

Is E-voting Systems based on Blockchain Technology Efficient in Nigeria General Elections?

Friday Ehi Ikuero, Vasileios Germanos, Laurence Brooks, and Wen Zeng*

School of Computer Science and Informatics, De Montfort University, Leicester LE1 9BH U.K.

Email: fikuero@yahoo.com, vasileios.germanos@gmail.com, laurence.brooks@dmu.ac.uk, wen.zeng.wz@gmail.com

Abstract

One of the most common problems of election in Nigeria is inefficient data management. All subsequent elections were blighted by inefficient data management that resulted in violence in the country and distrust among political parties. These flaws prompted the government at different times to modify the nation's electoral systems ranging from party systems to electoral management body reformation and electronics verification technologies. In this paper, we investigated the opinions of 71 Nigeria citizens about the Nigeria General Elections (NGEs) processes and data management in these processes. We found that the majority of the participants rated the existing voting system in Nigeria to be of low effectiveness and reliability. The majority of the participants believe that an e-voting system based on Blockchain technology has the capability to prevent alterations in the voting processes.

Received on 26 January 2021; accepted on 3 March 2021; published on 10 March 2021

Keywords: Election, data management, security, blockchain technology, voting system

Copyright © 2021 Friday Ehi Ikuero *et al.*, licensed to EAI. This is an open access article distributed under the terms of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>), which permits unlimited use, distribution and reproduction in any medium so long as the original work is properly cited.

doi:10.4108/eai.10-3-2021.168964

1. Introduction

The Nigerian state returned to the current democratic system of government in 1999 after several years of military rule. The various political parties and their candidates went to the polls also known as NGEs, being a process that enables eligible voters to elect candidates of their choice who will represent them at the different levels of government ranging from the ward to the presidency. The NGEs which holds after a period of four years has held six times as follows; 1999, 2003, 2007, 2011, 2015 and 2019 in the last two decades [7].

The results of the NGEs were often rejected because of allegations of improper election data management comprising of result modifications, rigging, biases of officials, alteration of election results amongst others [6]. Consequently, the aggrieved political parties, members and supporters usually embark on protests which sometimes lead to violence with loss of lives and destruction of property [1].

The government has made some reasonable efforts to address the challenges to general elections in Nigeria.

The efforts include the Electoral Act 2010, the 1999 Constitution as Amended, the institutionalisation of elections management bodies and other related matters in Nigeria which has over the years transmogrified into Independent National Electoral Commission (INEC) [33].

The rising problems of inefficient electoral data management in the NGEs under the Fourth Republic covering 1999 to 2019 has elicited serious concern both at the national and international communities due to the threat it poses to security and national developments. For example, the 2003 and 2007 NGEs respectively recorded over 100 and 300 death, about 1000 casualties were recorded in the 2011 polls and more than 65,000 persons were displaced following the crisis that ensued after the announcement of the winner of the presidential poll [8, 27]. Similarly, the 2015 NGEs recorded 30 deaths [27] while the 2019 election witnessed some cases of partisan activities of officials, falsification and alteration of results that led to killings, shoot outs, vandalism of electoral materials among others.

In view of the foregoing, we are passionate to end the violence, killings, maiming and destruction

*Corresponding author. Email: wen.zeng.wz@gmail.com

of properties that occurs either before, during or immediately after general elections. Consequently, Nigeria would achieve the benefits of democracy to the nation.

There are some existing works, which convince that there are challenges with Nigeria voting systems and the challenges could be solved with blockchain technology. It is necessary to collect opinion from the Nigerian citizens because some of the literature opinions may be theoretical and not based on data. As far as we know, nobody or group of persons have previously researched on this topic. Therefore, we considered it is important to collect our data from the citizens to ensure originality and thoroughness of the research.

The aim of this study is to investigate the knowledge and opinions of the citizen about the NGEs processes and data management in the processes, and identify their opinions on the effectiveness and reliability of block-chain technology in Nigeria General Elections.

This paper is organized as following: Section 2 is the related work. Section 3 is the basic concepts in this paper. Section 4 will discuss the research hypotheses of this study. We will discuss the methodology in Section 5. In section 6, we will discuss and analyse the findings of this study. In Section 7, we will evaluate if the findings meet the hypothesis. Section 8 concludes the paper.

2. Related works

There are some existing works on the problems associated with the current voting system in Nigeria. In [26], the authors argue that the current voting system in Nigeria is susceptible to various electoral irregularities. In [4], the authors opine that the NGEs experience recurring issues of result alteration and rigging, signifying its inefficiency of the voting system.

There are some existing work on how to solve electoral issues and electronics voting system: In [2], the paper stresses the need for Federal Government of Nigeria (FGN) to decentralize some duties of INEC due to overwhelming responsibilities, leading to its inability to curtail the challenges of election falsifications. In our study, we discuss the need for the FGN to adopt an Electronics Voting System (EVS) to curb the irregularities of election data management. In [25], the researchers suggest a centralized EVS based solely controllable by INEC. However, we assert that the adoption of blockchain will enable a decentralized voting system where INEC would not have sole influence over data. In [21] the authors discuss various problems of data management common to all NGEs since 1999 thereby; the nation is unable to achieve credible elections. Our study emphasizes that alteration of election result is the commonest of

these electoral data management, hence it constitute the highest threats. Regarding existing works about Blockchain: In [19], the authors stress that blockchain has the capability that enables individuals to own and control their data. Our study examines the capability of blockchain to effectively manage all data in the blockchain network. Many authors extensively discussed about blockchain as a secure technology. In [5, 10, 11], they assert that the security capabilities such as cryptography signature prevents alteration, deletion and editing of any data that has been added to the system. In our work, we focused on how the security of blockchain enable electorates votes to count. In [5], the authors discuss that the implementation of blockchain technology is capable of solving the problems associated with the customary voting systems in African countries. Meanwhile, we identified citizens' opinions on the effectiveness of blockchain technology in the NGEs.

