

# Blockchain's Applicability and Limitations in GovTech: A Literature Review

Holden Brett Bronson

*Received August 29, 2025*

*Accepted April 30, 2025*

*Electronic access May 15, 2025*

Blockchain, popularized by Bitcoin, has expanded the conversation about non-fungible tokens (NFTs) and cryptocurrencies. However, its potential applications extend far beyond these realms, encompassing business, healthcare, logistics, and many other industries. Notably, blockchain technology (BT) could significantly advance government operations due to its inherent secure, immutable, transparent, and decentralized characteristics. Blockchain could revolutionize various aspects of GovTech, including electronic voting (e-voting), tracking public funds, tax administration systems, and government tokenization. While other reviews focus on specific blockchain applications within GovTech, this article aims to provide a comprehensive overview of various blockchain applications within GovTech. This article addresses the limitations of blockchain within government operations, assesses whether blockchain can benefit government operations, explores the applicability and feasibility of such changes, and proposes future research directions. This article used a Google Scholar search based on the keywords below from recent (after 2009) articles. This resulted in highly relevant and insightful literature mentioned and discussed in this review. Due to this search system, this article reveals many factors within the realm of blockchain that are limiting its applicability. Some include environmental damage, high energy use, and a lack of public knowledge/awareness.

**Keywords:** GovTech, Blockchain, E-Voting, Carbon Credit, Government Tokenization, Decentralized Systems

## Introduction

Government transparency is paramount in a stable, trusted country. Many governments lack this highly acclaimed characteristic in ways such as corruption, allocation of funds, and governmental transactions. The US Government has recently hit 34 trillion dollars in debt years before predicted<sup>1</sup>. A solution to this seemingly uncontrollable debt begins by revolutionizing budgeting. A Better Budgeting Control Act would stabilize debt and account for emergencies without losing control of debt, amongst many other benefits<sup>2</sup>. While an act like this is argued to revolutionize countries, a strong foundation is required to implement such policies. This strong foundation often stems from trust in governance. Budget transparency is critical to human development and the development of a nation as a whole<sup>3</sup>. This development must be achieved in order to tackle numerous complex issues like a debt crisis. Blockchain technology can heavily assist in creating a more transparent government. Blockchain technology's appeal and primary strengths stem from its ability to be a ledger for secure and reliable transactions<sup>4</sup>, as seen by Bitcoin, the first use of blockchain. These strengths can theoretically be directly applied to government systems. Trackable and easily verifiable e-voting has been proposed as a suitable government voting mechanism<sup>5</sup>. Blockchain is seen as a semi-viable solution to e-voting. It enables votes to be saved easily on nodes,

and votes are easily traceable as each transaction (vote) is secure and supposedly non-tamperable. The implications of blockchain technology research have extended beyond simply cryptocurrency and e-voting to be implemented into other government sectors like tax administration. Blockchain's primary challenges are believed to be security, scalability, and flexibility<sup>4</sup>. Security breaches have happened in circumstances of blockchain's use in e-voting as a security vulnerability occurred in a mobile voting application used during the 2018 midterm elections in West Virginia<sup>5</sup>. Blockchain scalability limitation is evident as it is incredibly inefficient compared to standard transactional companies such as Visa or Paypal. Bitcoin has a throughput of 3-4 transactions per second (TPS), while Visa achieves 1667 TPS<sup>6</sup>. Flexibility, referring to Blockchain's decentralized nature, is beneficial but also causes detriments as it reduces efficiency and scalability. These challenges have been identified in broad discussions and specific reference to Blockchain's application within GovTech. Many of these problems have been sought to be solved as the applications of Blockchain Tech are numerous. Blockchain's application and total usefulness are lacking when the environment it is applied to is lacking crucial characteristics. This is evident in many Latin American countries that lack infrastructure and other things optimal for effective blockchain implementation in the public sector<sup>7</sup>. This literature review provides an overview of blockchain technology within

---

GovTech. This review had its articles chosen from a comprehensive Google Scholar search using keywords, “GovTech”, “blockchain”, “tokenization”, and “e-voting”. This paper aims specifically at addressing limitations and providing possible solutions. These solutions will apply depending on whether the issue is built on a lack of technology or an environment in which the tech is to be used. Some examples of solutions could include changing the blockchain-proof system or using a different blockchain framework. Government systems are the primary focus of blockchain technology, specifically how blockchain’s limitations can be solved so BT can be tailored to GovTech needs. This will include various technologies; some being tested and some being prototypes or theoretical. Most literature highlights that these areas are lacking, while this review will address these issues directly and attempt to provide potential solutions.

## Methods

Articles mentioned and cited in this review were chosen from a comprehensive Google Scholar search using carefully considered keywords and filters. The keywords used were “e-voting”, “GovTech”, “blockchain”, and “tokenization”. The keyword “GovTech” was used often in conjunction with another or multiple other keywords (e.g., “GovTech” + “blockchain”). Publications and articles from 2010 onward were included in this review due to blockchain being a relatively new technology (the first blockchain emerged in 2009). Additional sources were found by researching blockchain-related concepts on the web. Articles reviewing or discussing potential blockchain technologies related to GovTech were included. Despite cryptocurrency and NFTs being briefly mentioned in this paper, exclusion criteria included articles that heavily focused on these topics to focus on the application of blockchain in GovTech. This search method was partially limiting in that cryptocurrency and NFTs are important to the development and history of blockchain technology. This article, while excluding these topics in the main literature review, does touch on these topics in order to build proper context to the current state of blockchain technology. Furthermore, articles that summarized electronic GovTech but did not mention blockchain were generally avoided.

