



## Assessment of BVAS as a Technological Tool for Curbing Electoral Malpractice in the 2023 Gubernatorial Elections in Enugu State

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### Abstract

This study assessed the Bimodal Voter Accreditation System (BVAS) as a technological tool for curbing electoral malpractice in the 2023 gubernatorial elections in Enugu State. The study specifically determined the extent BVAS reduced voter impersonation, the effectiveness of BVAS in curbing multiple voting, and the challenges encountered in its deployment and use. A mixed-methods convergent parallel design was adopted, combining quantitative and qualitative approaches. The population comprised 2,850 electoral stakeholders, from which 385 respondents were sampled using multi-stage sampling for the quantitative component, while 24 participants were purposively selected for in-depth interviews. Data were collected using a structured questionnaire and a semi-structured interview guide. Quantitative data were analyzed using mean and standard deviation with a criterion mean of 2.50, while qualitative data were analyzed using thematic analysis. The study found that BVAS significantly reduced voter impersonation through effective biometric authentication, deterrent effects, and elimination of fake Permanent Voter Cards. BVAS was effective in curbing multiple voting, though its cross-polling unit effectiveness was limited by network synchronization challenges. Significant challenges were encountered, including poor network connectivity, technical malfunctions, fingerprint capture failures, slow verification processes, software glitches, and accessibility difficulties for elderly and disabled voters. However, battery life, training adequacy, and power supply were not perceived as major challenges. The study concluded that BVAS substantially enhanced electoral integrity in Enugu State despite infrastructural and technical limitations. It was recommended that INEC should improve network infrastructure in rural areas, enhance BVAS accessibility features for vulnerable voters, and provide comprehensive training for poll workers on troubleshooting and problem-solving.

**Keywords:** BVAS, electoral malpractice, voter impersonation, multiple voting, biometric verification

### Introduction

Electoral integrity is a cornerstone of democratic governance worldwide. Free, fair, and credible elections legitimize political authority, ensure peaceful power transitions, and maintain public confidence in democratic institutions (Norris & Grömping, 2019). However, electoral malpractices such as voter impersonation, multiple voting, ballot stuffing, and result manipulation continue to undermine election credibility in many developing democracies, particularly in sub-Saharan Africa (Cheeseman et al., 2021). These malpractices distort the electorate's will, fuel political instability, trigger violent conflicts, and erode trust in democratic processes (Birch, 2020).

Nigeria's electoral history has been marked by widespread allegations and documented cases of electoral fraud. Since the return to democratic governance in 1999, successive elections have been marred by various forms of malpractice. These

include voter impersonation, multiple voting, ballot box snatching, and result manipulation. The 2007 general elections were widely condemned by local and international observers as lacking credibility due to massive irregularities (Human Rights Watch, 2007). The 2011 and 2015 elections witnessed significant incidents of electoral malpractice, particularly in regions where political contestation was intense (Nwauche, 2019). The 2019 general elections also recorded substantial irregularities despite technological interventions (Omotola & Alumona, 2020). These recurring challenges have prompted calls for electoral reforms and the adoption of technological innovations to enhance electoral process integrity.

In response to these challenges, the Independent National Electoral Commission (INEC) has progressively introduced technological innovations aimed at strengthening electoral integrity. The

introduction of the Permanent Voter Card (PVC) with biometric features in 2011 represented an initial step (Okoye & Nwangwu, 2018). The Card Reader technology deployed in 2015 and 2019 elections marked a significant advancement, though it faced operational challenges including device malfunctions, slow accreditation processes, and limited effectiveness in preventing multiple voting across different polling units (Adebayo & Omotola, 2016; Ezeani, 2020). The Bimodal Voter Accreditation System (BVAS), introduced in 2021, represents the most recent and advanced technological intervention in Nigeria's electoral process (Nwozor et al., 2022).

