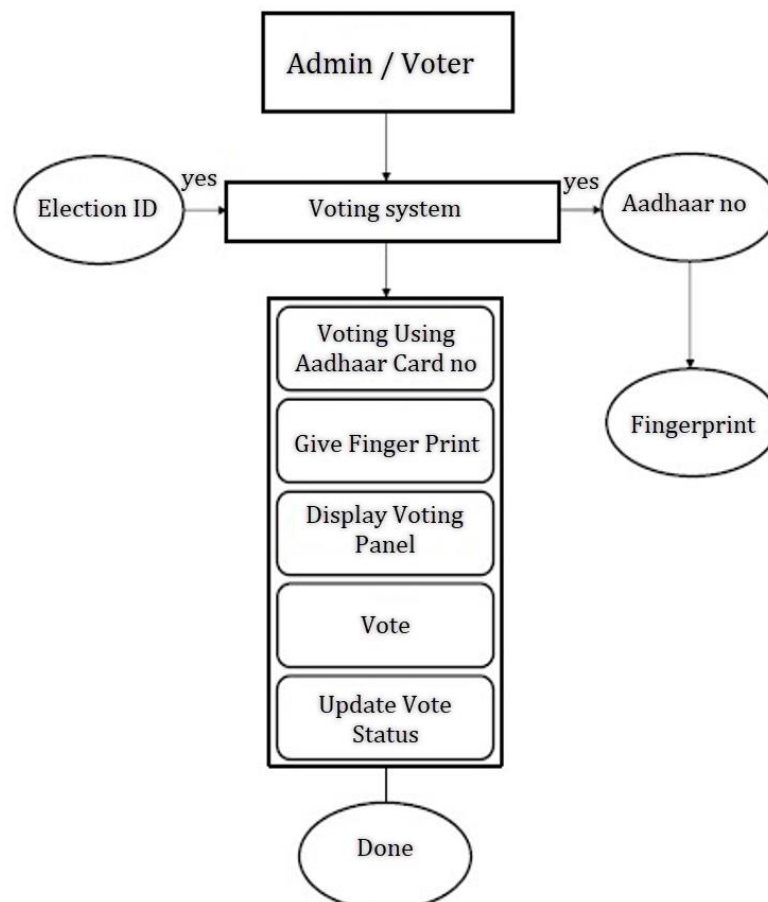
- To deal with the challenges of the manual approach of how bids are filed for a specific tender and the best offer is picked at the end of the manual bidding procedure is time-consuming and costly, as well as vulnerable to manipulation and corruption (Goswami, 2020) created a fair and transparent procurement process that involves active public involvement and fund tracking.
- In accordance with the urge to improve the citizens' overall quality of life, (Oliveira, 2020) provided insights into how smart city concepts, in light of recent breakthroughs in blockchain technology, may assist society in dealing with daily issues to raise citizen awareness and improve their engagement in social decisions which is critical for influencing public policy decisions affecting government, regulation, and education.
- Furthermore, to address the enormous challenge of real-time wide-range data handling in a scalable, safe, and secret method that the exponential growth of digitalization has provided, (Das, 2020) suggested a Blockchain-enabled Vehicle Certification (BVC) framework (shown in Fig. 2 below) in which the government body, automobile owners, drivers, and other suppliers are linked via a secure communication Channel.
- Regarding the critical need for transparency and transaction security in e-government services to help build trust in the services offered to ensure data security and data synchronization difficulties, (Geneiatakis, 2020) analyzes an e-government service as a good nominee for a blockchain transformation.
- Also, the centralization of existing e-government systems resulting in a single point of failure and cyber-attacks was addressed by (van Engelenburg, 2020), who proposed a blockchain design-based framework linking control points and design choices to rights.