## Results

### Basics of Blockchain Technology

While ideas regarding decentralized networks and ledgers are decades old<sup>8</sup>, Blockchain’s first appearance was in the emergence of Bitcoin in 2009. The creator of Bitcoin was and is anonymous, but his technology structure was not, and soon, cryptocurrencies similar to Bitcoin began to increase in abundance. Bitcoin initially caught society’s attention because of its role as a fully digital currency, backed by nothing except

its limited and distinct nature. Soon, its value rose, and it was more seriously looked at. It began to be taken more seriously due to both its monetary value and its unique functionality—the blockchain structure. Eventually, Bitcoin’s blockchain structure began to apply to other areas besides crypto (see later sections on Application of Blockchains).

A blockchain is a decentralized, immutable, and shared ledger consisting of a chain of blocks, which are data sets. For every transaction, a new block is added, holding the previous block’s hash, a timestamp, and the transaction’s information: this is usually the new owner, previous owner, and other specific data regarding the transaction. Each block is added to the chain; thus, the blockchain’s history is stored. This produces secure, manageable, and trackable transactions. For every transaction, all members of the network (nodes) record the transaction into a block.

A node is simply a device, often a computer, that is part of the blockchain network. This device aids in Proof-of-Work (more on this later) and other software procedures in the decentralized network. To be a member, one must simply have a device part of the network (possess a node). A blockchain network is decentralized because it relies on many different nodes to execute appropriately. After that, nodes must execute Proof-Of-Work (PoW)—mathematical operations that are difficult to solve but easily verified<sup>9</sup>. The first node to find the solution announces it, and the other nodes verify the solution. With that solution, the block is verified and added to the chain. The first person who finds the solution “mines it” and is rewarded with the network’s currency.

Another aspect and use of blockchains is tokenization, which is the creation and use of a digital, specialized representation of a real asset or thing. Blockchains often accompany tokenization as they are digital, trackable, and secure, all crucial in this unique process.

On top of the formerly mentioned limitations of blockchains, such as inefficiency and lack of security, there are other limitations. One of these lies in the Proof-Of-Work system, as it requires lots of energy to verify each transaction. Another hindering aspect of blockchains is their limited ability to interact or communicate with other blockchains, thus reducing the applicability of blockchains’ current implementations. Another unique negative aspect of blockchains is how they have the potential to represent a currency managed by the consumers rather than the government. This takes power from the government, distributes it to the people, and gives the government less influence over the economy.

Blockchains consist of five layers: the hardware layer, data layer, network layer, consensus layer, and application layer (see Figure 1). These layers are used to maintain a secure exchange of value and data between users.

As shown in Figure 1, the hardware layer is simply the database where the information regarding the blockchain is

LAYERS	DESCRIPTION
Network Layer	<ul style="list-style-type: none"> <li>• Foundational Layer Maintaining</li> <li>• Managing the Peer-to-Peer Network, Including Protocols, Infrastructure, Nodes, and Connections</li> </ul>
Consensus Layer	<ul style="list-style-type: none"> <li>• Maintains a Single Agreed-Upon Truth Across Nodes</li> <li>• Validating Transactions</li> <li>• Adding Them to the Blockchain Through Consensus</li> </ul>
Contract Layer	<ul style="list-style-type: none"> <li>• Hosting Smart Contracts</li> <li>• Validating and Adding Transactions</li> <li>• Executing Business Logic for Applications and Contracts</li> </ul>
Application Layer	<ul style="list-style-type: none"> <li>• User-Facing Layer With Web Interfaces, Mobile Apps, and Tools</li> <li>• For Interacting With the Blockchain Infrastructure</li> </ul>

Fig. 1 Layers of Blockchain with the basic functionality of each<sup>10</sup>.

stored. This includes databases, computers, and other physical components necessary for blockchain to run.

The data layer consists of two parts: the linked blockchains and the pointers on the blocks that point to the previous block. A crucial structural component of blockchains is the Merkle tree, which is a binary tree made of hashes. Each block in a blockchain will contain the Merkle tree's root hash and information like the previous block's hash and timestamp. A Merkle tree is going to provide security, integrity, and a distributed nature to blockchains<sup>11</sup>. Another aspect of the data layer of blockchain relies on the presence of the private key. This key is used to sign transactions, and someone with the public key is needed to verify the signer. This ensures increased security and a lack of unauthorized tampering within the blockchain.

The network layer is responsible for interactions between different nodes. This layer, also called the P2P layer, manages the transactions, discovery, and spreading of blockchains themselves<sup>11</sup>.