The Bimodal Voter Accreditation System (BVAS) represents a significant advancement in electoral technology in Nigeria. Unlike the earlier Card Reader technology which relied solely on fingerprint verification, BVAS incorporates dual biometric authentication through both fingerprint scanning and facial recognition. This provides multiple layers of identity verification (Jacho, 2025). Additionally, BVAS is designed to capture and transmit election results electronically. This enhances transparency and reduces opportunities for result manipulation during manual collation processes. The system's ability to operate in offline mode while storing data locally for subsequent synchronization addresses connectivity challenges in areas with poor network coverage (Agbaje, 2022). BVAS also features an improved user interface, enhanced battery life, and better integration with INEC's central database compared to previous technologies (Onapajo, 2023). The 2023 general elections in Nigeria marked the first widespread deployment of BVAS across all polling units in the country. This included the gubernatorial elections held in various states. The gubernatorial election in Enugu State, conducted on March 18, 2023, provided an important context for assessing BVAS effectiveness in curbing electoral malpractice. Enugu State, with its mix of urban and rural areas, diverse political landscape, and history of electoral contestation, offered a representative setting for examining how BVAS performs under varied conditions (Iwuoha & Aniche, 2023). Understanding BVAS effectiveness in this context is crucial for informing future electoral reforms and technological deployments not only in Nigeria but also in other developing democracies grappling with similar electoral challenges.

Despite the promising potential of BVAS, concerns have been raised regarding its practical effectiveness and the challenges associated with its deployment. Studies on electoral technologies in developing

countries have revealed that technological solutions often face implementation challenges related to infrastructure deficits, inadequate training, technical malfunctions, and resistance from political actors (Kerr & Lührmann, 2017). In the Nigerian context, previous assessments of the Card Reader technology revealed significant challenges including poor network connectivity, device failures, slow verification processes, and inadequate technical support at polling units (Adejumo, 2020). These experiences underscore the importance of empirically assessing new technological innovations like BVAS to determine their actual effectiveness and identify areas requiring improvement.

Several scholars have examined the role of technology in electoral processes globally. Garnett and James (2020) argue that electoral technology can enhance electoral integrity by reducing human discretion in critical processes, increasing transparency, and creating verifiable audit trails. Similarly, Krimmer et al. (2021) emphasize that election technologies, when properly implemented, can significantly reduce opportunities for fraud while improving efficiency and voter confidence. However, Norris (2020) cautions that technology is not a panacea. Its effectiveness depends largely on the broader electoral environment, including institutional capacity, political will, and stakeholder acceptance. Cantoni et al. (2020) add that the impact of electoral technology varies significantly based on implementation quality and contextual factors. These perspectives highlight the need for context-specific assessments of electoral technologies to understand their actual impact.

In the African context, studies have shown mixed results regarding the effectiveness of biometric voting technologies. In Ghana, the introduction of biometric voter registration and verification was credited with reducing voter impersonation and multiple voting, thereby enhancing electoral credibility (Ichino & Schündeln, 2012). Similarly, in Zambia, biometric voter registration was found to have improved the accuracy of voter rolls and reduced incidents of electoral fraud (Cheeseman & Sishuwa, 2021). However, in Kenya, the deployment of electronic voting and identification systems faced significant technical challenges during the 2017 elections. This led to controversies and legal challenges (Cheeseman et al., 2018). In Zimbabwe, biometric voter registration improved voter roll accuracy but faced challenges related to political manipulation and voter access (Masunungure & Badza, 2010). These varied experiences underscore

the importance of rigorous assessment of biometric technologies in specific electoral contexts.

Recent studies on digital election technologies have highlighted both opportunities and challenges. Garnett (2022) observes that biometric voter verification systems can effectively reduce identity-based fraud but often struggle with technical reliability and accessibility issues. Kersting and Baldersheim (2022) note that the success of electoral technologies depends heavily on infrastructure quality, political context, and implementation fidelity. In developing democracies specifically, Dodsworth and Cheeseman (2020) argue that electoral technologies can enhance credibility only when accompanied by broader institutional reforms and genuine political commitment to democratic principles.