3. Preliminary material

In this part, the definition of the basic concepts are presented making it easier to follow the technical content of this paper.

3.1. Components of Nigeria's general elections process

Election refers to a process for eligible individuals to elect leaders who will govern them in given democratic regime [31]. The process of NGEs involves many components: INEC, political parties, election, security agency, voting systems, judiciary and Civil Society of Nigeria. The combination of the roles of these components when free from irregularities produces credible electoral process.

The INEC is a body set-up by the 1999 constitution to manage independently both the national and state elections also known as the NGEs. The INEC is the coordinator and the umpire of the NGEs, it plays a major role in the management of electoral data in reflecting the polls of the voters as it administers, organises, and announces election results in an unbiased manner [15].

Political parties refer to sets of individuals having the same political objectives, win offices after contesting elections and thereafter ratify public laws [38]. The Alliance for Democracy (AD), All Nigeria People's Party (ANPP) and People's Democratic Party (PDP) were the political parties registered for the 1999 NGEs [18]. Similarly, thirty (30) political parties were registered for the 2003 NGEs and seventy three (73) parties were registered for the 2019 polls. Some of the registered political parties for 2019 NGEs include All Progressives Congress (APC), All Progressives

Grand Alliance (APGA), Peoples Coalition Party (PCP), African Democratic Congress (ADC), Labour Party (LP), Accord Party (AP), AD, PDP [23].

The judiciary is the third arm of government that is saddled with the responsibilities of legislative and constitutional laws [22]. It uses electoral legal instrument to ensure adherence to the constitution of electioneering processes and accordingly, adjudicate any subsequent litigation [2].

In electioneering context, security refers to the acts of safeguarding election stakeholders, data, facilities and the events. [29] posits that there are three categories of election security; the physical (e.g. offices, ballot boxes etc.), the personal (e.g. candidates, voters, observers etc.), the event (e.g. campaign rallies, voters' registration etc.).

Media denotes all ways through which information, messages, ideas are conveyed to large audience [32]. Media reports are communicated vide the print and electronics means. Examples of the print media comprise newspaper and books. Similarly, examples of electronic media include television and radio amongst others [28].

Civil Society Organisation (CSO) is a collection of organisations such as human right, professional bodies, students union and labour union with the objective of counterbalancing the activities regarding state power [36]. It is a platform that enables citizens to express their ideas and interests for collective goal of transparency and accountability in national responsibilities, which includes electoral process.

3.2. Nigeria electoral voting systems

Nigeria State adopted the paper voting systems (PVS) form of balloting that existed before this present Fourth Republic, which commenced in 1999. The PVS has undergone several modifications over the years. These improved voting systems are Modified Open Ballot System, Re-modified Open-secret Ballot System as well as the Verification and Accreditation Systems (VAS) aided by Electronics Card Reader (ECR).

Modified Open Ballot System (MOBS) entails voters queuing openly to cast their votes but choices of votes are secret. It is an advanced form of the Open Ballot System commonly called Option A4 where electorates queue up to openly cast their votes [9]. Vote cast in MOBS are secret while balloting in Option A4 are open. The MOBS approach was adopted in 1999, 2003 and 2007 NGEs.

Re-modified Open-secret Ballot System (ROBS) is an approach in which voters are accredited and ballot papers are issued openly to individuals, thereafter cast their votes privately. The NGEs held in 2011 adopted the ROBS. In the PVS, voters are required to mark their choices of candidates on the ballot mostly by

fingerprint, seal and put them inside the dedicated electoral boxes [24].

The ECR a.k.a Smart Card Reader (SCR) is for verifying the identity of voters presenting the permanent voters' card and accrediting such individuals for balloting if successfully authenticated. The NGEs for both 2015 and 2019 adopted the VAS system. However, in 2015 NGEs, voting commenced after the accreditation phase elapsed while the 2019 polls allowed concurrent accreditation and voting [9].

The voting system in Nigeria has undergone several transformations; however, not without challenges [12]. The challenges, which has remained unsolved may be due to inefficiency in the existing voting system in Nigeria [26]. According to [37], the adoption of an effective technology into the Nigeria voting system could eliminate the challenges.

3.3. Data management in Nigeria

Data refers to the gathering of documented values, symbols, numbers and characters to obtain information which could be used in the present times or future [39]. In Nigeria, electoral data such as gender, date of birth, address, and numbers of vote are solely collected and transmitted from registration point or voting unit to INEC central database system [20]. Managing electoral data in both storage and transit is the responsibility of INEC, thereby, making it a centralized data management system.

3.4. Blockchain technology

Blockchain is a decentralized public ledger for recording and sharing transactions in a given network [5]. It has several uses; thus gaining more acceptance in different spheres of the economy such as internet of things, decentralized payment (crypto currency) amongst others [13, 35]. The numerous benefits of blockchain technology including transparency, recording and computation (tallying) of election results has paved the way for its demand for electioneering process [34]. This study will discuss the following terms and concepts of blockchain: transactions, provenance, immutability and finality.

Transactions: In blockchain, it refers to invoking the set rules for a contract [30]. Examples of transaction in blockchain enabled voting systems include votes cast, election results and dates of birth.

Provenance: All participants domiciled in the blockchain network can determine the origin of blocks (transactions) and its owner at a given time [17]: thus, enables appraisal of previous transactions and further ascertain their history. In electoral processes, all participants in the network are able to confirm that their votes were counted [10, 11].

