Blockchain Based Voting System

A Project Report

Submitted by:

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in partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Faculty of Engineering and Technology, Institute of Technical Education and Research

SIKSHA 'O' ANUSANDHAN (DEEMED TO BE) UNIVERSITY

Bhubaneswar, Odisha, India

(June 2024)

CERTIFICATE

This is to certify that the project report titled “Blockchain based Voting System” being submitted by Yashpal Rout, Ashirbad Behera, Ashutosh Dash and Kirtikanta Sekhar to the Institute of Technical Education and Research, Siksha ‘O’ Anusandhan (Deemed to be) University, Bhubaneswar for the partial fulfillment for the degree of Bachelor of Technology in Computer Science and Engineering is a record of original confide work carried out by them under my/our supervision and guidance. The project work, in my/our opinion, has reached the requisite standard fulfilling the requirements for the degree of Bachelor of Technology.

The results contained in this project work have not been submitted in part or full to any other University or Institute for the award of any degree or diploma.

(Prof. Saurav Kumar)

Department of Computer Science and Engineering

Faculty of Engineering and Technology;
Institute of Technical Education and Research;
Siksha ‘O’ Anusandhan (Deemed to be) University

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who contributed to the successful completion of this work on Blockchain Based Voting System.

First of all, we express our sincere appreciation to our supervisor Mr. Saurav Kumar for his valuable guidance, ongoing support, and insight throughout the project. His expertise and encouragement have been invaluable in developing our research direction and improving our work. We are extremely grateful to our university & college for providing us with the necessary materials and resources for this project. Their contributions have been invaluable in enabling us to perform the necessary experiments and analyze the results more efficiently. We would also like to acknowledge the support of the research team and the authors of the papers and studies cited in our literature review. Their incredible work laid the foundation for our research and inspired us throughout the project.

Finally, we would like to express our sincere gratitude to our family and friends for their unwavering support, understanding and encouragement throughout this project. Their motivation and belief in our abilities has always been a source of inspiration. We recognize that this project would not have been possible without the collective efforts and support of all the individuals and organizations listed above.

Place: Bhubaneswar, Odisha **Signature of Students**

Date: 20th June 2024

DECLARATION

We declare that this written submission represents our ideas in our own words and where other's ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/fact/source in our submission. We understand that any violation of the above will cause for disciplinary action by the University and can also evoke penal action from the sources which have not been properly cited or from whom proper permission has not been taken when needed.

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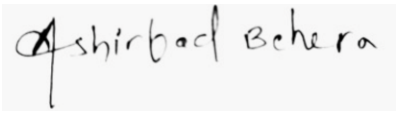
2041002052 

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Date: 20th June 2024

REPORT APPROVAL

This project report titled **"Blockchain Based Voting System"** submitted by **Yashpal Rout, Ashirbad Behera, Ashutosh Dash and Kirtikanta Sekhar** is approved for the degree of *Bachelor of Technology in Computer Science and Engineering*.

Examiner(s)

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Supervisor

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Project Coordinator

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PREFACE

Our project uses Blockchain technology to provide a safe, open, and unchangeable voting mechanism. Traditional voting methods frequently have issues with confidence, security, and transparency, raising questions about the accuracy of election results. Our approach solves these problems by using the decentralized ledger of Blockchain technology to produce an accurate and unchangeable voting transaction record. Our main goal is to address the widespread mistrust and lack of transparency around traditional voting methods. Election-related conflicts, manipulation, and fraud erode the legitimacy of democratic processes. The goal of deploying a voting system based on Blockchain technology is to improve election integrity and rebuild public trust in the political process. Our system provides a number of essential features and technological aspects to guarantee the fairness of the voting procedure. To ensure the integrity of votes during elections, these include a Decentralized Ledger, Voter Authentication, Transparency and Auditability, Security Measures, and Immutable Records. Our project has many societal benefits and contributions. We advance democratic ideals and fortify civic engagement by improving voting's security and openness. Because of our technology, voters can participate in elections with confidence, knowing that their votes will be accurately recorded and counted. Furthermore, the openness that Blockchain technology provides encourages accountability and confidence between the voters and election institutions, which strengthens democracy. In conclusion, the goal of our project is to use Blockchain technology to establish a safe and transparent voting system, thereby revolutionizing the political process. We advance democratic ideas and principles by overcoming the drawbacks of conventional voting procedures and paving the path for fairer and more credible elections.

INDIVIDUAL CONTRIBUTIONS

Yashpal Rout	Schematic model diagram;Material and Methodologies Used
Ashirbad Behera	Literature survey
Ashutosh Dash	Experimentation; Result analysis and design; Documentation
Kirtikanta Sekhar	Introduction; Result validation;Conclusion; Documentation

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1. INTRODUCTION

1.1 Introduction

The Blockchain-Based Voting System project aims to revolutionize the electoral process by addressing key challenges in traditional voting systems, such as security vulnerabilities, lack of transparency, and diminished public trust. By leveraging blockchain technology, this project seeks to create a secure, transparent, and tamper-proof voting environment. The system will utilize smart contracts to ensure that each vote is recorded accurately and immutably, providing a verifiable and permanent record of the election. This innovative approach not only enhances the integrity and transparency of elections but also promotes greater accessibility and inclusivity, ensuring that every voter can participate confidently and securely. By modernizing the voting process through cutting-edge technology, this project aspires to restore trust in democratic institutions and pave the way for future advancements in governance.

1.2 Project Overview

Traditional voting systems face significant problems like fraud, manipulation, and lack of transparency, which can lead to a loss of public trust in elections. Fraud can occur in various ways, such as ballot stuffing or tampering with voting machines, while manipulation might involve altering vote counts or exerting undue influence on voters. Additionally, the lack of transparency in these systems makes it hard for people to verify that votes are counted accurately, which further undermines confidence in the process.

To tackle these issues, a blockchain-based voting system offers a promising solution that ensures secure, transparent, and tamper-proof elections. Blockchain technology addresses the challenges of traditional voting by providing a modern, decentralized approach. It allows for secure and anonymous voting, protecting voter privacy while maintaining the integrity and openness of the election process. Each vote is recorded on the blockchain using smart contracts, which automatically execute and document transactions according to pre-set rules, ensuring accuracy and fairness.

These records are permanent and unchangeable, creating a transparent and verifiable trail that can be audited if necessary. By using blockchain, elections can become more reliable and secure, making it much harder for fraud or manipulation to occur. This increased security and transparency can help restore public trust in the democratic process, ensuring that every vote is counted accurately and fairly.

1.3 Motivation

Traditional voting systems have several security concerns that need to be addressed. Fraud, like ballot stuffing or tampering with voting machines, and manipulation, such as altering vote counts, can severely undermine the integrity of elections. By developing more secure systems, we can better protect against these threats and ensure every vote is counted accurately. Promoting transparency and accountability in elections is crucial. Many current systems lack clarity, making it difficult for voters to confirm that their votes are counted properly.

Implementing technologies that provide clear, verifiable records can help ensure that the voting process is open and fair, allowing for proper oversight and confidence in the results.

