

E-Voting and Credible Elections in Nigeria

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ABSTRACT: *Despite huge sums of money being spent by the federal government of Nigeria in adopting various techniques for a free and fair election in the country, numerous problems are still militating against it. These problems include:- wide rigging of elections, multiple registrations and voting, late arrival of ballot boxes, stealing of ballot boxes, under-aged voting, illegal voting by non-Nigerian nationals, rioting and fighting at election venues due to insufficient number of security personnel, disenfranchisement of those in Diaspora as well as the physically handicapped by virtue of election distances to them, prolonged delay in accreditation of voters for election, cancellation of votes due to improper voting, prolonged counting of votes and delay in determining the result of an election, etc.*

This work showed how e-voting through the use of mobile phones and PCs would totally eradicate all these problems as people would no longer go to election venues to cast their votes, rather they would be at the comfort of their homes and offices to exercise their franchise using any of these electronic devices effortlessly. E-voting requires a web application program – at the back end – that would be written by computer experts and deployed on a web server so that clients – that is, PCs and mobile phones of voters – can be used to query it on constant basis during elections.

KEYWORDS: *credible election, e-voting, mobile phones and PCs, Nigeria*

I. INTRODUCTION

Conducting a credible election in Nigeria is increasingly becoming a very difficult task, and this has adversely affected the socio-political and economic well-being of the nation. Technocrats and technologists that would have emerged as winners in order to carry the nation along are constantly being rigged-out of elections. Where rigging becomes difficult, ballot boxes are stolen or brought to election venues too late for voting. Worse still, riots and/or fights can be induced by some disgruntled elements that are hell-bent on disrupting elections in some areas. As if this is not yet enough damage, the under-aged as well as non-Nigeria nationals are involved in voting. The resultant effect of all these are mediocres emerging as winners in various offices to lead the nation to economic, social, and political doom.

Should all these election quagmire continue endlessly? Certainly No! **E-Voting** through the use of **mobile phones** and **PCs** is the answer. People should be properly sensitized on how to use these very efficient and convenient devices to vote electronically so that credible elections can be achieved in Nigeria.

e-voting stands for “electronic voting” or “internet voting”. It is the use of electronic devices like laptops, desktops, tablets, smartphones or mobile phones (that have Internet access) to vote online without the use of ballot papers.

“The first use of Internet voting for political election took place in the US in 2000, with more countries subsequently beginning to conduct trials of and/or use Internet voting” (Pran & Merloe) [1].

These countries are: “Australia, Belgium, Brazil, Canada, Estonia, the European Union, France, Germany, India, Ireland, Italy, the Netherlands, Norway, Peru, Romania, Switzerland, the United Kingdom, Venezuela, and the Philippines” [2].

Examples of how some of these countries practice e-voting are narrated below for **Estonia** and **Arizona[USA]**.

Each Estonian citizen possesses an electronic chip-enabled national ID card which allows him/her to vote over the Internet. The ID card is inserted into a card reader which is connected to a computer. Once his/her identity is verified (using the electronic ID card as a sort of digital signature) he/she can then cast his/her vote via the Internet. [2].

Arizona made transitional moves towards online voting. Each registered Democrat received a personal identification number (PIN) in the mail. These citizens had the option to either cast ballots at a designated location or over the Internet at the comfort of their own home. Voters voting over the Internet were required to insert their PIN and answer two personal questions. Once all the information is verified, they have the voting options. [2].

There are basically, two main types of e-voting:-

- a. E-voting which is physically supervised by representatives of governmental or independent electoral authorities (e.g. electronic voting machines located at polling stations).

- b. Remote e-voting where voting is performed within the voter's sole influence, and is not physically supervised by representatives of governmental authorities (e.g. voting from one's personal computer, mobile phone, television via the Internet). [2].

This work focuses on item (b) above.

The question now is, "How can one make use of mobile phones and PCs to vote, and vote credibly?" This is what this work succinctly explained in the sections that follow.

II. METHODOLOGY

The following techniques will be used to analyze and design the e-voting system:-

- 2.1 Requirement document
- 2.2 Object-Oriented design
- 2.3 Database design
- 2.4 User-interface design
- 2.5 System architecture
- 2.6 Procedural design

2.1 Requirement Document

For us to have a credible election in Nigeria through e-voting, the following bodies must be integrated into the system:-

- i. Hospitals
- ii. Corporate Affairs Commission (CAC)
- iii. INEC (Independent National Electoral Commission)
- iv. Users

2.1.1 Hospitals

The major responsibilities of every hospital are as follows:-

(1) To upload a **birth profile** of every new-born baby at the hospital to INEC's website for official storage. The birth profile should contain the following information:-

- (a) Full name of the child
- (b) Gender
- (c) Residential address
- (d) Birth certificate number

The Birth Certificate number (BCN) should have the following 31-character format:
CCCSSLLLHHHHNNNNNTTTTDDMMYYYY

Where,

CCC denotes the country of origin of the child

SSS denotes the state of origin of the child

LLL denotes the LGA of origin of the child

HHHH denotes the hospital code number

NNNNNN denotes the serial number of the child at the hospital

TTTT denotes the time the child was born (in 24-hour format, e.g a child born at 8:19pm should be written thus: 2019)

DD denotes the Day the child was born

MM denotes the month the child was born

YYYY denotes the Year the child was born

All these will provide the necessary information about the child – who is a potential voter in future – to INEC for data storage. As we can see, the issue of "age authenticity" as well as the "nationality" of the child would always be guaranteed. Later on, when the child grows up, he/she can update his/her profile to include the following:- phone number, passport, email, occupation, change of name (especially for the married ladies), and change of address.