Immutability: It is a security capability that makes it impossible to delete or edit a transaction that has been added to the blockchain. It restricts data alteration and falsification [11].

Finality: A block or transaction cannot be modified once it is added to the ledger. All participants across the blockchain network must unanimously accept and verify every transaction [19, 30]. Therefore, finality capability of blockchain could ensure security of transactions therein.

4. Research hypotheses

In this section, we will discuss the hypotheses of this study, which are enumerated as follows:

- **Hypothesis 1:** Nigeria citizens believe that INEC has distinguished itself in ensuring effective data management during NGEs.
- **Hypothesis 2:** Many people would rate the effectiveness of the existing voting system in Nigeria to be low.
- **Hypothesis 3:** Nigeria citizens believe that there are issues facing election data management in the NGEs.
- **Hypothesis 4:** Small percentage of respondents would be familiar with Blockchain technology.
- **Hypothesis 5:** People believe that Blockchain technology has the capability to prevent alteration of data.
- **Hypothesis 6:** People believe that Blockchain technology has the capability to ensure votes count.
- **Hypothesis 7:** Few people would recommend the adoption of Blockchain in the elections.
- **Hypothesis 8:** People believe that policy makers would be the main hindrance to the adoption of Blockchain technology.

5. Research methodology

Questionnaire will be used for this research. It allows anonymity of the participants and be conveyed via email or postal service to potential participants. It is self-administered where the respondents read the questions and provide answers accordingly. Furthermore, it is an easy and faster way of collecting data from wide range of people spread across different settlements specifically as the country. The anticipated participants are worldwide spread. The approach would enable easy distribution of questionnaires to large number of people unlike the interview technique or the focus group. Telephone or computer aided communication were not

used because good recording of conversation could not be achieved.

The research targeted audience in different age categories. The age were categorised into; 18–30, 31–40, 41– 50, 51–60 and above 60 years old. The idea behind the choice of age range was that the participants would have experienced at least one Nigeria general election since he or she was born. In addition, at these age ranges, they are considered adult who could willingly participate in research and give opinion on their own. The participants were randomly selected from citizens of Nigeria across the globe, hence the option for location in the demographic information section of the questionnaire. The research avoided engaging only citizens resident in the country in order to eliminate biases of opinion and to have wider inputs regarding global best practices. Additionally, these participants cut across all disciplines such as business people, public servants and students among others. Their knowledge regarding the use of technology was highly considered, as it will enable them to be objective in their opinion.

The questionnaire was created with the Google doc and sent to participants via the link: <https://forms.gle/qpGd1djAPnm5GJvC7> using computer aided communication that included email and social media specifically the WhatsApp platform.

6. Findings

Table 1 shows participants' knowledge related Nigeria General Elections. We investigated the effect of gender on the statement: I am familiar with the NGEs and its data management processes. It revealed that there is significant margin between the opinion of male (80.3%) and female (19.7%) genders that participated in the study. We found that 63.3% of the male and 11.3% of the female was familiar with the NGEs and its data management process. Therefore, showing unparalleled gender participation in the research, making the distribution of opinion tending more towards the male, and consequently suggests that male are more passionate about election processes than the female gender.

Furthermore, we investigated the effect of age on the statement: I am familiar with the Nigeria General Elections and its data management processes. The investigation revealed that the highest opinions: 19.7% and 63.4% were respectively from groups ranging 31 – 40 and 41 – 50 years old. We also found out that though majority of the participants were from the age group from 41 – 50, but those from age group 31 – 40 are more familiar. The high familiarity of the 31 – 40 could be because of the widespread of political information using social media platforms.

Table 2 to 5 illustrate the findings according to the different question groups in the questionnaire, which

Table 1. Participants' knowledge related to Nigeria General Elections.

I am familiar with the Nigeria General Elections and its data management processes.					
	Very familiar	Familiar	Neutral	Unfamiliar	Very unfamiliar
Number of respondents with their percentages	23 (32.4%)	29 (40.8%)	9 (12.7%)	8 (11.3%)	2 (2.8%)

I agree that the NGEs have been credible since 1999.					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Number of respondents with their percentages	None	1 (6.8%)	6 (37.5%)	6 (37.5%)	3 (18.8%)

The election I think has been more credible.						
	1999	2003	2007	2011	2015	2019
Number of respondents	17(25%)	2(2.9%)	3(4.4%)	14(20.6%)	27(39.7%)	5(7.4%)

can identify the participants' knowledge related to the electoral processes, data management and technologies.

1. What are the components of electoral processes in NGEs?
2. What are the previous and current data management systems for electoral process in Nigeria?
3. What are the issues associated with the previous and the current data management in NGEs?
4. What are the concepts of blockchain?
5. How will block-chain technology manage data during NGEs?

6.1. Knowledge related to components of electoral processes

This part shows findings on participants' knowledge on the components of electoral processes in NGEs which encompasses how the electorates perceive the election procedures in Nigeria. Table 2 illustrates the findings on this section.

In Table 2, the outcomes indicated that INEC had 81.7% in the statement of component that could mostly influence the management of election data. The authors in [15] argues that INEC is the coordinator and the umpire of the NGEs; thereby having much influence over other electoral components. Therefore, the result of this study (81.7%) corroborates the opinions of these researchers that INEC is the most influential component of election processes in Nigeria.

The results in Table 2 statement 2 showed that none of the electoral components has distinguished itself as each component scored below 50%. In [36], the authors stress that reasons that bothered on the overwhelming responsibilities of INEC, manipulations of electoral guidelines by political parties among others has caused the poor performances of the electoral components. In

view of the foregoing, opinions of the researchers are similar to those of our study.