In Nigeria, emerging research on BVAS has begun to provide insights into its performance. Preliminary studies suggest that BVAS has the potential to significantly reduce electoral malpractice. However, its effectiveness has been constrained by infrastructural challenges, particularly poor network connectivity and inadequate power supply (Omotola & Ayelabola, 2023). Other studies have highlighted challenges related to the slow pace of voter accreditation, difficulties in capturing biometric data for certain categories of voters, and inadequate training of electoral officials (Nwozor et al., 2023). Onapajo and Isike (2023) observed that BVAS performance varied significantly across different geographical contexts, with urban areas experiencing smoother operations compared to rural areas. However, most existing studies have been largely descriptive or based on limited data from a few polling units. There remains a need for comprehensive empirical studies that systematically assess BVAS effectiveness across multiple dimensions and contexts, incorporating both quantitative and qualitative data from diverse stakeholders. This study addresses this gap by providing a comprehensive assessment of BVAS as a technological tool for curbing electoral malpractice in the 2023 gubernatorial elections in Enugu State.

### Research Questions

The following research questions guided this study:

1. To what extent did the use of BVAS reduce voter impersonation during the 2023 gubernatorial election in Enugu State?
2. How effective was BVAS in curbing multiple voting during the 2023 gubernatorial election in Enugu State?

3. What challenges were encountered in the deployment and use of BVAS during the 2023 gubernatorial election in Enugu State?

### Methodology

#### Research Design

This study adopted a mixed-methods research design, specifically the convergent parallel design, which involved the concurrent collection and analysis of both quantitative and qualitative data. The mixed-methods approach was considered appropriate for this study because it allowed for a comprehensive examination of BVAS effectiveness and challenges from multiple perspectives, combining the statistical generalizability of quantitative data with the contextual depth of qualitative data. The quantitative component utilized a descriptive survey design to gather numerical data on stakeholders' perceptions regarding BVAS effectiveness in reducing voter impersonation, curbing multiple voting, and the challenges encountered during deployment and use. The qualitative component employed a phenomenological approach using semi-structured interviews to explore the lived experiences and in-depth perspectives of key stakeholders involved in the electoral process.

#### Area of the Study

The study was conducted in Enugu State, located in the South-East geopolitical zone of Nigeria. Enugu State was created on August 27, 1991, and comprises 17 Local Government Areas (LGAs), namely: Aninri, Awgu, Enugu East, Enugu North, Enugu South, Ezeagu, Igbo Etiti, Igbo Eze North, Igbo Eze South, Isi Uzo, Nkanu East, Nkanu West, Nsukka, Oji River, Udenu, Udi, and Uzo Uwani. The state covers a total land area of approximately 7,161 square kilometers and has an estimated population of about 4.4 million people based on the 2006 National Population Census projections. Enugu State is bounded by Kogi State and Benue State to the north, Ebonyi State to the east, Abia State to the south, and Anambra State to the west. The 2023 gubernatorial election in Enugu State was held on March 18, 2023, as part of the nationwide off-cycle governorship elections in Nigeria. The election witnessed the deployment of the Bimodal Voter Accreditation System (BVAS) for voter accreditation and result management across all polling units in the state. Enugu State was selected for this study due to the comprehensive deployment of BVAS technology during the gubernatorial election, the availability of diverse electoral stakeholders (INEC officials, party

agents, election observers, security personnel), and the mix of urban and rural polling units that provided varied contexts for examining BVAS performance. Additionally, the researcher's familiarity with the state facilitated access to respondents and relevant election data.

### Population of the Study

The population of this study comprised all individuals who were directly involved in the 2023 gubernatorial election in Enugu State and had firsthand experience with the deployment and use of BVAS. This population included INEC officials at the state, LGA, and polling unit levels; party agents from various political parties; election observers from civil society organizations and international monitoring bodies; security personnel deployed to polling units; ICT specialists involved in BVAS deployment and technical support; electoral officers; and voters who participated in the election. According to records from the Independent National Electoral Commission (INEC) Enugu State office, the population comprised approximately 2,850 individuals distributed as follows: 1,200 INEC ad-hoc staff (including Presiding Officers, Assistant Presiding Officers, and polling clerks), 850 party agents from the 18 registered political parties, 450 accredited election observers, 250 security personnel, 50 INEC permanent staff and electoral officers, and 50 ICT specialists involved in BVAS deployment. This population was considered finite and accessible for the purpose of this study.