Restoring trust in the electoral process is essential for a healthy democracy. When people believe that their votes are not secure or accurately counted, they lose faith in the system. By addressing security and transparency issues, we can rebuild this trust, encouraging more people to participate in elections. Enhancing accessibility and inclusivity in voting is also important. Many people face barriers to voting, such as long wait times, complicated registration processes, or lack of accessible polling places. By making voting easier and more accessible for everyone, we can ensure that all voices are heard and represented.

Finally, driving innovation in governance through technology can lead to more efficient and effective election processes. Embracing new technologies, like blockchain, can modernize the way we vote, making it more secure, transparent, and accessible. This not only improves the voting process but also sets the stage for other advancements in how we manage and govern our societies.

1.4 Uniqueness of the Work

The uniqueness of our project lies in its transformative approach to modernizing the electoral process. Unlike traditional voting systems that often struggle with security flaws and a lack of transparency, our project harnesses the power of blockchain technology to create a voting environment that is secure, transparent, and virtually tamper-proof. By utilizing blockchain, we ensure that every vote is recorded in an immutable and verifiable way, thanks to smart contracts. This makes it extremely difficult for fraud or manipulation to occur, restoring trust in the integrity of elections. Moreover, our system enhances accessibility and inclusivity in voting by providing a user-friendly platform that allows more people to participate confidently and securely, regardless of their background or technological proficiency. By breaking down barriers to participation and ensuring the accuracy and fairness of every vote, our project not only revitalizes trust in the electoral process but also sets the stage for innovative advancements in democratic governance, paving the way for more transparent and accountable societies.

1.5 Report Layout

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2. LITERATURE SURVEY

2.1 Existing System

- Hiroyuki Sato et al. (2018) published "A proposal of Blockchain based electronic voting system" proposing a blockchain-based electronic voting system to enhance verifiability, combining double envelope encryption for security and blockchain for transparency and integrity. [1]
- Rohith Marath et al. (2023) propose e-stamping for digital voting, utilizing Blockchain and Cloud, with an Android app enabling remote voting via facial recognition and OTP, ensuring transparency and preventing multiple votes. [2]
- Sarah Al-Maaitah et al. (2021) surveyed blockchain's potential in improving e-voting, focusing on security, privacy, and cost efficiency, while exploring its applications for distributed electronic voting to address trust and security concerns in traditional and online voting. [3]

2.2 Problem Identification

- Research in electronic voting systems has recognized persistent challenges, particularly in ensuring universal verifiability and availability. The Estonian electronic voting system, despite its prominence, has not been immune to these issues. [1]
- To overcome these obstacles, researchers have turned to blockchain technology as a potential solution.
- Blockchain distributed ledger architecture offers inherent advantages for electronic voting, including increased availability by removing reliance on centralized servers and ensuring transparency through its immutable nature.[3]

3. MATERIALS AND METHODS

3.1 Datasets Description

In the case of our real-time voting application, the data set mostly consists of data that changes during each voting period rather than historical data. Here's a breakdown of what the dataset comprises:

3.1.1 Election Commissioner Admin Data:

This section includes information about the persons who have the right to start new elections, add or remove candidates, work with voters' lists, and complete elections. Admin data is different from the general election management tasks, which include usernames, encrypted passwords, and permissions.

3.1.2 Voter ID Data:

For each election session, the system creates fake voter IDs or uses real voter IDs of a small sample. These IDs help in identifying voters and also ensure that no voter votes more than once within a specific election.

3.1.3 Voting Records:

The dataset records the live voting processes, which include the voter ID, the candidate or option voted for and the time of the vote. These records are important for tallying scores and deciding on election results.

3.1.4 Election Metadata:

Details of each election include the election name, start time, end time, candidate details including full name, political party, candidate photo, and the election status whether active or closed.

3.1.4 Blockchain Transactions:

Since the application under development is based on blockchain technology, this section contains parameters associated with blockchain processes. It includes the transaction ID, the gas fees of the transactions, and the smart contract interactions in the voting and election processes.

This application improves the efficiency and effectiveness of election management by focusing on the generation and management of real-time data. It guarantees that important election data complies strictly with the set procedures, replacing trend analysis with the current status of elections and voting processes within the voting system framework.

