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Development of a Robust Electronic Voting System (REVS) for Reliable Electioneering Process

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Abstract: Electioneering process is so cumbersome and prone to hazard in African Nations, and higher institutions of learnings are not excluded. The electioneering process is characterized with various fraudulent activities and threat to lives and properties. Though several systems and frameworks have been developed to address the inherent problems, electioneering processes among students of higher institutions of learning are still prone to different dissatisfactory deliverables. These setbacks prompted the Development of a Robust Electronic Voting System (REVS) using Blockchain Technology, that can deliver a trusted, acceptable and reliable electoral process. The developed REVS employed Windows, Apache, MySQL, and PHP(WAMP) for its back engine and JAVA was used for the front-end of its design. Results from the REVS reveals employability, acceptability, deploy ability of the software for conduct of election in dangerous and problematic terrains. The REVS can be employed on large coverage electioneering process with reliable and acceptable election results.

1.0 Introduction

E-voting stands for electronic voting and can be specified in multiple ways. Alvarez, Hall and Treschel (2009) mention that the term electronic voting means that a voter through the usage of a computer, mobile phone or anything electrical, can cast their vote using a ballot over the internet prior to the voting day without it being supervised by official authorities.

The goal for e-voting is Remote Internet Voting which means that voting can take place wherever internet is available, this being the most accessible way of e-voting. This would allow voters to cast their ballot from any electrical device that can connect to the internet whether they are at home, at work or outside the physical vicinity of the electioneering process ranges from social problem (Estefanía and Darwin, 2021), security problem (Chaeikar*et al.,* 2021). When it comes to these types of system, many studies have focused on the vulnerability of the systems while others have targeted how to develop the systems in hope that the development when it comes to the integrity, privacy and security of e-voting systems are high enough to withstand any breaches possible (Becker et al., 2013; Pandey and Tiwari, 2023).

Electronic voting system in electoral processes is not new in our world today and this can be seen as an easy way by which citizens can discharge their civic responsibility. But it possible to be computerized because we already have a lot of system doing that already but they're limited and not reliable and that leads to the Development of a Robust Electronic Voting System (EVS) using Blockchain Technology for reliable electioneering process. This will bring unfathomable reliance and acceptability on electioneering processes, students populate inclusive. Blockchain technology has proved to be a reliable technology for enhancing EVS performances (Golosova and Andrejs, 2021; Pandey and Tiwari, 2023; Vatsa 2024; Kafhali, 2024).

Nigeria electoral system has been held down by various factors such as fraud, multiple voting, underage voting among other things (Obiefuna-Oguejiofor , 2019; Oyelude and Olojede, 2023; Lawrence and Ajisebiiyawo, 2023), india (Kamalraj and Ashish, 2024), Indonesia (Risnanto*et al.,* 2022) etc.

Electronic voting systems are rapidly overlapping the conventional voting system. Traditional voting comes with a lot of factors that make rigging in whole electoral process such as counting of votes, fake voters and involvement of outside sources and also other problems like time consumption, cost budget problems etc. These problems, among others, bedeviling traditional voting system necessitate the development of the Robust Electronic Voting (e-voting) system which biometrically authenticate voters, eliminate multiple voting, real-time vote update and enhances reliability, acceptability, timely release of vote results and confidentiality (privacy) of rights of voters. The current e-voting system is not reliable it can be compromise and it will favor any contestant that know the limitation and that's not supposed to be.

2.0 Literature Review

Electronic voting in polling stations has come to stay in some of the world's largest democratic settings. Internet voting is used in some, initially mainly small and historically conflict-free, countries. Many countries are currently considering introducing e-voting systems with the aim of improving various aspects of the electoral process. E-voting is often seen as a tool for advancing democracy, building trust in electoral management, adding credibility to election results and increasing the overall efficiency of the electoral process (Silhavy and Silhavy, 2008).

The technology is evolving fast and election managers, observers, international organizations, vendors and standardization bodies are continuously updating their methodologies and approaches. Properly implemented, e-voting solutions can eliminate certain common avenues for fraud, speed up the processing of results, increase accessibility to sensitive materials and make voting more convenient for citizens—in some cases, when used over a series of electoral events, possibly even reducing the cost of elections or referendums in the long term. Unfortunately, not all e-voting projects succeed in delivering on such high promises. The current e-voting technology is not problem-free. Legislative and technical challenges have arisen in some cases; in others, there has been skepticism about or opposition to the introduction of new voting technologies. The inherent challenges of e-voting are considerable and linked to the complexities of electronic systems and procedures. Many e-voting solutions lack transparency to voters and even for election administrators. Most e-voting solutions are only fully understood by a small number of experts and the integrity of the electoral process relies largely on those small group of system operators instead of thousands of poll workers. If not carefully planned and designed, the introduction of e-voting can undermine confidence in the whole electoral process. It is therefore important to devote adequate time and resources to considering its introduction and looking at previous experiences of electronic voting.

