

Blockchain Based E-Voting System

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Abstract— *The modern democracies of the world have witnessed numerous cases of electoral frauds, in-house manipulations, violent clashes during the elections, forgery in counting of votes, and evidences of cross-border third party involvement to rig the elections. The root cause of these problems lies in the traditional voting systems, such as the paper ballot system, or the machine lever system which are innately vulnerable. There has been a consistent effort by the academia to assist the policy makers in establishing a secure, trusted and reliable voting process, since any attack on voting system undermines the essence of democracy.*

To address the challenges of traditional voting mechanisms, such as cost of expenditure, security and reliability of the electoral process, trust deficit among the citizens and the government, declaration of result in a time bound manner and preserving the anonymity of the voter, several electronic voting (e-voting) systems have been devised, however, there has been a lot of hype around the term blockchain in the last decade. Due to this, several researchers in the recent past have been pursuing blockchain based e-voting systems to help establish a more transparent, secure and trust inducing democratic setup for the modern society.

This research report intends to examine and analyze the application of blockchain technology to the e-voting process by reviewing some of the previous works related to the field, the technical aspects of the underlying process, a few global examples of the technique and the benefits this technique offers along with its challenges. Finally, the report comments upon the future scope of blockchain based e-voting system.

1. INTRODUCTION

Blockchain- A Groundbreaking Concept

Popularized primarily by digital currency, blockchain has become a buzz word in the markets in the present day, with its realms reaching diversified sectors such as banking & finance, hospitality & tourism, healthcare & medical infrastructure, academia & research, supply chain & marketing, and of lately, voting in elections. As a concept it seems surprising, controversial, confusing yet encouraging to pursue, thereby becoming one of the most sought-after field of study. This is evident from the fact that in 2020, more than 8000 patents were exclusively filed for studies related to blockchain [1]. In a life span of not even one-and-a-half decades since its formal inception by pseudonymous Satoshi Nakamoto in his work [2], blockchain took the whole world by storm. The study [2] has roughly 21000 citations by the research community and this number is sure to increase given the rising of trend of digital currencies. The idea of Blockchain is based on a decentralized system that is distributed on multiple users (nodes), connected over a network. Every user is collectively involved in the Proof-of-Work [2] algorithm to ensure the authenticity and legitimacy of the blockchain network. Blockchains are often connected via secure encryption mechanisms, such as Secure Hash Algorithm or SHA-256.

Growing Popularity of Blockchain

Although the concept of blockchain lays the basis of Bitcoin and similar hyped digital currencies, computer scientists, world leaders and various business leaders have been vocal about blockchain technology that it has a potential to change universal businesses, markets, policies, services and delivery of services by

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the governments. Some of the facts and statistics [3] related to blockchain technology are:

- About 90% of European and American banks had started exploring blockchain's potential by 2018.
- By 2024, it has been estimated that corporations will spend \$20 billion per year on blockchain technical services.
- 74% of tech-savvy executive teams say they believe there's a huge business potential in blockchain technology.
- Financial institutions alone have spent about \$552 million on blockchain-powered projects.
- More than 20 countries have adopted or at least researched the concept of a national cryptocurrency.
- The global blockchain market will be worth \$1,431.54 billion by 2030.
- Blockchain could boost global GDP by \$1.76 trillion by 2030.
- 96% of financial service experts believe blockchain has achieved mainstream adoption.
- Blockchain in manufacturing is growing at a rate of 73%, between the years of 2022 and 2026.

The above data clearly highlight the claims by several famous personalities across the world, including Elon Musk- the wealthiest man on the planet, that blockchain technology is the next big thing. It is definitely the technology of the future!

