E-voting in developing countries: Challenges and Realities

BY

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Abstract

Voting process is at the center of every democratic society. Conventional electoral processes can be laborious and time consuming particularly in the third world nations. Accuracy, integrity and Security of voting processes are also of great concern in these countries. Furthermore, countries all over the world are now exploring the e-voting system in their electioneering process, for it has stunning advantages over conventional paper voting, including security for casting votes, accuracy and analysis of votes. With electronic voting, the problems with the traditional system of voting (ballot paper) such as transparency of the electoral process, securing polling stations and the man power needed, all these issues will be mitigated. Electronic voting system could help increase the efficacy and transparency of electoral processes and support free and fair election. However, the implementation of e-voting system has also been characterized with flaws and associated risks. The trustworthiness of the e-voting system has also raised concern in most developed countries where it has been implemented. Thus, this paper seeks to address the problem associated with the adoption and implementation of e-voting systems in developing countries. The paper delve into various e-voting Architectures, security protocols and the implementation in developed countries with a view to providing a framework for implementing a faster and secured e-voting System in developing countries.

KEYWORDS: E-voting system, Developing Countries, Electoral Process, Security.

INTRODUCTION

The delicate frame of democracy in developing countries and the tension among the political gladiators is known to all and sundry and cannot be over emphasized. Elections in these part of the World has been marred by diverse election vices. Several lives and properties have been lost as a result of the inability of the warring political parties to accept the result of the election. The credibility of the electioneering process is questionable since the problem of mass thumb printing, ballot box snatching, impersonation and other election offences are still thriving. The electoral vices are still prevalent in most of these countries because of the manual system of voting that is still in operation. Globally, the sustenance of democracy in any society is rooted in standard electoral processes that is nourished by veritable voting system. Furthermore, the agitation of every eligible voters is to have trust in the procedure in which their votes will be counted, anything contrary will affect the credibility of the election.

Shafii et al (2013) noted that elections in most developed countries conducted using electronic method has been adjudged to be free, fair and credible. Furthermore, a number of government especially from developing countries have already adopted e-voting. For instance India, Venezuela and Brazil are good example in this regard.

This paper presents some of the problems associated with the implementation of e-voting system in developing countries, x-raying the Nigeria experience and proffered solutions to some of the problems. The paper also delve into the various architectures of e-voting and also examine how the developed countries are faring in terms of e-voting.

ELECTRONIC VOTING

Electronic voting also known as e-Voting is computerizing voting procedures, it implies the use of computer technology in undertaking such activities as voter registration, voter authentication, voting, transmission of votes and votes counting.

Qadah and Taha (2007) also defined e-Voting systems as systems that allow the eligible voters to cast their vote via a computer normally connected to internet or intranet from anywhere like home or office. The basic feature of electronic voting and an electronic voting system is that

electorates are able to cast their votes electronically with the use of computers in such a way that the ballots can be transmitted electronically through a secure channel to a central collation center where the votes can be counted in real-time with ease, thereby eliminating the usual delays and challenges associated with handling manual voting and collation

However, a lot of concerns have been raised over the years about the risks of using electronic voting systems considering all the possible threats they face such as privacy issues, double voting etc. The electronic voting system must be sufficiently robust to be resistant to different kinds of attack and it must not be too complex so that voters can understand how to use these systems and also have confidence in the system. An e-Voting system is made up of several components as seen in figure 1.0 below

