IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 6, June 2024

DOI: 10.17148/IJARCCE.2024.13670

Blockchain Based E-voting System for Campus Election

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Abstract: The proliferation of digital technologies has ushered in a new era of efficiency and transparency in various sectors, including governance and electoral processes. Traditional paper-based voting systems often face challenges such as logistical complexities, security vulnerabilities, and low voter turnout. In contrast, this work proposes a Blockchain-Based E-Voting System with OTP Validation tailored for campus elections. Leveraging blockchain technology ensures transparency, immutability, and security in the voting process, while OTP validation adds an extra layer of authentication to ensure the integrity of each vote. The system aims to streamline campus election procedures, enhance voter confidence, and prevent tampering or fraud, thereby promoting fair and efficient democratic processes within educational institutions. Through the utilization of smart contracts, voters can securely cast their votes remotely, eliminating the need for physical presence and streamlining the voting process.

Keywords: Blockchain; cryptography; e-voting; smart contracts.

I. INTRODUCTION

In an age marked by technological advancements and digital transformation, traditional methods of conducting elections are ripe for innovation. Campus elections, while pivotal in shaping the governance and representation within educational institutions, often grapple with challenges such as logistical inefficiencies, low voter turnout, and concerns regarding the integrity of the electoral process. In response to these challenges, this project proposes a pioneering solution: A Blockchain-Based E-voting System fortified with One-Time Password (OTP) validation. The proposed system harnesses the power of blockchain technology, which operates on a decentralized ledger ensuring that no single entity has control over the entire system. Each vote is recorded in a transparent and immutable manner, making it virtually impossible to alter or delete votes once they are cast. This transparency builds trust among voters, as they can independently verify the integrity of the electoral process. Furthermore, the blockchain's inherent security features, such as cryptographic hashing and consensus mechanisms, protect the system from tampering and fraud. Each vote is encrypted and linked to the previous vote, creating a chain that is exceedingly difficult to break or manipulate [1]. This immutability ensures that once a vote is cast, it remains unaltered. Additionally, every transaction on the blockchain is time-stamped and traceable, providing a complete and auditable record of the voting process. This audit trail can be used to verify results and investigate any discrepancies, ensuring accountability and transparency.

Complementing the blockchain's robust security is the implementation of One-Time Password (OTP) validation, which adds an additional layer of security to the voting process. When a voter initiates the voting process, they receive a unique OTP on their registered mobile device or email. This OTP must be entered to verify their identity before they can cast their vote. This two-factor authentication ensures that only legitimate voters can participate, significantly reducing the risk of identity fraud. OTP validation is not only secure but also user-friendly and accessible, requiring only a mobile device or email access. This method simplifies the authentication process while maintaining high security, making it easier for voters, including those in remote or underserved areas, to participate in the election.

II. MOTIVATON

Traditional paper-based systems are vulnerable to various forms of manipulation, such as ballot stuffing, tampering, or coercion. Moreover, they often lack transparency, making it difficult to verify the integrity of the election process. By transitioning to a blockchain-based electronic voting system, we aim to address these challenges comprehensively. Blockchain technology offers inherent advantages such as immutability, transparency, and decentralization. Each vote cast on the blockchain is securely recorded in a tamper-proof and transparent manner, providing an auditable trail of the

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entire voting process. This not only enhances the integrity of the election but also fosters trust among voters, candidates, and stakeholders.

Furthermore, the integration of OTP (One-Time Password) validation adds an additional layer of security and authentication to the voting process. Before casting their vote, each voter must authenticate their identity through a unique OTP, ensuring that only authorized individuals can participate in the election. This mitigates the risk of unauthorized access or fraudulent voting attempts, further bolstering the credibility of the electoral process.

III. LITERATURE SURVEY

Kabra et al. [1] proposed about an electronic voting system, based on blockchain technology, securely stores voting data in a decentralized manner. Each vote is represented as a block with a unique code, forming a chain of interconnected blocks. Utilizing SHA-256, unique hash codes are generated for each block, ensuring tamper-proofing of the data. This model provides a high level of security, making it challenging for unauthorized parties to tamper with voting information.