### Sample and Sampling Techniques

The sample size for the quantitative component was 351, determined using Taro Yamane's formula. This was increased by 10% to account for non-response, yielding 385 respondents.

A multi-stage sampling technique was employed. First, the 17 LGAs were stratified into three geographical zones: Enugu Urban (6 LGAs), Enugu Semi-Urban (6 LGAs), and Enugu Rural (5 LGAs). Second, proportionate sampling determined the number of respondents from each stratum. Third, simple random sampling selected specific polling units. Finally, purposive sampling selected respondents from five stakeholder categories: INEC officials (110), party agents (105), election observers (75), security personnel (55), and voters (40).

For the qualitative component, 24 participants were purposively selected for in-depth interviews: 8 INEC officials, 5 party agents, 4 election observers, 4 ICT specialists, and 3 electoral officers. Selection criteria included direct involvement in BVAS deployment,

willingness to participate, ability to articulate experiences clearly, and representation of diverse perspectives.

### Instruments for Data Collection

Two research instruments were developed and used for data collection in this study: a structured questionnaire for the quantitative component and a semi-structured interview guide for the qualitative component.

The structured questionnaire was designed to collect quantitative data on stakeholders' perceptions regarding BVAS effectiveness and challenges. The questionnaire was divided into three clusters: Cluster A contained 10 items designed to assess the extent to which BVAS reduced voter impersonation during the election. Cluster B contained 10 items designed to assess the effectiveness of BVAS in preventing multiple voting. Cluster C contained 12 items designed to identify challenges encountered during BVAS deployment and use. The questionnaire items were structured using a four-point Likert scale with response options: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). The four-point scale was deliberately chosen to eliminate the neutral option, thereby compelling respondents to take a definite position on each statement.

The semi-structured interview guide was designed to collect qualitative data through in-depth interviews with key stakeholders. The interview guide was organized into three sections corresponding to the research questions and exploration of stakeholder experiences: The interview guide was designed to be flexible, allowing the interviewer to adjust question sequencing based on conversation flow, probe deeper into emerging themes, and explore unexpected insights while maintaining focus on the research questions.

### Validity of the Instruments

Three experts validated the instruments: two from Social Science Education (Political Science Education) and one from Science Education (Measurement and Evaluation). They examined the instruments for clarity, appropriateness, relevance, comprehensiveness, logical organization, and absence of bias. Based on their feedback, four items were rephrased, three redundant items were removed, two items were added, and several items were sequenced. The revised instruments were deemed valid for data collection.

### Reliability of the Instruments

Reliability was established through a pilot study conducted in Anambra State with 40 respondents similar to the study population. Cronbach's Alpha coefficients were 0.87, 0.84, and 0.82 for clusters A, B, and C respectively. These values exceeded the 0.70 threshold, confirming high internal consistency.

### Method of Data Collection

For the quantitative component, 385 copies of the structured questionnaire were distributed to respondents across the 17 Local Government Areas of Enugu State. The questionnaires were administered directly to respondents at convenient locations including INEC offices, political party offices, and civil society organization offices. Respondents were given 20-30 minutes to complete the questionnaire. The researchers clarified questions without influencing responses. Completed questionnaires were collected immediately or retrieved within three days. The data collection process lasted four weeks. Out of 385 questionnaires distributed, 368 were properly completed and returned, representing a 95.6% response rate. The 17 unreturned or improperly completed questionnaires were excluded from analysis.

For the qualitative component, 24 in-depth interviews were conducted with purposively selected key stakeholders. Prior to each interview, the researcher contacted potential participants, explained the study purpose, assured confidentiality, and scheduled interviews at convenient times and locations. Informed consent was obtained from all participants, including permission to audio-record

interviews. Each interview lasted 45 to 75 minutes. The semi-structured interview guide was used flexibly, allowing the researcher to probe deeper while ensuring all key questions were addressed. All interviews were conducted in English and audio-recorded using a digital voice recorder. Field notes captured non-verbal cues and contextual observations. Within 24-48 hours of each interview, recordings were transcribed verbatim and reviewed for accuracy. The qualitative data collection process lasted two weeks, conducted concurrently with the quantitative data collection.