(2) To upload the **death profile** of every patient that died in the hospital to the INEC's database for storage. The main information required here is the name of the deceased or his/her birth certificate number. This is very important in order to guide against any member of the deceased family or his/her friend from making use of his/her voter's number.

2.1.2 Corporate Affairs Commission (CAC)

The major responsibility of this body is to upload the **profile** of every **hospital** that registered with her to INEC’s database for storage. The profile to be uploaded is: hospital registration number, hospital code number, name of the hospital, phone number, email, and street address. Immediately the profile is uploaded, INEC will sent a password to the hospital’s email address with which the hospital will use to upload the birth profiles of babies born at the hospital.

2.1.3 INEC

The responsibilities of this body include the following:-

- (1) To use the birth certificate number contained in the birth profile of Users in the database to determine **prospective voters** – that is, those that are 18 years or above, and are citizens of Nigeria.
- (2) To issue a **voter’s number** to every legitimate voter. The voter’s number should have the following 29-character format: SSSLLLNNNNNNNNNTTTTDDMMYYYY

Where,

SSS denotes the state of origin of the voter

LLL denotes the LGA of origin of the voter

NNNNNNNN denotes the serial number of the voter (to be generated randomly)

TTTTTT denotes the time the voter’s number was issued (in hours, minutes, seconds)

DD denotes the day of issuance of the voter’s number

MM denotes the month of issuance of the voter’s number

YYYY denotes the year of issuance of the voter’s number

- (3) To upload **election guidelines** to the users
- (4) To upload the various political parties and their candidates for various posts to users
- (5) To upload the exact date and time for every election
- (6) To enable any voter that was previously issued a permanent voter’s card convert it to the 29-character standard format for e-voting
- (7) To ensure that the result of an election is accessible to voters immediately the stoppage time for an election elapsed

2.1.4 Users

This refers to a prospective voter that will be issued with an e-voter’s number after satisfying the following two conditions:-

- (1) the voter is a citizen of Nigeria, and
- (2) have attained the age of 18 years or above.

2.2 Object Oriented Design:

Here, we shall consider the following two **UML** tools:-

- (i) Use-Case diagram and (ii) Activity diagram

Use-Case diagram: This modeling tool is used to show the different activities that can be performed on a system by the “external users” – that is, those that will make use of the e-voting system. According to Chaffey [3].

When performing process analysis to define use-cases, we ask questions such as, “who are the actors for this process?”, “what services do these actors provide?”, “what are the actors’ tasks?”, and “what changes do they make to the status of the overall process?”

Fig.1 below shows the **use-case** diagram of an e-voting system.



Fig.1 Use Case diagram of an e-voting system

Activity diagram: This shows a detailed ‘workflow’ for each of the ‘use-cases’ of a system. We shall in this work present the activity diagrams for the following use-cases shown in Figure 1 above:-

1. diagram for “Register” Activity
2. diagram for “Vote” Activity
3. diagram for “View election result” Activity

The activity diagram for **Register** is shown in fig.2 below.

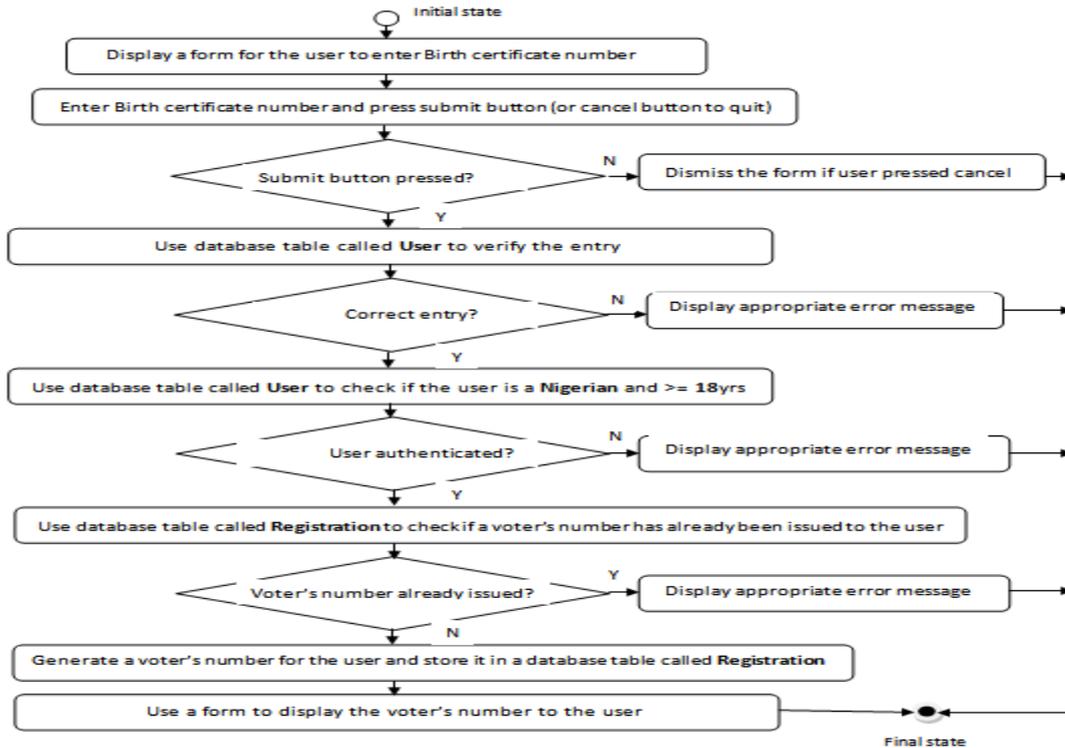
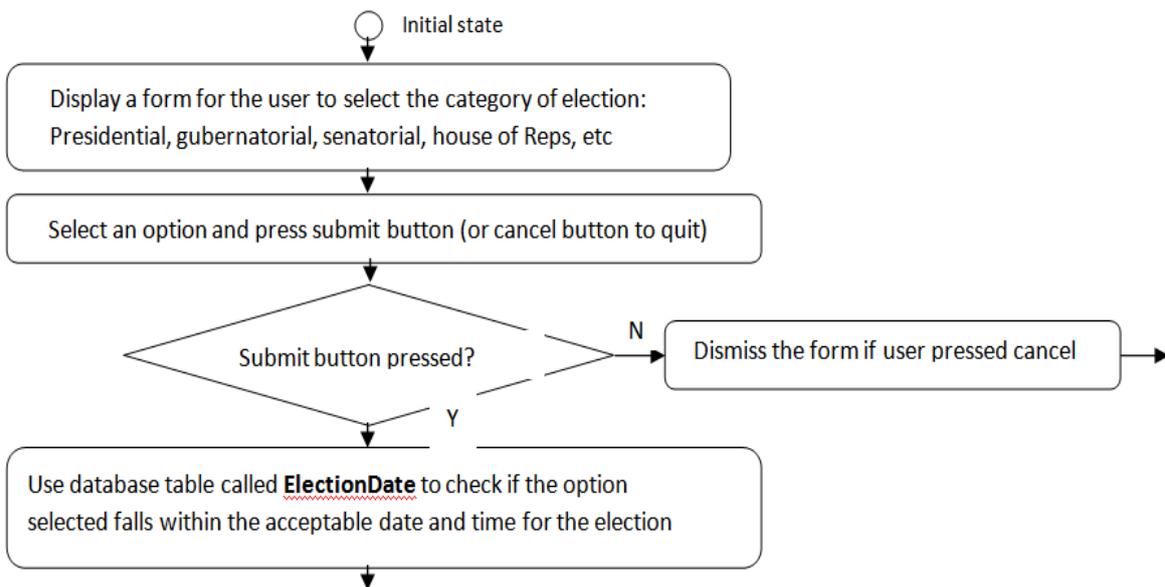