Parmar et al. [2] suggest an E-Voting System fortified by Blockchain technology and Face Recognition alongside Mobile OTP authentication. Users will be authenticated through Aadhaar, with face verification and mobile OTP for additional security layers. Voting data will be securely stored on a blockchain, ensuring incorruptible records, while administrative functions such as candidate management and smart contract implementation will prevent duplicity in voting. The system's primary goal is to establish transparent and secure national elections.

Domakonda et al. [3] proposed an E-Voting System encompassing both I-Voting (Internet Voting) and SMS-Voting functionalities. During registration, users furnish their mobile numbers, which are linked to a central database. Verification is carried out through a one-time password (OTP) sent to the mobile number, followed by face recognition for cross referencing with the database.

Pramulia et al. [4] proposes an Blockchain-based electronic voting using Ethereum and Meta-Mask addresses challenges of confidence in e-voting systems, upholding six key electoral principles. These include secrecy, transparency, and accuracy of ballot papers, alongside vote recording and counting reliability. Evaluation results highlighted Gas delay as the most effective option for ensuring system reliability. This approach provides a promising solution to the vulnerabilities inherent in traditional electronic voting systems.

Taş et al. [5] provides an in-depth look at blockchain-based voting, examining its potential to enhance electronic voting systems. It identifies shortcomings in current electronic voting methods and delves into the advantages and obstacles of implementing blockchain. Additionally, scalability concerns and the necessity for extensive testing are addressed, advocating for initial trials in smaller settings before widespread adoption. Despite its promise, the study concludes that blockchain technology is still evolving in the realm of electronic voting.

Kurbatov et al. [6] discusses the use signature rings for anonymous electronic voting. Unlike standard signatures, ring signatures hide your true public key, ensuring anonymity. Blockchain technology ensures vote integrity, authenticity, counting, and accuracy, verified by users.

P. Katta et al. [7] proposes an e-voting system which adopts a multimodal approach, incorporating fingerprint, facial, and OTP verification to overcome traditional limitations and bolster security measures. By leveraging the unique capabilities of each biometric modality, the system ensures both accuracy and the ability to detect liveness, while also integrating secure communication protocols and tamper-proof data storage for safeguarding voter information. Despite its potential for enhanced security and improved user experience, addressing concerns related to privacy, biometric accuracy.

Çabuk et al. [8] evaluates the feasibility of integrating blockchain into e-voting systems, considering technical and non-technical aspects. While e-voting adoption varies, its implementation demands attention to security and anonymity. Beyond governmental services, businesses and non-profits can benefit from e-voting's efficiency and scalability. Blockchain technology is seen as a solution to enhance security, integrity, and anonymity in e-voting systems, as supported by our analysis findings.

Patil et al. [9] examines blockchain's role in decentralized evoting, addressing security and transparency. It proposes an Ethereum-based system with smart contracts for accuracy and real-time updates. Smart contracts on a local blockchain network ensure data security and reliability. The user interface facilitates easy candidate selection, enhancing transparency in voting.

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Al-Madani et al. [10] suggests using blockchain to build a decentralized e-voting system. It aims to overcome security weaknesses and transparency issues in centralized systems. The approach utilizes Ethereum's blockchain and smart contracts for accuracy and reliability. Voters can select candidates via a user-friendly interface, ensuring real-time updates and preventing duplicate voting.

Garg et al. [11] introduces a decentralized application (DApp) for electronic voting (e-voting) using blockchain technology. It utilizes decentralized blockchain networks and smart contracts to improve security, transparency, and efficiency in voting. The DApp incorporates smart contracts to manage voting procedures, securely record votes on the blockchain, and maintain the integrity of voting data. Through the planning, execution, and evaluation of a prototype, the paper addresses challenges faced by traditional e-voting systems, contributing to the advancement of secure and transparent voting solutions with blockchain.

Gupta et al. [12] proposes a preferential e-voting system on Ethereum's blockchain to address the challenge of determining a clear majority in elections. It introduces a vote-trading mechanism for redistributing votes among candidates when no decisive majority is achieved, offering flexibility for organizations to define their own criteria. Developed in Solidity, the system enables voters to prioritize candidates instead of casting a single vote per candidate. By employing preferential voting methods and cryptographic techniques, it aims to enhance the integrity of the voting process and mitigate concerns associated with conventional systems, such as tampering and coercion.