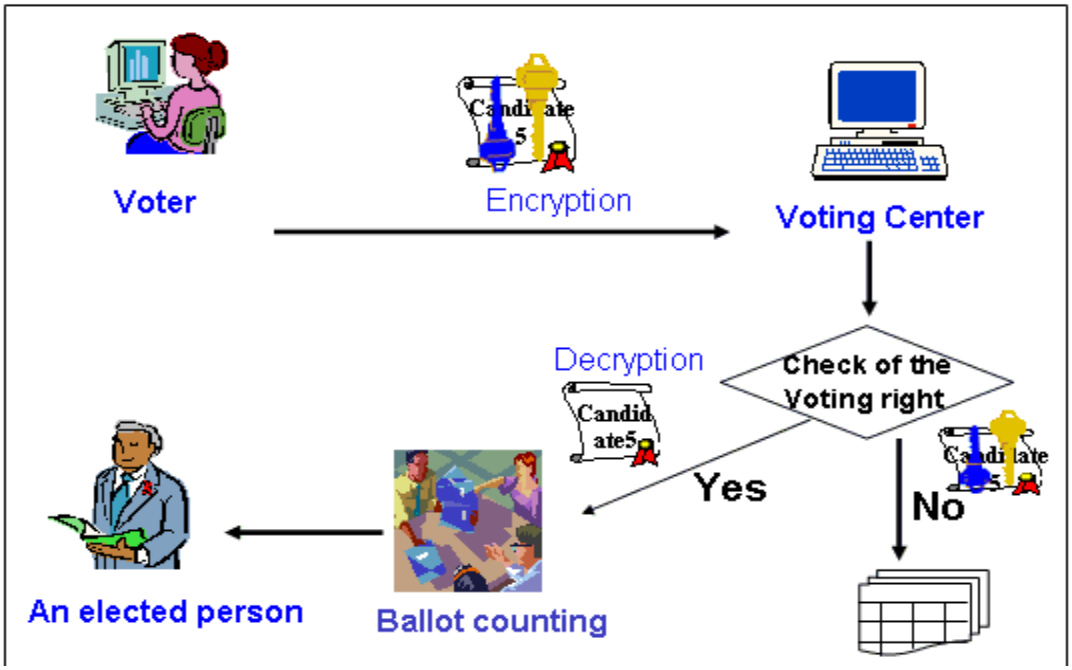

Figure 1: E-voting System. (Source: Umar, 2015)

Potential advantages of e-Voting over traditional voting systems incudes:

- Increases the speed and accuracy of ballot tabulation.
- Saves materials required for printing and distributing ballots.
- Offers better accessibility for people with disabilities.
- Reduces the number of man-power needed for elections.
- Provides multiple-language support for the ballots.
- Prevents unintentional mistakes by voters (both in over voting and under voting).

Audreu and Brown (2013) classified e-Voting system into two main groups depending on where the casting of the ballot takes place: poll-site or remote system.

Poll-site voting systems consists of Direct Recording Electronic (DRE) devices situated at polling places, which allow voters to cast their ballots directly through the machines typically by means of touch-screen apparatus. Voters have to go to the polling stations, and they are identified by conventional means.

Remote electronic voting systems allows the casting of ballots remotely, such as from home using one's own personal computer, or from computer kiosks at embassies or at hospitals. The basic idea behind these systems is to move digital information (the votes) through communication networks instead of obliging people to move to the voting location such as internet voting

PREVIOUS E-VOTING SYSTEM ARCHITECTURES

Yossef and Avishai (2013) proposed an e-Voting scheme using a near-field contactless cards and readers instead of traditional smartcards. They showed this voting scheme aims to save paper and manpower, makes forgery difficult and makes counting process transparent. To cast votes, the voters use a computer terminal to write their choice into a contactless smartcard, and then physically deposit this smartcard into a ballot box. The voting committee "manually" counts the votes. This probably means they take the Smart cards and feed them into another counting machine C. Machine A electronically counts the votes chosen there.

Okediran et al (2011) designed and implemented a generic and secure electronic voting system where voters are given remote access to cast their vote using several number of electronic devices. The system as shown in figure 1.1 was designed based on a three tier architecture: client tier, server tier and database tier. Mobile terminal, remote computers are some of the components on the client's tier. Similarly, the application tier and server tier contains both the SMS server and web server respectively which interface the e-voting system to web voters.