Fig.2 Activity diagram for **Register**

The activity diagram for **Vote** is shown in fig.3 below.



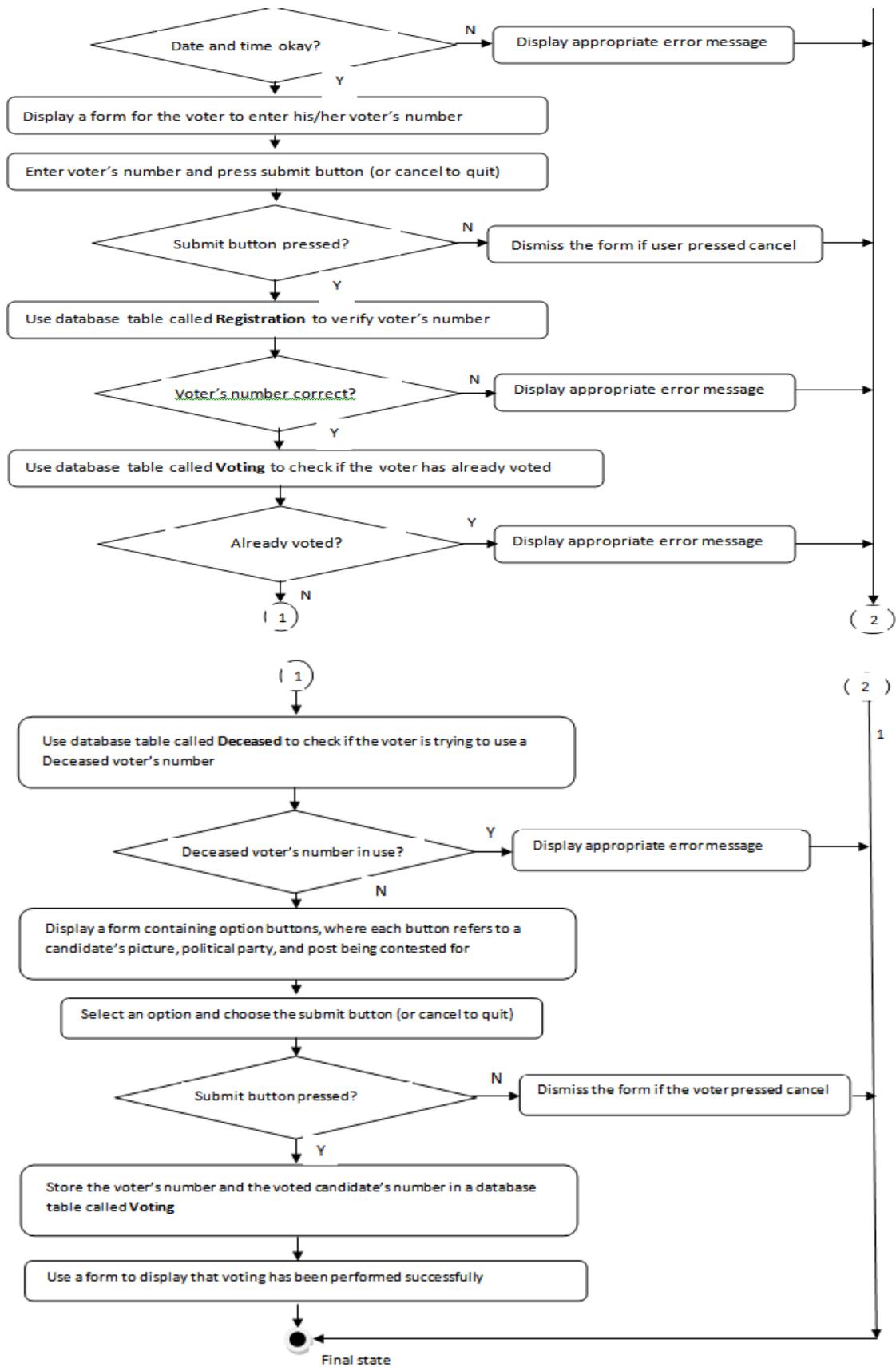