IV. PROPOSED SYSTEM

The proposed e-voting web application leveraging blockchain technology is designed to ensure transparency, security, and integrity in the electoral process. The system features two main user roles: administrators and voters. Administrators oversee the setup and management of elections, ensuring the proper configuration of voting parameters and candidate registration. Users, on the other hand, are equipped with individual wallets created upon registration, providing a secure means for casting their votes.

The blockchain serves as an immutable ledger, recording each vote transaction transparently and cryptographically, thereby eliminating the risk of tampering or fraud. Through the integration of blockchain technology, this e-voting system aims to enhance trust and confidence in the democratic process, fostering greater participation and accountability. Fig 1 shows the proposed system architecture.

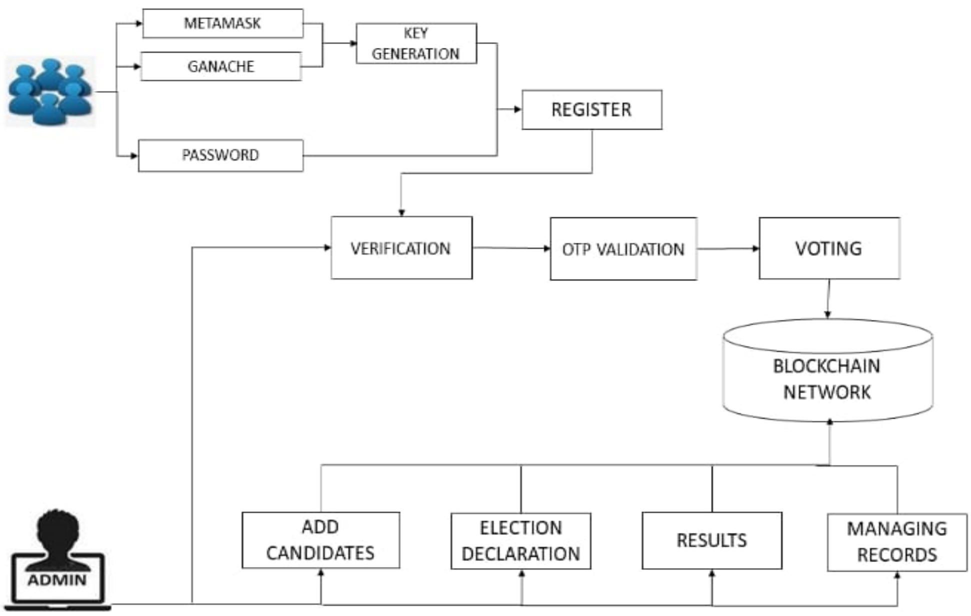

Fig. 1: System Architecture

A. *User Registration*:

The user opens a Ganache and MetaMask account to interact with the blockchain network to generate a unique key.

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a) Setting up Ganache: - Install and open Ganache, which is a personal blockchain for Ethereum development. - Ganache will provide you with a set of accounts, each with a unique address and private key.
b) Creating an Account in MetaMask: - Install the MetaMask browser extension - In MetaMask, you can create a new Ethereum account. Each account in MetaMask will have its unique address and private key.
c) Integrating MetaMask with Ganache: - In MetaMask, you can import the accounts generated by Ganache by importing the private keys. - This integration allows you to use MetaMask to interact with the blockchain created by Ganache.

Simultaneously, the user enters a password and this information is stored securely.

B. *User Login and Admin Verification:*

After the users register, the admin verifies the user's identity before granting permission to cast their vote. - Once verified, they can log in to the system with OTP validation to cast their vote, which is securely stored on the blockchain network.

C. *Admin Functions:*

The admin has the exclusive authority to add new candidates by verifying their details through an application process. Admin also has the provision to initialize and end elections as well as oversee the voting process.

D. *Candidate Registration:*

Candidates must undergo a separate registration process to cast their votes as voters, maintaining the integrity of the voting system. In our system we provide candidates like the chairman, vice chairman, secretary, joint secretary and other representatives.

E. *Result Publication:*

The election results, in the form of counts, are generated by the blockchain network, ensuring transparency. All information related to the results and election declarations is securely stored on the blockchain network.

F. *Managing Records:*

The admin can download these records for further review and analysis. -the admin has the capability to oversee and handle the data related to previous elections.

V. RESULTS AND DISCUSSIONS

In the following section, the results of e-voting system implementation, showcasing the culmination of meticulous design and robust development efforts. Below are screenshots providing a glimpse into the functionality and user experience of our platform, offering a visual representation of the successful execution of the electoral process.