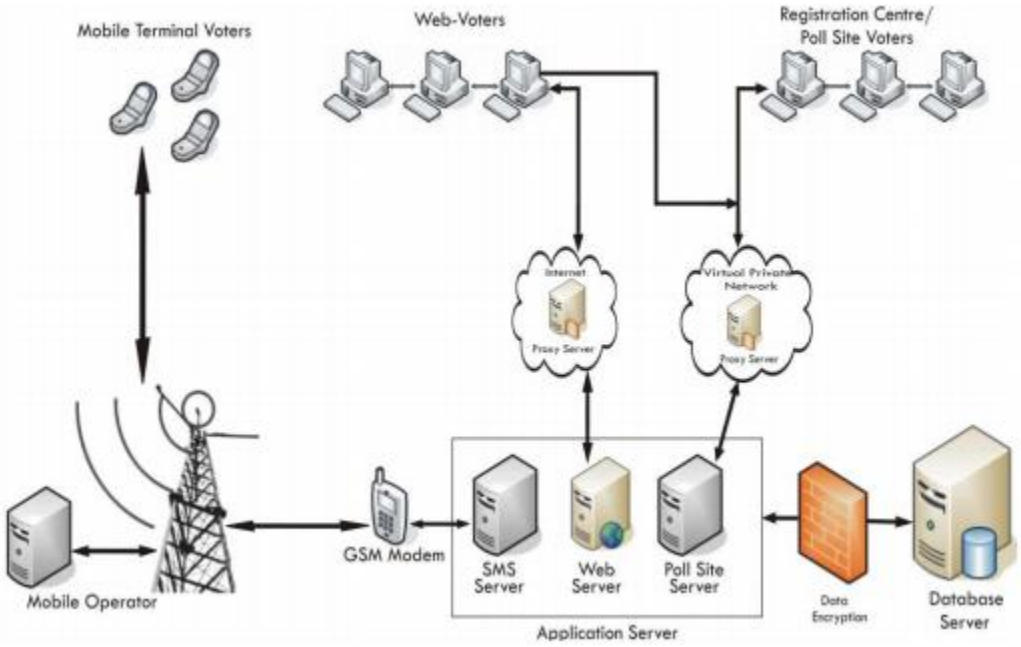

Figure 2: E voting Architecture (Source: Okediran, 2011)

Rexha et al (2012) in their research work proposed a framework aimed at improving authentication and transparency in e-voting systems. Their systems framework was to replace the manual system so electorates will be able to vote from any polling station. This concept was derived from dynamic queue list which is based on voters' arrivals and identification at the polling station. However, the system could not address how the centralized database could be protected to check for content; whether there are votes or no votes already in the in database before voting starts. Again, their research work did not consider the integrity of casted votes during the time of voting.

Rexha et al (2011) proposed an e-voting framework that will enhance the security of their immediate manual system if they adopted their framework. To enhance the security they implemented it using smart cards and digital certificates. However their framework is expensive because at every polling station they implemented two (2) ARC (Archive) redundant servers which invariable stored small amount of records. Also, to secure records, the systems were configured by the national election commission. Their research did not cover the polling agents at this level, for which it can implicate the trust of the system by the voters

In the research of Bamiah et al (2010) they proposed a framework to manage a secure trustworthy e-voting system, by securing each and every side of the system from its initial stage to finishing stage by implementing Trusted Platform Technology (TPM). The TPM serve as a chain of trust that combines hardware and software to provide trusted client device.

Mohammad Malkawi et al (2009) proposed a robust e voting system as shown in figure 1.2 in their research work on "Modeling and Simulation of a robust e voting system". The proposed system consist of central mirrored database server which contains information of voters and candidates, this arrangement will improve the reliability of the system. Voting centers consist of a shared local database distributed across the given country. A voting center is made up of local DB server and several voting stations