3.2 Model Diagram

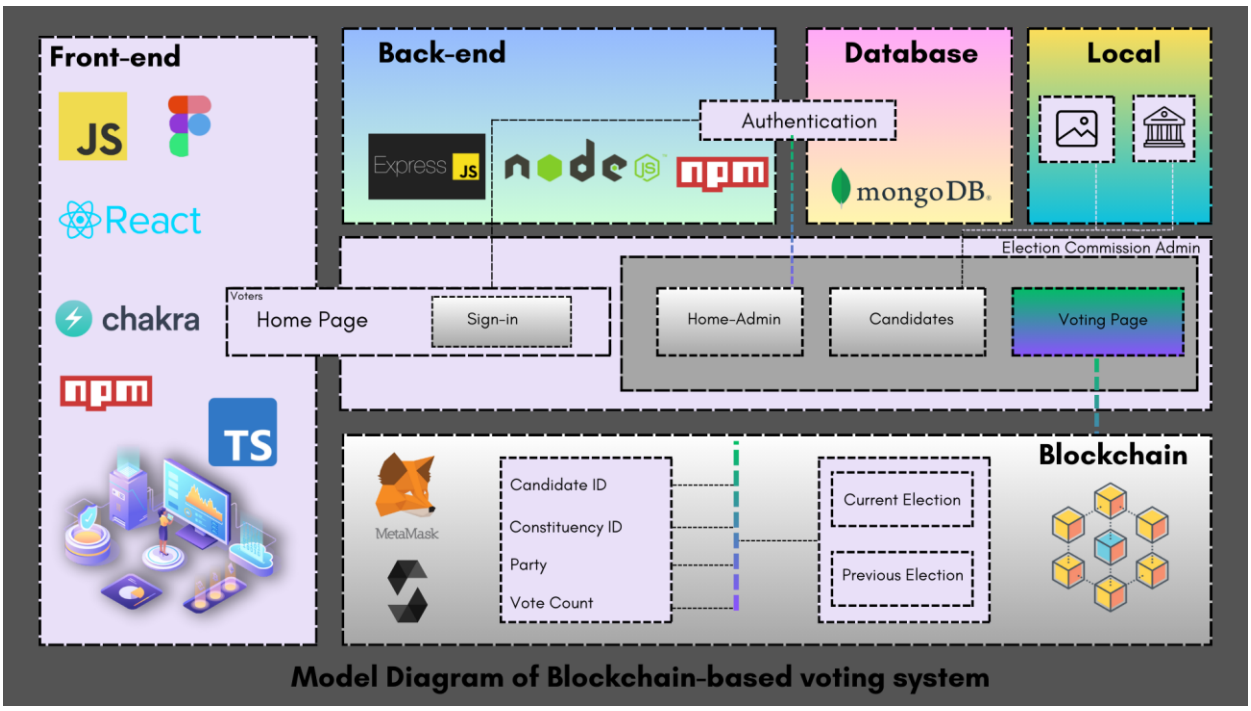

Fig 1. Model Diagram of Blockchain-Based Voting System

3.3 Methods

The VotingSystem smart contract is responsible for decentralized elections and it employs various algorithms and methods. These structures are the Candidate struct for candidate details and mappings that connect election IDs to candidates, voter participation, and election names and winners. The startElection method starts a new election, and checks if no other election is running and if there are candidates. It cleans the voter list and switches on the election mode. The addCandidate method enables the addition of candidates before an election and is protected to prevent such an action during an active election. The castVote method ensures that the election is active, the voter has not voted before, and the candidate exists. It increases the vote of the candidate, changes the maxVoted if the current candidate has more votes, and logs a VoteCasted event. The endElection method ends the election, changes the state, stores the winner, and resets the necessary variables for the next round, emitting an ElectionEnded event. Voter statuses are reset, and the election ID is incremented. Some of the methods like getResult and getCandidates are used to get the election results and candidate details respectively and this makes it transparent. getWinner displays the chosen candidate and isElectionInProgress checks the election status. The getCurrentElectionId and getElectionName functions are utility functions that retrieve the current election ID and name. These algorithms and methods guarantee secure, transparent, and efficient elections on the blockchain while preserving the integrity of elections and voters' confidence.

3.4 Tools Used

The voting system based on the blockchain technology includes a number of modern tools and instruments to ensure the safe, effective, and convenient voting. On the frontend, React. js is used to make the application more interactive and dynamic for the user; Chakra UI is used to make sure that the application has a consistent design of the UI components.

TypeScript improves the quality of the code written by adding the type safety and reducing the amount of runtime errors. The backend is built on MongoDB, a free-form NoSQL database, to store the user authentication details and the election data. JWT is used for managing the user authentication and session to ensure that only the authorized users can access the administrative functionalities and to enable the voters to vote securely.

The voting mechanism is decentralized through the use of Ethereum blockchain and the smart contracts govern the creation of elections, registration of candidates, voting and tallying of results. MetaMask is an Ethereum wallet that allows users to safely engage with the blockchain, and the voting can be conducted right in the browser. The combination of Ethereum and MetaMask ensures the transparency and immutability of the voting process. Together, these technologies create a single and secure environment for admins to conduct elections and voters to believe in the process, leveraging the principles of modern web development, UI/UX design, and blockchain.

3.5 Evaluation Measures

Evaluating a blockchain-based voting system involves assessing several critical aspects: security, efficiency, availability, responsibility, legal, performance, and satisfaction of the users.

Security makes sure that the vote is real and the voter is anonymous to the server through blockchain and JWT respectively. The system can therefore be scaled based on the number of transactions that the system can handle per time and the number of votes that the system can handle.

Usability focuses on the experience that is offered by the interfaces created with the assistance of React.js and Chakra UI, the following factors were considered: The reasons that may lead to the choice of this type of website include: The website’s functionality and navigation. Transparency is that the voting should be transparent and the result can be verified on the blockchain.

Legal compliance is useful in a way that it assists in ascertaining whether the electronic voting systems are legal or not. Stress testing defines the time that is needed to work with a certain load and the resources that have to be spent to guarantee the stability of the system.

User feedback is a process of gathering data concerning the level of satisfaction of the users and the problems they faced. These aspects can be critically examined and optimized for security, effectiveness, availability, legal requirements, speed and other improvements according to the feedback on the blockchain voting system.

4. EXPERIMENTATION AND RESULTS/ APPLICATION/ SYSTEM DESIGN AND OUTPUTS

4.1 System Specification

The system specifications for our real-time voting application outline the technical requirements and capabilities necessary to ensure its functionality and performance:

4.1.1 Frontend Technology:

React.js with TypeScript: Utilized for building a responsive and interactive user interface (UI).

Chakra UI: Provides accessible and customizable UI components to enhance user experience and ensure consistency.

4.1.2 Backend Technology:

Node.js with Express: Powers the backend server to handle API requests and business logic.

MongoDB: Stores data related to election administration, voter IDs, voting records, and election metadata securely.

4.1.3 Blockchain Integration:

Ethereum: Utilized for implementing smart contracts that manage election processes, candidate registration, vote casting, and result tallying.

MetaMask Integration: Enables secure transactions on the Ethereum network, allowing voters to cast their votes directly from their browser wallets.

4.1.4 Authentication and Security:

JWT (JSON Web Tokens): Implements secure authentication and session management for admins and voters.

4.1.5 Real-Time Data Handling:

WebSocket (or similar): Facilitates real-time updates and notifications for admin actions and voting events.

Event Emitters: Used to trigger and handle events such as election start, candidate addition, and vote casting across the application.

4.1.6 Performance and Scalability:

Load Balancing: Distributes incoming traffic to ensure optimal performance during high user activity.

Caching Mechanisms: Employed to improve response times and reduce database load for frequently accessed data.

4.1.7 Compliance and Regulatory Considerations:

Data Privacy: Adheres to data protection regulations to safeguard voter information.

Legal Compliance: Ensures the system complies with electoral laws and regulations governing digital voting systems.

4.1.8 Monitoring and Logging:

Logging Frameworks: Captures and stores logs for debugging, auditing, and monitoring system activities.

Metrics Monitoring: Tracks system metrics such as server load, database performance, and transaction throughput.

4.2 Parameters Used

In the context of our real-time voting application, various parameters are employed to ensure the system operates effectively and meets its objectives:

4.2.1 User Authentication Parameters:

Username: Unique identifier for election commission administrators and voters.

Role: Specifies whether the user is an admin or voter, determining access permissions within the system.

4.2.2 Election Management Parameters:

Election Name: Identifies the specific election cycle or event being conducted.

Start Date/Time: Marks the commencement of the election voting period.

End Date/Time: Indicates the deadline for voters to cast their ballots.

Status: Tracks whether an election is active, pending, or concluded.

4.2.3 Candidate Parameters:

Name: Full name of each candidate running in the election.

Party Affiliation: Political party or group affiliation of the candidate.

Candidate Photo: Visual representation of the candidate for voter recognition.

Party Logo: Graphic symbol representing the candidate's political party.

4.2.4 Voter Parameters:

Voter ID: Unique identifier assigned to each voter for tracking participation.

Vote Status: Records whether a voter has cast their ballot or not.

Vote Timestamp: Date and time when the voter submitted their vote.

4.2.5 Blockchain and Smart Contract Parameters:

Transaction ID: Unique identifier for each blockchain transaction related to voting.

Gas Fee: Cost paid in cryptocurrency (e.g., Ethereum) to execute transactions on the blockchain.

Smart Contract Events: Parameters emitted by smart contracts upon specific actions (e.g., vote casted event).