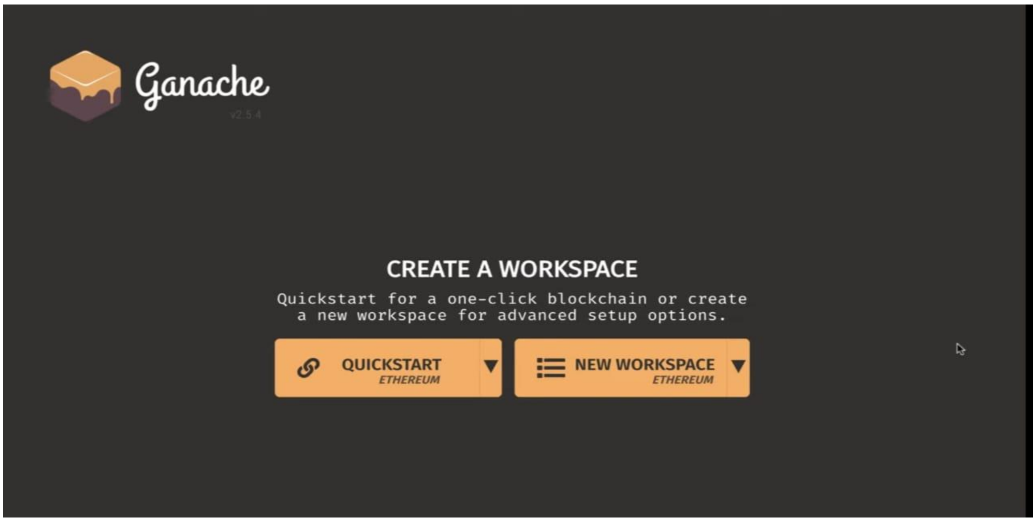

Fig 2: New ganache workspace.

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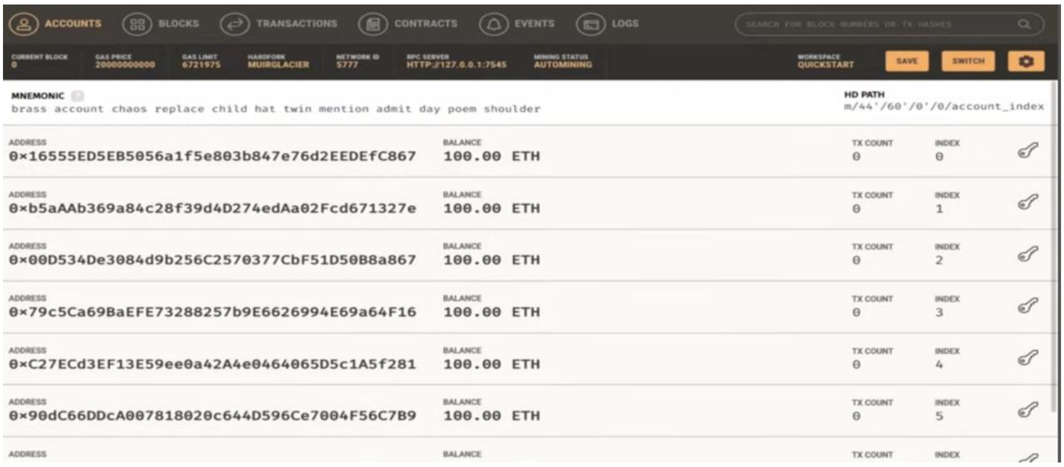

Fig 3: Test account with Ganache Ethereum gas coins.

