IJARETY

International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 12, Issue 3, May-June 2025

Impact Factor: 8.152

www.ijarety.in editor.ijarety@gmail.com

International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 8.152| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 3, May-June 2025 ||

DOI:10.15680/IJARETY.2025.1203031

A Blockchain –Powered Voting System for College Elections

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ABSTRACT: Efficient voting systems are critical for democratic processes, but traditional methods often encounter challenges related to security, transparency, and accessibility. This project presents a college-level voting system designed to address these issues using the MERN stack (MongoDB, Express.js, React, Node.js), providing a secure, scalable, and user-friendly platform for voting. The system integrates React for an interactive user interface, Node.js with Express.js for a robust backend, and MongoDB to securely store user data and voting records. Key security measures, such as user authentication, data encryption, and secure data storage, are incorporated to prevent tampering and ensure the integrity of voting records.

KEYWORDS: Voting System, MERN Stack, Web Security, User Authentication, Digital Voting

I. INTRODUCTION

Voting is a cornerstone of democratic systems, enabling individuals to participate in decision-making processes.In educational institutions, voting is essential for events such as student council elections, club leadership, and various other decision-making processes that impact the student body. Traditional voting methods, however, face challenges such as logistical complexity, time consumption, and risks related to tampering and fraud. These issues highlight the need for a secure, efficient, and transparent digital voting solution that can meet the unique demands of a college environment.This project introduces a digital voting system designed specifically for college-level use, leveraging the MERN stack (MongoDB, Express.js, React, and Node.js) to provide a reliable and scalable platform. The use of the MERN stack not only enables a responsive user Interface but also offers a secure and organized backend system. Key features of the system include robust user authentication to ensure voter legitimacy, data encryption for security, and real time vote tracking to enhance transparency.These features aim to mitigate the common challenges associated with traditional voting, making the voting process more accessible and
trustworthy for all participants.

II. METHODOLOGY

The methodology for the Blockchain-Based Secure Voting System for college elections involves designing a decentralized and tamper-proof digital platform that ensures transparency, security, and trust in the electoral process. First, eligible voters are authenticated using secure credentials such as student IDs or biometric verification. Once verified, voters receive a unique and encrypted token to cast their vote. The voting process is facilitated through a smart contract deployed on a blockchain network, which ensures that each vote is immutable and can only be cast once. The system records each vote as a transaction on the blockchain, making it publicly verifiable while maintaining voter anonymity. The use of consensus mechanisms guarantees that the data on the network cannot be altered without detection. After the election period ends, the smart contract automatically counts the votes and declares the results, eliminating manual errors and manipulation. This methodology ensures high reliability, data integrity, and transparency, making it a robust solution for conducting secure college elections.

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III. MODELING AND ANALYSIS/ARCHITECTURE

