Blockchain Based E-Voting System

Mahima Churi, Anmol Bajaj, Gurleen Pannu, and Megharani Patil

Abstract The process of establishing democracy in a country is defined by election. Elections might just be a significant event in today's democracy, however many segments of population throughout the world lack faith in their electoral system, which is a major source of concern for democracy. Even the world's most powerful democracies, such as the Republic of India, the United States, and Japan, have a flawed legal system. To eliminate these drawbacks of the electoral system, Blockchain Technology is considered as an ultimate solution. With the present surge in sales and use of blockchain technology for a number of purposes, including banking, medical, and identity, a lot of attention has been focused on the legal concerns rather than its practical uses in administration. In this paper, we discuss the concept of Blockchain in a detailed manner making the reader understand the working of blockchain, its characteristics etc. everything from the scratch, as well as how this concept can be implemented as an efficient solution for public voting and how it is more beneficial from the traditional voting methods, with the goal of eliminating the drawbacks of India's current electoral system while also providing a better, more trustable, safe, and transparent means of public governance. Blockchain is really an emerging technology that promises to improve the resiliency of electronic voting systems. This method offers a way to profit from blockchain's advantages, such as cryptological foundations and transparency, to achieve an efficient theme for the e-voting system.

Keywords Distributed ledger · Hash value · Timestamp · Blockchain · Cryptocurrency

1 Introduction

Electoral integrity is important not just for democratic countries, but also for public voters' transparency and trust. Political voting methods are crucial in this sense. From

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a government standpoint, electronic voting methods have the potential to enhance participation. Voter turnout and confidence are both increasing, and so are interest in the voting system, to meet all of these requirements, E-voting has shown to be the most effective way of satisfying voters' rights while also providing elected members with a sense of fulfilment. Electronic voting is a voting method in which electronic devices are used to record or tally the number of votes cast. Such systems may be capable of carrying out a variety of activities, ranging from election setup through vote storage [1]. Apart from the benefits listed above, E-voting has significant drawbacks that have led to it being deemed faulty by the security community, particularly owing to physical security issues. Such Security issues with respect to e-voting systems have been the topic of concern that is extensively studied in Literature [2]. This is when blockchain technology may be seen as a benefit to the E-voting system, allowing it to become more efficient and effective. Blockchain is a new technology that has revolutionized the industry in recent years. Blockchain has recently gained popularity as a technique for increasing the efficiency of systems in a variety of industries. The first and most well-known use of blockchain technology was to keep track of bitcoin transactions. In Cryptocurrency, the fundamental blockchain technology plays a vital role through which another application of it such as an e-voting system comes into existence. Blockchain-enabled voting systems were proposed as the next generation of modern electronic voting systems because the immutable feature of the blockchain has made it a decentralized distributed ballot box [3].

2 Concept of Blockchain

Election is a very major symbol of democracy activities but still a large portion of people in the world do not keep faith in their election system. Many countries are still using a centralized system for the election that can cause some discrepancies. Blockchain technology is one of the solutions, because it strains a decentralized system and the entire database system is owned by many users. The blockchain concept was initially proposed by Haber and Stornetta in 1991. The main purpose of designing this technology was to avoid tampering with documents. The first system based on blockchain is believed to be developed by Satoshi Nakamoto in 2008 [4]. Bitcoin is recognized as the first application of blockchain technology to create a currency that could be transacted among the related parties over the internet based on the cryptographic method to secure the transactions.

Blockchain is a database of records which is distributed on the network, or we can say, it is a public ledger of all transactions that have been executed and are shared between every user on that blockchain network. A blockchain is a list of records which keeps on growing as new data is added, called blocks, which are linked using cryptographic algorithms. Each block contains a cryptographic hash value of the previous block, a timestamp, transaction data, and a hash for its own complete block, making it like a linked chain. A hash is basically a unique code which is given to every block in the chain [5].

The blockchain is a distributed ledger which means it is completely open to anyone. It has an interesting property i.e. When some data is recorded inside a blockchain, it becomes very difficult to change it. If any changes are done inside the block it will lead to a change in the hash of the block. So blockchain secures itself by being distributed. Instead of using a central entity to manage the system, blockchain use Peer to Peer (P2P) networks where everyone is allowed to join. Here each node plays an important role and its main aim is to check whether data is tampered or not, by offering such a secure network Blockchain surely aims to improve the E-voting system.

2.1 Working of Blockchain

Whenever a block has some new data to store, it is added at the end of the blockchain. To add a new block to the blockchain, four things must take place [6]:

1. A Transaction or a particular event takes place which is being recorded over the blockchain network.
2. After a particular event occurs for example, a vote made by a person, this event is verified and in blockchain, the process of verification is done by the network of computers. These networks often consist of thousands or more computers spread across the globe. When an event occurs, that network of computers rushes to check whether that particular event happened in a way it is supposed to be done (Fig. 1).
3. After the event (vote making) has been verified as accurate, and complete, it goes to the next step. The Voter's ID, name, name of the party which is being