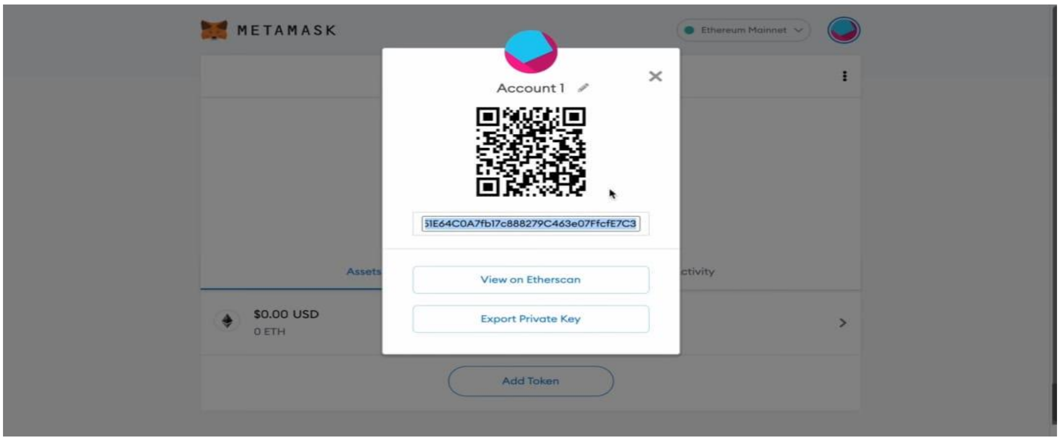

Fig 4: MetaMask account creation.

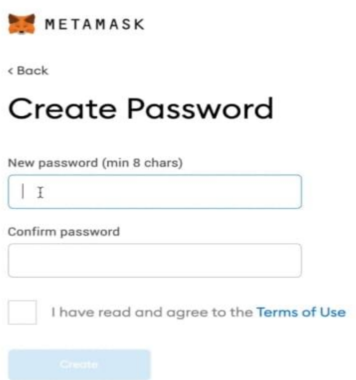

Fig 5: Ganache account deployed to MetaMask wallet.

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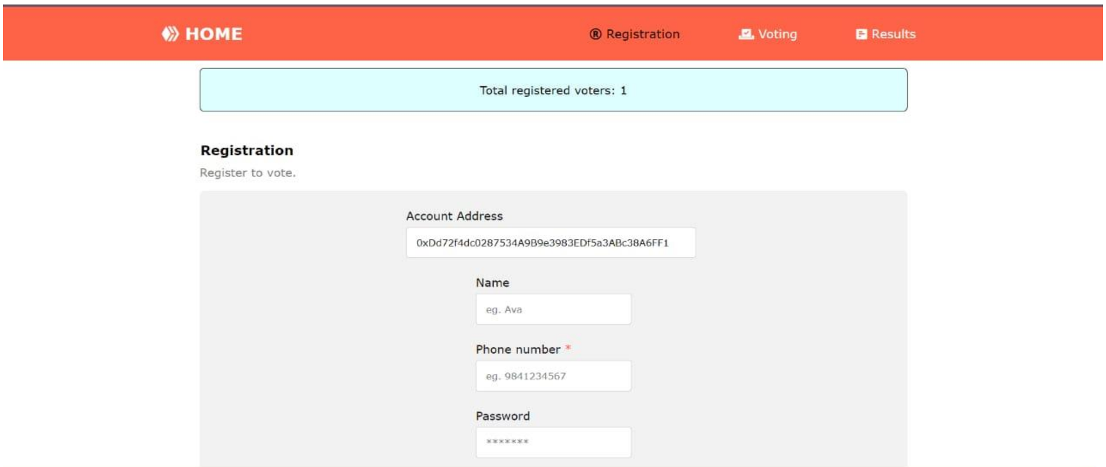

Fig 6: user registration: The process begins with voter registration, where voters register on the platform using their unique identification details.