4.3 Results and Outcomes

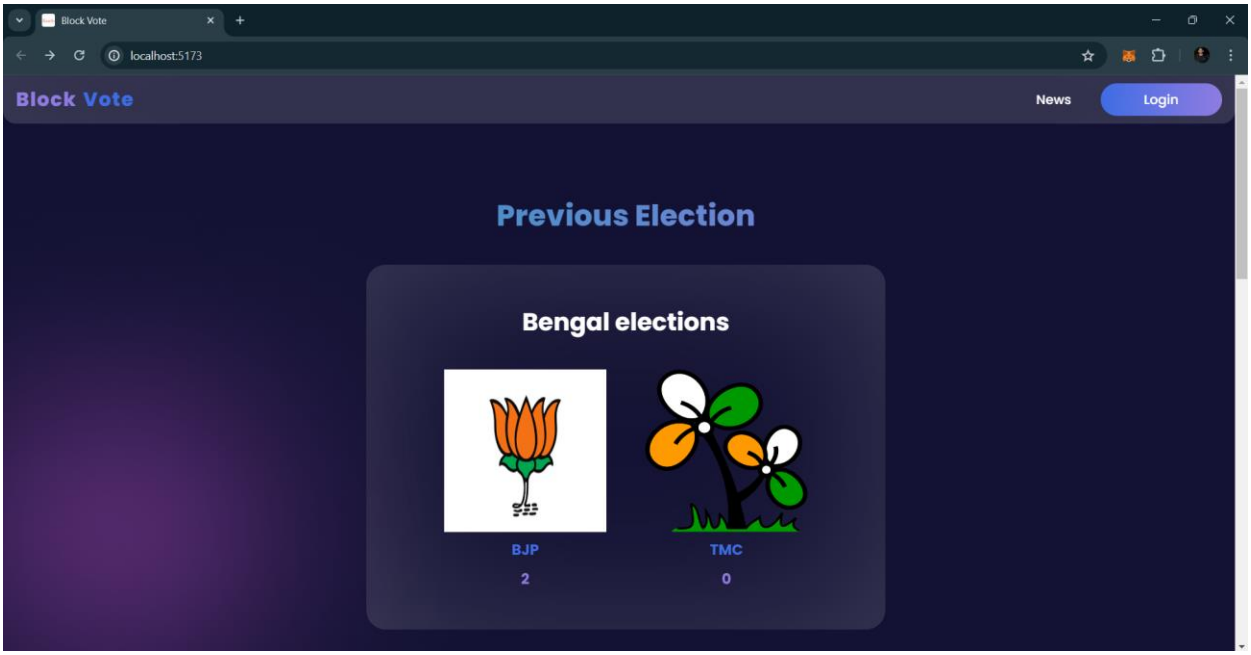

Fig 2. Home Page showing previous election results

Fig 3. News section of home page

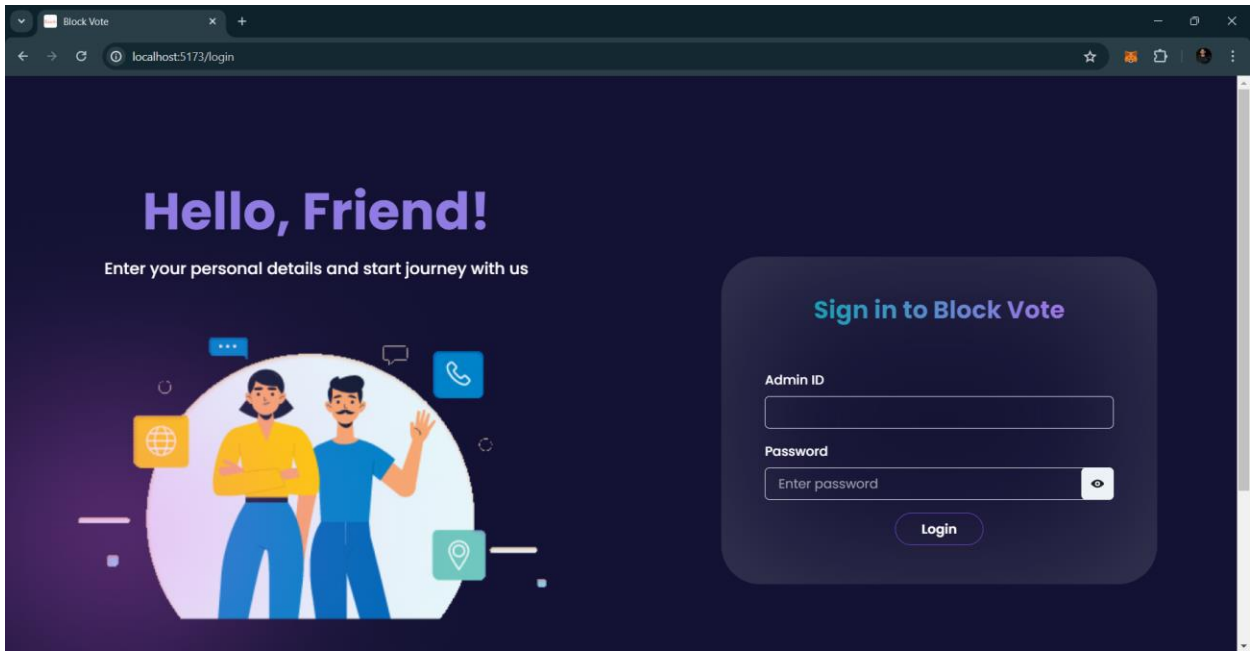

Fig 4. Login Page for Admins(Election Commission representatives)

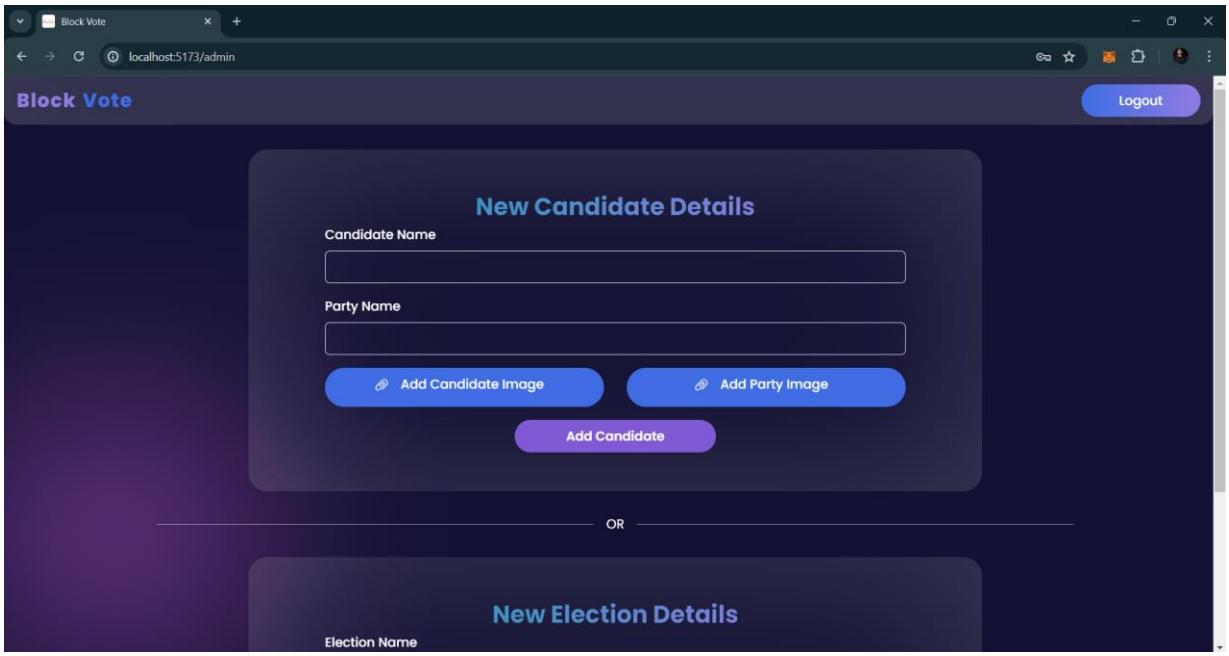

Fig 5. Admin Home Page (Add new candidates section)