Fig. 3 Activity diagram for **Vote**

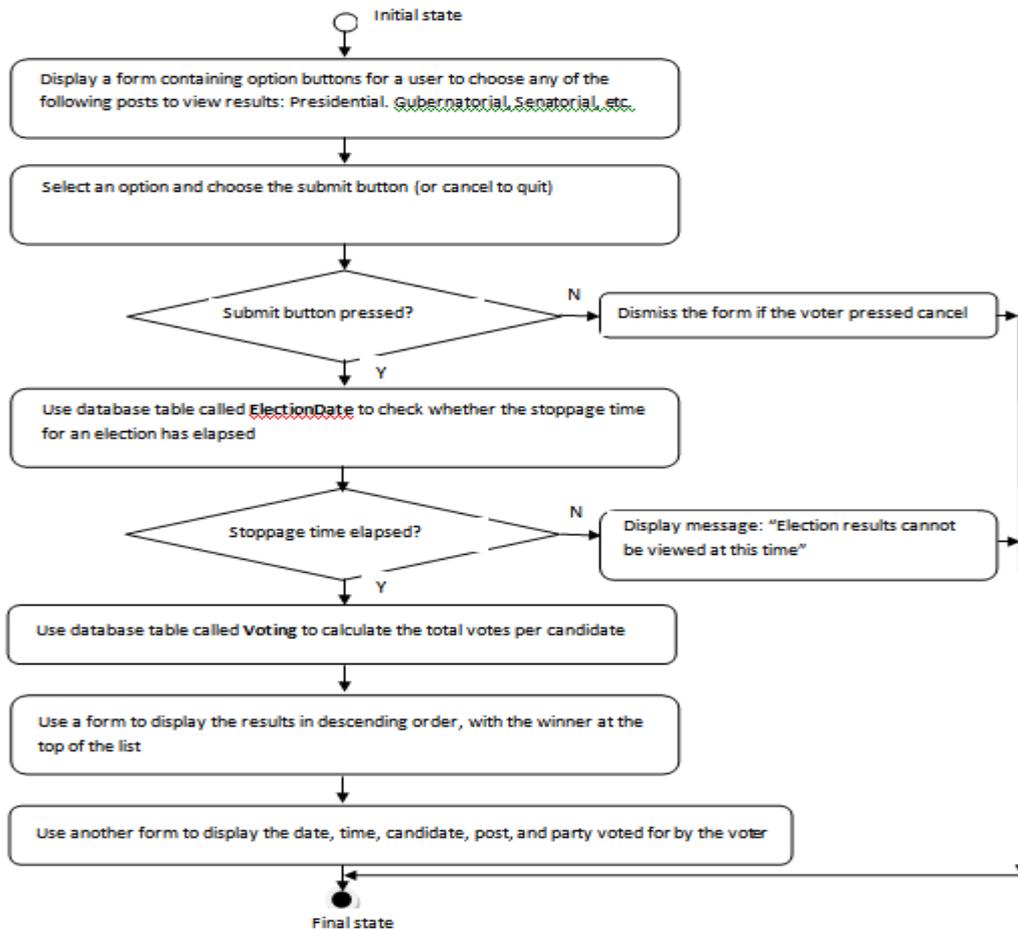


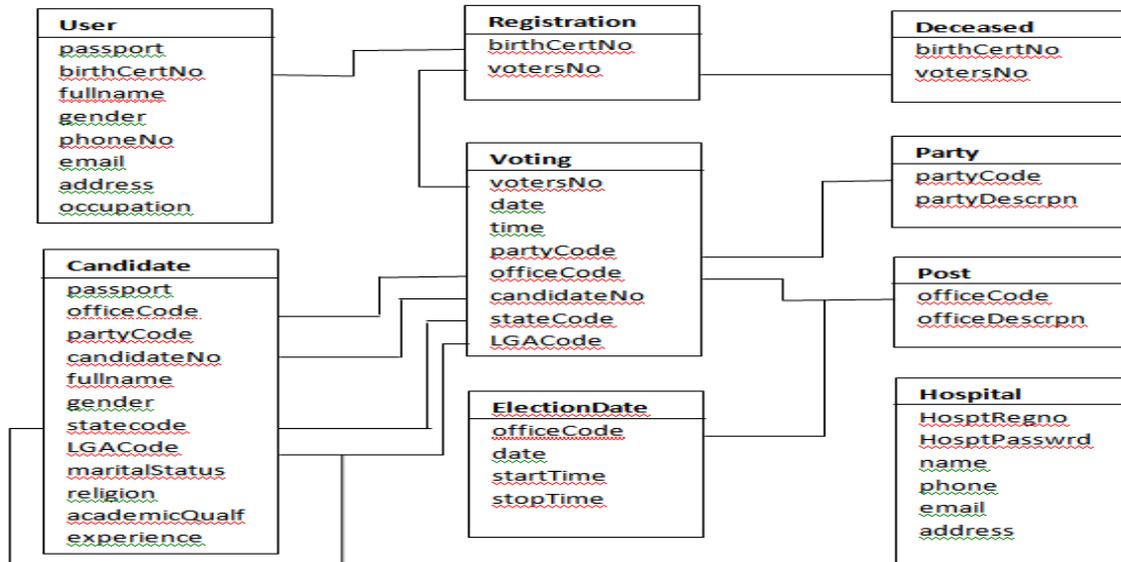
Fig. 4 Activity diagram for **view election results**