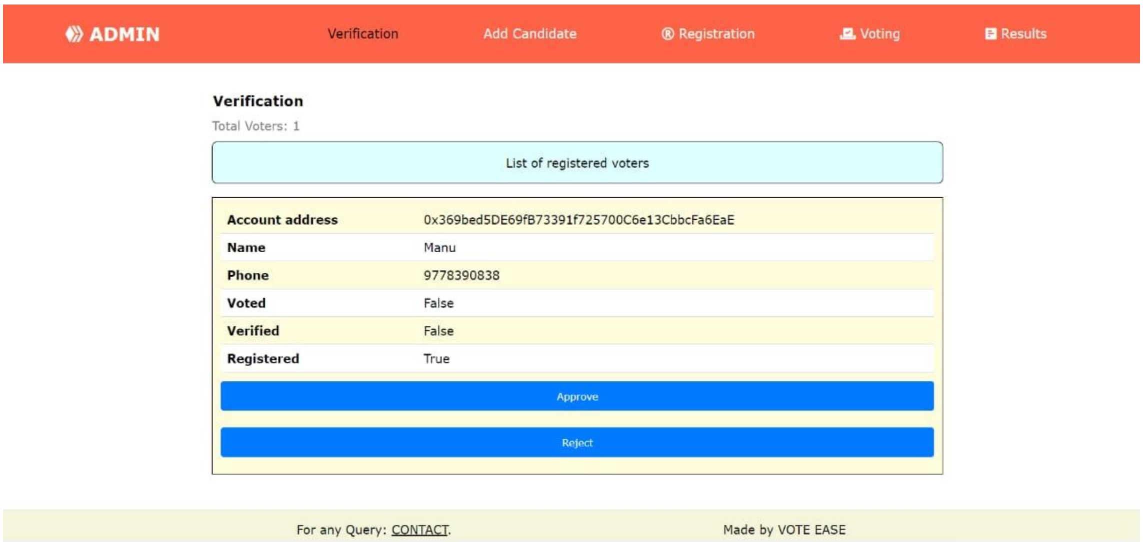

Fig 7: User Verification: Admin verifying user account for enhanced security.

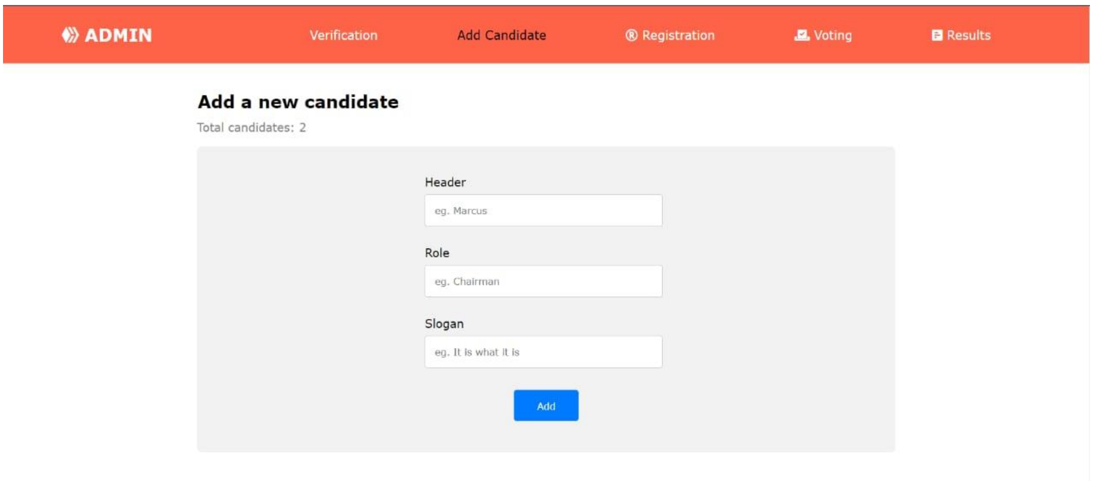

Fig 8: Candidate details: manage candidate registration by adding candidates to the election.

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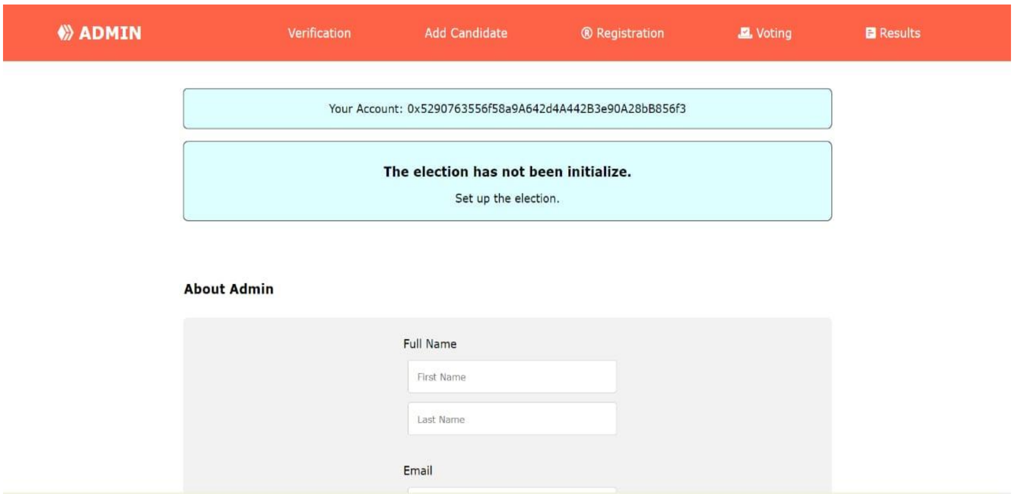

Fig 9: Admin details: Admin registration involves securely registering administrators on the platform, enabling them to declare elections and oversee the voting process.