The consensus layer, the crucial aspect of blockchains, is in control of validating blocks and ensuring all nodes and everyone agree. The consensus layer performs a multitude of tasks to accomplish its goal:

1. Establishing a clear set of agreements among all nodes.
2. Making sure control over the blockchain network is equally distributed, thus maintaining the decentralized nature.
3. Establishing a clear set of rules for all nodes to follow so that transactions are validated, and blocks are created in a consistent, trusted manner.

These tasks all ensure reliability and trust for blockchain users.

The application layer is made of smart contracts, chain code, and decentralized applications. Its protocols are divided into two separate layers: the application and execution layers. The application layer will comprise APIs, UIs, and scripts<sup>11</sup>. The smart contracts, underlying rules, and chain codes will all be part of the Execution Layer. The application layer will give instructions to the execution layer, which will perform the transaction itself.

## Applications of Blockchains

The most familiar application of blockchains is in cryptocurrencies, NFTs, and other digital assets. Cryptocurrencies are digital, decentralized currencies represented by blockchains. They are the oldest uses of blockchain because, as previously mentioned, Bitcoin pioneered blockchains' basic structure and function. In the past 15 years, tens of thousands of currencies have emerged, thus showing the rise in importance and usage of blockchains in terms of sheer scale and value in today's developing society. Beyond simply crypto's skyrocket in usage, non-fungible tokens (NFTs) have emerged and become extremely popular. NFTs are often digital things represented as data in a blockchain token. Almost always, NFTs are pieces of art or other visual pieces in which the owner of the blockchain token determines ownership. This market has risen to become extremely valuable as millions of NFTs are traded daily, and the market is worth billions<sup>12</sup>. Another aspect and use of blockchains is tokenization, which is the creation and use of a digital, specialized representation of a real asset or thing. Blockchains often accompany tokenization as they are digital, trackable, and secure, all crucial in this unique process.

A sector in which blockchain holds great potential is the logistics industry. Logistics is how goods are transported from their point of origin to the point of use or consumption. Transparency is crucial when dealing with supply chain and logistics as many locations and companies/persons are involved with the transportation of these goods. Due to the complex and convoluted nature of logistics, blockchain perfectly complements many of the difficulties that arise in logistics. A decentralized app and smart contract were created as a prototype to improve the logistics process in Cyprus' attempt to be involved in the future of logistics<sup>13</sup>. The transparency and decentralization of the blockchain proved a relatively viable technology to apply in the future<sup>13</sup>. This model was simple yet accomplished the task exceptionally well, as blockchain technology perfectly complements logistics.

Blockchains have become progressively more helpful in business in recent years. In many ways, businesses as a whole have been impacted by the newly shifted economy: the economy is beginning to focus on digitalization and, thus, digital assets, currencies, and technologies. These are all factors that heavily

---

dictate businesses and their success. For example, e-commerce is now a primary method of buying and selling goods and services in today's society. With a blockchain's secure, simple, and transparent nature, the online exchange of everyday goods could heavily rely on blockchain technology. Since blockchains could greatly improve supply chains<sup>14</sup>, they allow companies to manage inventories with blockchain records. This enables immutable records of their products. The blockchain data could hold whether or not the item has been sold and where the location of that item is. This would make inventories extremely traceable regarding price, location if a good is sold or bought, weight, and other characteristics.

Some businesses are accepting cryptocurrency payments for goods. On top of cryptocurrency being accepted as a payment, it is also now part of an Exchange-Traded Fund (ETF)<sup>15</sup>. The first and only cryptocurrency ETF is the Bitcoin ETF which was approved by the SEC (Securities Exchange Commission) in 2024<sup>15</sup>. This holds great implications for the future of cryptocurrency in the finance world as crypto can now be traded on the stock exchange. Another sector in which blockchain has been found applicable is the healthcare sector. Blockchain is said to have great potential in healthcare<sup>16</sup>. This is evident in a multitude of ways. On the one hand, building off the previous supply chain discussion, hospitals, and healthcare facilities require many high-demand products that heavily rely on timely shipments and accurate records. Products can be tracked to arrive on time and in the proper quantity at the correct locations. This could improve the quality of healthcare in that more products could be accessed and properly trusted to arrive in total. Furthermore, blockchains could represent patients' records and documents. Blockchains could be embedded with patient information such as allergies and previous surgeries; each procedure or new information could be a block added to the blockchain. This approach not only enables centralization of patient information but also makes it accessible to all medical facilities. This would eliminate a third party for patient information exchange, thus making access to critical patient information less convoluted and chaotic.

## Recent Potential Blockchain Technologies in GovTech

### Government Tokens / Securities

E-government has become an increasingly growing concept, and part of this field could involve the use of blockchain tokens to represent value of some sort. Government tokens are simply the representation of government-based value. This token can be used to represent anything. A government token is no different than a regular blockchain token except that it represents a value that has specific importance to the government. One token of particular importance is the carbon credit, which will be discussed in more depth later on in this section.

Government securities could also be tokenized using

blockchain. A security is simply defined as an interest in a corporation or other legal entity with certain rights such as voting, ownership, cash flows, assets, statutory or contractual rights, corporate governance rights, and the expectation of profit<sup>17</sup>. Based on this definition, blockchain could represent government securities in the future because it would make these securities trackable and transparent. Creating fraudulent securities would be less feasible, and the data regarding the security would all be stored in the blockchain block data for that security token. Due to government securities' change in monetary value over time, it would be fitting for a security's data to be stored in a secure blockchain. Currently, securities like bonds are intangible, meaning they lack physical substance. Since many government securities already don't need to be physical, representing them with blockchain tokens is a very fitting replacement as the average citizen with bonds would not notice a dramatic shift in how securities like bonds are handled.