Applications of Blockchain

In addition to the concept, the strength of blockchain technology rests in its flexibility and robustness to be smoothly employed trans boundaries across various domains, sectors and industries with the list continuing to expand even further. Some of the well-known applications of Blockchain technology are summarized as follows:

- **International Payments**
Removing the centralized authentication mechanism, blockchain can facilitate international payments by creating a tamper-proof record of confidential information.
- **Compliance and Audit**
Blockchain greatly lessens the likelihood of human errors. Further tampering with records

would render blockchain useless, thereby ensuring integrity of data.

- **Money Laundering Protection**
Blockchain technology strengthens the monitoring and surveillance components such as Know Your Customer (KYC) to verify the identity of end user thereby delegitimizing 'hawala' transactions.
- **Healthcare**
Blockchain technology envisages a decentralized system of health data exchange which protects and helps authenticate health information, reducing the cost associated with traditional methods.
- **Identity Management**
Using blockchain, people would only need to provide the bare minimum for instance, date of birth to prove their identities.
- **Tax filing**
Blockchain can make the otherwise laborious and error-prone task of tax filing more efficient and precise by maintain relevant information via blockchain.
- **Cybersecurity**
Blockchain provides end-to-end encryption, privacy and trust using consensual participation in Proof-of-Work.
- **Voting**
Blockchain based e-Voting is a recent addition to the already versatile nature of blockchain and its applications. It can make the voting process more accessible, more secure and more reliable. This would reduce the burden off the shoulders of both the government officials and the people. It has a huge potential especially for major democracies of the world like India, US.

4 Problem Definition

One of the most groundbreaking applications of blockchain technology is voting conducted in the elections, especially in a democratic setup. Voting is conducted across several sectors and at multiple levels, such as voting for the post of class representative in a school/college, voting for the designation of an Executive in an organization, voting for head of a state (chief minister) or head of a nation (prime minister). Voting represents the general will/ consensus/

agreement of the concerned stakeholders and thus the integrity, security and legitimacy of voting process can never be undermined. There have been several cases of electoral fraud, corruption, vote buying, ballot forgery, booth capturing and numerous other controversies in voting process particularly when the voting is being conducted for selection of political representatives in a nation [4]. This has been one of the major problems of the modern world. The principle of consensus is central and integral to both the voting process and the blockchain technology. Hence, this report focuses on exploring and analyzing blockchain based e-voting mechanisms and attempts to provide insights on the problems, the benefits and the opportunities offered by this technology in the domain of e-voting.

Objectives of the Study

In light of the problem definition presented in the preceding section, this section enumerates the primary goals and objectives of this study. Succinctly, the motivation behind this study can be listed as follows:

- To investigate and explore the process and mechanism of blockchain based e-voting.
- To examine and discuss a few case studies of blockchain based e-voting and discuss the scope of the technology.

The forthcoming chapters in this report are structured as follows. Chapter 2 briefly walks through the related work reviewed from the literature. Chapter 3 describes the working of a blockchain, blockchain-based e-voting system, problems with traditional voting systems and advantage of the former with respect to security. Chapter 4 elucidates a few case studies based on the research topic, globally. Chapter 5 concludes this study and discusses the future scope of the work.

2. LITERATURE SURVEY

Blockchain technology has notably flourished in the last decade and has become a central point of discussion among the prominent leaders, research community, business leaders, philanthropists, computer scientists and the common man. Among the multitude of application that blockchain technology offers, the current focus has been revolving around blockchain based e-voting since elections have the potential to change the fate of the citizens and the country. The

21st century has witnessed a rise in the instances of cases of electoral frauds [5], tampering with electoral process, time taken to count the votes and concluding the elections. This has led to a lack of interest in the citizens to cast their vote. Further it has also increased the trust deficit among the citizens and their respective governments, thereby reinstating the fact that elections are crucial and central to the essence of modern democracy [6]. Elections should not only be free and fair, but should also appear to be free and fair especially in the eyes of a common man. The solution to these problems lies in developing a secure, smart, trusted, reliable and resilient e-voting system that can withstand potential attacks and ensure end to end encryption of both the identity of voter and the sanctity of his/her vote. A great deal of work is undergoing in this field and there have been several studies in the past that have paved way for subsequent investigation and analysis of blockchain based e-voting to inspect its challenges, opportunities and strengths. This paper presents a brief literature survey of some recent studies in blockchain based e-voting.