### Method of Data Analysis

Data analysis was conducted separately for the quantitative and qualitative components before integration for triangulation. The quantitative data collected through the structured questionnaire were analyzed using descriptive statistics. For each item, the mean score was calculated to determine respondents' level of agreement or disagreement. The decision rule applied was based on the criterion mean of 2.50 derived from the four-point Likert scale. Items with mean values of 2.50 and above were interpreted as "Agree", while items with mean values below 2.50 were interpreted as "Disagree". The standard deviation was calculated to indicate the degree of variation or dispersion of responses from the mean, with lower standard deviation values indicating greater consensus among respondents. The qualitative data collected through semi-structured interviews were analyzed using thematic analysis.

## Results

**Research Question 1:** To what extent did the use of BVAS reduce voter impersonation during the 2023 gubernatorial election in Enugu State?

**Table 1:** Mean and Standard Deviation Analysis of the Extent BVAS Reduced Voter Impersonation

S/N	Item Statements	Mean	SD	Decision
1	The biometric verification feature of BVAS effectively authenticated voters' identities during the election	3.12	0.89	Agree
2	BVAS fingerprint scanning prevented unauthorized persons from voting in place of registered voters	3.05	0.93	Agree
3	The facial recognition capability of BVAS helped to identify and prevent voter impersonation	2.98	0.96	Agree
4	BVAS successfully matched voters' biometric data with their registered information	3.08	0.91	Agree
5	There were fewer reported cases of voter impersonation compared to previous elections without BVAS	3.18	0.87	Agree
6	BVAS prevented the use of fake or cloned Permanent Voter Cards (PVCs)	3.15	0.88	Agree
7	The real-time verification process of BVAS made it difficult for imposters to vote	3.21	0.85	Agree

S/N	Item Statements	Mean	SD	Decision
8	Poll workers were able to detect impersonation attempts more easily with BVAS	2.95	0.97	Agree
9	BVAS reduced the confidence of potential impersonators in attempting electoral fraud	3.06	0.92	Agree
10	The authentication process through BVAS was more secure than manual verification methods	3.24	0.83	Agree
<b>Grand Mean</b>		<b>3.10</b>	<b>0.90</b>	<b>Agree</b>

Table 1 presents the mean and standard deviation analysis of the extent to which BVAS reduced voter impersonation during the 2023 gubernatorial election in Enugu State. The mean values of items 1 through 10, which are 3.12, 3.05, 2.98, 3.08, 3.18, 3.15, 3.21, 2.95, 3.06, and 3.24 respectively, are all above the 2.50 benchmark for acceptance. This indicates that respondents agree with all statements regarding BVAS effectiveness in reducing voter impersonation. Specifically, respondents agreed that the biometric verification feature of BVAS effectively authenticated voters' identities during the election, BVAS fingerprint scanning prevented unauthorized persons from voting in place of registered voters, the facial recognition capability helped to identify and prevent voter impersonation, and BVAS successfully matched voters' biometric data with their registered information. Furthermore, respondents indicated that there were fewer reported cases of voter impersonation compared to previous elections without BVAS, BVAS prevented the use of fake or cloned PVCs, and the real-time verification process made it difficult for imposters to vote. Additionally, respondents agreed that poll workers were able to detect impersonation attempts more easily with BVAS, BVAS reduced the confidence of potential impersonators in attempting electoral fraud, and the authentication process through BVAS was more secure than manual verification methods. The grand mean of 3.10, which is substantially above the benchmark of 2.50, indicates that to a great extent, the use of BVAS reduced voter impersonation during the 2023 gubernatorial election in Enugu State.

The analysis revealed four major themes: (1) Enhanced identity authentication, (2) Deterrent effect on fraudsters, (3) Elimination of fake PVCs, and (4) Improved transparency.