The Types of E-Voting Systems

Technically, most e-voting systems fall into one of the following four types.

1. **Direct recording electronic (DRE) voting machines:** DREs can come with or without a paper trail (VVPAT, or voter-verified paper audit trail). VVPATs are intended to provide physical evidence of the votes cast.
2. **OMR systems which are based on scanners that can recognize the voters' choice on special machine-readable ballot papers:** OMR systems can be either central count systems (where ballot papers are scanned and counted in special counting centres) or precinct count optical scanning (PCOS) systems (where scanning and counting happens in the polling station, directly as voters feed their ballot paper into the voting machine).
3. **Electronic ballot printers (EBPs):** devices similar to a DRE machine that produce a machine-readable paper or electronic token containing the voter's choice. This token is fed into a separate ballot scanner which does the automatic vote count.
4. **Internet voting systems where votes are transferred via the Internet to a central counting server:** Votes can be cast either from public computers or from voting kiosks in polling stations or more commonly from any Internet-connected computer accessible to a voter.

Strengths Associated with E-Voting

The strength associated with e-voting are: Faster vote count and tabulation, More accurate results as human error is excluded, Efficient handling of complicated electoral systems formulae that require laborious counting procedures, Improved presentation of complicated ballot papers, Increased convenience for voters, Potentially increased participation and turnout, particularly with the use of Internet voting, prevention of fraud in polling stations and during the transmission and tabulation of results by reducing human intervention, Increased accessibility, for example by audio ballot papers for blind voters, with Internet voting as well for housebound voters and voters from abroad, Possibility of multilingual user interfaces that can serve a multilingual electorate better than paper ballots etc.

Electronic voting machines (EVMs) were introduced in 1964 to improve the efficiency and transparency of voting/counting procedures. There are different types of EVMs, including DRE voting/counting machines, EVMs with voter verifiable paper audit trail (VVPAT), and EVMs with paper ballots. EVMs offer benefits such as faster vote casting and counting, standardized counting of ballots, reduced margin of error, and prevention of certain forms of election fraud. However, there are drawbacks to EVMs, including loss of transparency, stakeholders' distrust, software and hardware maintenance challenges, security vulnerabilities, and financial considerations. India has the largest national population to vote using EVMs, but there have been concerns about their security and integrity ().

Blerim, Vehi and Ramadan (2012) emphasized the need for a robust authentication and transparency in e-voting systems. Dynamic queue was employed in the architecture and the architecture allows for voters to cast their vote in any polling station in contrariwise to paper voting where voters can only vote in a single polling station.

Electronic voting systems have become an important tool in democracies around the world. They aim to improve the transparency, efficiency, and accessibility of the electoral process. E-voting systems can eliminate human error in vote counting and authentication, speed up the processing of results, and make voting more convenient for citizens. They also have the potential to increase voter turnout and participation. However, there are challenges associated with e-voting, such as the need to protect the secrecy of the vote and ensure the integrity of the system. Different types of e-voting systems exist, including direct recording electronic (DRE) machines, optical mark recognition (OMR) systems, electronic ballot printers (EBPs), and Internet voting systems. E-voting can be conducted in controlled environments, such as polling stations, or in uncontrolled environments, such as voting from home. Some e-voting systems provide physical evidence of the votes cast, while others rely on indirect verification methods. Overall, e-voting has the potential to enhance democracy, but careful planning and consideration of previous experiences are necessary for successful implementation (GSJ, 2019).

In his work, (Mudda and Choubey, 2018) discussed the future of Election Management System (EMS), having strong securities in the way that the hackers cannot be able to enter the system to make any change during the registration of voters and candidates as well as in the election period till the end of the electioneering process. Osho et al., (2016) proposes a framework for an e-voting system that ensures availability of the system to only eligible voters and integrity of the voting process through its capacity to identify and prevent ineligible voters and multiple voting.

In order to solve the problem of auditability, block chain technology was designed for e-voting system (Pawlak et al., 2018). An intelligent agents-based block-chain e-voting system was developed which demonstrated desirable features such as fraud prevention, accelerated results processing, reduction of cost etc.