Researchers in the study [12] introduced the system of reward/penalty in the fundamental e-voting protocol using the popular cryptocurrency ‘Bitcoin’ (based on blockchain technology). Each voter will get rewarded for correct (expected) behavior, i.e., adhering to the protocol and will be penalized for deviating from the underlying protocol. The proposed protocol mandates the casting of vote coupled with Bitcoin transactions. This acts as a security deposit amount to penalize those who deviate from the protocol. Despite certain fundamental assumptions which need to be ensured such setting up every eligible voter as a node on the blockchain network, maintaining sufficient bitcoins for transaction, this protocol was one of the initial efforts in the direction of e-voting based on blockchain technology and has been pursued by various studies following its publication.

In the research work [7], the authors made use of foundational characteristics of blockchain technology: cryptographic security and transparency, to propose an e-voting system. The authors implemented their proposed system using Multichain [8] and performed an in-depth evaluation of the system. However, the proposed system did not address the ‘double spending’ problem [9] which will translate as ‘double voting’ for

e-voting systems. The authors were able to discover this shortcoming and concluded on the remark that further efforts are underway to improve their blockchain based e-voting system.

The study [10] proposed a database recording e-voting system built on top of blockchain technology. In this system, each node (voter) will wait for her/his turn to vote and generate the corresponding block. Then verification of the block will be done to ensure its legitimacy. Post verification, the block is added to the database. A second verification step is performed when the node will ensure the legitimacy of the node ID brought to it. The verification helps to ensure the sanctity of the voting process. Finally, the block created and submitted by the node will be broadcasted on the network to avoid any collisions and the next node will cast vote according to its turn. The authors implemented their proposed model via Python programming. The authors found their proposed system to be cost-efficient, space-efficient and time-efficient, which can be scaled to a large voter base and can facilitate announcement of results of the voting in a time bound manner.

The authors in [11] proposed an e-voting protocol based on blockchain technology to address the security concerns with traditional voting mechanisms and also provided the flexibility to the voter to change their vote or to cancel their vote. The authors attempted to provide for maximum degree of decentralization, however, after a careful analysis, it was found that a small degree of centralization is necessary in an electoral system. Central authority would be required to uphold the privacy and anonymity of the voter's identity while at the same time authenticating only eligible voters to cast their vote. Although the proposed system seems robust there are certain shortcomings to it. The author, in his concluding remarks, suggests an integrated and collaborated efforts on part of research community and international organizations to fully realize the true potential of blockchain technology and its applications.

The research work [13] proposed a decentralized, flexible e-voting based blockchain protocol without a trusted third party. Theoretically, the proposed protocol incorporates several desirable traits of a secured e-voting system viz. individual verifiability, consistency, auditing, anonymity, and transparency.

Blind signature [14] and blockchain are the primary technologies employed in the research work. Blind signature is used to preserve the voter's choice while the blockchain ensures the transparency of the overall process. The study ended on an open end, creating scope for future implementation and extension of the proposed protocol.

It can be inferred from the aforementioned studies that blockchain based e-voting offers a lot of potential and has the scope of smoothly replacing the existing voting techniques, particularly the traditional paper ballot-based voting. The blockchain technology can significantly revolutionize the voting mechanisms by addressing the concerns of security, transparency, anonymity, trust, flawless counting of votes, and the time taken to conclude the elections. Although, blockchain based e-voting system is still in nascent stages, international partnership and association can accelerate the development of this technology and eventually result into full realization of this technology for the common good of all in the contemporary democracy.