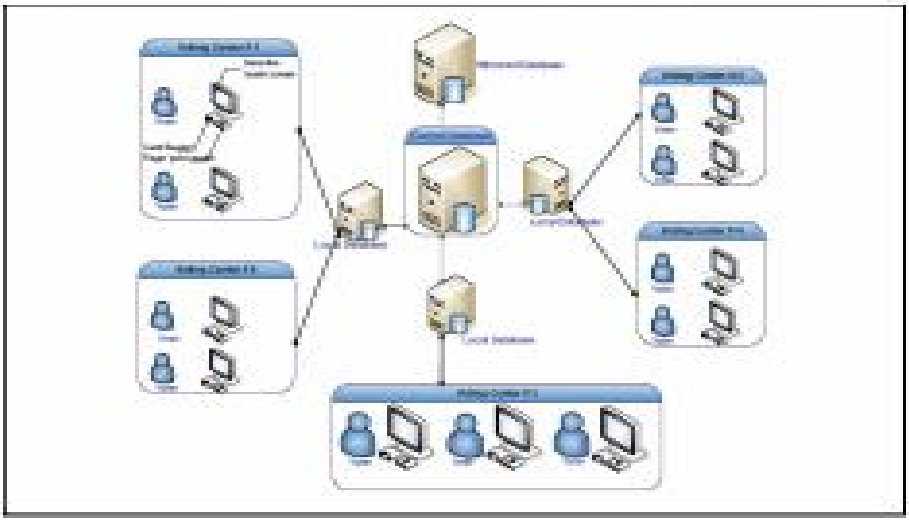

Figure 3: E voting Architecture (Source: Malkawi, 2009)

REQUIREMENTS FOR ELECTRONIC VOTING

According to Internet Policy Institute (2001), e-Voting systems should satisfy the following security requirements:

i. **Authentication:** Only authorized voters should be able to vote.
ii. **Uniqueness:** No voter should be able to vote more than once.
iii. **Accuracy:** Voting systems should record the votes correctly.
iv. **Integrity:** Votes should not be modified without detection.
v. **Verifiability:** It should be possible to verify that votes were correctly counted in the final tally.
vi. **Auditability:** There should be reliable and demonstrably authentic election records.
vii. **Reliability:** Systems should work robustly, even in the face of numerous failures.
viii. **Secrecy:** No one should be able to determine how any individual voted.
ix. **Flexibility:** Equipment should allow for a variety of ballot question formats.
x. **Convenience:** Voters should be able to cast their votes with minimal equipment and skills.
xi. **Transparency:** Voters should have a general understanding of the whole process.
xii. **Cost-effectiveness:** Systems should be affordable and efficient.

PREVALENT CHALLENGES OF THE MANUAL SYSTEM OF VOTING

According to John and Koffi (2015), some of the challenges facing the traditional system of voting includes the following:

- **Bad documentation and recording:** In the past elections there were several situations of poor recording of total ballots in some of the polling stations. For example 270 writing in words as twenty seven zero. Their respective meanings are completely different.

- **Fraudulent Modification of Alteration of votes**: Votes can easily be manipulated because they are directly recorded on paper. The records can be exposed to any voter or official with malicious intention. According to Mercouri (2002) electoral personnel always replicate the votes which at the normal circumstance would not have been so as compared to e- voting which is claimed to be devoid of such

- **Voter Error**: Voters sometimes makes errors. For example voter may unintentionally thumb print against the picture of a candidate for which he did not intend to have voted for.

However, you cannot make changes to the selected option. Also, if voter do not fold their ballot papers well, the ink can spread to another candidate column, and hence the vote is disqualified and nullified

Others challenges are: Deferrals in showcasing final results, Ballot design and Count, Unsecured medium for transfer of ballot count

E-VOTING: THE NIGERIAN EXPERIENCE

According to Nwogu E.R (2015), the election in Nigeria is based on an open secret ballot system. It is called an open system because elections are conducted in the open where potential voters queue up to wait for their turn; the ballot paper is dropped in a transparent ballot box.

The whole voting process in the country at the just conclude general election in 2015 can divided into five phases by (Voke Augoye, 2013): **Registration Phase, Accreditation, Voting Phase, Initial Tallying, Announcement.** The only process that seems to be automated is the registration and accreditation of voters.