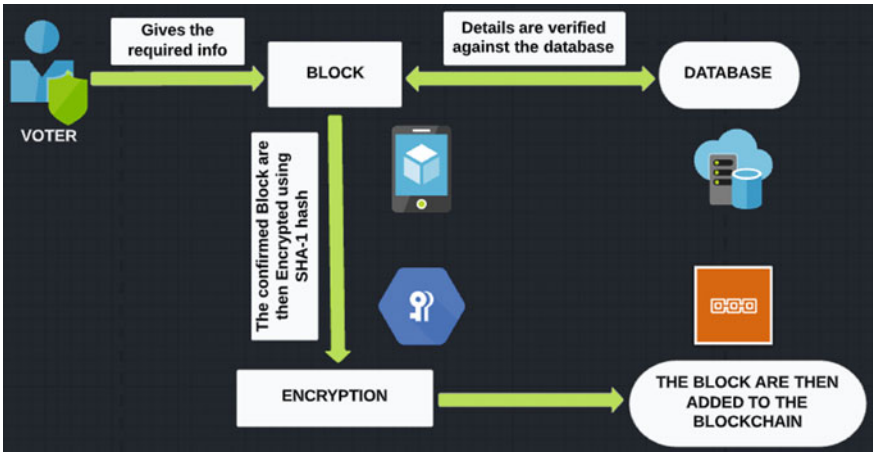

Fig. 1 Working of blockchain

voted etc., are stored in a block. Here, this particular data is likely to be joining hundreds, or thousands, of other data like itself.

4. The block must be given a hash. Once all the data of a block has been verified, it must be given a unique, identifying code called a hash. The block is also given the hash of the previous block that was the most recent block added to the blockchain. Once the hash value is generated, the block can be added to the blockchain. The block becomes publicly available for anyone to view, as soon as, it is added to the blockchain.

2.2 Characteristics of Blockchain

Blockchain has introduced a whole new technique to combat security threats, and it is the sole solution to today's security challenges. An electronic voting system must be user-friendly to each and every qualified voter, while also ensuring a high degree of security. However, ensuring the security of digital voting is always a challenge to the Voting systems [7]. However, this E-voting method is not without flaws, it is exposed to a variety of security risks and issues [8]. Blockchain has provided several new features to help with the problems and to make the technology stand out of the crowd (Fig. 2).

(1) ***Decentralization***: A database system that allows anybody connected to the network to access it. Votes are accurately, permanently, securely, and openly recorded. Furthermore, blockchain ensures that the participant's identity is

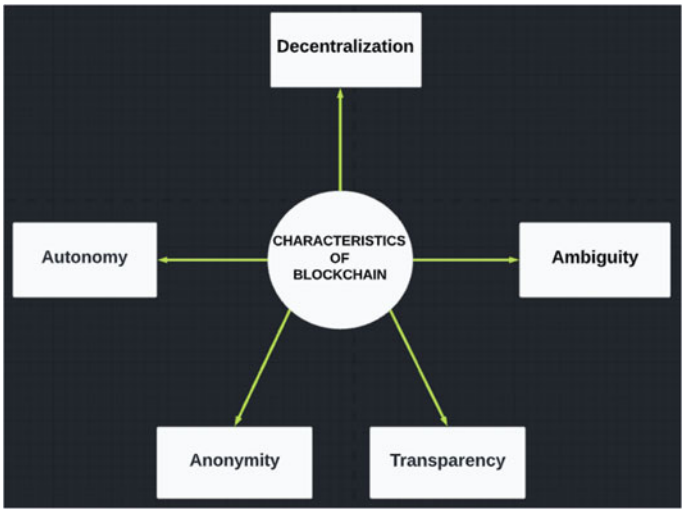

Fig. 2 Characteristic of blockchain

protected while yet allowing for public scrutiny. As a result, no one may alter or change votes [9, 10].

(2) ***Ambiguity***: Blockchain has the potential to minimise ambiguity. For example, In the 2017 Virginia House of Delegates election, the winner was picked from a pot of paper votes. One vote wasn't counted at first because the voter made a mistake by putting several ambiguous markings. Such ambiguity is less likely to lead to confusion with BEV [9, 10].

(3) ***Transparency***: Online voting had been used in 23 nations as of 2017. Some voters may be perplexed by current online voting procedures. It's difficult to tell whether the vote was cast in the intended manner or whether it was counted as cast [9]. Some electronic and online voting security mechanisms may have been created decades ago and are still in use today, unsecured against tampering. Blockchains' transparent nature might undoubtedly prevent data from being tampered with or stolen [10].

(4) ***Anonymity***: Since data is sent from node to node, the individual's identity remains anonymous, resulting in a more stable and trustworthy system [10]. This might motivate more people to vote.

(5) ***Autonomy***: The blockchain system is unique and autonomous, which means that any node on the network may safely access, store, and update data, making it reliable and free of external interference [10].

3 Existing Methodology

Voting systems currently in use in the current electoral system face significant technical challenges. Every voter must be registered to vote before the election, according to the current voting system. Their data must be stored in a secure, digitally protected format on a website, with the identity information kept private.

3.1 Traditional Ballot Paper System

Until the 1990s, India used paper ballots. As a result, in the ballot paper system, every voter must go to the polls and vote according to their motives. The results of the voting process are announced after the votes have been counted in person. There are several vulnerabilities in this system. As a result, it requires all voters to vote, and if someone does not vote, the situation may become enraged. Calculating the number of specific votes in an overcrowded country is also time consuming, costly, and difficult. The ballot paper system is very irresponsible because it replaces ballot boxes with duplicate paper, damages the ballot paper, and allows multiple people to vote.

3.2 EVM

The Electronic Voting Machine (EVM) is a mainstay in the electoral process, replacing the ballot box. The first time EVMs had been used was in a general election in Kerala in May 1982; however, due to the lack of a specific law mandating their use, the Supreme Court refuted that election. In 1999, the electronic voting machines (EVMs) were used for the first time in a general election (statewide) to the Goa assembly. Encouraged by the use of EVMs in all by-elections and state elections in 2003, the election commission decided to use EVMs in all 543 Parliamentary Constituencies in the country for the Lok Sabha elections in 2004 [11]. EVM, which comprises of 2 components, was introduced to overcome the problems associated with ballot paper systems:

1. ***Control Unit***: It stores and assembles votes, used by poll operators.
2. ***Ballot Unit***: It is placed in the polling place and is used by voters to cast their ballots.