In the third statement, the 81.4% of the respondents that opined non satisfaction with the combined role of the electoral components as investigated by this study corroborated with the opinions of respondents in statement 2 of table 2 where all the components were unable to distinguish themselves as the highest score was 40%. The individual components fallen short of expectation in discharging their responsibilities as opined by respondents in statements 2 above further corroborates their views in statement 3 as reflected in Table 2 above. Thereby, agreeing with the opinions of the researchers in the above two paragraphs.

6.2. Findings on existing voting technology/system

This section presents the opinion results on the existing voting technology. Opinion data were collected from respondents based on 6 statements as indicated in table 3.

Majority of the respondents comprising 77.4% (57.7% plus 19.7%) rated the effectiveness of the existing voting technology in Nigeria to be on the low range while 1.4% rated it to be very high. In [4, 21], the authors asserts that there are recurring issues of result alteration, rigging and lack of transparency during the NGEs, showing that the existing voting technology is ineffective. Since both the authors and the study of this pointed out ineffectiveness in the current voting system in Nigeria, they have similar opinion.

Furthermore, in Table 3, majority of the people 89.4% (47.9% plus 41.5%) believe that it is possible to alter or falsify results based on the way election data is managed currently in Nigeria. In addition, majority of the respondents feel that improving the existing voting technology will impact confidence in the electoral processes. Similarly, the authors in paper [12, 21] postulates that the manual approach to handling election data is prone to falsification and alterations.

Table 2. Participants' opinion related to components of electoral processes in the NGEs.

The component I think could mostly influence the management of election data in Nigeria.							
	INEC	Security Agencies	Political Parties	Civil Society Organisations	Judiciary	Media	Neutral
Number of respondents with their percentages	58(81.7%)	2(2.8%)	4(5.6%)	1(1.4%)	1(1.4%)	2(2.8%)	3(4.2%)

The electoral component I think has distinguished itself in ensuring effective data management in the NGEs.								
	INEC	Security Agencies	Political Parties	Civil Society Organisations	Judiciary	Media	Neutral	None
Number of respondents with their percentages	11(15.7%)	None	1(1.4%)	28(40.0%)	2(2.9%)	4(5.7%)	4(5.7%)	20(28.6%)

I am satisfied with the combined role of the electoral components concerning the way electoral data is being managed in Nigeria.			
	Yes	No	Neutral
Number of respondents	8(11.4%)	57(81.4%)	5(7.2%)

Table 3. Participants' opinion related to existing voting technology/systems

The rating of the effectiveness of the existing voting technology in Nigeria.					
	Very high	High	Uncertain	Low	Very low
Number of respondents with their percentages	1(1.4%)	6(8.5%)	9(12.7%)	41(57.7%)	14(19.7%)

I agree that it is possible to alter/falsify data (results) in the way elections are currently managed in Nigeria.					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Number of respondents with their percentages	32(41.5%)	34(47.9%)	4(5.6%)	1(1.4%)	0%

The improvement(s) in the existing technology will impact confidence on the electoral processes in Nigeria.					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Number of respondents with their percentages	37(52.1%)	25(35.2%)	7(9.9%)	1(1.4%)	1(1.4%)

The probability for falsification(s) to occur in the use of the existing technology or system in the electoral processes in Nigeria.					
	Very high	High	Uncertain	Low	Very low
Number of respondents with their percentages	21(29.6%)	38(53.5%)	7(9.9%)	4(5.5%)	1(1.4%)

Rating the transparency of results collation and computation during the past general elections in Nigeria.					
	Very high	High	Uncertain	Low	Very low
Number of respondents with their percentages	1(1.4%)	7(9.9%)	10(14.1%)	35(49.5%)	18(25.4%)

The present system is secure enough to ensure that the votes of the electorates count.					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Number of respondents with their percentages	1(1.4%)	3(4.2%)	11(15.5%)	35(49.3%)	21(29.6%)

In comparison, the opinions of these authors and those of the 89.4% of respondents above are similar. The similarity of opinions may have been informed from the PVS, which require manual interventions such as collation, computation and conveyance of data on hard copies from polling unit to collation centre.

A total of 87.3% (52.1% and 35.2%) agree that improving the existing voting technology will impact confidence in the electoral processes. In [20], the authors emphasize that the adoption of SCR since 2015 has reduced election frauds, litigation, as well as increased voters' trust and confidence in election process. Therefore, these researchers' opinions concur with the respondents above agreeing with the improvement of existing voting technology to impact confidence in the electoral processes.

Meanwhile, 83.1% (53.5% plus 29.6%) of the respondents believed there is probability for falsification to occur in the use of the current processes in NGEs. In the studies [26], the authors argue that the existing technology is inefficient; therefore, prone to vote tampering and falsification. Given the foregoing, the opinions of the majority of the respondents during our research (83.1%) and that of the writers are related since both believe there are the chances for falsification to occur in the current voting system in Nigeria.

Considering the statement of rating the transparency of result collation and computation, more than half of the people 74.9% ((low - 49.5% and very low - 25.4%) have low satisfaction for result collation and computation in the current NGEs systems. In [12], the researchers elucidate that little or absence of transparency during election is one of the factors responsible for flaw in NGEs. These researchers' views agree with those of the majority of our study; hence, opinions are alike.