- **Registration phase**: In this phase all citizens eligible to vote choose a polling unit that is easily accessible to them to register. A computer is used to capture all the details (like name, DOB, etc.) of the citizens. There is also a device to capture the biometric finger prints of eligible voters. This is also done manually by the electoral official. A temporary voter's card with relevant details is giving to each voter. Finally, a permanent voters card (PVC) which is a smart card will be issued to electorates with embedded biometric strip that contain the data capture and bio-data of the. This permanent voter's card (PVC) shows that you are an eligible voter that has been registered and it must be brought by each voter on the day of the election.
- **ACCREDITATION**: On the Election Day each voter comes to the polling center with their PVC cards and stand on a queue till they get accredited by the officials. The accreditation process includes verifying the cards and finger prints on the card reader and biometric reader. The voting authorities place the card near the reader and the details of the user is displayed to verify the eligibility of the voter. If for some reasons the reader is not working the officials go through the list of registered voters, confirm the face on the voter's card matches with the voter and that on the register. If the voter is a legitimate one, the voter fills in some details in the register

to acknowledge that he have been accredited. After all the voters have been accredited, a time is officially chosen to begin the voting proper.

- **VOTING PHASE**: In the voting phase every accredited voter stands on a queue and according to your number that you may have been accredited. The officials at this stage go through the accreditation register to confirm the details of the voter. If there are no discrepancies the voter signs and thumb prints against his details on another register called the voting register. The voters are now handed the blank ballot with the party name and symbol. The voter then proceeds to a secret ballot stand (Kiosk) to cast his vote. After the last voter has voted the voting phase is ended and the election progresses to the next phase.
- **INITIAL TALLYING**: At this stage of the electoral process all the votes from the various ballots are collated and counted by the voting officials in the presence of voters, observers and party officials. The results are announced at the polling center, the result sheet is completed and party officials sign to acknowledge satisfaction with the process and the results. At the completion of this stage the ballot boxes with the votes and result sheets are then transported to the central collating center for the final collation, tallying and announcement of the result.
- **ANNOUNCEMENT**: When all the ballots and result sheets have gotten to the central collating center, they are tallied, re-counted and verified. If everything checks out correctly the results are then announced to the general public and the head of the electoral commission announces the winner.

Challenges of Transition to e-Voting System in Nigeria

In Nigeria, transition to e-voting adoption is likely to face wide-raging challenges that are considered crucial for successful adoption. Understanding the implication of these factors would abound policy makers and democratic practitioners with ability to effectively commit to acceptable yet reliable voting system.

Below are amongst the problem associated with the adoption and implementation of e-voting systems in developing countries:

Complementary ICT Infrastructure

Poor ICT infrastructure as an inherent characteristic of developing countries, poses serious challenge for transition to e-voting adoption. This is owing to the fact that in developing countries, advanced technologies are often proposed without prerequisite complementary infrastructure.). Development of robust technology such as e-voting system is closely associated with electricity supply, availability of wireless internet connectivity which are still epileptic in the country. In addition, a database for identification and authentication of electorates is a basic prerequisite.

Technological and Managerial Expertise

Infrastructures including hardware and software are the basic components of developing robust technology such as e-voting system are still lacked. What is more challenging is that whether the country has the required professional expertise capable of handling sophisticated technology such as e-voting remains unclear. Most developing nations still have most of its populace not IT oriented and aware of new trends in IT, so it's always difficult introducing and accepting new technologies by the populace.

Security and Reliability of the Technology

Citizens' should be confident that the e-voting security would protect individual identity from exposure as well as ensuring votes cast are count correctly would guarantee confidence and trust to adopt e-voting otherwise, it will discourage voters from participation. Therefore, popular risks of e-voting such as program error, software attack or system hacking, risk of fake voting sites and altered result should be mitigated against in the system.

Piloting e-Voting Technology

Piloting e-voting system has the potential to enhance trust and confidence of stakeholders that pave way for assessing adoption decision. Piloting involved understanding mandate of the project, legislative backup, developing requirement and technical specification and acquisition

of funding required for the implementation. By piloting, feedback about cost benefits of e-voting technology can be obtained. Hence, there is need to practically test the technology on non-public election platforms before the full scale, country-wide adoption.