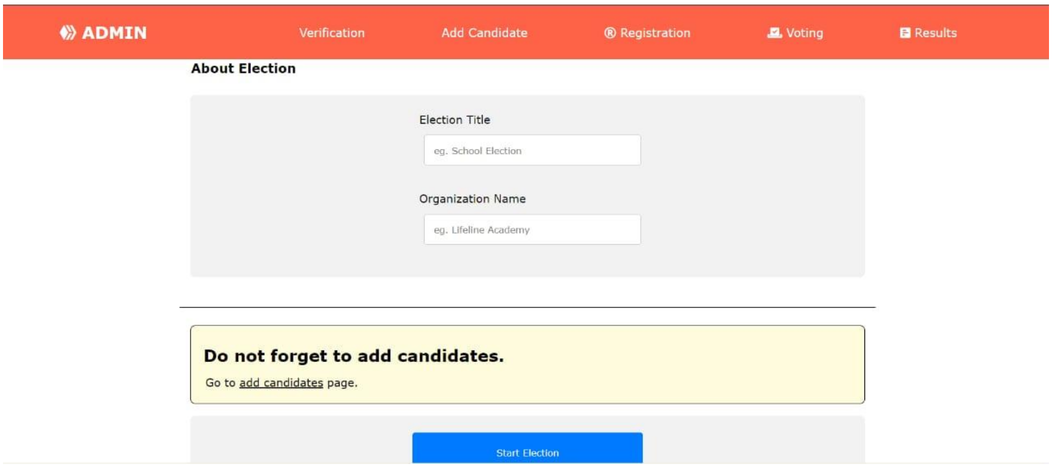

Fig 10: Election declaration: Admin declare elections, initialize and end the voting process, and manage candidate registration.

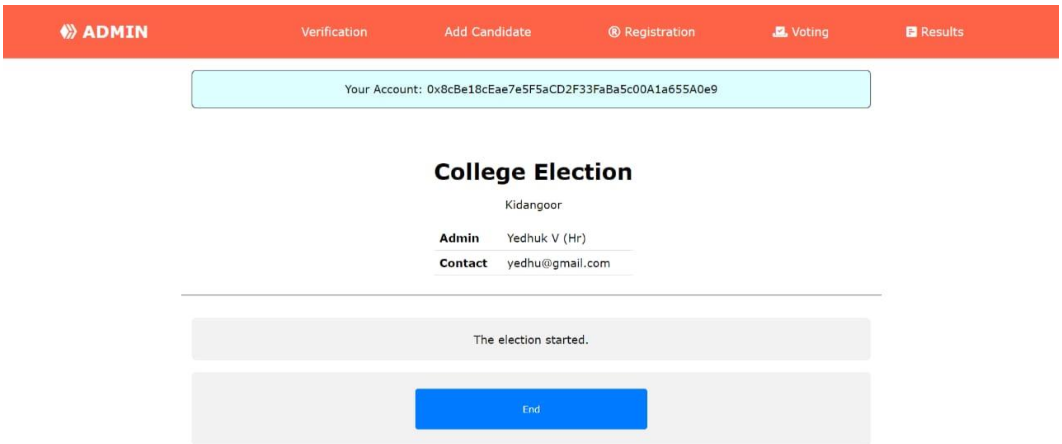

Fig 11: Election Details: Details regarding declared election.