Votes are properly recorded using EVMs, and none of the problems associated with them, such as calculation, measurement, accuracy, prompt declaration of effects, and system robustness, have become noticeable. However, the serious problem lies in the verification of authenticity; the person voting may not be present as a legitimate individual. Other issues such as political parties holding booths, voting for the elderly, as well as fraudulent voting all seem to be possible.

3.3 E-Voting

Electronic voting has become very popular in place of the ballot paper system since the late 1990s/early 2000s. Electronic voting is widely used, and the majority of applications are extensively tested and used on a limited basis. Despite concerns about audits and authenticity, electronic voting remains popular. Furthermore, in democratic societies, the most essential element is a strong electoral process that is transparent and confidential. It does, however, have some disadvantages. This results in a loss of privacy and makes calculating votes more difficult. Elections may be jeopardised by automatic vote buying and internal attacks on the voting system.

3.4 Blockchain a Better Technology for E-Voting

Blockchain is a digital ledger in its most primitive sense. To verify, process, and record all transactions across the system, the technology engages into the power of its peers or nodes on the network. This ledger is never stored; instead, it is kept on the "chain," which is supported by millions of nodes at once. Blockchain's transaction

database is incorruptible, and each record is easily verified, thanks to encryption and decentralisation. Because the network does not exist in a single location, it cannot be taken down or influenced by a single party.

Not only can blockchain be used for financial transactions, but it can also be used for any type of data transmission. This type of system infrastructure is extremely beneficial for voting because a vote is a small piece of high-value data. Due to necessity, modern voting systems are largely stuck in the twentieth century, and those who want to vote must leave their homes and submit paper ballots to a local authority. As a result, some of them attempted to implement this system on an internet platform, but the results were unsatisfactory due to major security flaws.

With blockchain, the various issues identified in these early attempts at online voting can be resolved. A blockchain-based voting application does not need to be concerned about the security of its Internet connection because any hacker with access to the terminal will be unable to affect other nodes. Voters can cast their ballots effectively without revealing their identities or political sentiments to the public. Because each ID can be linked to a single vote, no fakes can be made, and tampering is impossible, officials can count votes with absolute confidence [12].

A Genuine Democratic Republic: Blockchain is paving the way for direct democracy, in which citizens make their own policy decisions rather than relying on elected officials. While the rules of a political election may need to be changed to accommodate such a transparent system, blockchain can also be used to guide financial decisions, general meetings, polling, and surveys, among other things [13].

4 Literature Review

We shall look at numerous research articles and theses that looked into comparable subjects of study, such as Blockchain based electronic voting systems:

1. Kshetri, Nir and Voas, J. (2018). "*Blockchain-Enabled E-voting*" research paper, proposed the importance of BEV in context to reduce the security issues and it also highlighted various BEV implementations alongside giving a survey of Blockchain-based solutions deployed for voting at the community, city, and national levels [14].

Residents of Moscow began voting on a blockchain in December 2017, and the results were publicly auditable [15]. Neighbours should be able to influence their living circumstances in a convenient atmosphere, according to city officials. The officials also thought that a blockchain would improve citizen-government confidence [16]. Each community-discussed question was transferred to BEV. The results were released when the polling was completed [17].

The Ddabok Community Support Project was voted on using a BEV system in March 2017 in the South Korean province of Gyeonggi-do [18]. A blockchain platform established by the Korean financial technology firm Block that featured smart contracts was used to vote by 9,000 citizens. A blockchain was used to store

the votes, results, and other pertinent data. This approach involves no management or central authority [19]. This was the first time a technique like this was used in South Korea.

Estonian individuals and e-residents who own shares in the LVH Group, an Estonian technology business, may now utilise BEV to make corporate governance choices [20]. They can vote at LVH's annual general meeting by logging up with their verified national online ID. The e-residency platform in Estonia verifies e-resident shareholders [21]. Estonia intends to use blockchains in a variety of fields, including an e-residency programme (which permits foreign nationals to open businesses in Estonia) and healthcare (securing health data storage and allowing real-time monitoring of patient conditions).

Agora, a Swiss blockchain firm, gave a partial count of election results in Sierra Leone's general elections in March 2018 [22]. Agora was one of the approved observers who offered a comparable impartial count. Sierra Leone's elections were regarded by Agora as a "use case" rather than a "complete deployment" of BEV.

As a result, we carried out a detailed blockchain-based E-voting system survey, allowing us to better understand how far Blockchain's roots have scattered and how critical its implementation in various sectors has been.

2. The IRJET Journals published a research paper on "*Blockchain-Based Secured E-Voting System to Remove the Opacity and Ensure the Clarity of Election of Developing Countries*", in which they proposed an e-voting system based on blockchain technology that meets the inevitable e-voting properties while also providing a degree of decentralisation and putting as much control of the process in the hands of the voters as possible.

The Architecture was made in such a way that it meets the requirements like system integrity, data integrity, reliability, data confidentiality, and voter anonymity. The proposed architecture mainly consisted of four parts [23]:

- Voter Registration.
- Candidate Registration.
- Vote Casting Procedure.
- Result Publication (Fig. 3).

Because cell phones and smart cards are required in the given proposed system, the need for security to protect voter information is the primary concern. It utilizes a method called El Gamal Cryptosystem, which can produce a pair of keys as well as encrypt and decode data. It also employs the hash function (SHA-256) because it's one of the most important aspects of blockchain.