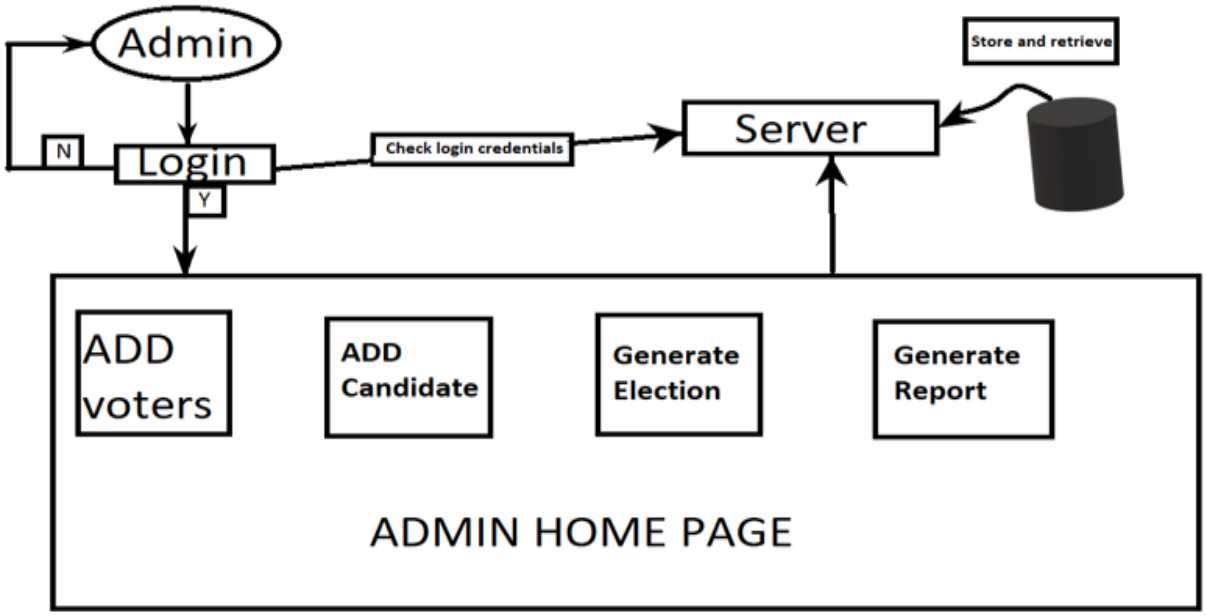

Fig. System Architecture

The architecture of the Blockchain-Based Secure Voting System for college elections is designed to ensure transparency, integrity, and security throughout the voting process. At the forefront is the Voter, who accesses the system through a secure Web Portal. This portal serves as the interface for authentication, ballot access, and vote casting. Once a vote is submitted, it is processed via a Smart Contract — a self-executing program deployed on the Blockchain Network that ensures that each vote meets the predefined conditions (e.g., valid voter, vote cast only once, within election time). The vote is then recorded in an immutable Ledger that resides on the blockchain, providing tamper-proof storage of all voting data.

The Admin component oversees the configuration of the election process, including candidate registration, voter verification, and monitoring. However, the Admin cannot alter votes due to the decentralized and transparent nature of the blockchain. The Blockchain Network itself acts as the backbone of the system, linking all nodes and maintaining consensus on the state of the ledger. Once the election period ends, the results are automatically computed based on the data stored on the ledger, and the final Result is made publicly viewable to all stakeholders through the same Web Portal. This architecture ensures end-to-end security, decentralization, and auditability, which are critical for building trust in digital voting processes.

A key advantage of this blockchain-based voting system lies in its use of decentralization and cryptographic verification to prevent common election issues such as vote tampering, double voting, and unauthorized access. Each transaction (or vote) is encrypted and time-stamped, then validated by consensus mechanisms across multiple blockchain nodes, ensuring that no single entity can manipulate the outcome. Voter identities can be anonymized using cryptographic techniques such as zero-knowledge proofs or hashed identifiers, preserving privacy while still enabling auditability. Additionally, the smart contract automates vote counting and enforces election rules without the need for manual intervention, reducing human error and potential bias. Overall, the architecture not only strengthens security and transparency but also increases efficiency, scalability, and trust in college-level electoral processes

IV. SYSTEM OVERVIEW

The Blockchain-Based Secure Voting System for college elections is a decentralized application designed to ensure secure, transparent, and tamper-proof electoral processes. By leveraging blockchain technology, the system records each vote as an immutable transaction on a distributed ledger, making it virtually impossible to manipulate or alter voting data. This approach eliminates the need for a central authority, reducing the risk of fraud and promoting trust among students and administrators. The system typically includes features such as voter authentication via unique IDs,

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real-time vote counting, and an auditable trail of all election activities.This voting system offers significant advantages over traditional paper-based or centralized electronic voting methods. Voter anonymity is preserved using cryptographic techniques, while the transparency of the blockchain ensures that all stakeholders can independently verify the integrity of the election results. The system can be accessed via a secure web or mobile interface, allowing students to vote remotely, thereby increasing participation and convenience. Overall, this solution demonstrates the practical application of blockchain in real-world scenarios, addressing critical concerns of trust, security, and accessibility in campus elections.

V. ALGORITHM

1 Voter Registration and Verification
Each student registers using a secure web portal with identity verification (e.g., student ID, OTP, biometrics). Once verified, the system assigns them a unique digital identity.