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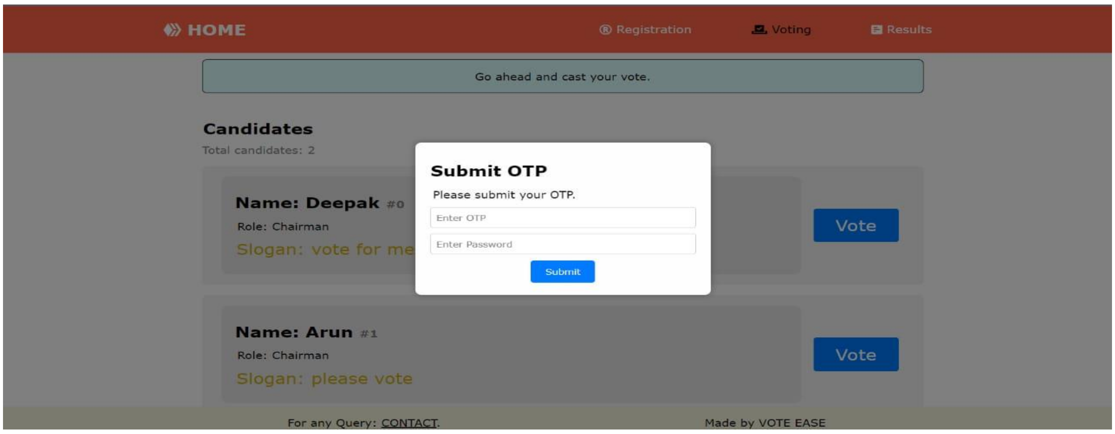

Fig 12: OTP validation: User must complete OTP validation before casting their vote.

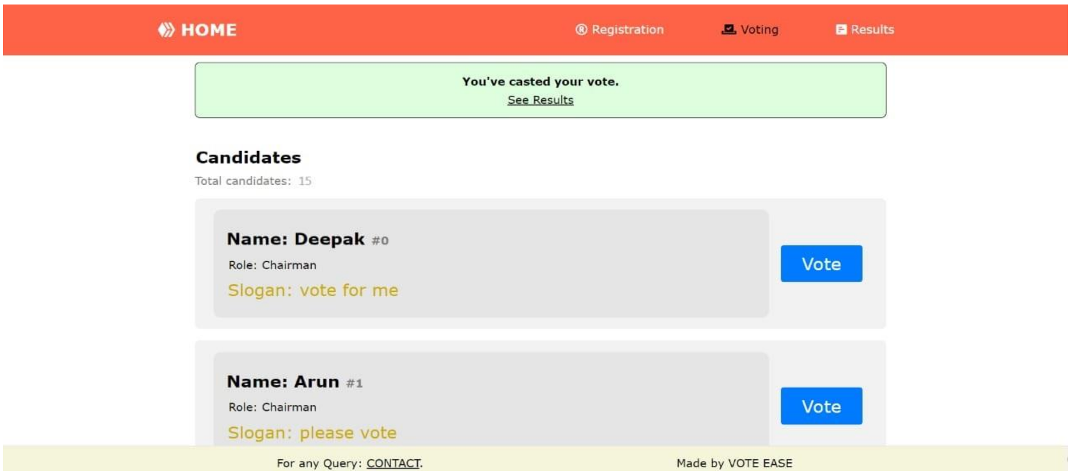

Fig 13: Status of voting: It provides the candidates list and voting option to user

Fig 14: Election Results: See the winners and vote counts on the results page.

Benefits of the proposed work includes integration of blockchain technology with OTP validation. This addresses several critical issues in traditional voting systems.

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The decentralized nature of blockchain ensures that the electoral process is transparent and tamper-proof, building trust among voters. The addition of OTP validation enhances security by ensuring that only legitimate voters can cast their votes, significantly reducing the risk of fraud. Moreover, the system's user-friendly interfaces and robust backend functionalities demonstrate its potential for wide-scale adoption. The ability to audit the election results adds an additional layer of trust and reliability, ensuring that every vote is counted accurately. Overall, the proposed system represents a significant step forward in modernizing the electoral process, making it more secure, transparent, and accessible for all participants.

VI. CONCLUSION

In conclusion, the implementation of a blockchain-based e-voting system with OTP validation significantly enhances the security, transparency, and efficiency of electoral processes. This system ensures that each vote is securely recorded and immutable, while OTP validation adds an additional layer of security to verify voter identity, preventing fraudulent activities. The decentralized nature of blockchain fosters trust in the electoral process, as results are tamper-proof and publicly verifiable. Moving forward, the future scope of this technology includes further advancements in user-friendly interfaces, integration with biometric authentication, and the scalability to handle larger elections with millions of participants. Additionally, research into quantum-resistant cryptographic techniques will be crucial to maintain security against future computational threats. By continuously evolving and adapting to new technological developments, blockchain based e-voting systems can become the cornerstone of secure and transparent democratic processes worldwide.

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