Despite the fact that the blockchain-based e-voting system is safer and more transparent, there were some drawbacks in the proposed system:

Since the entire voting process has been digitized, it is nearly difficult for people to cast votes if they do not have access to the internet.

The system may run slowly at times owing to workload because it is a highly secure and busy procedure.

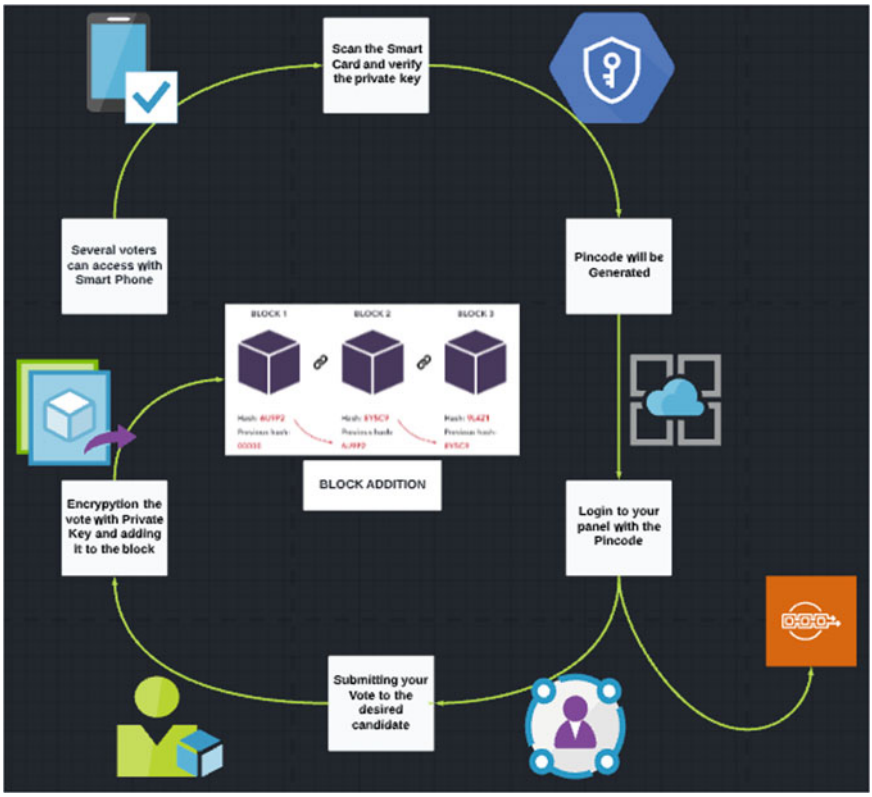

Fig. 3 Process of adding blocks in blockchain

Since the majority of people in impoverished nations have low literacy rates and little awareness of technology, it may be difficult for them to cooperate with this system.

3. *Adida, B., Helios (2008).* "*Web-based open-audit voting.*", in Proceedings of the 17th Conference on Security Symposium, ser. SS'08. Berkeley, CA, USA: USENIX Association, 2008.

This paper proposes associated justifications for an adequate security model as well as comprehensibility criteria [24]. It also describes a web ballot theme, pretty understandable Democracy, and shows that it meets the adequate security model while being much more understandable than Pretty smart Democracy, which is currently the only theme that also meets the planned security model [25].

4. Chaum, D., Essex, A., Carback, R., Clark, J., Popoveniuc, S., Sherman, A. and Vora, P. (2008). "*Scantegrity: End-to-end voter-variable optical- scan voting.*", *IEEE Security Privacy, vol. 6, no. 3, pp. 40–46, May 2008.*

Scantegrity is the first independent E2E verification mechanism that keeps optical scan as the underlying voting system and does not interfere with a human recount [26].

5. Dalia, K., Ben, R., Peter Y. A, and Feng, H. (2012). *"A fair and robust voting system by broadcast.", 5th International Conference on E-voting, 2012.*

This paper proposes a recovery round to allow for the announcement of the election result if voters abort, as well as a commitment round to ensure fairness. Additionally, it provided a computational proof of ballot secrecy security [27].

Secure digital identity management is one of the most recent major technical challenges relating to e-voting systems, but it is not the only one. Before the elections, any potential voter should register with the electoral system. Their information should be in a format that can be processed digitally. Furthermore, their personal information should be kept private at all times. The following issues could arise if the old E-voting system is used:

- Anonymous vote-casting.
- Individualized ballot processes.
- Ballot casting verifiability by (and only by) the voter.
- High initial setup costs.
- Increasing security problems.
- Lack of transparency and trust.
- Voting delays or inefficiencies related to remote/absentee voting.

Limitations of Existing system:

(1) *Anonymous vote-casting*: Each vote, which may or may not include a choice for each candidate, should be anonymous to everyone, including system administrators, once submitted through the system.

(2) *Individualized ballot processes*: The manner in which votes are represented in web applications or databases is still up for debate. A hashed token, on the other hand, is more likely to provide uncertainties and integrity than a transparent text message. Meanwhile, the vote should be untrustworthy, as the token resolution cannot attach it.

(3) *Ballot casting verifiability by (and only by) the voter*: When an elector submits a vote, he or she should be prepared to see and verify his or her own vote. This is important to understand in order to prevent, or at the very least detect, any potential malicious activity. This justification, aside from providing pre signals, can certainly increase voters' feelings of trust. In some recent applications, these issues are partially self-addressed. However, evidence suggests that e-voting is currently in use in a number of countries, including Brazil, the United Kingdom, Japan, and the Republic of Estonia. The Republic of Estonia should indeed be evaluated differently than the others because they provide a complete e-voting solution that is said to be equivalent to traditional paper-based elections.