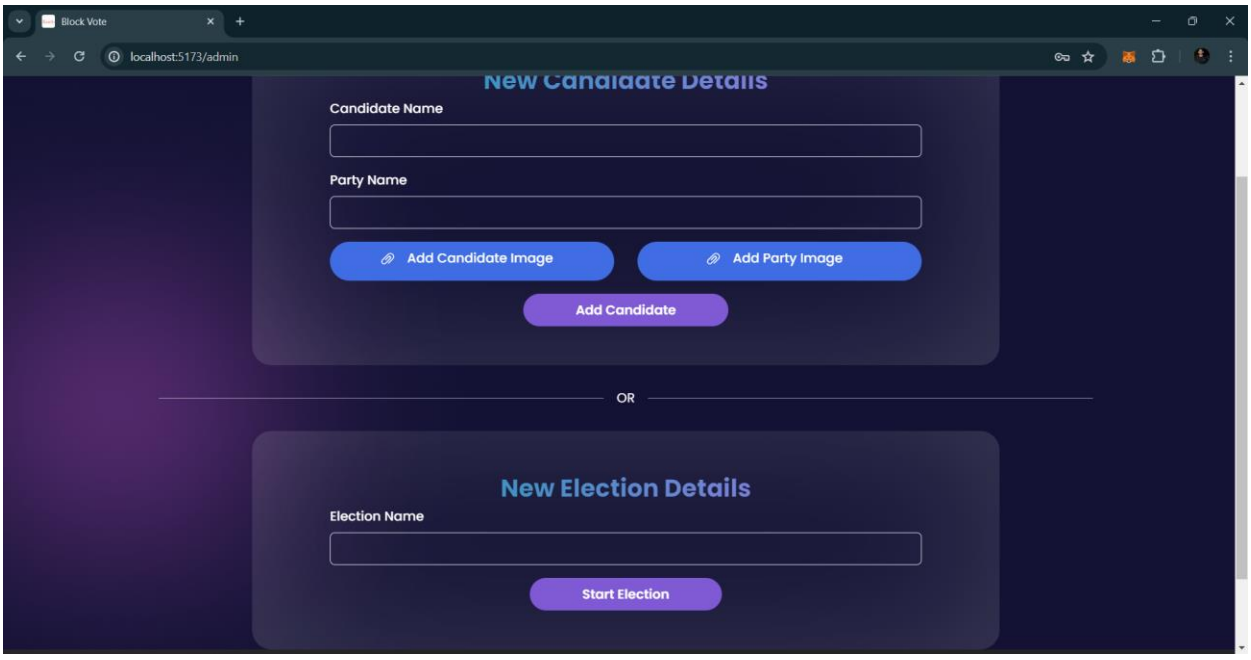

Fig 6. Admin Home Page (Start election section)

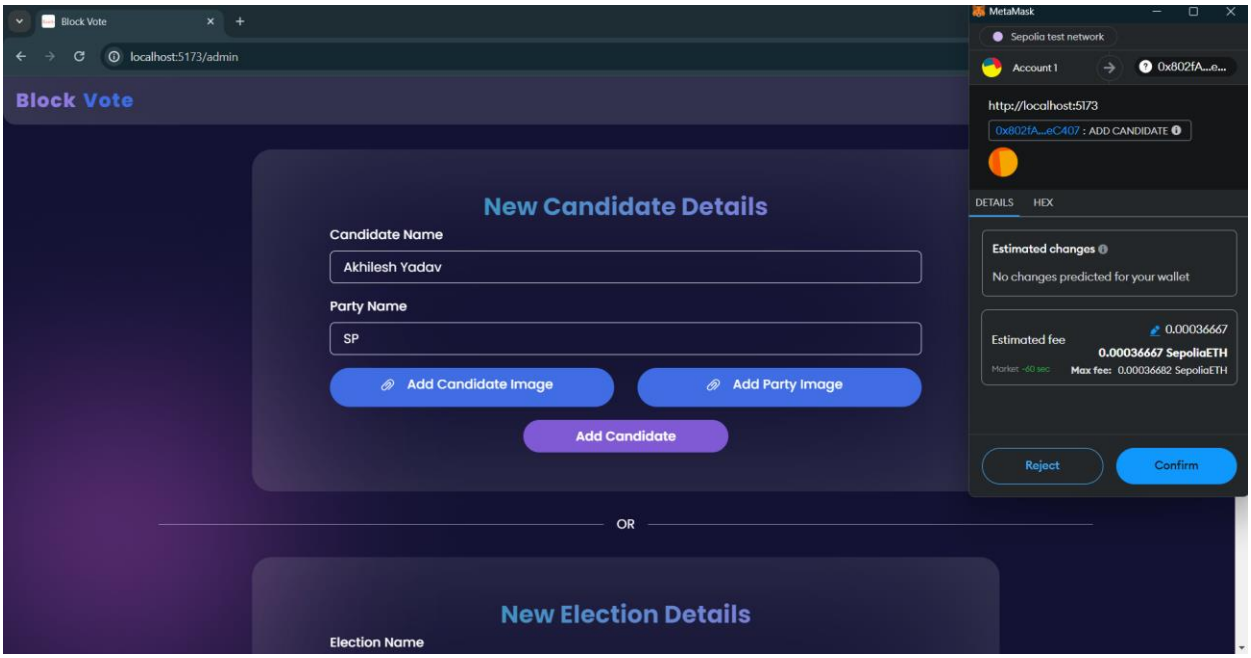

Fig 7. Adding New Candidates (Confirming transactions on Blockchain)