2.3 Database Design:

The following database tables will be used by the e-voting system:

- (i) User (ii) Registration (iii) Candidate (iv) Voting (v) ElectionDate (vi) Party (vii) Post
- (viii) ElectionRules (ix) Deceased (x) Hospital (xi) OldPVC (xii) CAC (xiii) INEC (xiv) State
- (xv) LGA

The relationships of these tables are shown in fig.5 below.



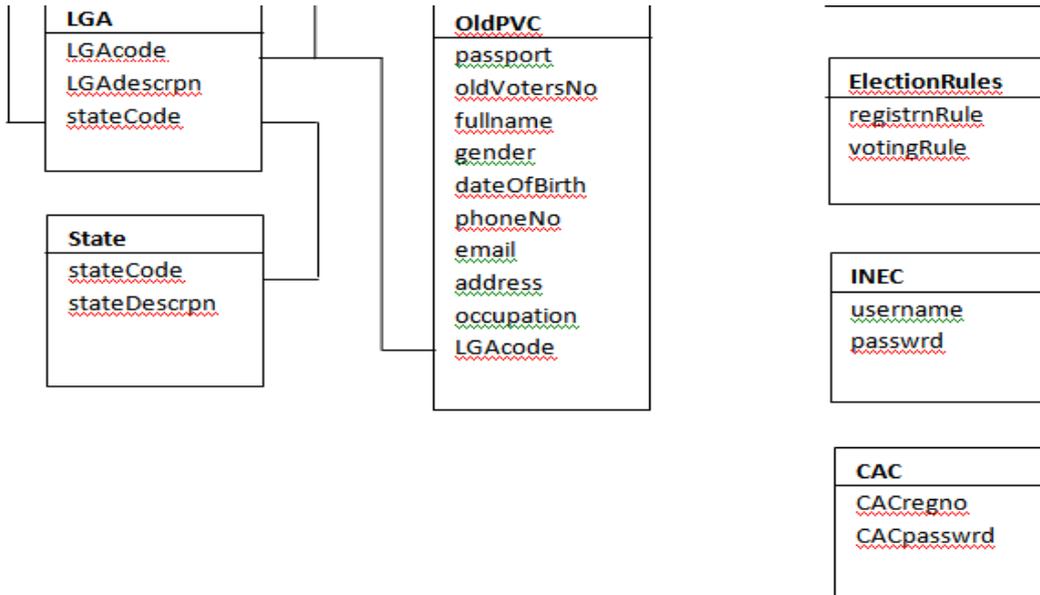


Fig.5 Database tables Relationships

As we can see in the relational database tables above, each of the tables contains a **unique key** or **password** to guard against any unauthorized access. Jeffrey, Lonnie and Bentley [4] emphasized on database security by saying that, “databases are shared resources; the designer must design internal controls to ensure proper security and disaster recovery techniques, in case data is lost or destroyed”.

2.4 User-Interface Design:

Here, we show how the input/output forms (that is, web pages) will appear for each of the activity diagrams of the use-cases of a system. For instance, the user-interface design for the activity diagram “Register”, is shown in fig.6 below.

Enter Birth Certificate number:

Fig.6 Input form for “Register”

When the user presses the **Submit** button, the system uses the database tables called “User” and “Registration” to perform some checks on the “Birth Certificate number” entered for **authenticity** (that is, whether it is genuine), for **maturity** (that is, whether the user is 18 years or above), and for **abuse** (that is, whether the user has registered before). If all these checks are successful, the system displays the output form shown in fig.7 below, otherwise an error message occurs.

	<p>Federal Republic Of Nigeria Independent National Electoral Commission Website address: <input style="width: 150px;" type="text"/> <i>Permanent Electronic Voter's Card</i></p>	
<p>Name: <input style="width: 400px;" type="text"/></p> <p>Date of Birth: <input style="width: 150px;" type="text"/> Age: <input style="width: 50px;" type="text"/></p> <p>Phone No: <input style="width: 150px;" type="text"/> Gender: <input style="width: 50px;" type="text"/></p> <p>Address: <input style="width: 400px;" type="text"/></p> <p>Occupation: <input style="width: 400px;" type="text"/></p> <p>State: <input style="width: 150px;" type="text"/> LGA: <input style="width: 50px;" type="text"/></p> <p>Electronic Voter's No: <input style="width: 300px;" type="text"/></p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">Voter's Passport</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">PRINT</div> <div style="border: 1px solid black; padding: 5px;">Date of issue: <input style="width: 50px;" type="text"/></div>	

Fig.7 Output form for “Register”

Similarly, the user-interface design of the activity diagram “Vote”, appears as shown below:

The form is titled "Federal Republic Of Nigeria Independent National Electoral Commission" and includes a "Website address:" field. It features the Nigerian and INEC logos. Under the heading "Vacant posts (Make a choice)", there is a list of seven options, each with a radio button: President, Senate, House of Reps, Governor, House of Assembly, Local Govt. Chairman, and Councilor. At the bottom right, there are "Cancel" and "Submit" buttons.