Yousif et al. (2020), having identified the associated problems with block chain method to include energy consumption, compromise of scalability, efficiency, and latency of the system, proposed an hybrid system which combined Block chain with sharding. The hybrid consensus model (PSC-Bchain) which composed of Proof of Credibility and Proof of Stake that work mutually to address the aforementioned problems to secure e-voting system. Anita et al., (2020) developed a blockchain technology-based EVS which performed impressively both in voters' verification and correct vote counting. It was able to overcome some of the identified limitations in the existing EVS such as anonymous vote casting, individualized ballot processes, ballot casting verifiability (only) by the voter, high initial setup cost and security problems. Blockchain technology in software development has proved to be good in development of E-voting system (Uzma et al., 2021; Camilo et al., 2022).

3.0 Methodology

The software model employed for this design is the System Development Life Cycle (SDLC). In order to achieve the objectives of the system, it is important to apply the right method that will achieve the goals. The techniques that will be used to carry out the implementation of the project consist of the following;

Text Editor: (Sublime text): This will be used to carry out the coding aspect of the system.

Programming Language: The programming language for the implementation consists of:

HTML (HyperText Markup Language**):** this was used to carry out the structure of the system.

CSS (Cascading Style Sheet**)**:CSS was used in the design of the GUI of the system.

JavaScript: was used to make the system easy to use both on PC and on mobile devices.

PHP (Pre Hypertext Processor**):** PHP is a server language that accepts and passes the entire user's input to the server.

MySQL (Structured Query Language): MySQL is a database language, it is used to store all kind of records to the database, and it will take all users input accepted by PHP and stores it to the database.

Database: The database software used for the system was WAMP (Windows, Apache, MySQL, and PHP), it is used to manage the database and every record stored.

Typical features and functionalities of the REVS systems: Internally, the electronic voting systems have many functions, including encryption, randomization, communication and security systems. Among some of the features obtainable on he REVS are:

Electronic Voters' lists and Voter's Authentication:This list was used to authenticate eligible voters and to record their voting status.

Poll Workers' Interfaces: Special functionalities that are only available to poll workers, to enable reset of vote count at the opening of the polling station, closing polling, printing and transmission of results.

Vote Casting Interfaces: These include touch screens, optical mark recognition (OMR) ballot papers that were fed into a scanner, touch-sensitive tablets, push buttons, web pages or special client software for Internet voting.

Special interfaces for handicapped voters: These include Braille or audio input devices for the blind, easier access for voters with physical disabilities, and simpler interfaces for illiterate voters.

Interfaces for the results output: For voting machines (see the definition below) this is often a printer. However, some machines only use digital displays. Once voting is closed this interface can be used to display or print the results that were recorded by the voting machine. If results are printed the printouts can be used as physical evidence of the results produced by the voting machine, and copies can be distributed to stakeholders present at the polling station and can also be posted for public display.

Printers for printing a voter: verifiable receipt for each vote (see below on the voter verified audit paper trail, VVPAT).

1. **Result Transmission System**:Many voting machines can transmit results to central counting systems, for example via the Internet, telephone, mobile phone or satellite connection. In the absence of communication links, the results can also be transported physically, using electronic storage media such as memory cards.
2. **Result Tabulation Systems:** usually located at result processing centres: At the end of election day, they receive electronic results from polling stations and automatically tabulate the results for the various competitions and districts.
3. **Result Publication Systems:** Preliminary and final results can be published in many different ways including on websites, CDs, and geographic visualization systems, and if required on all levels of detail down to single polling stations. The more detailed the published results are, the more transparent the election.
4. **Confirmation Code Systems:**Some e-voting solutions allow for control codes that are intended to allow individual verification of each vote by the relevant voter.

Operational flow diagrams for administrator and users are shown in Figure 1 and Figure 2, respectively.