**Figure 2.** The proposed Blockchain-enabled Vehicle Certification (BVC) framework (Das, 2020)

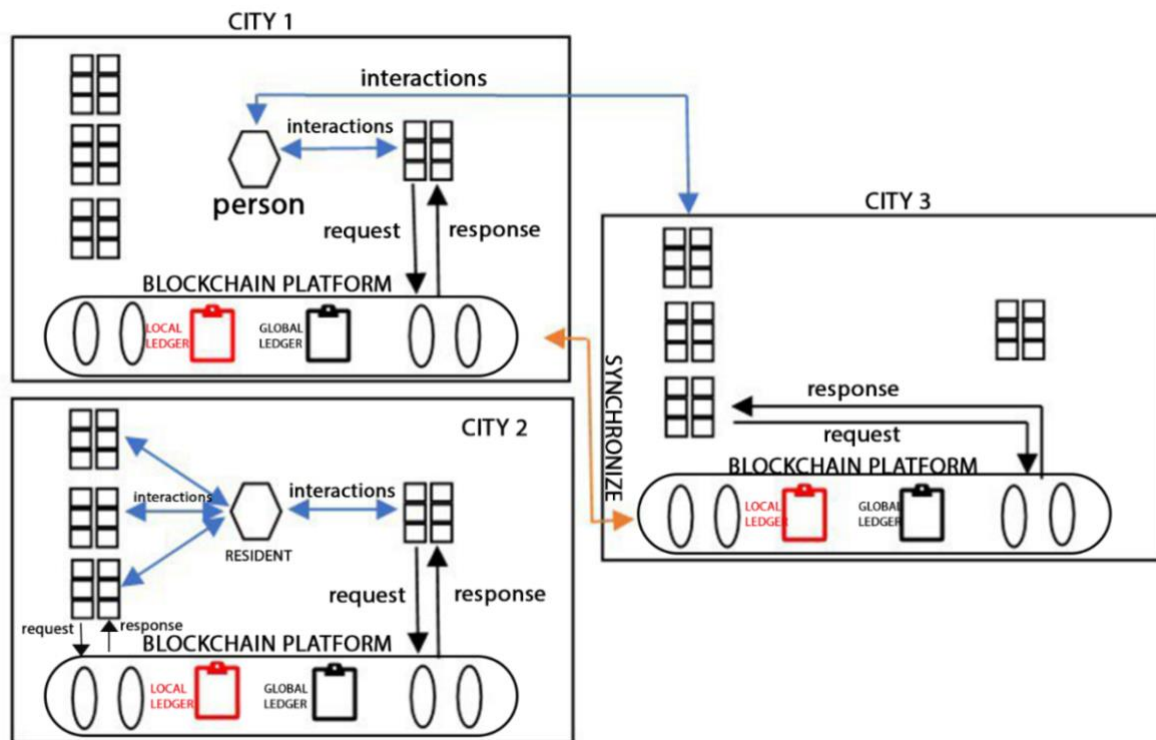
- In relation to the challenge of a centralized administration and validation system in e-government that may have a single point of failure, rendering it vulnerable to denial of service (DoS), malicious software, and distributed denial of service (DDoS) attacks (DDoS), (Elisa, 2020) provided a framework and prototype for a blockchain-based secure and privacy-preserving e-government system that any government may use to assure both security and privacy while boosting public sector confidence.
- (Talamo, 2020) demonstrated how public key infrastructures (PKIs) are hierarchical infrastructures. However, their use in non-hierarchical contexts has subjected them to various attacks. They are vulnerable to hazards due to probable failures of certificate authorities (CAs), which might be used to issue end users unauthorized certificates. Thus, to circumvent some of the flaws presented by using PKIs, a blockchain solution based on an original consensus algorithm built for use on blockchain technology was offered.
- Along the same lines, (Jagrat, 2020) stated an urgent need for enhanced data security, which has been widely exploited in the financial sector, and demonstrated the pressing need to show that blockchain is a helpful solution for governments worldwide.
- In accordance with the vulnerability of the e-government system that uses information and communication technology (ICT) to security risks and cyber-attacks, e-government systems raising worries about user privacy, as well as the confidentiality and integrity of data (Assiri, 2021) proposed a new framework for securing the Saudi e-Government system using blockchain technology.

- Similarly, **(AlMendah, 2021)** proposed using blockchain technology to secure platforms and services as a viable solution for major problems such as security and privacy concerns that are faced by systems using e-services, which provide consumers and users with speed of implementation and comfort, as well as high-luxury features.
- **(Chen, 2021)** proposed a low-cost blockchain data storage architecture for managing e-government data in response to the challenge of ensuring data integrity and tracking the trustworthy traceability of data usage managed in e-government applications via the basic systems that the information providers maintain, they often use a central architectural design that can lead to a single point of failure and information ownership issues.
- **(Thoppae, 2021)** underlined the need for the government to enhance performing functions, information storage, transaction execution, and how you can create trust in an open architectural environment, and advocated where and how Blockchain technology may be used to promote Thailand's 4.0 and digital economy ambitions.
- Likewise **(Mezquita, 2021)**, the benefits and contributions that blockchain technology in land registries would have if employed in the instance of the land register system in e-governments were emphasized. **(Gupta, 2021)** review of the literature demonstrated a variety of blockchain approaches proposed by several studies to make the e-voting process more secure and legitimate in e-governments. The proposed system architecture for this study can be shown in **Fig. 3**.