Finally in Table 3, result shows that 78.9% (49.3% plus 29.6%) that forms a greater proportion of the opinion do not believe that the existing technology has the security capability for ensuring vote count. The authors in [21] posit that elections including those held in 2003 and 2007 were marred with frauds during result collation. The common opinion of these researchers agrees with the outcome of this study that the existing voting technology is unable to ensure votes of the electorates to count. A technology that lacks security allows frauds. Therefore, in our research, we believe that it is vital for the FGN to consider adopting a technology that has security capabilities that will ensure vote count in the future polls.

6.3. Findings on the problems of existing voting technology/election data management

This section presents the findings of problems associated with the existing technology for managing election data. Firstly, majority of the respondents affirmed that there are problems with the existing election data management. In [4], the authors posit that there are problems including data alterations, centralization and lack of transparency amongst others facing data management during Nigeria elections. Therefore, it signifies that both opinions are similar.

As shown in Table 4 in statement 2, we found that alteration of results recorded the highest rating on the problems facing election data management, and then followed by centralized control. The authors in [12, 26], the writers states that the NGEs held between 1999 and 2019 were challenged for electoral irregularities including alterations and falsifications of results. Our study's outcomes align with the opinions of these writers regarding the existence of alteration of results in NGEs. However, it differs by establishing that alteration of results is the commonest problems facing election data management in Nigeria. It is therefore necessary for relevant stakeholders of NGEs to examine the causes of alteration of results with a view to proffering solutions.

The third statement in table 4 illustrates that majority of the people believe that the adoption of a technological innovation that guarantees confidentiality and promotes transparency in electoral data management in Nigeria. The authors in [20] discuss the adoption of SCR and its contributions to the Nigeria voting systems. Aligning with our study, they assert that the SCR has made verification and accreditation more transparent; thereby increasing voters' confidence.

Furthermore, respondents respectively rated 95.8% (67.6% plus 28.2%) in recommending the adoption of an innovative technology that will make the collation and computation of election results more transparent in the nation. In [16], the authors postulate that the adopting advanced technology eliminates alteration and further promotes vote count. Therefore, the opinion of these researchers is similar to our findings.

The concluding statement in table 4 investigated the challenge that could mostly prevent the adoption of new technology in Nigeria future election. Consequently, majority of the people (78.9%) believe that biases of the policy makers could mostly inhibits the acceptance of new technology. In [37], the authors discussed about the adoption of new technology into the Nigeria voting system, They posit that the approval and disapproval by the policy makers is subject to the technology meeting the required standards, availability of funds amongst other things. Therefore, when it is disapprove for any reason, the policy makers could

Table 4. Participants' opinion related to the problems of existing voting technology/election data management.

There is problems facing the way electoral data are being managed in Nigeria.					
	Yes			No	
Number of respondents with their percentages	63(90.0%)			7(10.0%)	

The highest rated problem facing election data management in Nigeria.					
	Centralized control	Alteration of result	Stakeholders' cooperation	Inadequate skills for INEC staff	Inadequate voters' education
Number of respondents with their percentages	17(26.6%)	37(57.8%)	5(7.8%)	3(4.7%)	2(3.1%)

The extent of adoption of a technological innovation that guarantees confidentiality and promote transparency in electoral data management in Nigeria.					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Number of respondents with their percentages	38(55.1%)	25(36.2%)	6(8.7%)	None	None

Recommendation for the adoption of an innovative technology that will make the collation and computation of election results more transparent in Nigeria.					
	Very high	High	Uncertain	Low	Very low
Number of respondents with their percentages	48(67.6%)	20(28.2%)	3(4.2%)	None	None

The challenge that could mostly prevent the adoption of new technology in Nigeria future election.					
	Inadequate funding	Biases of the policy makers	Lack of interest from the general populace	Lack of trust in technology	Indifference
Number of respondents with their percentages	7(9.9%)	56(78.9%)	4(5.6%)	3(4.2%)	1(1.4%)

be seen as hindrance to the acceptance of the proposed technology. To this end, the opinions of these researchers affirm our findings.

6.4. Findings on Blockchain technology

This aspect shows the results to RQ4 and RQ5 as illustrated in Table 5.

In the first statement, 68.1% of the participants selected yes indicating that they have heard about blockchain technology while 31.9% chose no meaning they have not heard about it.

Out of the respondents that have heard about the blockchain technology, 15.5% of them are very familiar with it, 45.3% are familiar. In [13], the researchers posit that blockchain is gaining popularity across the globe due to its numerous benefits and applicability in different disciplines; hence similar opinions.

In the third statement of Table 5, majority of our respondents totaling 65.3% (strongly agreed - 28.8% and 36.5% - agreed) believe that blockchain technology has the capability to prevent alterations. We found out in our study that blockchain technology has security capability that prevents alterations. In paper [10], the authors also examined the security feature of

blockchain. They argue that it has a characteristic of cryptography signature that authenticates every transaction (vote), which restrict alterations. Therefore, the opinions of these authors agree with those of our findings.

Further findings in statement 4 of Table 5, total of 71.1% (26.9% and 44.2%) opinions believe that blockchain has the capability in ensuring the votes of the electorates to count in the NGEs. Some authors also discussed on the capabilities of blockchain. In ([10, 11], the authors opine that blockchain does not allow modifications of votes that have been committed. Similarly, the authors in [5], assert that retrieval and deletion of committed votes are impossible in blockchain. Furthermore, [11] postulates that any voting transaction on the blockchain is verifiable and audit-able. Therefore, our opinion on blockchain ensuring vote count in blockchain relates to those of the researchers.