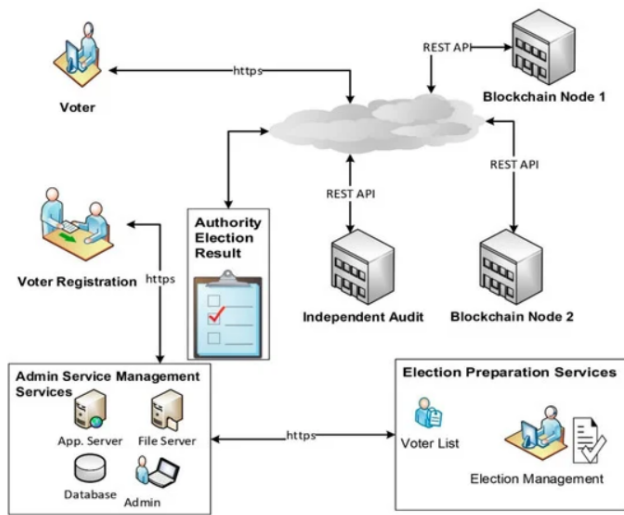
The use of blockchain for securities has already begun with governance tokens. Governance tokens are not strictly for a country's government, but they are simply cryptocurrencies that allow stakeholders (people who possess that security) to vote on the direction of a blockchain project<sup>18</sup>. The primary purpose of governance tokens is to distribute power<sup>18</sup>. Possessors of these tokens can potentially stand to take out loans with their tokens, stake them, and even earn money through them. The government can use governance tokens to gather the public's vote on the direction of a community project. In this way, governance tokens could be influential in the future of community projects. Furthermore, a voting mechanism similar to governance tokens could be used in elections for an e-voting system. This will be elaborated on later in the section.

On top of governance tokens, there are also utility tokens, which are digital assets that can be used for payment or to access a specific product or service<sup>18</sup>. Utility tokens can be applied to aspects of government, like tax payments, as will be discussed later.

### E-Voting

An essential aspect of government is voting on various officials and laws. E-voting is the process by which electronics are used to count and cast ballots on a particular topic/issue/election. This is currently used in numerous cases, such as online forums, polls, and sometimes tests. This process, however, has been criticized due to possible fraud and the protection of both oneself and their votes. This is where blockchain can perfectly complement e-voting. Blockchain-based E-Voting (BEV) would provide more extraordinary precautions to prevent voter fraud. The general concept regarding BEVs is that each voter would be given a blockchain token, similar to a cryptocurrency 'coin', that they could use. Using a token would be to perform a transaction between a voter's wallet and the candidates, in which the candidate's wallet will have the voter's original tokens by the end of the election. This model employs a personal ID and

tamper-proof key to authorize and perform transactions, making E-Voting secure and not easily fakeable.



**Fig. 2** Diagram of how blockchain-based E-voting would work<sup>5</sup>.

Figure 2 represents how users would have to first register online on the government-chosen platform. Authorities would then check user credentials and validate them. A voter would then be able to cast a vote that is encrypted and verifiable which would be a blockchain token transaction. Then votes and token counting would take place, revealing the outcome of an election or vote.

One company, Voatz, uses biometrics and real-time ID verification to perform small-scale BEVs<sup>19</sup>. They have been used in various elections, such as student government elections, union voting, church group voting, and sub-national voting. They have been able to influence the way secure local voting commences.

Another more significant use of BEV would be in Moscow’s Active Citizen Program<sup>19</sup>. This program has used BEV to conduct a variety of elections and had millions of votes cast under it. It is not mentioned whether or not the BEV was implemented permanently. However, this system has yielded significant benefits as many Moscow residents didn’t have the time or ability to go to a location in order to vote on an important matter. This potentially could have improved voter participation, but it is not confirmed. In both Voatz and the Active Citizen Program, the efficiency of voting was amplified, proving BEV’s value in catalyzing change at an efficient pace.

Despite these benefits, BEVs are yet to be implemented for national elections<sup>19</sup>. Even though the benefits of BEVs are evident in these examples, they are not a panacea for voting complications. While many were able to get involved where they wouldn’t have if the vote had been in person, there was a general distrust or lack of confidence in a BEV system due to

its complex nature<sup>19</sup>. Furthermore, when discussing Moscow’s Active Citizen program, it was claimed that the Ethereum-based blockchains were relatively ‘immature’ with 15-50 defects per 1000 lines of code<sup>19</sup>.

Since the voting/transaction defects are due to the immaturity of the Ethereum-based blockchains in Moscow, a more mature one would exemplify how and what to use when building a secure Blockchain-based E-Voting. Many different types of defects exist in blockchains<sup>20</sup>, but the article describing Moscow’s program does not identify which defects are occurring, so it would be difficult to pinpoint a solution to the Ethereum defects. However, many solutions exist to identify and fix blockchain defects<sup>20</sup>.