3. BLOCKCHAIN BASED E-VOTING SYSTEM

The e-voting system addresses various limitations of the traditional voting system such as standing in long queues at the polling booth, security leaks, tampering with vote, excessive use of paper which is less eco-friendly and time-consuming, challenges for differently-abled voters to reach their designated polling booth, general lack of interest especially among the urban youth to cast their vote perhaps because of a far-off designated polling booth or due to lack of trust in the electoral process, high expenditure incurred on the elections. Additionally, blockchain based e-voting is an ideal solution in the covid-19 pandemic times, by allowing the voter to cast his vote from anywhere, anytime.

As per the Fig-1 depicts, a full-fledged electronic application will be leveraged to facilitate decentralized, distributed e-voting backed by new technology, from even the remotest places, provided internet connectivity is ensured. The process of blockchain based voting can be summarized in the following four steps:

- Step 1- On the application, the registered voter will enter the credentials, from a smartphone or a

computer, in order to cast the vote. The application can also make use of smart biometrics and real-time voter ID verification to be doubly sure that only the eligible voters participate in the process. Entire data will get encrypted and stored as a transaction to maintain anonymity.

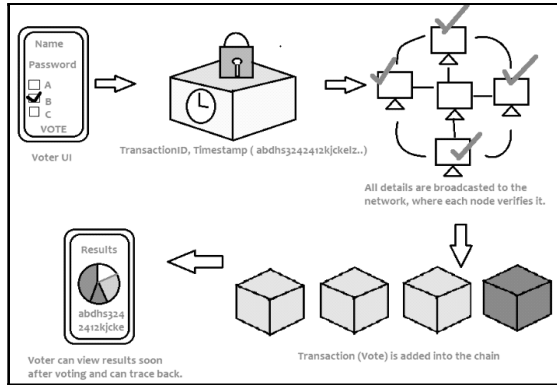


Fig-1 : A Generic blockchain based e-voting system [16]

- Step 2- The transaction is broadcasted to every node in the blockchain network. This transaction will then be verified to ensure that it is legitimate and no foul play was done.
- Step 3- If the blockchain network approves broadcasted transaction, it will get saved in a block and get added to blockchain. Once the block gets linked to the blockchain, it will stay in the chain permanently and cannot be manipulated. If any attempt is made to rig the chain, it can be easily detected by the consensual network by the Proof-of-Work algorithms, thereby depicting the resilient nature of the blockchain based e-voting system.
- Step 4- The voters can view the election results in real-time and also undo their transaction if they want to, thereby making the blockchain based e-voting flexible and adaptive.

The audit trail of the blockchain based e-voting system ensures that no vote has been altered or detached. As the present voting systems fail to ensure the security requirements of a modern democratic setup, the need of the hour is to develop a robust system that incorporates security, speed, efficiency, convenience, and most importantly trust in the voting process. Therefore, voting system backed by the blockchain technology

adds the much-needed layer of extra security in the process, which in turn encourages voters to vote from anywhere, any time without any issues. It definitely makes voting process cost and time-effective, both for the election conducting authority and the voters.

4. CONCLUSION AND FUTURE SCOPE

This primary motivation behind this research paper is to explore and investigate the realms of blockchain based e-voting systems. The study commenced with understanding the buzz around the word blockchain technology also provided a comprehensive account of the limitations of the traditional voting system, and how the application of this technology can achieve path breaking results in the electoral process. The study also provided a specified review of literature, summarizing some of the research studies conducted in the past related to the field. Subsequently, the research provided a detailed account of the technical aspects, terminologies and working principle and the application into the voting process. Using blockchain .Some case studies from across the globe were also discussed and countries like India and S. Korea that are lined up to introduce blockchain facilitated e-voting to revolutionize the electoral process.

A careful and thorough examination of the opportunities and challenges of this new technology depicts that this is a futuristic approach for e-voting system. The technology calls for an integrated, collaborated and joint cooperation between all the stakeholders, government, academicians, scientists, research community, and the business leaders, both at the national and the international level, to fully avail the uncapped benefits of blockchain technology for the people.

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