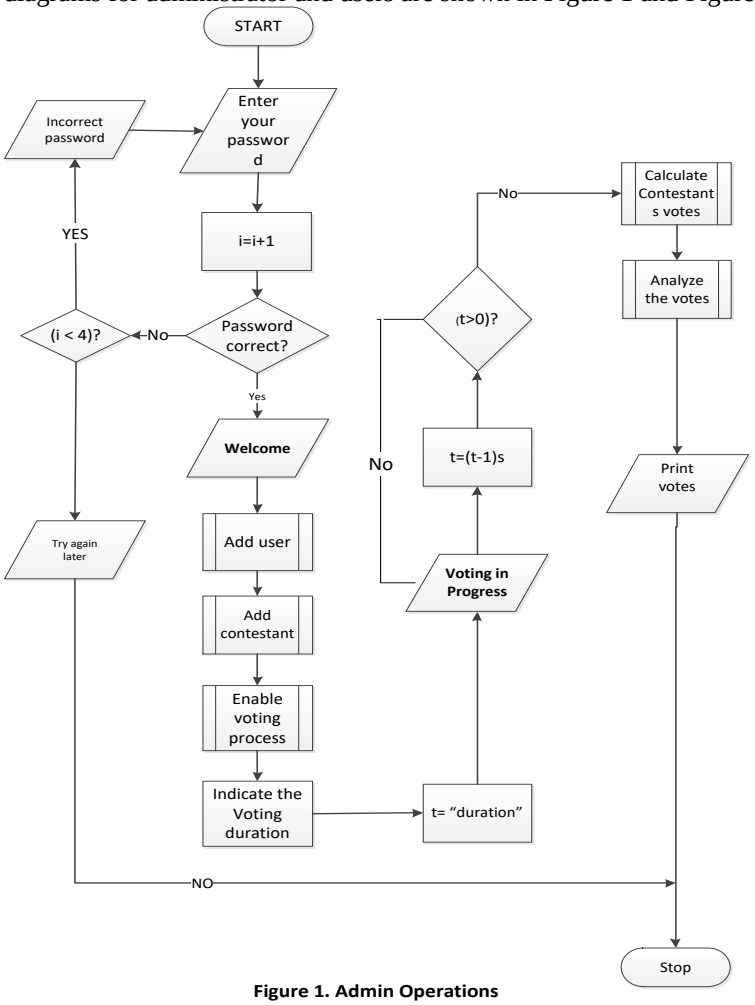

Figure 1. Admin Operations

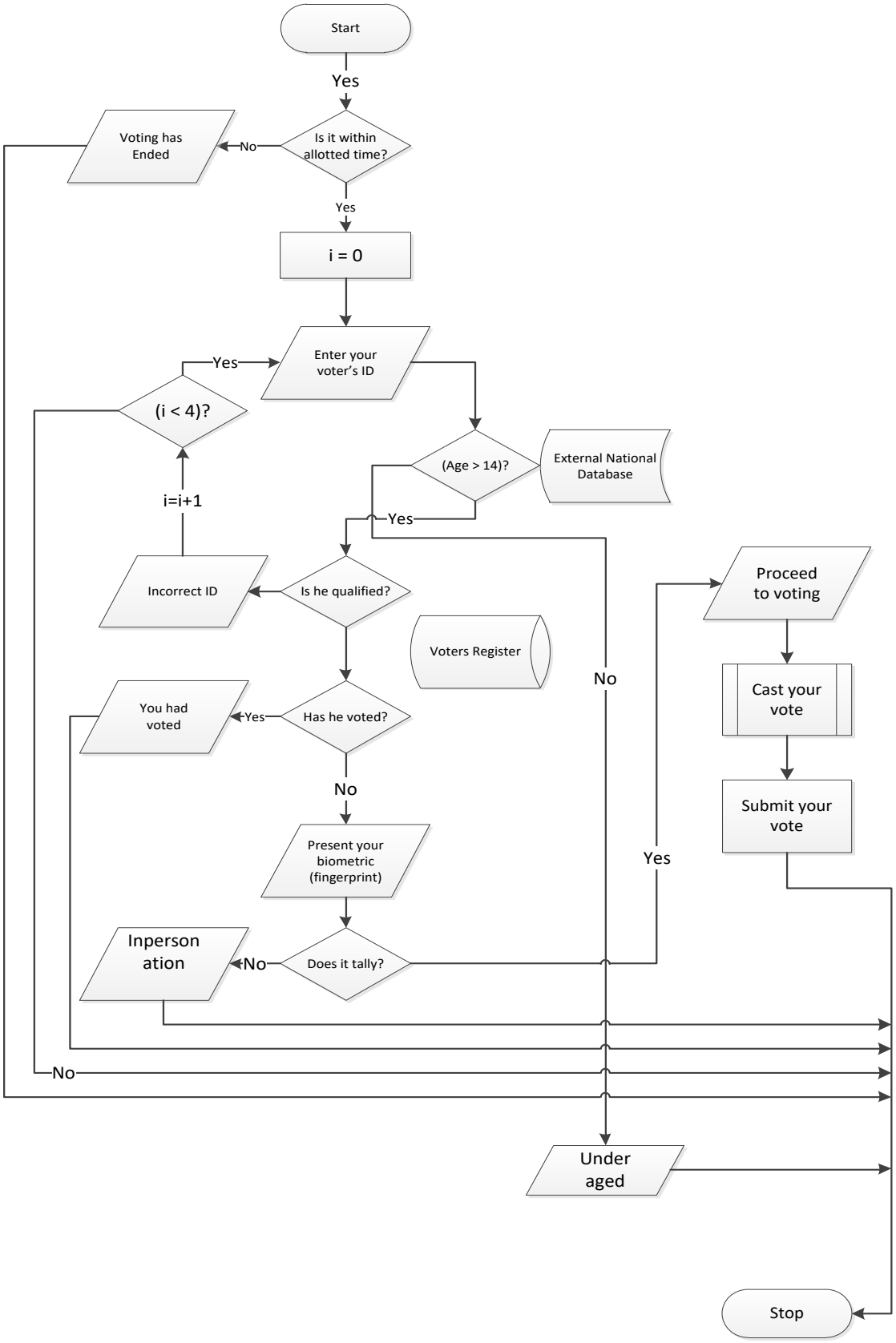

Figure 2 Software Operation

4.0 Results and Discussions

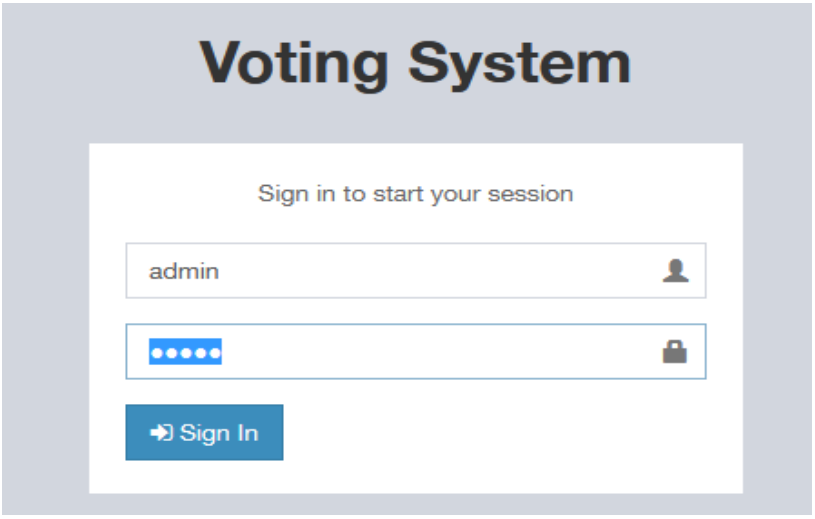

Figure 3 The Admin Login page

The admin login page (Figure 3.) serves as the gateway for authorized users to access the administrative dashboard of the project. It is designed to ensure secure access by requiring valid credentials from authorized personnel. Components include

Username Field: This is where the admin enters his/her unique username.

Password Field: Here, the admin inputs their confidential password.

Login Button: Upon entering the username and password, the admin clicks this button to initiate the login process.