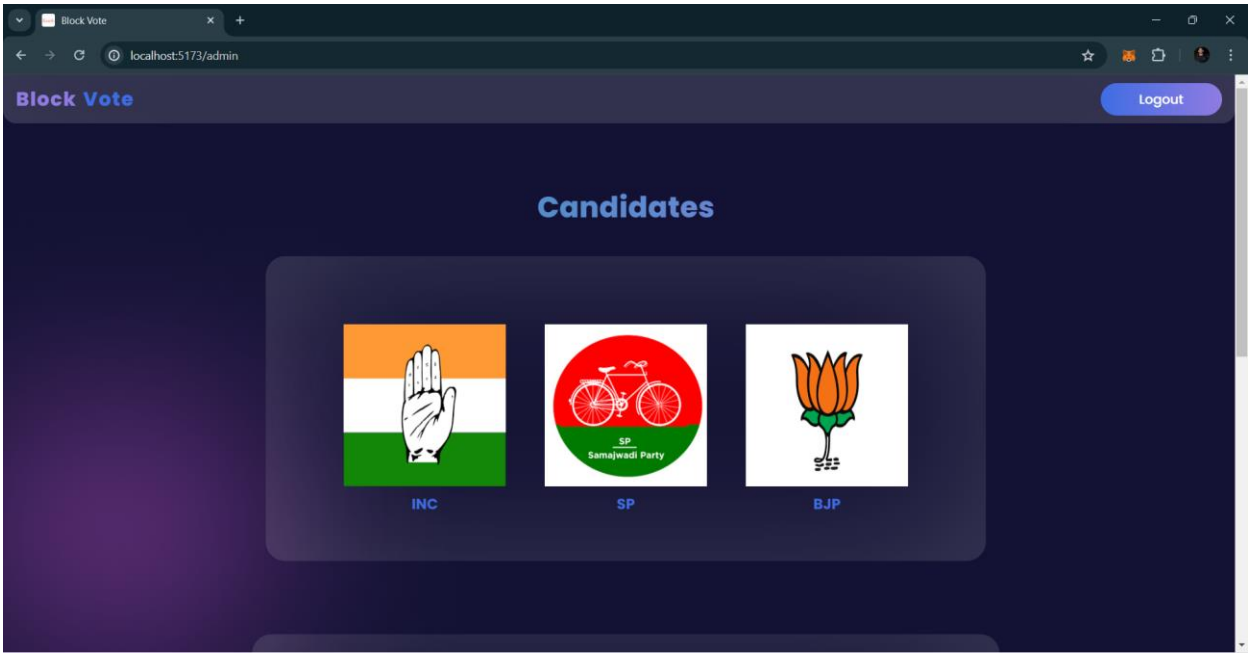

Fig 8. Candidates Added for the current Election

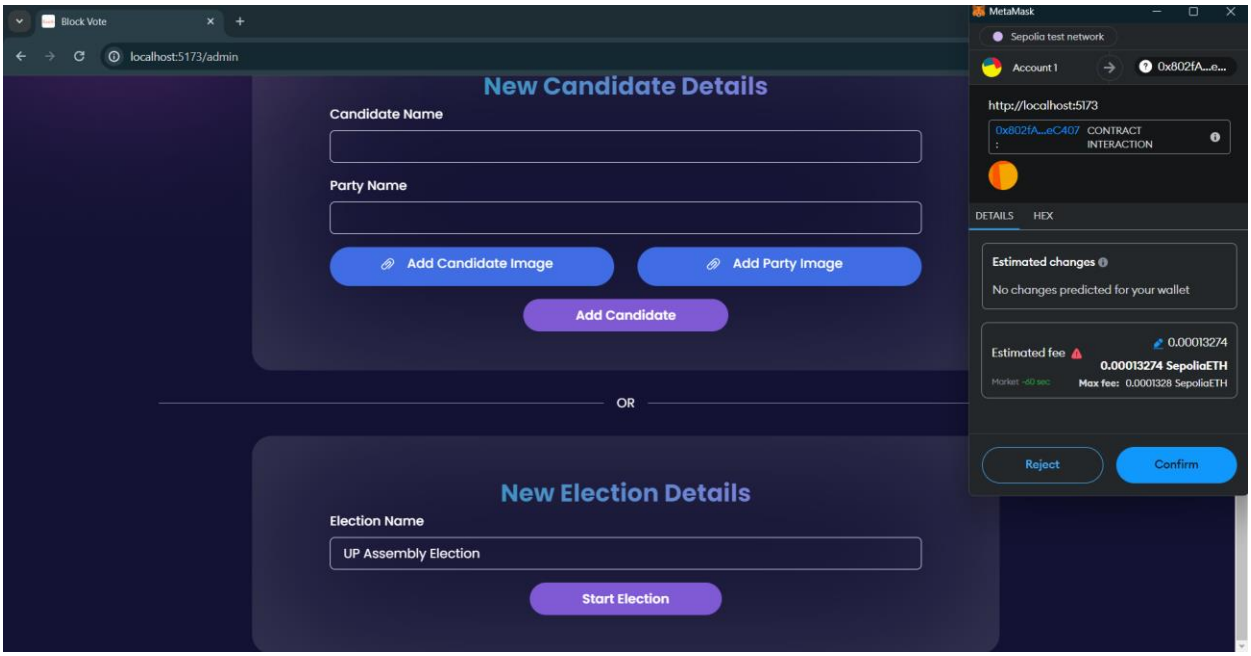

Fig 9. Starting the current Election

Fig 10. Ongoing current elections

Fig 11. Ongoing Election Details on Homepage

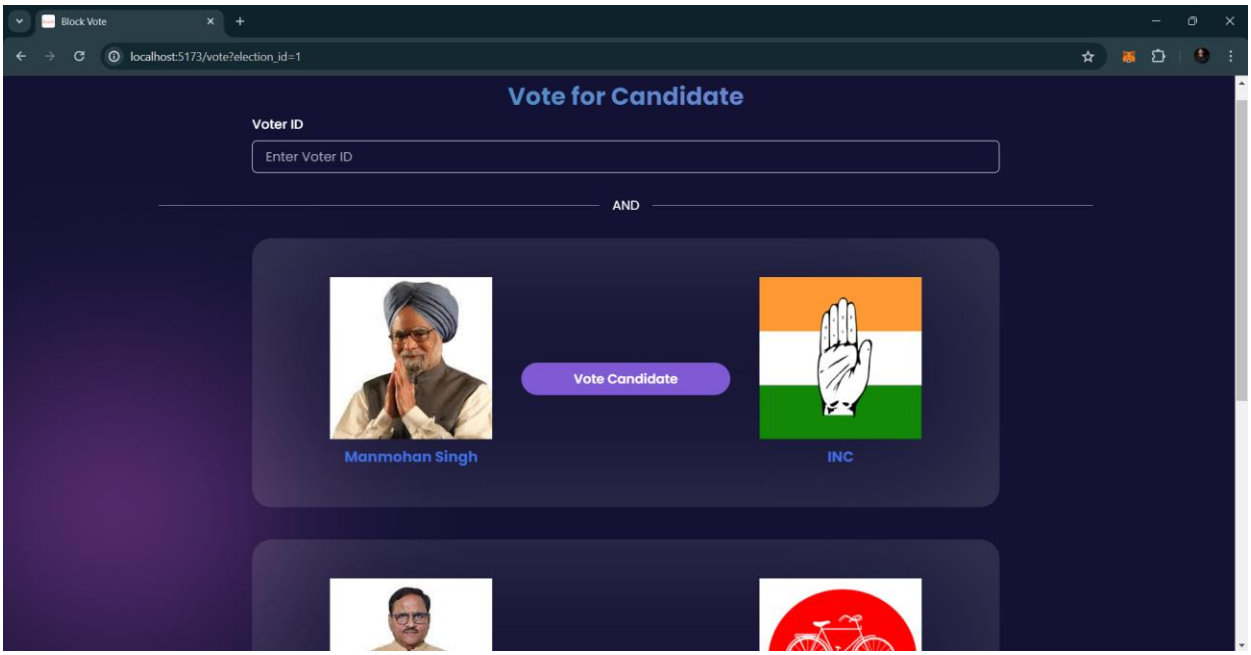

Fig 12. Voting Page

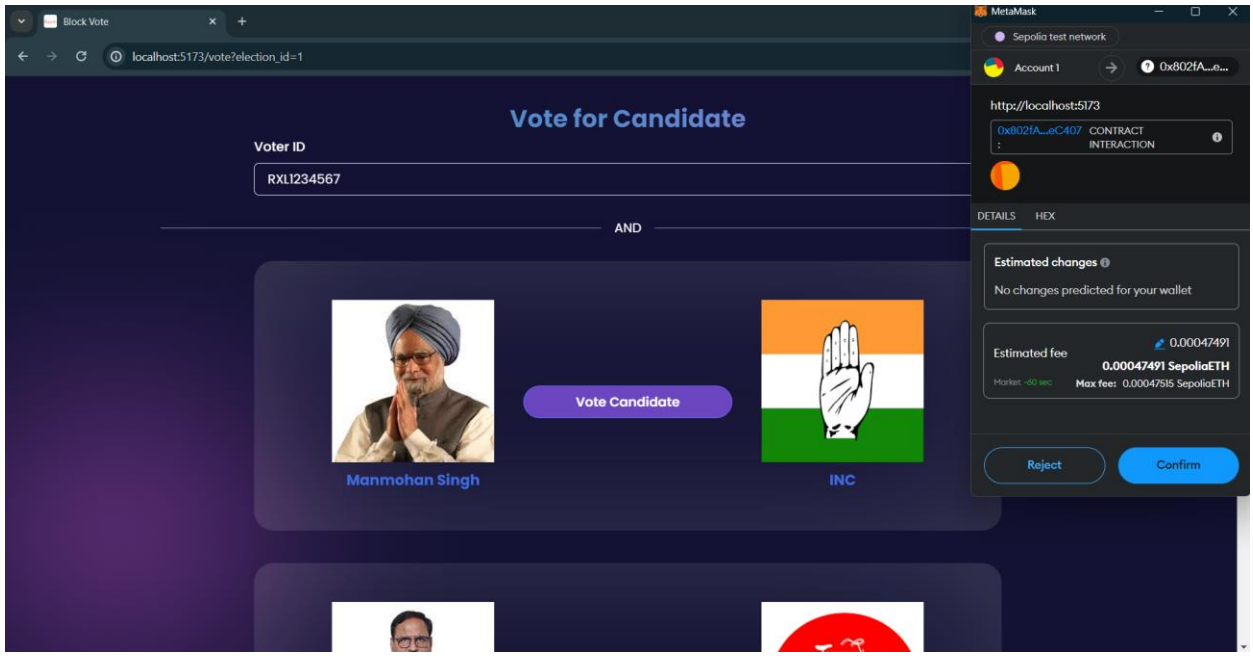

Fig 13. Voter giving vote through blockchain

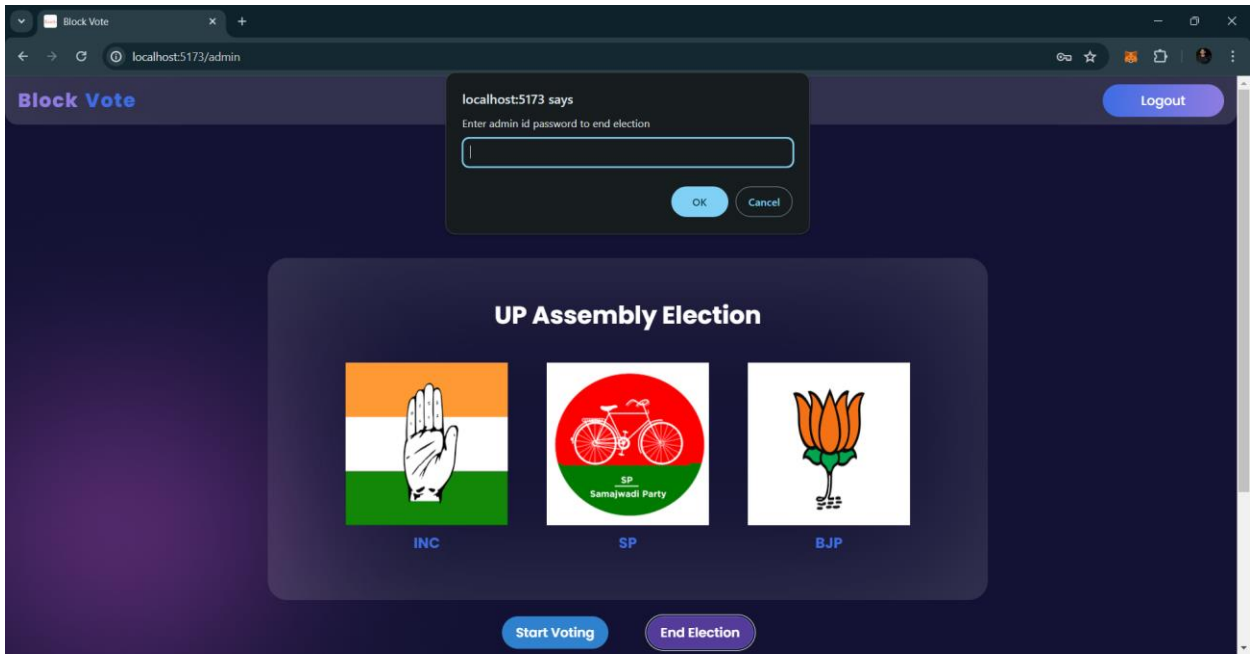

Fig 14. Admin ending the current election

4.4 Result Analysis and Validation

Fig 15. Result on homepage after the election ends

5. CONCLUSIONS

A blockchain-based voting system's deployment solves a number of serious problems with conventional voting procedures, including fraud, manipulation, and a lack of transparency. By offering a safe, transparent, and unchangeable voting framework, blockchain technology has the potential to completely transform the political process, as we have shown via our research. Every vote is cast and recorded using smart contracts on the blockchain, which guarantee its integrity, security, and anonymity. The election results are more credible since this system effectively removes the chance of outside interference or vote manipulation.

More trust and confidence in the voting process is fostered by the transparency of the blockchain, which enables all stakeholders to independently verify the results. A fair and democratic environment is promoted by the decentralized nature of blockchain technology, which guarantees that no one entity may control or influence the voting outcome. Furthermore, by facilitating the participation of a diverse population in elections, blockchain voting systems' accessibility and inclusion may raise voter turnout. All things considered, our effort has been effective in achieving its goals, which included improving security, encouraging openness, rebuilding confidence, improving accessibility, and stimulating innovation in government. Our study's findings show that a blockchain-based voting system is a workable and sensible way to update elections and deal with the serious problems that occur with using traditional voting methods.