In another BEV<sup>21</sup>, Go-Ethereum or Geth is used. This eliminates third-party interference and fraud. The study suggests that the Geth blockchain is best suited for local small-scale voting as it is the most developer-friendly.

To implement e-voting on a larger or nationwide scale, particularly for national government elections, it would be preferable to develop a custom blockchain system. This approach would minimize reliance on private companies and enhance protection against voter fraud and security vulnerabilities. Furthermore, the current system of physical ballots, either mailed, dropped-off, or in-person clearly has shown its own merits as the system has reliably worked for countless elections. There have been some instances where people have distrusted the system, but overall, the system has been reliable.

### Public Funds Tracking

The importance of tracking funds has yet to falter in recent years and has reached peak potential in terms of preventing fraudulent activity. When discussing building trust and a stable political system, transparency is paramount regarding a government’s budget. Blockchain’s transparent nature when performing and tracking transactions is well-suited for the task of monitoring government funds and what they are being put towards. In a proposed blockchain-based fund tracking system, blocks would be created for different sums of money in a budget. For example, a government sector would have its own blockchain. Each time funds were used for a project or task, a block would be added with information such as payment amount, date, buyer, seller, and a description of what the transaction was. This is a simplified version of a potential technology on a broader scale.

An experimental prototype of a fund-tracking blockchain was created with the Hyperledger Composer from the Linux Foundation<sup>22</sup>. This experiment was laid out similarly to the previously described logic; a new block would be added for every transaction. This simple system did, though, represent promising leaps made in GovTech: all transactions made were visible to the public. This powerfully addresses one of the government’s goals of achieving trust and transparency. This incredibly reliable government technology could provide a savvy, efficient method

---

of providing the public with all transactional information. The implications of this are tremendous, as this could be applied to reducing corruption<sup>22</sup>.

The authors acknowledge that their prototype represents a basic model with significant potential for enhancement. These improvements could come in many ways, such as making wallet addresses public so that it is easy to track the path of money in various government transactions. Furthermore, access control and users would make this model more substantial and more realistic in its applications<sup>22</sup>.

A more intricate solution to addressing the tracking of the allocation of public funds was proposed in<sup>23</sup>. Their goal was similar: creating a blockchain to maintain all of the data regarding government transactions transparently and securely by keeping the flow of public funds. Their model consisted of two modules: 1. allocation and tracking of funds and; 2. the e-tendering system carried out at the district level. When the government allocates funds, the funds will follow a sequential order with the government first, then the state, then districts, and so on. This wallet proposed would be an Ethereum wallet so that funds and transactions can be reviewed by the end of each day. Departments will add transaction details to a sub-module of the larger blockchain in their blocks. Each district will represent a node in the larger blockchain network. In this way, the blockchain's decentralized network is ensured. All of these documented transactions are made easily observable and trackable via a graphical representation using Neo4J<sup>24</sup>, a graph database. With this, one can click on nodes and see the transactions involving that specific node. This visualization technique is far more sophisticated and reasonable than the proposed solution<sup>22</sup>. The second module, the e-tendering system, will, once a district is assigned a project, put out tenders to complete said project. This framework will also be blockchain-based. This will be done all while checking for fraud and illegal activity.

Overall, the second public fund tracking system described here provides a far more refined solution to creating a transparent fund allocation tracing method. Due to various aspects, such as the graphic visualization program and the sequential order of tracking funds, this program exemplifies an excellent solution to addressing fund tracking within GovTech.

### **Carbon Credits**

As the priority of reducing CO<sub>2</sub> emissions has become increasingly important, many methods to reduce emissions have emerged. One of these is the emergence of carbon credit: a digital smart contract and blockchain-based token that can be used to justify emitting CO<sub>2</sub>.

It functions as follows: once a tonne of CO<sub>2</sub> is verified as having been removed, captured, and stored, a blockchain-based carbon credit is minted<sup>25</sup>. These credits can be sold and purchased for future use. They have become a valuable tool for companies to attempt to reach climate change goals and also as an incentive to remove carbon from the atmosphere.

The Kyoto Protocol is an international agreement that calls for commercial entities to reduce CO<sub>2</sub> emissions<sup>26</sup>. One way this was done was by imposing emissions limits on countries, which in turn caused limits to be placed on businesses. Emissions can be exceeded if carbon credits are bought. If a company is below that limit, it can sell its remaining carbon credits.

Using blockchains to represent these carbon credits was especially smart as the chain stores information like the original possessor and whether or not the carbon credit has been 'burned' or not. Due to the chain always having this information, credits cannot be reused. Also, since blockchain technology is transparent, it is a trusted system that governments and international organizations can use. Carbon credits have been adopted internationally and are continually showing beneficial impacts on climate change, as well as exemplifying how international cooperation can benefit from new technologies.

The system used for carbon credits is similar to that of tracking public funds in how both systems employed the use of tokens to represent a quantity of something even though carbon credits deal with private corporations whereas public fund blockchains do not. The units of carbon credits represented were tonnes of CO<sub>2</sub> while the units measured on public fund blockchains were simply dollars. These systems also differ in how the carbon credits are tradable while the public fund blockchains are simply used as a method for a government's spending that is transparent and visible to the public.