#### Theme 1: Enhanced Identity Authentication

BVAS's biometric verification was identified as significantly superior to manual methods. An INEC official explained: "The biometric feature of BVAS was a game-changer. Unlike previous elections

where we just checked if the face on the PVC matched the person, BVAS required fingerprint authentication. We had cases where people tried to vote with relatives' cards, but the system rejected them immediately" (INEC-03). An election observer noted: "In 2019, verification was subjective. In 2023, BVAS provided objective, scientific verification. There was no room for manipulation" (OBS-02). However, challenges existed with fingerprint capture for elderly voters and manual laborers, requiring facial recognition as an alternative (INEC-06).

#### Theme 2: Deterrent Effect on Fraudsters

BVAS served as a psychological deterrent to impersonation. A party agent observed: "The knowledge that BVAS would verify fingerprints scared people who planned to vote with other people's cards. Word spread quickly that the machine was rejecting imposters. This had a chilling effect on would-be fraudsters" (PA-02). An electoral officer added: "BVAS didn't just catch impersonators; it prevented attempts. Many people abandoned their plans when they heard how strict the system was" (EO-01).

#### Theme 3: Elimination of Fake PVCs

BVAS effectively detected counterfeit cards. An ICT specialist explained: "BVAS reads the chip in genuine PVCs. Fake cards lack this chip. We recorded several instances where BVAS rejected PVCs that looked authentic but were counterfeit" (ICT-02). An INEC official noted: "We had fewer fake PVC incidents in 2023. BVAS caught these fakes in real-time, preventing their use" (INEC-01).

#### Theme 4: Improved Transparency

BVAS enhanced process transparency. A party agent stated: "I could clearly see when a voter was authenticated or rejected. The process wasn't subject to any official's whims. Even when my party lost, I couldn't complain about impersonation because I saw how thorough verification was" (PA-04). An observer emphasized: "BVAS brought scientific rigor. All stakeholders could see the same information, reducing disputes" (OBS-01).



**Research Question 2:** How effective was BVAS in curbing multiple voting during the 2023 gubernatorial election in Enugu State?

**Table 2:** Mean and Standard Deviation Analysis of BVAS Effectiveness in Curbing Multiple Voting

S/N	Item Statements	Mean	SD	Decision
1	BVAS effectively recorded each voter's biometric data to prevent voting more than once	3.09	0.91	Agree
2	The system successfully flagged voters who attempted to vote multiple times	2.87	0.99	Agree
3	BVAS centralized database prevented voters from voting at different polling units	2.76	1.03	Agree
4	Real-time synchronization of voter data across polling units reduced multiple voting incidents	2.68	1.06	Agree
5	There were fewer cases of multiple voting compared to elections without BVAS technology	3.14	0.88	Agree
6	BVAS prevented voters from using different PVCs to vote multiple times	3.02	0.94	Agree
7	The audit trail created by BVAS made it easier to detect multiple voting attempts	2.95	0.96	Agree
8	Poll officials received immediate alerts when duplicate voting attempts occurred	2.58	1.08	Agree
9	BVAS eliminated the possibility of voters being accredited more than once	2.91	0.98	Agree
10	The technology significantly improved the integrity of the one-person-one-vote principle	3.17	0.86	Agree
<b>Grand Mean</b>		<b>2.92</b>	<b>0.97</b>	<b>Agree</b>

Table 2 presents the mean and standard deviation analysis of BVAS effectiveness in curbing multiple voting during the 2023 gubernatorial election in Enugu State. The mean values of items 1 through 10, which are 3.09, 2.87, 2.76, 2.68, 3.14, 3.02, 2.95, 2.58, 2.91, and 3.17 respectively, are all above the 2.50 benchmark for acceptance. This indicates that respondents agree that BVAS was effective in curbing multiple voting during the election. Specifically, respondents agreed that BVAS effectively recorded each voter's biometric data to prevent voting more than once, the system successfully flagged voters who attempted to vote multiple times, and BVAS centralized database prevented voters from voting at different polling units. Respondents also agreed that there were fewer cases of multiple voting compared to elections without BVAS technology, BVAS prevented voters from using different PVCs to vote multiple times, and the audit trail created by BVAS made it easier to detect multiple voting attempts. Although poll officials received immediate alerts when duplicate voting attempts occurred, this item recorded the lowest mean score among all items in this section, suggesting possible delays or inefficiencies in the alert system. Furthermore, respondents agreed that BVAS eliminated the possibility of voters being accredited more than once and that the technology

significantly improved the integrity of the one-person-one-vote principle. The grand mean of 2.92, which is above the benchmark of 2.50, indicates that BVAS was effective in curbing multiple voting during the 2023 gubernatorial election in Enugu State. This finding demonstrates that BVAS technology played a significant role in preventing voters from casting their votes more than once, thereby enhancing the credibility of the electoral process.