Fig.8 First Input form for “Vote”

When the voter makes a selection and clicks the **Submit** button, the system checks whether the option selected falls within the acceptable **date** and **time** for the election. If yes, the following form will be displayed for the voter to enter his voter’s number, otherwise an error message occurs.

The form is titled "Enter voter’s number:" and contains a single text input field. Below the input field are "Cancel" and "Submit" buttons.

Fig.9 Second Input form for “Vote”

When the user enters his/her voter’s number and presses the Submit button, the system uses the database tables called, “Registration”, “Deceased”, and “Voting” to perform the following checks, otherwise an error message occurs.

1. Whether
the voter’s number is genuine
2. Whether
the voter has not already voted
3. Whether
the voter is not using a deceased voter’s number

If all these checks are successful, the following form containing all the contestants vying for a particular post (such as the post of “President”) will be displayed:-

Note: - for non-presidential posts, the system will automatically retrieve the LGA and State of origin of the voter from the Voter’s number, in order to determine the various contestants of such posts in that LGA or State before displaying the form below.

The form is titled "Federal Republic Of Nigeria Independent National Electoral Commission" and includes a "Website address:" field. It features the Nigerian and INEC logos. Under the heading "The Post of President (make a choice)", there are three rows of candidate information. Each row consists of a radio button, a box for "Candidate1/2/N Passport & name", and a box for "Party1/2/N Logo & name". At the bottom right, there are "Submit" and "Cancel" buttons.

Fig.10 Third Input form for “Vote”

When the voter clicks on the candidate of his/her choice and then clicks the **Submit** button, the system stores the information in the database table called **Voting**, and then displays the following satisfactory output form to the voter:-



Fig.11 Output form for “Vote”

2.5 System Architecture

Deitel and Deitel [5] stated that,

the basic structure of a web-based application is a **three-tier** architecture that divides the application functionality into logical groups called **tiers**: the **top tier**, **middle tier**, and **bottom tier**. The “top tier” is the client that takes charge of the *user-interface display*; the “middle tier” is the web server that *performs business logic*, while the “bottom tier” is the database server that *stores data*.”

Following the above perspective, the system architecture of an e-voting system can be drawn as shown in fig.12 below.

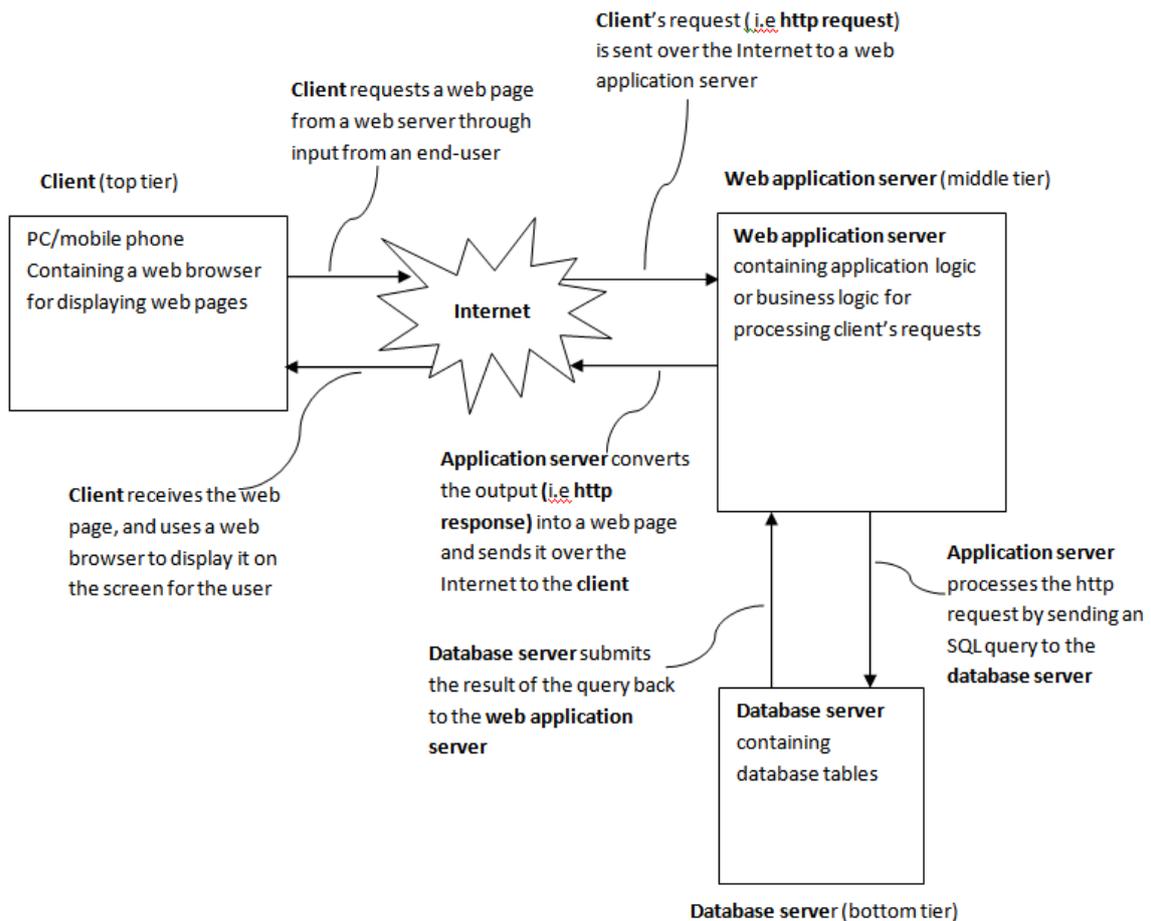


Fig.12. The system architecture of an e-voting system

The above architecture shows the basic infrastructure required for e-voting. These are:-