### **Tax Administration**

Blockchain's transparent and trackable nature makes it highly suitable to accommodate an improved taxation system. Many countries do not collect adequate tax revenue due to tax fraud. A system based on blockchain would make taxes transparent and easily tracked. This is because the government can easily see if taxes have been paid and how much is owed. Furthermore, the encryption and security of blockchains make it reasonable for an important task such as tax tracing. One of the goals of employing blockchain technology in tax administration is to eliminate the asymmetry between citizens and government<sup>27</sup>. This is often a problem due to self-reported tax information and disagreement between these two parties: taxpayers and authorities. Taxpayers no longer have to report separately to state and federal authorities due to blockchain's transparent and easily trackable nature, thus reducing data entry redundancy. This can be avoided through a commonly agreed upon immutable blockchain system.

One proposed method comprised citizens, government constituencies, contractors, and central government depository as the nodes of a tax tracing system<sup>28</sup>. This is a proposed system for India called the Indian Tax Revenue system. Citizens must first verify their identity, and then pay their taxes promptly. Since the system is blockchain-based, there were fees for using it because of the high energy consumption of blockchain transactions. When one pays taxes, the money is converted to tax tokens to be deposited into the government's depository.

---

This is a relatively simple system, but it did exemplify transparent, trackable tax paying. Every payment was agreed upon and tracked. There were no mentioned disputes based on tax payments, which is part of the purpose of a blockchain-based tax system.

The system functioned as intended and demonstrated many of the intended benefits. However, aspects like gas/energy fees were not ideal, making the system unsuitable for implementation. Furthermore, many people would not be comfortable paying taxes like this, so gathering a population willing to accept this system would be especially difficult.

In another discussion regarding tax administration using blockchains<sup>27</sup>, it is explicitly mentioned that a private blockchain network could be necessary for an effective system. Although the Indian Tax Revenue system likely used a private network, it is important to mention the need for a private network because it is crucial that only allowed members (a country's citizens) are part of the network. This ensures that classified or confidential information is excluded from non-citizens and other countries. Some questions were raised regarding using a private blockchain network as the distributed nature of blockchain is one of its strengths; administrators could act immorally and exclude specific users, rewrite block history, and delete resources<sup>27</sup>. Though these are frightening possibilities, they are no more terrifying than a country possessing control over water and electricity use. Part of a government is that they have power and are trusted to use it wisely. However, to mitigate the frightening aspects of a private blockchain, this paper proposed a blockchain consortium: these only allow permissioned users but also maintain a partially decentralized nature, which is crucial to the function of a blockchain system. Therefore, the most suitable system for a blockchain-based tax administration system would be to use a blockchain consortium so that information is kept private and decentralized to keep a trusted system in place.

This paper also mentioned the suitability of using blockchain for international tax transactions<sup>27</sup>. It is mentioned that there has been a lot of "information asymmetry." This is due to no central authority over these transactions. A blockchain system accommodates this problem exceptionally well because blockchain offers a transparent transaction system for "parties who do not fully trust each other." This would ensure that every transaction regarding tax exchange is agreed upon. This agreement would decrease the asymmetry and ensure every transaction is agreed upon. However, this likely comes with a drawback of slowing down tax exchange due to the assurance of agreement, but ultimately, this would solve many transparency and traceability-related issues with international tax. Additionally, the current tax administration system is efficient and trusted. However, just because it is efficient and trusted, doesn't mean that the blockchain system wouldn't be overall better. Fraud could potentially be found easier and less easily achieved.

Finally, the paper described in mentioned the ideal time for implementing a blockchain-based tax system<sup>27</sup>. They mentioned it should be done when distributed ledger technology (blockchains) is used in various other sectors of society. However, for citizens to trust a government's use of technology, it is crucial to ensure that these citizens have witnessed this technology being used in a trusted and reliable manner. Currently, public trust and adoption of this system are limited due to the technology's novelty and its strong association with cryptocurrency. People use cryptocurrency and blockchain interchangeably, indicating a lack of understanding of this sector. It is important to foster a widespread knowledge of this technology before fully implementing a blockchain-based tax administration system.

## Discussion

At this point, blockchain still has a long way to go before it can be fully adopted and implemented by the government. It seems blockchain is becoming increasingly more refined and more suitable for usage. But for now, that usage will likely remain in the private sector and will not be used liberally by the government. This is partially due to, as discussed previously, the high energy cost and use of blockchain transactions and the slow transaction per second rate of blockchain. Due to both factors, it is hard to justify implementing blockchain in the government.

While some countries do have electronic voting systems that allow virtual vote casting (e.g., El Salvador<sup>29</sup>), nearly every country still uses some sort of physical ballot for elections. For many countries, E-voting is not an option due to the lack of necessary computers and electrical infrastructure. This makes widespread E-voting (even non-blockchain e-voting) especially improbable in non-first-world countries.