**Figure 3.** System Architecture **(Gupta, 2021)**

- Concerning the voting process, which is deemed an insecure procedure where they conducted votes, and it should be authenticated for all types of vulnerabilities, a blockchain-based system proposed by (Gao, 2021) (shown in Fig. 4 below) to address the challenges concerning the challenge related to the Notarial Office (NO), which is in charge of issuing various essential certificates, accreditation remains on manual processing and requires paper documents from other government organizations, causing significant disruption, rejecting non-local paper materials due to a lack of credibility in the local context, and thus being unable to provide cross-border services, and which can quickly lead to sensitive information leaks because copies of paper materials are stored.



**Figure 4.** Proposed blockchain-based system for Notarial Office Process (Gao, 2021)

## 5. BENEFITS OFFERED BY E-GOVERNMENT-BASED BLOCKCHAIN

Blockchain has demonstrated promising benefits and potential applications that have piqued the interest of stakeholders ranging from academia to industry, such as the following:

- Furthermore, (Kassen, 2022) Distributed ledger solutions could improve e-government reform efforts (such as Increased transparency in operations while improving government information bases). Many public information management procedures will be sped up and provide a prospective environment for testing various services that may be given using encoded communication channels. Given that the blockchain registration process makes all public transactions chronologically and irreversibly available, any data about registration systems and practices in e-government databases could now be disseminated in an essentially decentralized manner among many different beneficiaries,



not just those in government. **(Kassen, 2022)**. Because of the unique nature of blockchain technology, it will greatly enhance public service delivery models and, consequently, boost public trust in e-government by striving to make it more efficient, accountable, and transparent by relying primarily on more democratic peer-to-peer interactions and cooperation. **(Kassen, 2022)**. Previously, prior e-government frameworks could edit databases from the bottom, which is not currently possible, so decentralized administration of government databases helps improve transparency in all operations linked with information capture and storage. Nonetheless, there are several obstacles to conquer along the route. Most are concerned about regulatory conflicts and data leaks that may arise throughout the e-government automation process. By referring to fascinating examples from around the world that have been recognized and selected, **(Kassen, 2022)** discovered answers to the following critical questions: how the distinctive qualities of new technology might be implemented and shown in instructive cases, how they can help the government become more efficient and translucent, and What e-government services, processes, and procedures can automate along the way.

- According to the study of **(Ølnes and Jansen, 2017)**, Bitcoin and blockchain technology underpin it to create platforms for future innovation in monetary institutions and government. The technology appears to be maturing into a secure document-handling support infrastructure, placing it in a good position to impact future digital advancements, especially in the government. As a result, ICT systems based on blockchain technology, which implies decentralized administration and control, give more lasting and adaptable solutions that cannot be tampered with, according to the proposal. On the other hand, lessons learned from earlier attempts to adapt new technologies underline the need for a realistic and systematic approach. As a first start, **(Ølnes and Jansen, 2017)** gave instances of applications with straightforward technological solutions and minimal organizational or institutional stumbling blocks.
- **(Myeong, 2019)** According to the findings, In the future, governments will use the blockchain in electronic voting to motivate people to schedule the work that the government will do, improve tax security and transparency, and increase equality. Blockchain technology might be used to improve efficiency in delivering customized social welfare services, and its adoption through administrative reform could assist in reducing corruption in public sector personnel management, recruitment, and procurement **(Myeong, 2019)**. The purpose of **(Myeong, 2019)** research was to investigate and forecast the key technologies of blockchain and the value of its prospective contribution to society. This is critical; it has the potential to be a key engine of economic growth and a tool for development and innovation in a range of disciplines as a core technology of the fourth industrial revolution. Furthermore, dispersing information via distributed storage, sharing power, decentralizing paradigms, and discouraging hackers might increase security.
- Likewise, **(Alexopoulos, 2019)** According to the findings, blockchain-based technology is an enabling set of technologies that may help improve the openness and transparency of government services. Government 3.0, the future generation of government, has recognized this technology as a critical component. Technology based on the blockchain, based on the uses and benefits found, can be integrated into various public functions, increasing openness and trust in governments **(Alexopoulos, 2019)**. Blockchain-based technology has the potential to support many advancements, such as the Internet of Things, but also cause significant disruption to its operations. Many technologies have a



lot of application potential but don't contain service provisioning. Instead, blockchain-based technology is a practical technology that may be employed in the public sector due to its tremendous potential. Although blockchain is a transformative rather than a political technology, its political implications are significant, given its power to reshape larger socio-political interactions such as legal, institutional, and even economic ties (Alexopoulos, 2019). The study (Alexopoulos, 2019) examined the benefits and barriers to adopting BCT innovative technology in the public sector.