Upon successful authentication, the admin is redirected to the administrative dashboard, where various tasks can be performed and manage the project as per their role and permissions.

The admin dashboard presents the central hub of the administrative interface, where admin can manage the election process effectively (Figure 4).

Graphical Representation of Election Process:

One of the primary features of the admin dashboard is the graphical representation of the election process. This includes:

Graphs: Visual representations such as bar charts, pie charts, or line graphs displaying key metrics and statistics related to the election process.

Real-time Updates: The graphs are dynamically updated to reflect the latest information, ensuring that administrators have access to current insights into the election progress.

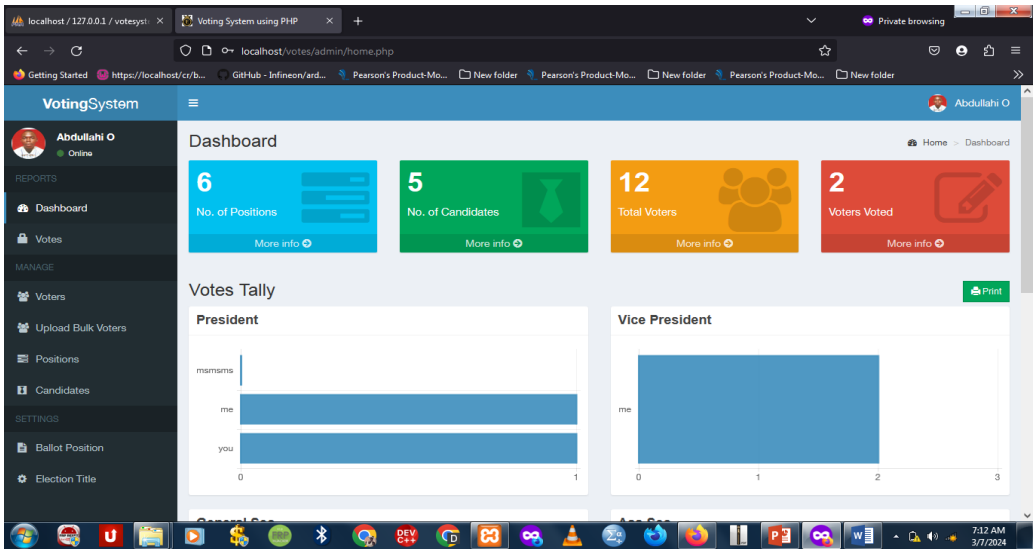

Figure 4 The Admin Dashboard:

Sidebar Navigation: The sidebar on the admin dashboard provides quick access to essential functionalities and options related to management of the election process. It typically includes the following sections:

1. **Voters:**It allows administrators to view and manage the list of registered voters, provides options for adding, editing, or removing voter details as necessary and include features for verifying voter identities and managing voter's eligibility.
2. **Upload Voter:** It: enables administrators to upload voter lists in bulk, streamlining the voter registration process, supports various file formats for importing voter data, such as CSV or Excel files, and allows validation checks to ensure the accuracy and integrity of the uploaded voter information.
3. **Position:** It facilitates the management of election positions or roles, such as president, vice president, treasurer, etc., allows administrators to define and customize the list of positions to be filled during the election process and provides options for configuring position-specific settings and criteria.
4. **Candidate:** This offers tools for managing the list of candidates participating in the election, allows administrators to add, edit, or remove candidate profiles, including personal information, campaign details, and associated positions, and supports features for organizing candidate profiles by position and managing candidate eligibility.
5. **Election Title:** This allows administrators to define the title or name of the election, providing a clear identifier for the current electoral event, and provides options for customizing and updating the election title as needed, especially for recurring or multi-phase elections.

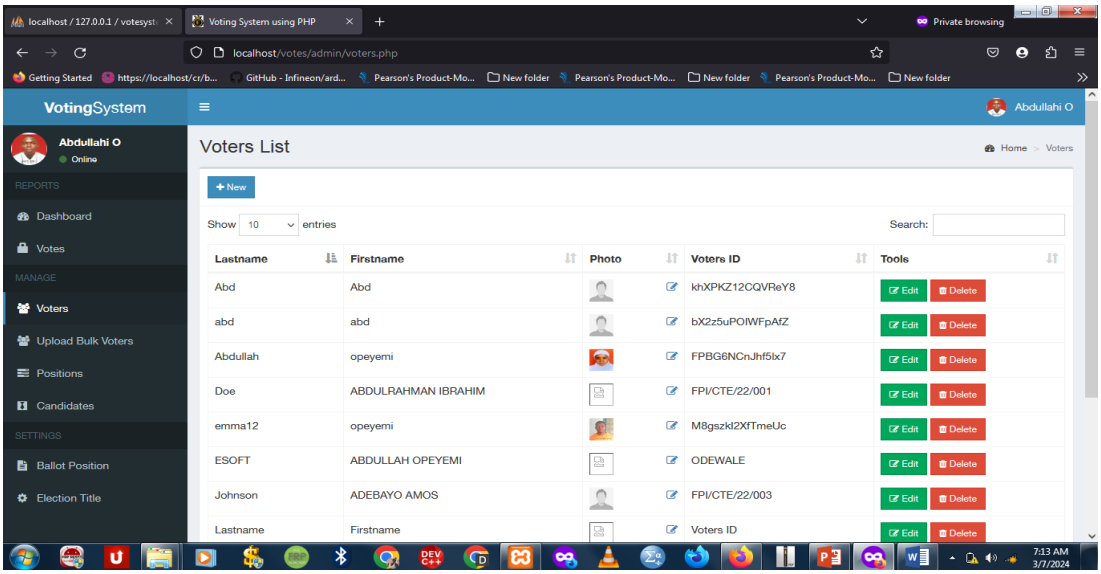

Figure 4 Voter List Page:

The Voter List page (Figure 4.) is a vital component of the administrative interface, providing administrators with a comprehensive view of registered voters and essential tools for managing their voter information.

Displayed Information:

- **Voter ID**: Each voter is assigned a unique identification number (ID) for tracking and reference purposes. The Voter List page displays this ID to facilitate easy identification and management of individual voter records.
- **Username**: The username associated with each voter account is displayed, enabling administrators to identify voters based on their login credentials. This information is essential for ensuring accurate voter authentication and access control.
- **Password**: For security purposes, the Voter List page displays encrypted or masked versions of voter passwords, ensuring confidentiality and protecting sensitive information from unauthorized access.