Social Security

Social security as an important factor in voting process continues to remain a critical issue in Nigerian election. An effective voting system must ensure adequate protection of the voting clients and votes cast including other election materials. The rising profile of security challenges in Nigeria such as the activities of "Boko Haram" insurgence, MEND militias and incessant kidnap is very critical to adoption of polling place e-voting. However, caution must be exercised in taking measures to ensuring social security. In either way, it is uneasy for average citizens to risk their lives for what they considered 'uncertain democracy-election' to thrive amidst fear of bomb blast and other intimidations. Either of these potential threats to social security affects voters' turnout and therefore an essential determinant for voters' participation.

Technology Acceptance

Change in the way people do things or processes is always hard for individuals. Therefore, strategic step must be taken by the election body to sensitize the populace about the new technology and even seminars can be organized to inform the electorate about electronic voting.

Proposed Framework for E- Voting System

In this research work, we have proposed a contactless e-voting system to replace the traditional voting system.

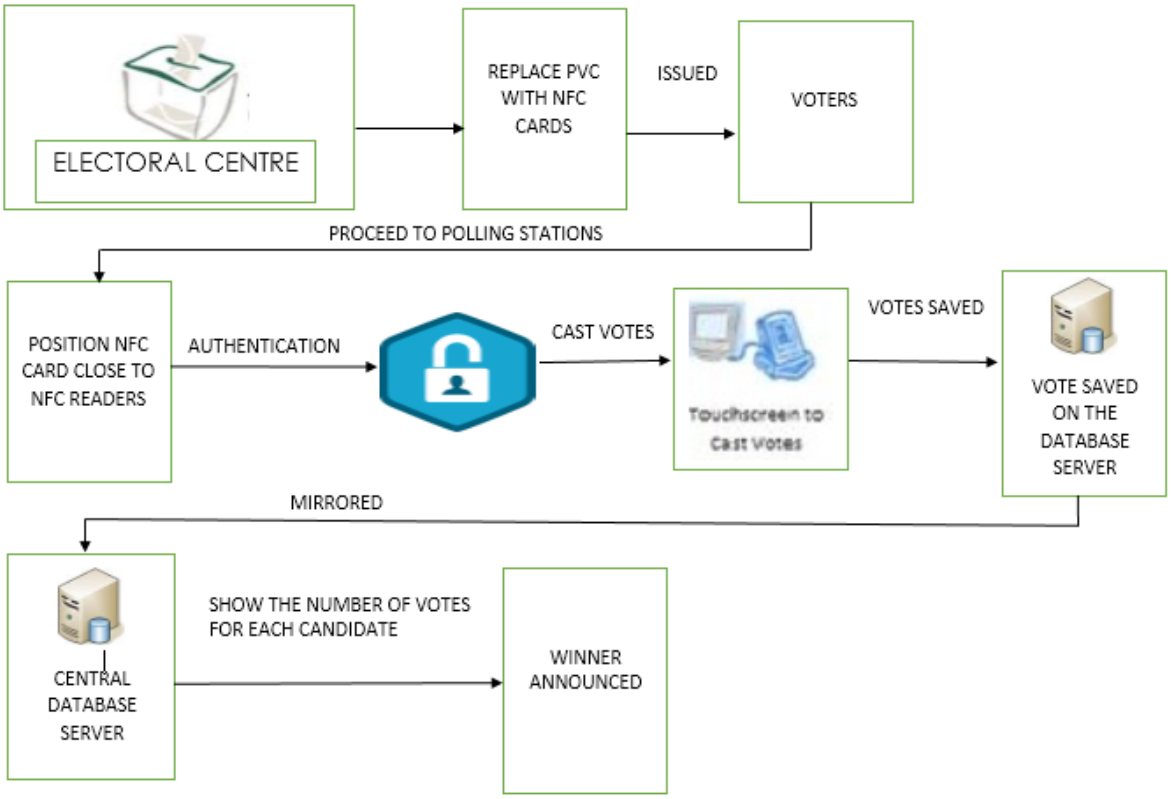

Figure 4: Proposed Framework

In this framework as shown in figure 4, we will be utilizing some of the infrastructures used in the past election and replacing them with new ones. Electorates will proceed to the electoral center where they registered for their PVC cards and the cards will be replaced with a contactless NFC cards with their details embedded in the card. Most of the voters that could not get their PVC cards will re-register and will be issued NFC cards.