(4) *High initial setup costs*: While maintaining and operating online voting systems is much less expensive than traditional elections, initial deployments can be costly, especially for businesses.

(5) *Increasing security problems*: Cyber-attacks pose a significant threat to public opinion polls. If a degree hacking attempt succeeds during an election, no one wants to take responsibility. DDoS attacks have been documented, but this is not the case in the elections. The United States' citizen integrity commission recently filed an affidavit regarding the state of the elections in the North American country. As a result, Ronald Rivest expresses that "hackers have a wide range of ways to assault pick machines." For instance, in the hacking method, barcodes on ballots and smartphones in specific locations may be used. Apple has consistently stated that we must not overlook the fact that computers can be hacked and that evidence will be erased. Double voting and voters from opposing regions are also common problems.

To counteract these dangers, software mechanisms that provide the following benefits should be implemented:

- Avoiding the erasure of evidence.
- Transparency while maintaining privacy.

Lack of transparency and trust: When everything is done online, how can people trust the results? Perceptual issues need to be addressed.

Delays or inefficiencies in voting due to remote voting: In voting schemes, timing is critical; technical capabilities and infrastructures must be reliable and operate at peak performance in order for distant voting to be synchronous.

5 Proposed System

Working Process

We have presented our proposed methodology with a user-friendly interface, as well as implementation of the blockchain idea at the back-end for the security of the voting process, in order to make the voting process easier and more efficient. The working process of the proposed system is mentioned in the following steps (Fig. 4).

Step 1: As the candidate would open the website, he would be directed to the login page, where he would put his credentials and would go to the main page of the website.

Step 2: On the main page the user would be briefed about all the information regarding the elections held and also about the candidates and their progress through the dashboard.

Step 3: Through the website the voter would register himself for the current elections by putting all the necessary details and by creating a password, and once the process is done the voter would get registered and a unique voter id would be generated for that particular user.

Step 4: A specific transaction representing the Candidate will be the first transaction added to the block. This transaction serves as a starting point and will not be counted as a vote. The user's information will be cross-referenced against the

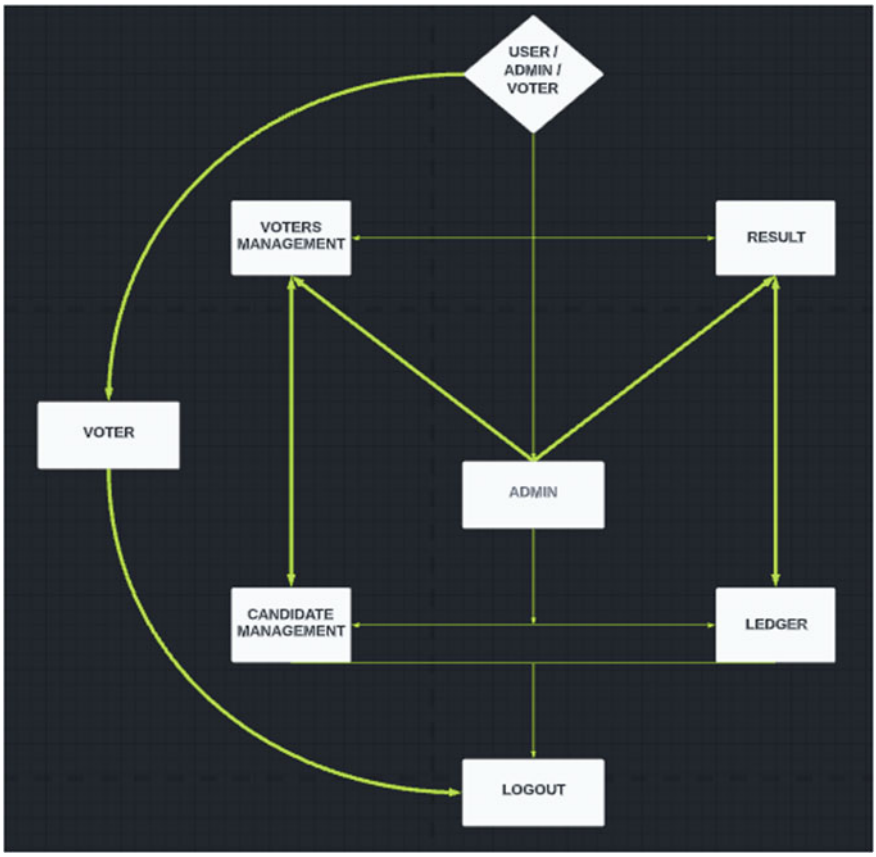

Fig. 4 System architecture

government database in the previous step. This is the final phase in the verification process. The procedure will not be able to proceed without verification.

Step 5: After the registration process is completed, the user would go to the vote casting website where he would cast a vote by putting his username that would be the unique voter id generated and the password that the voter has set, after putting all the details the voter would be directed to the vote casting section.

Step 6: In the vote-casting section, the voter will get the information about the candidates that are currently being selected for the election, the voter will vote for his desired candidate through the vote casting prompt and then the voting process will be completed. The candidate would not be able to change his vote and tamper the data once the vote is casted.

Step 7: After the voting procedure is done, the votes will be encrypted using the SHA-1 one-way hash algorithm to protect them from outside influence. This also eliminates any manipulation of the user's votes. The block will be given a timestamp and transmitted to the next checkpoint, which will be considered as a pointer for the

last made update to the blockchain, as soon as the user's block is encrypted. At the next checkpoint in the procedure, this timestamp will be verified. This phase entails linking this block to the node of the next checkpoint and adding it to the blockchain. This way the data would be added in the blockchain.