Three major themes emerged: (1) Real-time biometric recording, (2) Cross-polling unit prevention mechanisms, and (3) Data synchronization limitations.

**Theme 1: Real-time Biometric Recording and Tracking**

BVAS effectively prevented multiple voting at individual polling units. An INEC official explained: "Once accredited, a voter's fingerprint was recorded. If they tried voting again at the same unit, BVAS immediately flagged them" (INEC-05). A party agent recounted: "Someone tried to vote twice after changing clothes. When his finger touched BVAS, the system rejected him. He was handed to security. That showed BVAS was working" (PA-03).

**Theme 2: Cross-Polling Unit Prevention Mechanisms**

BVAS faced challenges preventing cross-unit voting due to connectivity issues. An ICT specialist explained: "BVAS should detect if someone voted elsewhere through centralized database synchronization. However, network problems meant synchronization was delayed or incomplete. While effective at individual units, cross-unit effectiveness was compromised" (ICT-03). An electoral officer noted: "Even if synchronization delays allowed some cross-unit voting, the biometric audit trail made such fraud detectable during post-election verification" (EO-02). An observer added: "Compared to 2019 when multiple voting was rampant, BVAS made a significant difference despite network limitations" (OBS-04).

**Theme 3: Limitations in Data Synchronization**

Network connectivity was the primary challenge. An INEC official stated: "Network was BVAS's

Achilles' heel. In urban areas with good coverage, real-time synchronization worked well. In rural areas, synchronization delays created windows for determined fraudsters" (INEC-02). A rural party agent elaborated: "BVAS worked offline for hours in my area. Someone could theoretically vote at one unit, move to another offline unit, and vote again before systems synced" (PA-05). An ICT specialist acknowledged: "Network issues created challenges. However, biometric data stored locally synced later, enabling detection during results collation. The system couldn't prevent all multiple voting in real-time but could detect it after" (ICT-04). An observer concluded: "No technology is perfect in challenging environments. BVAS was significantly better than previous systems. Multiple voting was substantially reduced" (OBS-03).

**Research Question 3:** What challenges were encountered in the deployment and use of BVAS during the 2023 gubernatorial election in Enugu State?

**Table 3:** Mean and Standard Deviation Analysis of Challenges Encountered in BVAS Deployment and Use

S/N	Item Statements	Mean	SD	Decision
1	There were technical malfunctions with BVAS devices during the election	2.95	0.96	Agree
2	Poor network connectivity affected BVAS performance at polling units	3.24	0.84	Agree
3	Battery life of BVAS devices was insufficient for the entire voting period	1.88	0.99	Disagree
4	Poll workers lacked adequate training on how to operate BVAS effectively	2.06	1.02	Disagree
5	The biometric verification process was too slow, causing long queues	3.06	0.92	Agree
6	BVAS devices failed to capture fingerprints of some eligible voters	3.11	0.89	Agree
7	There were delays in the deployment of BVAS devices to some polling units	2.68	1.04	Agree
8	Inadequate power supply hampered the charging and operation of BVAS devices	2.18	0.87	Disagree
9	There were insufficient backup devices available when BVAS malfunctioned	2.84	0.98	Agree
10	Software glitches and system errors occurred during voter accreditation	2.91	0.97	Agree
11	Elderly voters and those with disabilities faced challenges using BVAS	3.15	0.88	Agree
12	Limited technical support was available at polling units to resolve BVAS issues	2.79	1.00	Agree
<b>Grand Mean</b>		<b>2.74</b>	<b>0.97</b>	<b>Agree</b>