Furthermore, 40.4% of participants recommended very high for the adoption of the use of blockchain technology for NGEs and 38.5% suggested high, making 78.9% opinions altogether. Given the foregoing, majority of the respondents in our study commended

Table 5. Participants' knowledge related blockchain Technology

I have heard about the Blockchain technology.					
	Yes			No	
Number of respondents with their percentages	47(68.1%)			22(31.9%)	
I am familiar with the blockchain technology.					
	Very familiar	Familiar	Neutral	Unfamiliar	Very unfamiliar
Number of respondents with their percentages	8(15.1%)	24(45.3%)	12(22.6%)	8(15.1%)	1(1.9%)
The blockchain technology has the capability to prevent alterations or vote tampering.					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Number of respondents with their percentages	15(28.8%)	19(36.5%)	17(32.7%)	1(1.9%)	None
The blockchain technology can ensure the votes of the electorates counts in the NGEs.					
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Number of respondents with their percentages	14(26.9%)	23(44.2%)	15(28.8%)	None	None
Recommendation for the adoption of the use of blockchain technology for the NGEs.					
	Very high	High	Uncertain	Low	Very low
Number of respondents with their percentages	21(40.4%)	20(38.5%)	11(21.2%)	None	None
The challenge that could mostly prevent the adoption of Blockchain technology in Nigeria future election.					
	Inadequate funding	Biases of the policy makers	Lack of interest from the general populace	Lack of trust in technology	Indifference
Number of respondents with their percentages	7(13.2%)	40(75.5%)	2(3.8%)	4(7.5%)	None

for the adoption of blockchain technology. Equally, some authors conducted researches that relates to the implementation of blockchain. In [34], they mention that stakeholders have numerous benefits in implementing blockchain technology into voting system. It thus, suggests their advocacy for the adoption of blockchain; thereby, affirming the result of our study where the majority supported the adoption of blockchain.

Finally, this section evaluates the participants' opinion regarding the statement on the challenge that could mostly prevent the adoption of blockchain technology in Nigeria future election. The opinion data showed a significant margin between biases of the policy makers (75.5%) and its closest, inadequate funding (13.2%). Some authors have also, carried out studies about adoption of blockchain in the nation. In [14], the authors postulate that the policy makers could mostly prevent the adoption of the technology for the reason for fairness. Hence, opinions of these researchers are dissimilar to the outcome of our study.

7. Analysis

This section will examine our hypotheses using the research findings in above section. It will use 50 and above percent opinions as benchmark for testing the hypotheses (i.e. 50% and above opinions will validates while less than 50% invalidates the hypotheses).

Hypothesis 1: Based on Section 6.1, Nigeria citizens believe that INEC has distinguished itself in ensuring effective data management during NGEs. This hypothesis is premised on the facts that INEC is a technocrat in electoral data processes and improved its voting processes by introducing the SCR. In Table 2 of section 5.1, the second statement, few people (15.7%) believe that INEC has ensured effective data management, thereby invalidating the hypothesis. In [3], the author opines that INEC has enormous responsibilities that seem to affect its effectiveness; thereby, supporting the invalidation of the hypothesis. The INEC can simplify its responsibilities by automating some of electioneering process. Since data management in election is one of the processes that involves manual intervention, it would be necessary for the FGN to adopt a technology that

would automate data management; thereby, enhancing INEC's efficiency in managing electoral data.

Hypothesis 2: Based on Section 6.2, many people would rate the effectiveness of the existing voting system in Nigeria to be low. This assumption premises on the violence that arises during elections and after the announcement of results since 1999 NGEs due to allegation of irregularities in the voting processes. In statement 1 of Table 3, respondents totaling 77.4% (low - 57.7% plus very low - 19.7%) believe that the effectiveness of the current voting system in Nigeria is on the low range. The respondents' opinions, which validate the hypothesis, could be based on their experiences as election participants.

Hypothesis 3: Based on Section 6.3, Nigerian citizens believe that there are issues facing election data management in the NGEs. In the data collected, most respondents (90%) feel that there are problems with the management of data in the NGEs. Consequently, the outcome of the research validates this hypothesis. The wide margin between those who believe that there are problems and those that do not believe clearly suggest the need for the FGN and other relevant electoral stakeholders to identify the problems and work out the strategies that would accordingly proffer solutions.

Hypothesis 4: Based on Section 6.4, Small percentage of respondents would be familiar with blockchain technology. We based this hypothesis on the idea that blockchain is not a popular technology in Nigeria. As discussed in section 5.4, the result shows that 60.4% (familiar and very familiar) representing majority of the respondents are familiar with blockchain technology, thereby invalidates the research hypothesis. In [35], discussed on how blockchain has advanced the digital world. The writers assert that the use of blockchain for crypto-currency particularly the Bitcoin has revolutionized its applications in many areas. The opinions of the respondents that corroborated the views of the authors in [35] may have been informed mainly from the application of blockchain in financial services coupled with the fact that some of the respondents might be engaging the technology in their professions.

Hypothesis 5: Based on Section 6.4, people believe that blockchain technology has the capability to prevent alteration of data. In the research outcome as discussed in section 5.4 above, 65.3% individuals opined that blockchain has the capability to prevent data alteration. The outcome therefore confirms the research hypothesis that blockchain technology has the capability to prevent alteration of data, thus, validating the hypothesis. The immutability capability of blockchain makes it impossible to delete or edit any data that is committed to the blockchain. Therefore, considering the blockchain in Nigeria voting system will eliminate the chances of data falsification in its

future election; thereby, making the voting system to be more effective.

Hypothesis 6: Based on Section 6.4, people believe that blockchain technology has the capability to ensure votes count. In section 5.4 above, 70.6% of the respondents' opinions align with the hypothesis. Since 70.6% is well above average, it therefore, validates the hypothesis. Reference to the validation of hypothesis 5 above, every vote that have been committed to the blockchain network cannot be modified, suggesting that all votes are recorded in the ledger as originally verified by the participating nodes; thus, every vote remain unchanged as initially recorded as well as computed and accordingly ensures every vote to count.