Functionalities:

1. **Edit Button:** The Edit button allows administrators to modify voter information directly from the Voter List page. Administrators can then update the voter's username, password, or other relevant information as needed and save the changes.

2. **Delete Button**: It allows for deletion of a voter records from the database, after a confirmation about the intended delete operation.

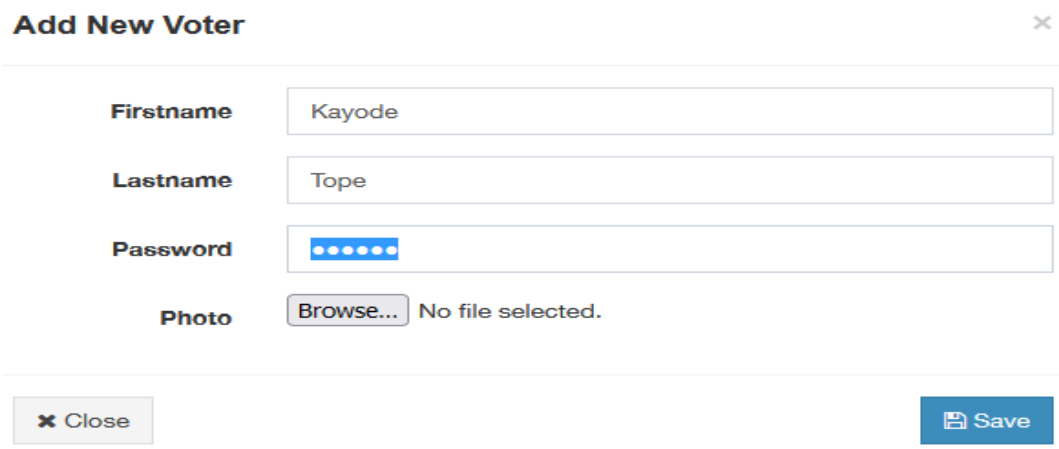

Figure 5 Voters Page:

Voters page is a crucial component of the administrative interface, providing administrators with the ability to add new voters to the system and manage their information securely.

Add Voter Form: This allows for insertion of new voters with First Name, Last Name, Password: A secure password is set for the voter's account, ensuring confidentiality and data security, and Profile Picture of the voter.

Automatic Unique ID Generation: Upon submission of the add voter form, the system automatically generates a unique ID for the voter's username. This unique ID serves as a distinctive identifier for the voter within the system, ensuring data integrity and facilitating efficient record-keeping.

Figure 6 Adding New Candidate

The New Candidate page is an essential feature of the administrative interface, providing administrators with the capability to add new candidates who are contesting for positions in the election.

Candidate Information: Candidate Name: Administrators input the full name of the candidate into the designated field. Candidate Picture: Administrators have the option to upload a picture of the candidate, enhancing recognition and personalization. Position: Administrators specify the position for which the candidate is contesting. This ensures proper categorization and organization of candidate profiles.

The Result page is a pivotal component of the administrative interface, providing a comprehensive display of election results alongside the election title. This page offers administrators the ability to view the number of votes each candidate received and facilitates the printing of the results in PDF format.Displayed Information include **Election Title**: The title of the election is prominently displayed at the top of the Result

page, providing context and identification for the displayed results. **Candidate Votes:** The Result page showcases the number of votes each candidate received during the election process.

Tally Result

President	
Candidates	**Votes**
Glory, Idowu	0
me, me	1
msmsms, mmama	0
you, you	1
Vice President	
Candidates	**Votes**
me, HAPPY	2
General Sec	
Candidates	**Votes**
you, 1234566	2
Ass Sec	
Candidates	**Votes**
Sport	

Figure 7 Result Page

This information is presented in a clear and organized manner, allowing administrators to easily analyze and interpret the election outcome effectively.PDF Export Button: Administrators have the option to export the election results to a printable PDF format.

The Voter Login Page is a crucial component of the system, providing registered voters with secure access to their accounts for participating in the election process. Components are **Username Field:** Voters enter their unique username, which serves as their identifier within the system. **Password Field:** Voters input their confidential password, ensuring secure authentication. **Login Button:** Upon entering their username and password, voters click this button to initiate the login process.

Its functionality among other things include, **Authentication**: The Voter Login Page verifies the entered username and password against the stored credentials in the system database. **Access Control**: Upon successful authentication, voters are granted access to their respective accounts, allowing them to participate in the election by casting their votes, and **Error Handling:** In case of incorrect credentials or any other authentication errors, appropriate error messages are displayed, guiding voters to correct the issue and try again.