Furthermore, even in developed countries with the necessary infrastructure such as the USA, blockchain is not currently suitable for the government because the vast majority of the general public needs more understanding of blockchain. Many older generations are unaware of blockchain, and many others who are aware of blockchain understand it solely due to Bitcoin and NFTs. This has caused a very misleading and warped perception of blockchain and its applicability. Due to the vastly warped perspective regarding blockchain technology, governments, especially the USA, are not ready to use blockchain technology in essential fields like elections. This is because the government is held to an incredibly high standard. With that high standard comes the need for trust in every aspect. Blockchain could increase transparency and government trust, but that is only by those who understand blockchain in the first place or at least understand the benefits and drawbacks of it. Since many don't understand it and its implications, the public would likely disregard blockchain GovTech, and there would be widespread distrust and disapproval. This creates controversy about whether

---

or not it is worth spending the resources and funds on educating the public on blockchain technology. The ideal time for implementation discussed for the tax administration technology is then similar to all the technologies discussed in the previous section.

Again, the problem of asking when the population is prepared for implementation is not the last concern with blockchain GovTech. Instead, there is also concern about the environmental cost and ethics of blockchain technology. If there is a problem with blockchain technology, then the question of whether the government can endorse this technology arises. The problem with blockchain is that it uses high amounts of energy to verify and perform transactions when using a proof-of-work transaction system. These transactions usually require powerful computers that consume large amounts of electricity. For now, since most electricity production is done so unsustainably, blockchain transactions are contributing to fossil fuel burning and unsustainable practices. Sure, the government already participates in many unsustainable practices, but it is hard to justify the increase in these practices when the justification is improving already functioning sectors. Water and land use are another area in which blockchain technology negatively impacts sustainability and the environment. Data centers, which blockchain technology heavily depends on, were ranked in the top 10 of “water-consuming industrial or commercial industries” in the U.S.<sup>30</sup>. These data centers, growing in demand partially due to blockchain and cryptocurrency usage, could require more land for their infrastructure which could ultimately negatively impact environmental factors like ecosystems, pollution, and fossil fuel emissions. Before the government can choose to implement blockchain, it must also decide if the upsides of blockchain technology outweigh its negative impact on the environment.

Due to many of the drawbacks just discussed, it is crucial to examine where blockchain as a whole can be improved to accommodate government uses better. Bitcoin for example runs off of the high energy use PoW system. Bitcoin transactions consume 127 terawatt-hours (TWh) a year<sup>31</sup>. This is more than some individual countries produce in a year<sup>29</sup>. One way is to find methods to reduce its high energy consumption to increase its suitability for a more sustainable future. One way this has been done for Ethereum-based blockchain networks is by using proof-of-stake (PoS) systems rather than PoW. PoS has been shown to use 99.9% less energy than PoW, allowing it to use roughly the same amount of electricity as a Mastercard transaction<sup>31</sup>. While PoW is the most widespread system for blockchain technologies, using PoS systems could make blockchain implementation in the government more feasible.

Other strategies besides PoS that could be effective at reducing energy use is hybrid blockchain models. These models use a combination of transparent public blockchains alongside private, more efficient blockchains. The result is a similarly trusted and secure system with reduced energy use and increased efficiency.

Another way besides reducing electricity consumption is to increase its transaction speed to make the technology more scalable and better suited to accommodate a whole country. Also, ensuring that each transaction and line of code has no defects is crucial before implementing it into the government. This was a problem for Moscow’s Active Citizen Program. There are still many areas where blockchain can improve before it becomes ideal in every circumstance.

## Conclusion

This paper sought to discuss the ideal places for blockchain to be implemented in the government. It also explored how the current technologies and discussions regarding those sectors fall short and are limited in their viability for a government. It was found that there are promising fields for blockchain within the government, such as e-voting, tracking public funds, and tracking government tokens such as carbon credits and tax tracing. Within all these fields, there were limitations. The criticisms of blockchain as a whole were found to be its struggle with transaction efficiency, which causes a lack of scalability. Also, it uses high amounts of electricity, which is not ideal as much of that energy comes from fossil fuels. Despite these criticisms, there are many hopeful aspects of blockchain for the government, as blockchain could lead to increased transparency, efficiency, trackability, data immutability, and a lack of tax asymmetry all in a more secure manner. Blockchain has also shown benefits in climate change as carbon credits have helped corporations reduce and focus on their emissions. Overall, blockchain could be implemented to benefit governments.

There are many other directions that the conversation of blockchain and its potential applicability to the government could go. A future study could examine whether or not blockchain’s implementation in the government would significantly increase fossil fuel consumption and unsustainable practices. The government should also take into account the return on investment in terms of citizen satisfaction; would citizens be more excited by blockchain technology or more appalled by the potential negative impact on the environment? How could proof-of-stake systems better accommodate blockchains within GovTech? Would the citizens be satisfied by the possible increase in government efficiency? Despite blockchain’s potential benefits, there are other factors and areas of improvement to consider before the government can fully employ blockchain technology.

## Abbreviations

**BEV:** Blockchain-based e-voting  
**BT:** Blockchain Technology  
**NFT:** Non-Funfible Token

---

## Acknowledgments

I would like to thank Mr. Patacky, my AP stats teacher, for taking the time to discuss the blockchain in broader contexts than cryptocurrency. I would also like to thank Mr. Fogg, my Computer Science teacher, for furthering my interest in fields related to computer science. Finally, I am especially thankful to my family for supporting and encouraging me to pursue this field and write this paper.