Hypothesis 7: Based on Section 6.4, few people would recommend the adoption of blockchain in the elections. This hypothesis is premised on the fact that blockchain is relatively a new technology; thus, its awareness may not have reached a larger populace in Nigeria. However, majority (78.9%) of the respondents as shown in statement 5 of Table 5 recommended the adoption of blockchain technology; thereby, invalidates our hypothesis. In [37], the authors postulate that blockchain is an evolving technology and stakeholders need to clarify their doubts regarding security, legal matters and overall effectiveness of the technology that will endear buy-ins of the populace and policy makers for adoption; thus agreeing with the hypothesis. [5, 13, 34], they argue that blockchain is gaining popularity due to its numerous benefits and areas of use. The assertions of these latter researchers affirm the result of this study where 78.9% of respondents supported the adoption of blockchain; hence, invalidate the hypothesis.

Hypothesis 8: Based on Section 6.4, people believe that policy makers would be the main hindrance to the adoption of blockchain technology. We premised this hypothesis on the fact that blockchain being a new technology, policy makers will have to explore all aspects of the technology in a constitutional manner. When the proposal for adoption is rejected or delayed for any reason, people would believe that the policy makers have hindered the adoption. The result as discussed in section 5.4 shows that 75.5% of respondents feel that the biases of the policy makers would be the most hindrances; thus similar to the hypothesis, thereby validating it. In view of the foregoing, it is necessary for future research to look into acquainting the policy makers with adequate knowledge and capability of blockchain technology in order to promote its adoption.

8. Conclusions

This research work has given significant insight into the Nigeria general election process. It discussed the

components of election process in Nigeria, the existing data management system and its problems. Thereafter, it examined some concepts of blockchain technology. We created questionnaire to identify citizens' opinions on the effectiveness of blockchain technology in the NGEs. The analysis of the findings forms the recommendations.

The study advocates that the adoption of blockchain technology will enable the Nigeria electoral system to secure and manage efficiently its election data. Consequently, it will improve the Nigeria general election process and democracy in ensuring that the electorates' vote would count; thereby significantly preventing violence, killings and destruction of properties that ensues before, during and after elections.

It adds to the academia a vital literature in the use of blockchain technology for efficient data management in Nigeria and roles of blockchain technology in data security. It enriches the software, hardware and political industries with a technology that could solve electoral problems; thus, contributing a huge opportunity for hardware and software industries development.

The research coincided with the period of the Covid-19 pandemic lock-down. As such, the research methodologies and number of respondents were limited. Consequently, the depth and the quality of data collected was somewhat affected.

The proportion of the research participants was small compare to the population of Nigeria, hence it may be unsuitable to generalise on the findings of the research. However, the research was able to ascertain the need for the adoption of blockchain technology.

It is imperative that future studies propose and develop a blockchain framework with a view to demonstrating it to Nigeria policy makers and INEC.

It is therefore recommended that: 1) FGN should encourage the decentralization of election data management to check anomalies and allow the electorate votes to count. 2) The FGN and other relevant electoral stakeholder should consider adopting the blockchain system for eliminating the chances of electoral irregularities. 3) Researchers could consider proposing and developing blockchain framework, its practical demonstration made to all relevant NGEs stakeholders in order to get their buy-ins. 4) The Framework demonstration should suggest a pilot project with the Local Government Elections' (LGEs) primary elections.

References

- [1] Adesola Samson Adesote and John O. Abimbola. Electoral violence and the survival of democracy in nigeria's fourth republic: A historical perspective. *Canadian Social Science*, 10(3):140–148.
- [2] E Remi Aiyede. Electoral laws and the 2007 general elections in nigeria. *Journal of African elections*, 6(2):33–54, 2007.
- [3] Emmanuel Aiyede. Electoral laws and the 2007 general elections in nigeria., journal of african elections. *Journal of African Elections*, 6:33–54, 10 2007.
- [4] Kunle Ajayi. Security forces, electoral conduct and the 2003 general elections in nigeria. *Journal of Social Sciences*, 13(1):57–66, 2006.
- [5] Mahtab Alam, Mukhtar Opeyemi Yusuf, and Nazifi Alhassan Sani. Blockchain technology for electoral process in africa: a short review. *International Journal of Information Technology*, pages 1–7, 2020.
- [6] Kunle Animashaun. Regime character, electoral crisis and prospects of electoral reform in nigeria. *Journal of Nigeria Studies*, 1(1).
- [7] Adeniyi Basiru and Kola Adesina. Electoral reforms and the administration of the 2015 general elections in nigeria. *Democracy and Security*, 15(3):207–229, 2019.
- [8] Coentien Cohen. Violence between and within political parties in nigeria: Statistics, structures, and patterns (2006-2014). *Contemporary Readings in Law and Social Justice*, 8:30–47, 2016.
- [9] Adebimpe Omolayo Esan and TB Ayeni. E-voting in nigeria: Barriers to full implementation. *Ahmadu Bello University*, 2017.
- [10] Robert Herian. *Regulating blockchain: Critical perspectives in law and technology*. Routledge, 2018.
- [11] Friðrik Þ Hjalmarsson, Gunnlaugur K Hreiðarsson, Mohammad Hamdaqa, and Gísli Hjalmtýsson. Blockchain-based e-voting system. In *2018 IEEE 11th International Conference on Cloud Computing (CLOUD)*, pages 983–986. IEEE, 2018.
- [12] Godwin Ihomeje. Election, international election monitoring groups and nigeria's fourth republic. *Journal of Arts and Humanities*, 8(11):54–62, 2019.
- [13] Ahmed Kosba, Andrew Miller, Elaine Shi, Zikai Wen, and Charalampos Papamanthou. Hawk: The blockchain model of cryptography and privacy-preserving smart contracts. In *2016 IEEE symposium on security and privacy (SP)*, pages 839–858. IEEE, 2016.
- [14] Svetlana Krivoruchko, Vladislav Ponamorenko, and Anatoly Nebera. Central bank policy and cryptocurrencies. *Journal of Reviews on Global Economics*, 7:549–561, 2018.
- [15] R.Z Maitama and S. Deepali. Democracy and credible election: The challenges of election administration in nigeria. *Our Heritage Journal*, 22, No 1,, 2020.
- [16] Mohammad Malkawi, Mohammed Khasawneh, Omar Al-Jarrah, and Laith Barakat. Modeling and simulation of a robust e-voting system. *Communications of the IBIMA*, 8(26):198–206, 2009.
- [17] Scott A McKinney, Rachel Landy, and Rachel Wilka. Smart contracts, blockchain, and the next frontier of transactional law. *Wash. JL Tech. & Arts*, 13:313, 2017.
- [18] Abubakar Momoh and Paul-Sewa Thovoethin. An overview of the 1998-1999 democratisation process in nigeria. *Development Policy Management Network Bulletin*, 13(3):4–9, 2001.
- [19] M Niranjnamurthy, BN Nithya, and S Jagannatha. Analysis of blockchain technology: pros, cons and swot.