2 Generation of Wallet and Cryptographic Keys
Upon verification, the system generates a cryptographic key pair (public and private keys) for each voter. The private key remains secure with the voter, and the public key is stored on the blockchain for verification.

3 Vote Casting with Encryption
The voter selects a candidate on the voting interface. The vote is digitally signed with their private key and encrypted before submission, ensuring authenticity and confidentiality.

4 Vote Broadcasting to Blockchain
The encrypted and signed vote is broadcast to the blockchain network as a transaction. Blockchain nodes validate the transaction using the voter's public key, ensuring that it hasn't been tampered with.

5 Consensus and Block Addition
Once validated by the network (via consensus mechanism like Proof of Authority or Practical Byzantine Fault Tolerance), the vote is added to a new block in the blockchain ledger.

6 Immutable Storage and Transparency
The blockchain ensures the immutability of recorded votes. Every node in the network maintains a copy of the ledger, providing transparency and preventing vote alteration.

7 Vote Counting and Result Declaration
Votes are decrypted (only when the election ends) and counted automatically through smart contracts or predefined rules. The result is transparent and auditable by all stakeholders.

VI. RESULTS

In a blockchain-based secure voting system for college elections, the result declaration process begins once the voting period concludes. All votes, which were previously encrypted to maintain voter privacy, are decrypted using secure cryptographic techniques such as threshold decryption or multi-party computation. This ensures that no single entity can decrypt the votes prematurely or manipulate the data.

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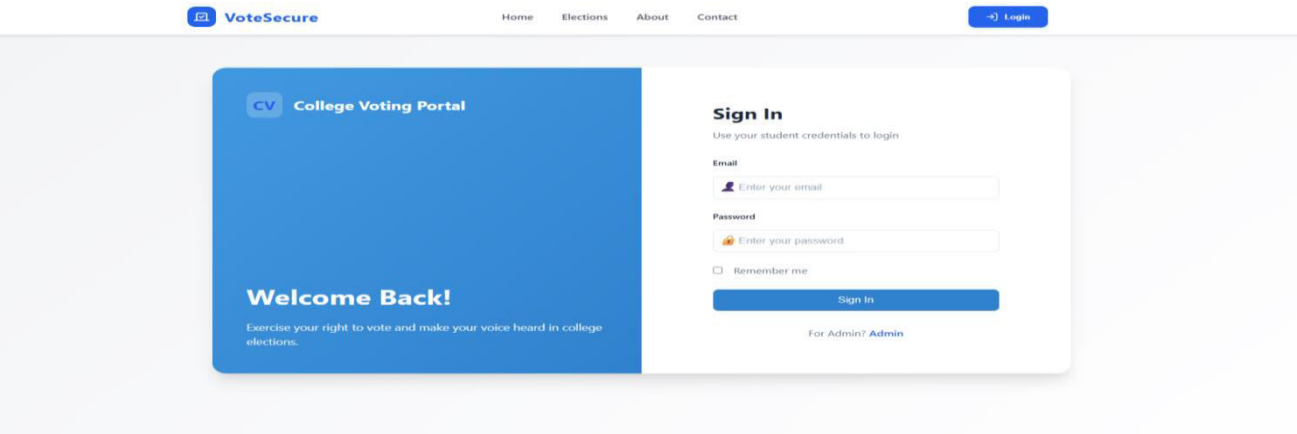

VII. CONCLUSION

The implementation of a blockchain-based secure voting system for college elections demonstrates a significant advancement in ensuring transparency, security, and trust in the electoral process. By leveraging the decentralized and tamper-proof nature of blockchain technology, this system effectively eliminates common vulnerabilities found in traditional voting methods, such as vote tampering, unauthorized access, and result manipulation.

In conclusion, this project not only proves the practical feasibility of integrating blockchain in campus-level elections but also sets a foundational framework that can be scaled for broader, real-world electoral applications. It reflects the potential of emerging technologies to foster more secure and trustworthy democratic processes in educational institutions and beyond.

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International Journal of Advanced Research in Education and Technology

ISSN: 2394-2975

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