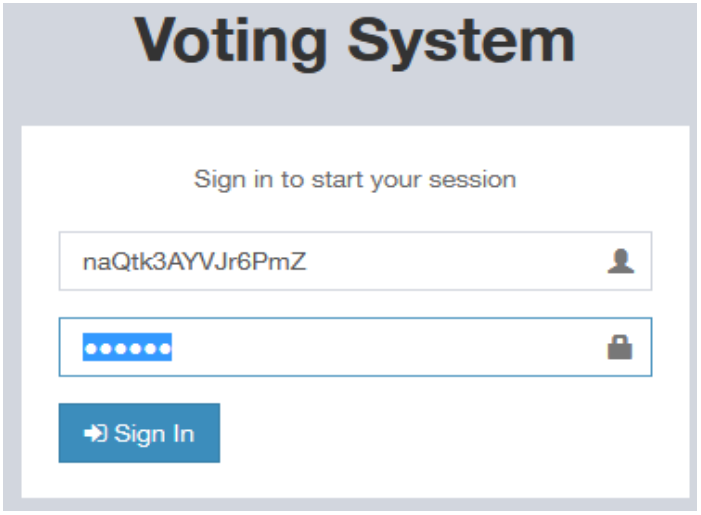

Figure 8 Voting System

The Election Page is pivotal component of the system, providing voters with a user-friendly interface to view the list of candidates per position and cast their votes.

Displayed Information: **Position**: The Election Page displays a list of positions available for the election, ensuring clarity and organization. **Candidates**: Under each position, the page lists the candidates contesting for that particular position. This information includes candidate names, pictures, and any additional relevant details.

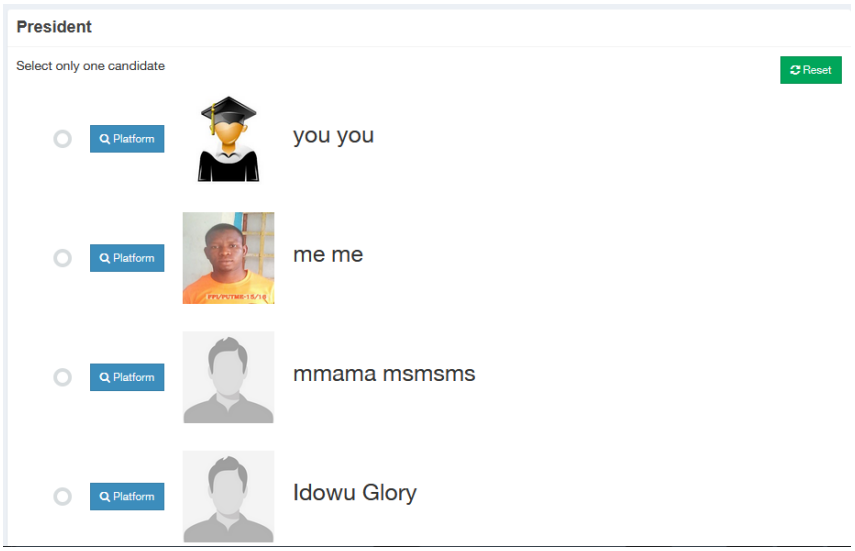

Figure 9 Election Page:

Functionality: Candidate Selection: Voters can select their preferred candidate by clicking on the corresponding option next to the candidate's name or picture. **Vote Casting:** After selecting their choice, voters proceed to cast their votes by confirming their selection or clicking a designated "Vote" button.

User Experience: Intuitive Interface: The Election Page features an intuitive and easy-to-navigate interface, enabling voters to view candidate lists per position and make their selections effortlessly. **Feedback Mechanisms:** Interactive feedback mechanisms provide voters with real-time feedback upon selecting their choices, ensuring transparency and confidence in the voting process.

Security Considerations: Access Control: Access to the Election Page is restricted to registered voters with appropriate credentials, ensuring that only eligible voters can participate in the election process. **Vote Integrity:** Measures are in place to maintain the integrity of the voting process and prevent fraudulent activities, such as duplicate voting or tampering with vote counts.

5.0 Conclusion and Recommendation

The research has been able to design and implemented a framework for a Robust Electronic Voting System (REVS) using Blockchain Technology. The developed EVS was able to produce electioneering system with reliable, votes and voter's security, "voters-only" verifiable voting, mobile devices adaptable. Having demonstrated good security, integrity, accessibility, privacy, transparency, end-to-end verifiability, affordability, coercion resistant and scalability, this system can be employed in lager population for adaptability and reliability test for nationwide application and acceptability.

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