## 6. IMPACT TO THE BODY OF KNOWLEDGE BY E-GOVERNMENT AND BLOCKCHAIN

In addition to the problems that previous studies have highlighted and their research objectives that were embodied in attempts to solve those problems, there are gaps in the literature on blockchain and e-government that can be listed below:

- Among those gaps is what (Ølnes, 2016; Ølnes and Jansen, 2017) highlighted that since the introduction of the blockchain in late 2008 and its implementation in early 2009, bitcoin has received much attention. Nevertheless, the primary focus has been on the currency rather than the underpinning blockchain technology, which includes peer-to-peer networking, security, and consensus procedures. Thus, (Ølnes, 2016; Ølnes and Jansen, 2017) explored the possible use of blockchain technology in enabling wiser governments through secure, distributed, open, and low-cost database technologies.
- Moreover, (Alexopoulos, 2019) said that although there are multiple blockchain implementations in the government sector, no systematic study has been conducted to analyze the key aspects of these advances. (Alexopoulos, 2019) surveyed to determine the benefits and challenges of using the BCT innovative technology in the public sector.
- Likewise, (AlMendah, 2021) highlighted that the use of Blockchain technology did not appear to be the primary priority, so greater depth observation-based evidence for using Blockchain technology was required.
- Additionally, as digital technologies become more prevalent in our daily lives and governments continue to integrate technology into their day-to-day operations to pursue "digital transformation," something else is happening behind the scenes: the explanation of what digital government entails (Draheim, 2020). Distinct mental models, understandings, and settings may all lead to different conceptualizations of digital government's ontological character.
- While this has societal ramifications, it is also critical for the burgeoning scholarly area of digital governance to grasp the many interpretations and discourses at play, as it is hard to explain without first generating an initial understanding (Draheim, 2020). Accordingly, (Draheim, 2020) study identified the important narratives, discourses, themes, and motifs that have appeared and continue to appear in the scholarly literature on e-government.
- Furthermore, (Heneem, 2020) identifying existing blockchain activities in governments worldwide might help to better awareness and create standards for individual countries. Although a number of evaluation research on Blockchain projects have been conducted, relatively few studies highlight blockchain activities by Asian governments (Heneem, 2020). The United Arab Emirates, Singapore, South Korea, Japan, and Cyprus are the top five nations in Asia in terms of e-government development index (EGDI).
- Other studies, such as (Al-Musawi, 2020), Musawi's focused on roadblocks to operational e-government, which result in low public satisfaction and e-service quality.



Consequently, the authors presented two models for a practical implementation of blockchain technology in developing a successful public e-service. According to the researchers **(Al-Musawi, 2020)**, few studies have shed light on the success features of blockchain and how the public sector will achieve maximum efficiency and effectiveness. Thus, **(Al-Musawi, 2020)** proposed blockchain-based mechanisms to increase trust and transparency and reduce the cost of transactions and process efforts.

- Another issue in the literature was related to the foreign qualification recognition for allowing the practice of a regulated profession, which is becoming more important in the globalized economy and international organizations such as UNESCO. Nevertheless, national procedures for such recognition have not yet seen the dramatic transformations that have transpired in other spheres of public administration **(Pauletto, 2021)**. According to **(Pauletto, 2021)**, "transborder digitalization" research is still in its early phases. While governments investigate using blockchain apps to manage trade-related operations such as customs procedures, it's also essential to think about recognition **(Pauletto, 2021)**. As a result, **(Pauletto, 2021)** assessed the administrative tool requirements of recognized authorities and studied the options and advantages of blockchain technology in light of those requirements. He also evaluated blockchain technology's prospects in that area, highlighting technological advancements that might make its adoption easier.

## 7. CONCLUSIONS

The issue of transforming governments from traditional systems to electronic ones has become inevitable. The blockchain system is emerging and established as the most efficient system among all systems, with a future to help transform government systems worldwide. There are great expectations and potential for the blockchain system, which makes it at the forefront of the systems through which the current system of government is expected to change forever. The literature on blockchain and e-government can be divided into two parts: the area it covers and the type of research. In terms of the area covered by the research that dealt with blockchain and e-government, it varied, as was previously presented. Some of the studies dealt with the problems facing public demolitions provided by governments to their citizens, and this occupied the largest space in the literature on the subject.

Followed by those related to the exchange of services and partnerships between business companies and government institutions. As for the types of research conducted on the subject of blockchain and e-government, it also varied. Including a review or survey of the literature on blockchain and e-government, this type of study had a large share in the studies on the subject in terms of number. Followed by the studies that proposed or developed a conceptual framework, where these types of studies occupied the largest part of the literature on the subject. This was followed by fewer studies that used quantitative and descriptive methods. The problems highlighted by the studies on the research topic were also many and varied, some related to a specific scope. The concerns, in general, focused on, e.g., the lack of effectiveness, trust, security, transparency, and efficiency of government institutions and their systems in providing services to all who are within the borders of a particular state or government, including citizens, organizations and business companies operating within the country.





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