- (a) the client – that is, laptop, desktop, tablet, smartphone, etc.
- (b) Internet service
- (c) a web server that hosts the web application program for e-voting
- (d) a database server that contains the database tables for e-voting

Out of the above four, the electorates would be required to purchase only the client. It is the responsibility of the federal government to provide the remaining three. Computer programmers can be hired by the government to write the web application program that would be deployed on web servers, while ICT professionals could as well be contracted to set up the necessary servers. The various telecommunication industries in Nigeria like MTN, GLO, Etisalat, Airtel, etc. could also be contracted by the government to provide Internet services to the electorates during elections.

The above system architecture, however, cannot be implemented “as is”, otherwise the servers could break down due to excessive workload on them in processing millions of http requests during elections. There is, therefore, the need for separate servers to do separate tasks in order to increase the **response time** and **efficiency** of the system. Forouzan [6] concurred to this by saying, “most networks use distributed processing, in which a task is divided among multiple computers. Instead of one single large machine being responsible for all aspects of a process, separate computers handle a subset”. In the same perspective, Chaffey [3] contributed to this by saying:-

Although the three-tier model of an e-business system suggests a relatively simple architectural design, the reality is more complex. Different servers are needed which combine application logic and database storage for different requirements. These may be physically separate servers or may be combined.

In this limelight, the e-voting system architecture shown above can be redesigned as shown in fig.13 below.

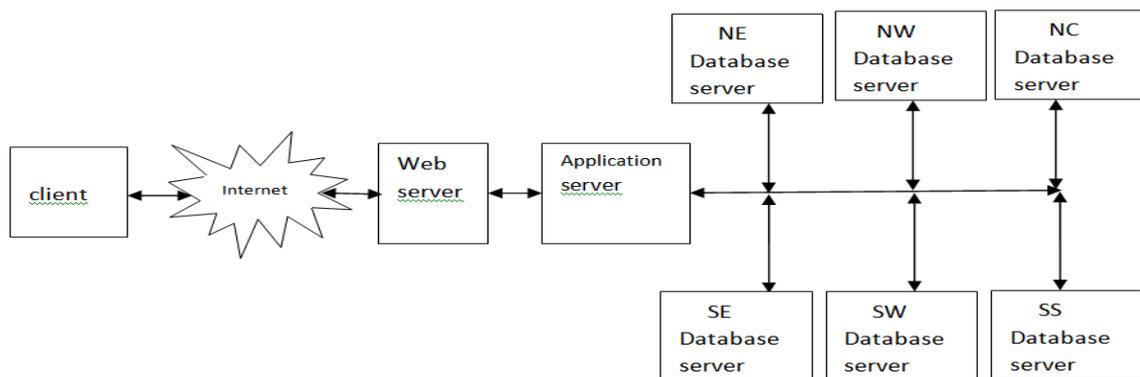


Fig.13. The modified system architecture of an e-voting system

As the above figure clearly shows, the application server now consists of two components: the web server and Application server; while the database server now consists of six components: the NE server, the NW server, the NC server, the SE server, the SW server, and the SS server. The functions of each of these components are explained below.

- **Web server:** this contains static and dynamic web pages for website interface. It receives http request from the client and sends it to the application server for processing. Conversely, it receives http response from the application server and returns it to the client.
- **Application server:** it contains the application logic, and accesses the six database servers connected to it for data processing.
- **NE server:** this stands for North-East server. It handles all the electorates’ data from the North-Eastern part of the country.
- **NW server:** this stands for North-West server. It handles all the electorates’ data from the North-Western part of the country.
- **NC server:** this stands for North-Central server. It handles all the electorates’ data from the North-Central part of the country.
- **SE server:** this stands for South-Eastern server. It handles all the electorates’ data from the South-East part of the country.
- **SW server:** this stands for South-Western server. It handles all the electorates’ data from the South-West part of the country.
- **SS server:** this stands for South-South server. It handles all the electorates’ data from the South-Southern part of the country.

2.7 Procedural Design

The procedural design for an e-voting system is given in the pseudo code below.

- Log onto the INEC website to display the homepage
- Select the tab “Election” on the homepage to display the following main menu with 15 options:
 1. Upload election guidelines
 2. Upload candidates’ profile
 3. Upload election dates and time
 4. Upload birth profile
 5. Upload death profile
 6. Upload hospital profile
 7. View election guidelines
 8. View candidates’ profiles
 9. View election dates and time
 10. Register
 11. Vote
 12. View election results
 13. View/print voter’s number
 14. Change personal profile
 15. Standardize voter’s number

If option = 1 then

Display a form to demand username and password

Use database table called **INEC** to authenticate the entries

If successfully vetted then

Store uploaded election guidelines in a database table called **ElectionRules**

Redisplay the main menu

Else

Display error message

Redisplay the main menu

End if

Else if option = 2 then

Display a form to demand username and password

Use database table called **INEC** to authenticate the entries

If successfully vetted then

Store uploaded candidates’ profile in a database table called **Candidates**

Redisplay the main menu

Else

Display error message

Redisplay the main menu

End if

Else if option = 3 then

Display a form to demand username and password

Use database table called **INEC** to authenticate the entries

If successfully vetted then

Store uploaded **dates** and **time** in a database table called **ElectionDate**