6. REFERENCES

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[2] Rohith Marath, Sachin C B, Sanjay S, Sanjeev F Annigeri, Abhinav R B proposes “ A Review on E-Stamping in Digital Voting System Using Blockchain and Cloud Server”. International Journal of Innovative Science and Research Technology, Volume 8, Issue 1, January – 2023.

[3] Sarah Al-Maaitah Department of Computer Science University of Jordan Amman, Jordan Mohammad Qatawneh Department of Computer Science University of Jordan Amman, Jordan “E-Voting System Based on Blockchain Technology”: A Survey - International Conference on Information Technology (ICIT),2021.

7.REFLECTION OF THE TEAM MEMBERS ON THE PROJECT

As a team, we discovered the tremendous benefits of working together and the significance of bringing a variety of viewpoints and skill sets to bear on challenging issues. In order to create the Blockchain-Based Voting System, we had to combine project management, technological know-how, and user-centric design concepts. We learned via endless conversations, brainstorming sessions, and iterative testing how important it is to properly communicate and encourage one another's ideas. We also learned to navigate and overcome challenges together, whether they were technical hurdles or conceptual disagreements, ultimately leading to a more robust and well-rounded project.

Here is the breakdown of each team member's learnings from the project:

Team Member 1(Yashpal Rout): I learned to design the overall system architecture, integrating blockchain with traditional voting mechanisms to create a robust and scalable solution. I tackled various challenges related to ensuring data integrity, preventing double voting, and maintaining voter anonymity, which honed my problem-solving and critical thinking skills.

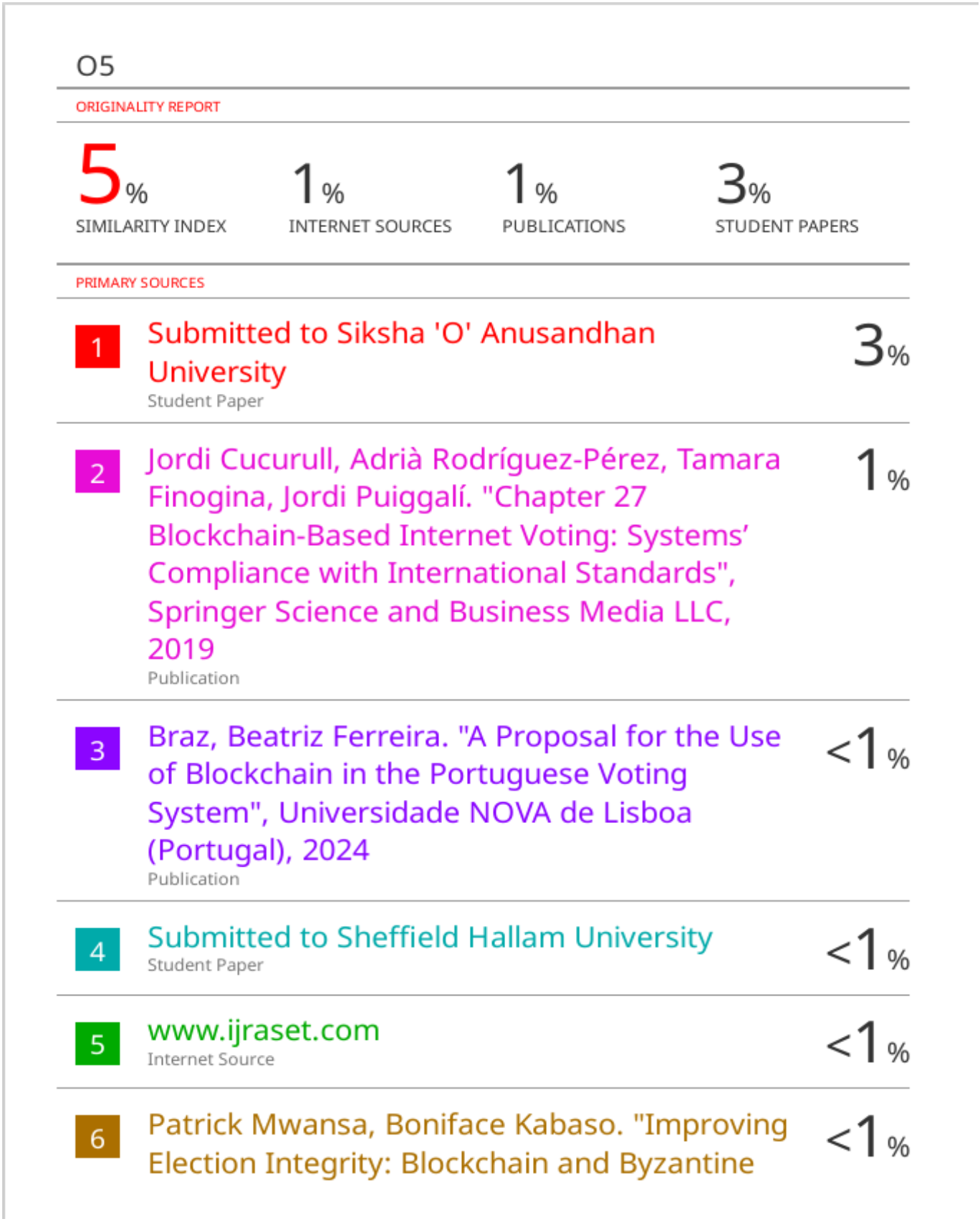
Team Member 2(Ashirbad Behera): I gained experience in managing project timelines, setting milestones, and ensuring timely delivery of project components, which are crucial skills for any successful project.

Team Member 3(Ashutosh Dash): I deepened my understanding of blockchain fundamentals, including its decentralized architecture, cryptographic principles, and how it ensures transparency and immutability in data transactions. I learned how to design and implement smart contracts using Solidity, ensuring secure and automated execution of voting processes on the Ethereum blockchain.

Team Member 4(Kirtikanta Sekhar): As a member of the team, I gained a deep understanding of blockchain technology and its potential applications beyond cryptocurrencies. My involvement in this project also enhanced my problem-solving skills, as I had to think critically about security vulnerabilities and user accessibility. Additionally, I developed better collaboration skills, learning to listen actively to my teammates, provide constructive feedback, and integrate diverse viewpoints into a cohesive solution.

Our design process had a lot of good points. We focused on making our voting system secure, transparent, and easy to use. Using blockchain, we made sure the system was safe and couldn't be tampered with. We kept improving our design by testing it and listening to feedback. However, we also faced some challenges. At first, we concentrated too much on the technical parts and not enough on making it user-friendly, which made us go back and redesign some parts. We also had big goals that sometimes made it hard to stick to our schedule. Despite these issues, we learned valuable lessons about balancing innovation with usability, which will help us in future projects.

8. SIMILARITY REPORT



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ORIGINALITY REPORT

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3	Braz, Beatriz Ferreira. "A Proposal for the Use of Blockchain in the Portuguese Voting System", Universidade NOVA de Lisboa (Portugal), 2024 Publication	<1%
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6	Patrick Mwansa, Boniface Kabaso. "Improving Election Integrity: Blockchain and Byzantine	<1%

Generals Problem Theory in Vote Systems", Electronics, 2024
Publication

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