## References

- 1 F. Hussein, *U.S. national debt hits record \$34 trillion as Congress gears up for funding fight*, PBS NewsHour, 2024, <https://www.pbs.org/newshour/politics/u-s-national-debt-hits-record-34-trillion-as-congress-gears-up-for-funding-fight>.
- 2 R. Boccia, *How a better Budget Control Act would limit spending and control debt*, Cato Institute Briefing Paper 156, 2023.
- 3 B. Cuadrado-Ballesteros and M. Bisogno, *International Review of Administrative Sciences*, 2023, **89**, 239–256.
- 4 F. R. Batubara, J. Ubacht and M. Janssen, *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age*, 2018, pp. 1–9.
- 5 R. Taş and Tanrıöver, *Symmetry*, 2020, **12**, 1328.
- 6 A. I. Sanka and R. C. Cheung, *Journal of Network and Computer Applications*, 2021, **195**, 103232.
- 7 C. Parenti, N. Noori and M. Janssen, *Journal of Smart Cities and Society*, 2022, **1**, 71–92.
- 8 S. S. Sarmah, *Computer Science & Engineering*, 2018, **8**, 23–29.
- 9 S. Ammous, *Blockchain technology: What is it good for?*, SSRN Preprints, 2016, Available at SSRN 2832751.
- 10 T. Tamplin, *Blockchain architecture*, Finance Strategists, 2023, <https://www.financestrategists.com/wealth-management/blockchain/blockchain-architecture/>.
- 11 G. Kaur, *A beginner's guide to understanding the layers of blockchain technology*, Cointelegraph, 2023, <https://cointelegraph.com/learn/a-beginners-guide-to-understanding-the-layers-of-blockchain-technology>.
- 12 D. Ghelani, *What is non-fungible token (NFT)? A short discussion about NFT terms used in NFT*, Authorea Preprints, 2022.
- 13 A. S. Andreou, P. Christodoulou and K. Christodoulou, *Cyprus Review*, 2018, **30**, 181–193.
- 14 X. Li, *Computers & Industrial Engineering*, 2023, **179**, 109196.
- 15 J. Chen, *Exchange-traded fund (ETF): What it is and how to invest*, Investopedia, 2024, <https://www.investopedia.com/terms/e/etf.asp>.
- 16 M. Hölbl, M. Kompara, A. Kamišalić and L. N. Zlatolas, *Symmetry*, 2018, **10**, 470.
- 17 M. Mendelson, *Stanford Technology Law Review*, 2019, **22**, 52.
- 18 S. Sriram, *What are governance tokens, and how do they work?*, Cointelegraph, 2022, <https://cointelegraph.com/news/what-are-governance-tokens-and-how-do-they-work>.
- 19 N. Kshetri and J. Voas, *IEEE Software*, 2018, **35**, 95–99.
- 20 J. Chen, X. Xia, D. Lo, J. Grundy, X. Luo and T. Chen, *IEEE Transactions on Software Engineering*, 2020, **48**, 327–345.
- 21 F. Hjálmarsson, G. K. Hreiðsson, M. Hamdaqa and G. Hjálmtýsson, 2018 IEEE 11th International Conference on Cloud Computing (CLOUD), 2018, pp. 983–986.
- 22 A. Mohite and A. Acharya, 2018 International Conference on Computational Techniques, Electronics and Mechanical Systems (CTEMS), 2018, pp. 231–234.
- 23 K. Bhole, Y. Galphat, K. Bathija, T. Saini and A. Bhosale, 2021 4th Biennial International Conference on Nascent Technologies in Engineering (ICNTE), 2021, pp. 1–4.
- 24 Neo4j, *Neo4j graph database & analytics*, Neo4j, n.d., <https://neo4j.com>.
- 25 P. J. Kroft *et al.*, *What exactly are carbon tokens?*, Lexology, 2022, <https://www.lexology.com/library/detail.aspx?g=731712ed-155b-4fd3-8824-562e5110965c>.
- 26 Y. Gupta, *Global Journal of Management and Business Research*, 2011, **11**, 16–19.
- 27 Y. R. Kim, *UCLA Law Review*, 2022, **69**, 240.
- 28 S. Dedhia, P. Mair, S. Waghmare and T. Nagarhalli, 2023 7th International Conference on Intelligent Computing and Control Systems (ICICCS), 2023, pp. 887–894.
- 29 E. O'Neill, *Voting from abroad: Enhancing electoral integrity in El Salvador*, International Republican Institute, 2024, <https://www.iri.org/news/voting-from-abroad-enhancing-electoral-integrity-in-el-salvador>.
- 30 R. Ahmad, *Engineers often need a lot of water to keep data centers cool*, Civil Engineering Magazine, 2024, <https://www.asce.org/publications-and-news/civil-engineering-source/civil-engineering-magazine/issues/magazine-issue/article/2024/03/engineers-often-need-a-lot-of-water-to-keep-data-centers-cool>.
- 31 S. Huestis, *Cryptocurrency's energy consumption problem*, RMI, 2023, <https://rmi.org/cryptocurrencys-energy-consumption-problem/>.