On the Election Day, electorates proceed to the polling units and the accreditation process will take place when electorates position their cards close to the NFC card readers to be authenticated, if an individual is a registered voter, the individual's details will be automatically shown on the readers screen. After authentication, voters are provided with a touch screen and another reader that enables them to place the card and choose who to vote for from the

candidates shown or listed on the screen. The votes are automatically saved on the database server at the polling center which is also mirrored to a central database server.

At the end of the election, the officials get the result from the central database which shows the number of votes for each candidate.

Some of the security concern with this proposed framework are as follows:

1. Eavesdropping: In this type of attack, unintended recipients are able to intercept and read messages. With NFC cards and readers, this is only possible at a distance less than 0.1m.
2. Data Modification Threats: Instead of just listening, an attacker can also try to modify the data which is transmitted via the NFC interface.

Recommendations

A lot of issues are pending on the adoption of e-voting in developing democracies such as Nigeria is. While the challenges are enormous, critical appraisal of the challenges is strategic to sustainable e-voting adoption. Understanding the implications of these factors would abound policy makers and democratic practitioners wherewithal to effectively commit to acceptable yet reliable voting system.

Conclusions

In Planning for future elections, the electoral body should carefully plan for elections and all the necessary requirements taken into consideration. Most importantly scholars and researchers in the institutions and the industry should be part of the planning committee so as to develop a stable system.

References

Augoye, V. (2013) Electronic Voting: An Electronic Voting Scheme using the Secure Payment card System. *Technical Report RHUL–MA–2013– 10 01*

Chaum,D. (1981) Untraceable Electronic Mail, Return Address and Digital Pseudonyms, Communications of the ACM, Vo1.24, No.2 pp.84-88

Qadah, G.Z., Taha, R.: Electronic voting systems: requirements, design, and implementation. Comput. Stand. Interf. 29(3), 376–386 (2007).

Prashanth, P. B and S, Sridhar (2002) Electronic Voting - A Survey. *Department of Computer Science. The Johns Hopkins University*

Chowdhury, M.J. (2010) Comparison of e-voting schemes: Estonian and Norwegian solutions URL:http://courses.cs.ut.ee/2010/security-seminar-fall/uploads/Main/chowdhury-final.pdf

Baldersheim, H. & Kersting, N. (Ed). (2004) Electronic voting and democracy: a comparative analysis. Palgrave Macmillan, New York.

OKEDIRAN O. O, OMIDIORA E. O, OLABIYISI S. O, GANIYU R. A, ALO O. O (2011) A FRAMEWORK FOR A MULTIFACETED ELECTRONIC VOTING SYSTEM, International Journal of Applied Science and TechnologyVol. 1 No.4

Yossef Oren and Avishai Wool. RFID based electronic voting: what could possibly go wrong)

Shafii Muhammad Abdulhamid, Olawale Surajudeen Adebayo, Damian Oshomah Ugiomoh (2013) The Design and Development of Real-Time E-Voting System in Nigeria with Emphasis on Security and Result Veracity *I. J. Computer Network and Information Security*, 2013, 5, 9-18

Nwogu Emeka Reginald (2015) Mobile, Secure E - Voting Architecture for the Nigerian Electoral System IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 17, Issue 2, Ver. II (Mar – Apr. 2015), PP 27-36 www.iosrjournals.org

John Kingsley Arthur and Kofi Sarpong Adu-Manu (2014) A Trustworthy Architectural Framework For the Administration of E-voting: The Case of Ghana" IJCSI International Journal of Computer Science Issues, Vol. 11, Issue 3, No 2, May 2014