Redisplay the main menu

Else

Display error message

Redisplay the main menu

End if

Else if option = 4 then

Display a form to demand RegNo and password

Use database table called **Hospital** to authenticate the entries

If successfully vetted then

Store uploaded Birth profile in a database table called **User**

Redisplay the main menu

Else

Display error message

Redisplay the main menu

End if

Else if option = 5 then
 Display a form to demand RegNo and password
 Use database table called **Hospital** to authenticate the entries
 If successfully vetted then
 Store uploaded Death profile in a database table called **Deceased**
 Redisplay the main menu
 Else
 Display error message
 Redisplay the main menu
 End if

Else if option = 6 then
 Display a form to demand RegNo and password
 Use database table called **CAC** to authenticate the entries
 If successfully vetted then
 Store uploaded hospital profile in a database table called **Hospital**
 Redisplay the main menu
 Else
 Display error message
 Redisplay the main menu
 End if

Else if option = 7 then
 Use database table called ElectionRules to display the information
 Redisplay the main menu

Else if option = 8 then
 Use database table called **Candidate** to display the information
 Redisplay the main menu

Else if option = 9 then
 Use database table called **ElectionDate** to display the information
 Redisplay the main menu

Else if option = 10 then
 Perform the activity diagram for 'Register' (shown previously in Fig. 2)
 Redisplay the main menu

Else if option = 11 then
 Perform the activity diagram for 'Vote' (shown previously in fig. 3)
 Redisplay the main menu

Else if option = 12 then
 Perform the activity diagram for 'View Election Results' (shown previously in Fig. 4)
 Redisplay the main menu

Else if option = 13 then
 Display a form to demand BirthCertNo
 Use database table called **Registration** to authenticate the entry
 If successfully vetted then
 Use database table called **Registration** to display the voter's number
 Redisplay the main menu
 Else
 Display error message
 Redisplay the main menu
 End if

Else if option = 14 then
 Display a form to demand BirthCertNo
 Use database table called **User** to authenticate the entry
 If successfully vetted then
 Display a form containing the following data for updating:-
 (user's passport, full name, phone No, email, residential address, occupation
 Store the data in a database table called User
 Redisplay the main menu
 Else
 Display error message
 Redisplay the main menu

```
End if
Else if option = 15 then
  Display a form to demand the old voter's number
  Use database table called oldPVC to authenticate the entry
  If successfully vetted then
    Generate a BirthCertNo and electronic voter's number
    Store the data in a database table called Registration
    Display the BirthCertNo and e-voter's number for the user to view/print
  Else
    Display error message
    Redisplay the main menu
  End if
End if
```

As the above pseudocode clearly shows, the whole process of e-voting starts when a user launches a web browser in his/her PC or Smartphone and then enters the **URL** of INEC in the address bar of the web browser's interface, and presses the Enter key. "The URL (Uniform Resource Locator) is a pointer to where web documents are stored on the Internet"(Abraham, Henry &Sudarshan) [7]. Each option selected triggers a web page to be displayed on the screen for interface with an end-user. This well-ordered arrangements of the web pages is emphasized by Owo[8] where he stated that, "a web-based application should be logically organized to minimize confusion...It should take them [that is, the users], step-by-step through the required screens in a logical manner so that they can achieve their goals".

III. CONCLUSIONS

In the words of Pran and Merloe [1],

Internet voting, however, presents a number of technological challenges focused on [trust], security, privacy, [availability of Internet service], secrecy issues, as well as challenges for stakeholder involvement in and observation of the process. All these must be comprehensively addressed for election authorities to consider moving forward with Internet voting. .

Perhaps all these problems may be why the chairman of INEC in Nigeria – Prof. Attahiru Jega said in ThisDayLive that, "... it would be practically impossible to use the electronic voting system in the 2015 general election, even if the National Assembly gave its approval." (ThisDayLive, as reported by Chuks Okocha, 7 Feb., 2014). [9]

This paper has addressed all these problems as follows:-

- Trust /Transparency in Internet Voting: the source code developed for e-voting should be made available for public scrutiny to party poll watchers, international observers, and the general public so as to ascertain that there is no e-cheating or compromise of any kind in the computer program. Also election results should be generated immediately the duration of an election is over.
- Security: secure hypertext transfer protocol (https) should be used for e-voting so as to ensure that every information sent online is fully encrypted from any eavesdropper.
- Secrecy/Freedom of the Voter: every voter has a unique electronic voter's number. No person can, therefore, vote for another except for the following conditions:-
 - a. Old age
 - b. Health problems
 - c. Literacy barrier
 - d. Abject Poverty

In any of the above cases, the voter can disclose his/her voter's number to a trusted friend or relation for assistance.

- Internet services: practically every nook and cranny of this country receives network signals from mobile telecommunication providers like MTN, Glo, Etisalat, Airtel, etc. They can equally render Internet services to the electorates during elections under the auspices of the federal government. This paper has done justice to all these problems as follows:-

As we can see, the e-voting system is not a difficult task to implement, after all. It is the gateway to a free and fair election in Nigeria. It is safe, secure, convenient, and economical. It would save billions of naira for the federal government from the purchase of ballot boxes, card readers, printing of election materials and voter's cards, as well as training of staff, etc that make the traditional voting system a very huge capital investment. Finally, every legitimate voter (including the able-bodied, physically handicapped, prisoners, as well as those in Diaspora can all partake in e-voting from the comfort of their homes/offices. This creates room for more Nigerians to participate in the polls from any part of the globe.

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