- Cluster Computing*, 22(6):14743–14757, 2019.
- [20] Chikodiri Nwangwu. Biometric voting technology and the 2015 general elections in nigeria. *Department of Political Science, University of Nigeria. Nsukka*, 2015.
- [21] Chikodiri Nwangwu, Vincent Chidi Onah, and Otu Akanu Otu. Elixir of electoral fraud: The impact of digital technology on the 2015 general elections in nigeria. *Cogent Social Sciences*, 4(1):1549007, 2018.
- [22] A Sat Obiyan and Oluwole I Olutola. Electoral conflicts, the judiciary, and democratic consolidation in nigeria. *Nigeria's Democratic Experience in the Fourth Republic since 1999: Policies and Politics*, page 158, 2012.
- [23] UG Ojukwu, CC Mazi Mbah, and VC Maduekwe. Elections and democratic consolidation: A study of 2019 general elections in nigeria. *Direct Research Journal of Social Science and Educational Studies*, 6(4):53–64, 2019.
- [24] Oladotun Okediran, Elijah Omidiora, Stephen Olabiyisi, Ganiyu Adesina, and Sijuade Adeyemi. Towards remote electronic voting systems. *Computer Engineering and Intelligent Systems*, 2, 07 2011.
- [25] Oladotun Olusola Okediran and Rafiu Adesina Ganiyu. A framework for electronic voting in nigeria. *International Journal of Computer Applications*, 129(3):12–16, 2015.
- [26] B Okemini Emmanuel. Presidential elections and electoral violence. 2020.
- [27] Olowojolu Olakunle, Rasak Bamidele, Ake Modupe, Ogundele Oluwaseun, and Afolayan Magdalene1. Trends in electoral violence in nigeria. *Journal of Social Sciences and Public Policy*, 11(1):37–52, 2019.
- [28] Olakunle Olowojolu. Role of media in 2015 presidential election in nigeria. *International Journal of Politics and Good Governance*, 5(7.1), 2016.
- [29] Samuel Oni, Felix Chidozie, and Godwyns Agbude. Electoral politics in the fourth republic of nigeria's democratic governance. *Developing Country Studies*, 3(12).
- [30] James Pratt, Nigel Bradley, Eric Zavesky, Nikhil Marathe, and Timothy Innes. Blockchain based information management, December 19 2019. US Patent App. 16/007,747.
- [31] Andrew Reynolds, B. Reilly, and ALEXANDER J. Ellis. Electoral system design: The new international idea handbook. 2005.
- [32] Tsegyu Santas and John Dogara Ogoshi. The 2019 presidential election in nigeria: An analysis of the voting pattern, issues and impact. *Malaysian Journal of Society and Space*, 10(1), 2016.
- [33] Babayo Sule. The 2019 presidential election in nigeria: An analysis of the voting pattern, issues and impact. *Malaysian Journal of Society and Space*, 15, 5 2019.
- [34] Pavel Tarasov and Hitesh Tewari. The future of e-voting. *IADIS International Journal on Computer Science & Information Systems*, 12(2), 2017.
- [35] Philip Treleaven, Richard Gendal Brown, and Danny Yang. Blockchain technology in finance. *Computer*, 50(9):14–17, 2017.
- [36] Patrick I. Ukase and B. C. Audu. The role of civil society in the fight against corruption in nigeria's fourth republic: Problems, prospects and the way forward. *European Scientific Journal, ESJ*, 11, 2015.
- [37] Alexander Wilhelm. Blockchain technology and the development of african economies: Promises, opportunities, and the legal issues at stake. *RiA Recht in Afrika | Law in Africa | Droit en Afrique*, 22(1):3–42, 2019.
- [38] Jong-Sung You. Elections, interest group politics, and mass media. *Routledge Handbook of Korean Politics and Public Administration*, page 59, 2020.
- [39] Chaim Zins. Conceptual approaches for defining data, information, and knowledge. *Journal of the American society for information science and technology*, 58(4):479–493, 2007.