Hardware and Software Requirements

1. **Frontend Requirements**
   - Code Editor
   - Browser
   - PHP
2. **Backend Requirements**
   - XAMPP
   - My SQL
   - PHP
3. **Blockchain Requirements**
   - Truffle framework
   - Ganache
   - Meta mask
   - Solidity language.

6 Result and Discussion

As previously stated, the primary goal of incorporating blockchain into the E-Voting system was to achieve decentralization. Where everyone has a right and can come up with a single decision if anything changes, and where the majority of them can appeal if any issues arise. In this era of technological advancement, we must accept and adapt to change, and this is how we can take a step forward in the direction of improving our voting system. As we all know, tampering with ballots has occurred in the past, and by engaging in such behavior, the majority of people are losing interest and faith in the current voting system. To avoid such tampering and to rekindle public interest in voting, a Blockchain-based E-voting system is the best solution for today's era, and now is the best time to implement one. Transparency and security are maintained with the help of blockchain technology. As we all know, the government spends a lot of money to hold elections, and with the help of technology, we can invest the money to greater use in different sectors for development. It has a wide range of applications, including corporate elections and opinion polls. So, the main goal would be and see if it has the potential to grow to the point where real-world problems can be addressed without resorting to the current voting system. As a result, the world requires a model in which optimal solutions are generated and improvements in their implementation can be applied by both the public and private sectors. We are also aware that we live in a country with a much higher percentage of youth than any other country on the

planet. As a result, focusing on such a central issue can put our country ahead in terms of development. Because we are a diverse country, people from all walks of life can come together and contribute to such a cause (Figs. 5, 6, 7, 8, 9, 10, 11, 12 and 13).

This is Admin Login page where it will lead to main page.

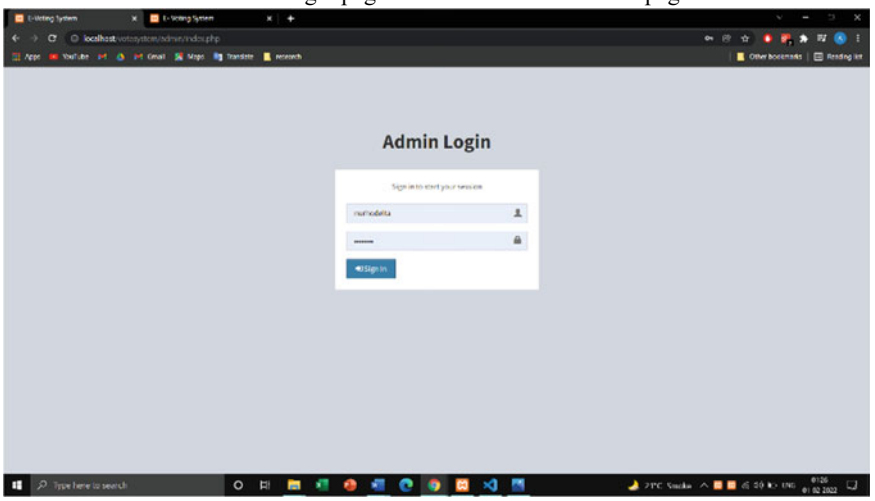

Fig. 5 Admin login page

This Page consists of Dashboard

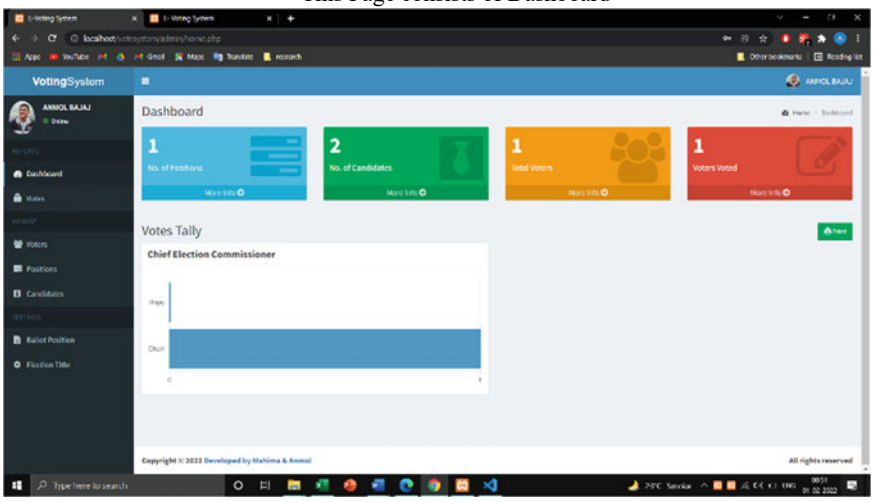

Fig. 6 Dashboard

This page shows the number of voters had registered.

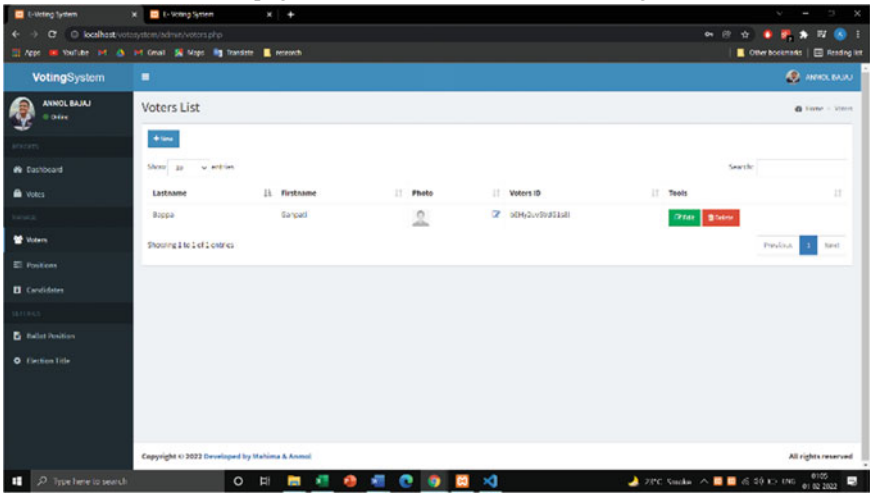

Fig. 7 Voters list

This Page is all about the Positon for which election is going to occur.

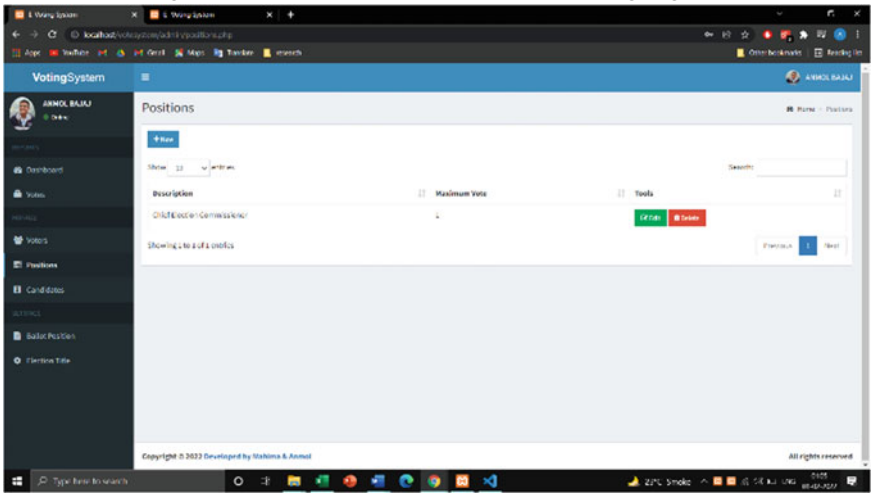

Fig. 8 Position

7 Conclusion

Businesses all across the world are commenting on the technology's possibilities and where it will go in the upcoming years. Blockchain, which is now a trendy topic, promises to improve the accuracy, efficiency, and security of business, government

This page incorporates about Candidate who areappointed for the required position.

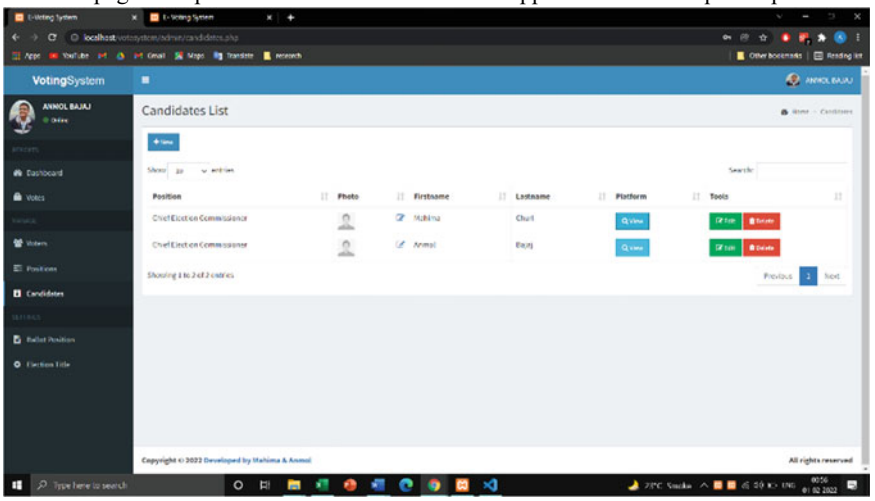

Fig. 9 Candidate list

This page is for voters login in which have to join with their Unique Voter ID and Password.

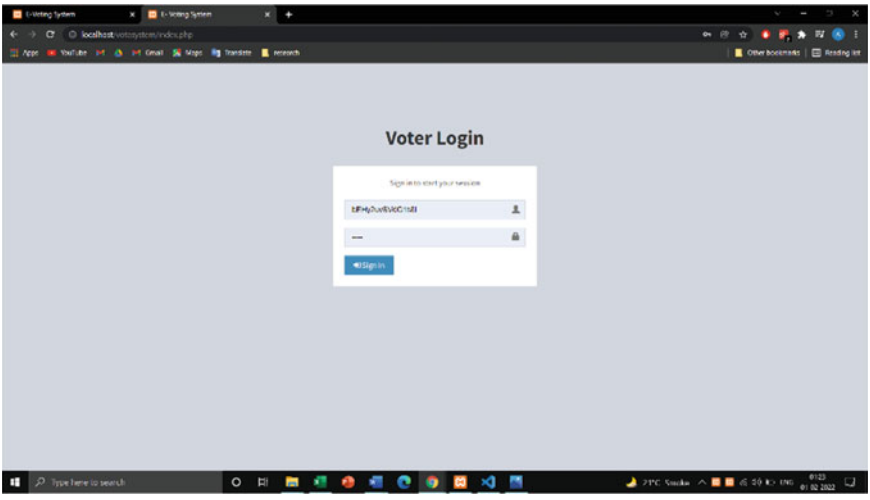

Fig. 10 Voters login

activities, and organizational activities, with its fundamental properties of persistency, security, decentralization, and integrity. Blockchains have the potential to impact established industries and institutions. Traditional administrative systems must be replaced with newer and more advanced technology, such as Blockchain,

This page is about to cast a ballot of their own choice

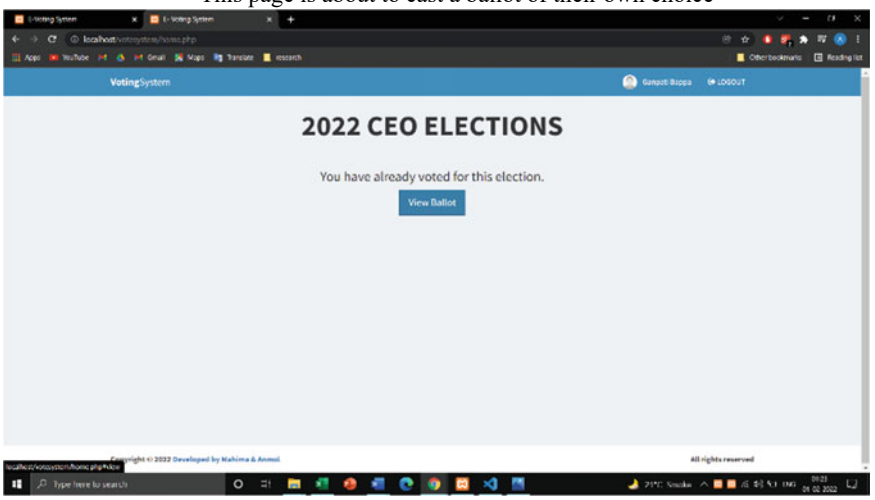

Fig. 11 Vote casting

The vote has been casted.

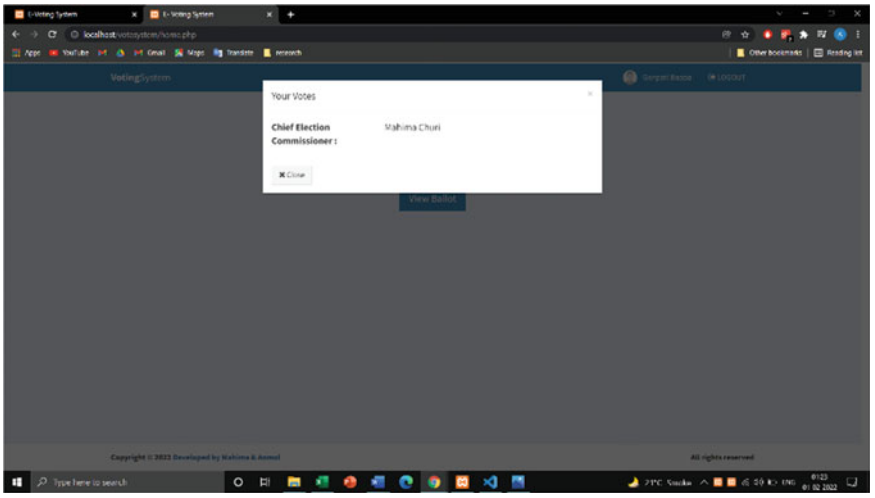

Fig. 12 Casting of vote prompt

given the present rate of growth that our country is experiencing. A comprehensive description of the blockchain idea was provided in this paper. An overview of blockchain technology, including how they function and their many characteristics, were also mentioned. We then examined the many conventional voting techniques used in our nation and how blockchain is the most efficient and successful of all

The casted ballot has been submitted in the admin page.

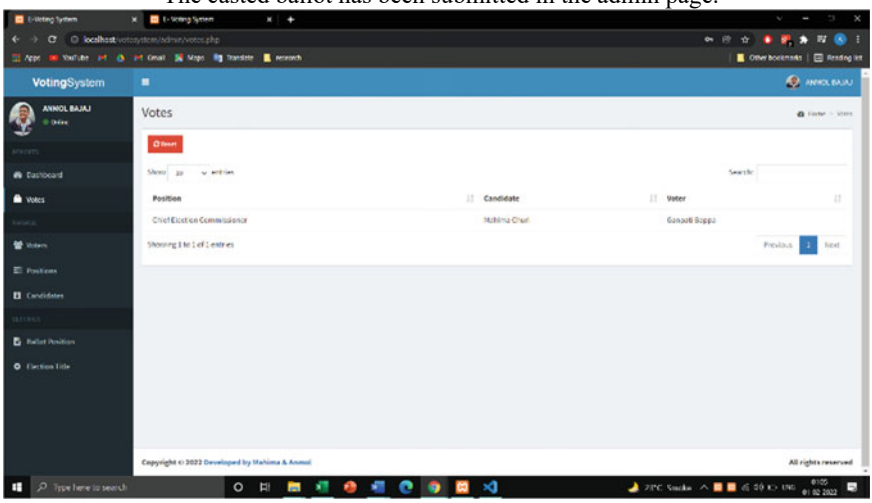

Fig. 13 Viewing casted ballot

of them. A few literature surveys showing the integration of blockchain in enterprises and organizations were also included. The uses, benefits, and drawbacks of Blockchain were also highlighted. As a conclusion, we propose a Blockchain-based E-Voting system that is more trustworthy, secure, and labor-saving. Such mechanisms will increase openness in Indian democracy, and we may anticipate our country to rank first in the World Democratic Index as a result of this system, as well as improved governance.

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