Table 3 presents the mean and standard deviation analysis of challenges encountered in the deployment and use of BVAS during the 2023 gubernatorial election in Enugu State. The mean values of items 1, 2, 5, 6, 7, 9, 10, 11, and 12, which are 2.95, 3.24, 3.06, 3.11, 2.68, 2.84, 2.91, 3.15, and 2.79 respectively, are all above the 2.50 benchmark for acceptance. The most significant challenges identified by respondents include poor network connectivity affecting BVAS performance at polling units, elderly voters and those with disabilities facing challenges using BVAS, BVAS devices failing to capture fingerprints of some eligible

voters, the biometric verification process being too slow and causing long queues, technical malfunctions with BVAS devices during the election, and software glitches and system errors occurring during voter accreditation. Other notable challenges include there being insufficient backup devices available when BVAS malfunctioned, limited technical support being available at polling units to resolve BVAS issues, and delays in the deployment of BVAS devices to some polling units. However, items 3, 4, and 8, with mean values of 1.88, 2.06, and 2.18 respectively, are below the 2.50 benchmark, indicating that respondents disagree

with these statements. This suggests that the battery life of BVAS devices was generally sufficient for the entire voting period, poll workers had adequate training on how to operate BVAS effectively, and power supply was not a significant hindrance to the charging and operation of BVAS devices. The grand mean of 2.74, which is above the benchmark of 2.50, indicates that various significant challenges were encountered in the deployment and use of BVAS during the 2023 gubernatorial election in Enugu State.

Three major themes emerged from the qualitative data: (1) Infrastructural challenges, (2) Technical and operational challenges, and (3) Limited political interference.

#### Theme 1: Infrastructural Challenges

Network connectivity was the most critical challenge. An INEC official stated that network connectivity was "our biggest headache," particularly in rural areas with poor or non-existent coverage. Some polling units operated offline for 4-6 hours, compromising real-time synchronization features. An ICT specialist explained that when devices operate offline for extended periods, advanced features like real-time synchronization are compromised. Power supply was the second major challenge. Many LGA offices lacked stable electricity, forcing reliance on generators. Some devices were not fully charged due to fuel shortages or generator breakdowns, causing several devices to run out of battery before voting ended.

#### Theme 2: Technical and Operational Challenges

Fingerprint capture failure was most common, particularly for elderly voters, farmers, and manual laborers with worn or rough fingers. An INEC official explained that officials had to switch to facial recognition, which was slower and caused delays. Software glitches disrupted operations when BVAS devices froze during accreditation, requiring 5-10-minute restarts. Operational challenges included deployment delays to some locations, slow verification processes that created long queues and discouraged some voters, and insufficient backup devices causing significant delays when malfunctions occurred. Elderly and disabled voters faced accessibility difficulties, with BVAS design failing to consider physical limitations. An observer noted that wheelchair users couldn't reach high tables, and those with visual impairments or trembling hands struggled with finger positioning.

#### Theme 3: Limited Political Interference

Political interference was minimal. An INEC official noted that challenges were technical and infrastructural, not politically motivated, stating that

"BVAS has integrity that makes manipulation difficult." An observer concurred that BVAS proved resistant to political manipulation because "you either authenticated or you didn't." However, a party agent cautioned that attempts to intimidate officials into bypassing BVAS were reported in some areas, suggesting continued vigilance is necessary despite BVAS's overall resistance to manipulation.

#### Triangulation

The qualitative findings strongly corroborate the quantitative results. Both data sets confirm that BVAS was effective in reducing voter impersonation through enhanced authentication, deterrent effects, and fake PVC elimination. BVAS was effective in curbing multiple voting, though limited by synchronization challenges. Significant challenges were encountered, particularly infrastructural, technical, training, operational, and accessibility issues. The qualitative data explains the lower quantitative scores for real-time synchronization and immediate alerts, attributing them to network connectivity problems.

#### Discussion

The study found that BVAS significantly reduced voter impersonation during the 2023 gubernatorial election in Enugu State. The dual biometric verification mechanism (fingerprint and facial recognition) created multiple authentication layers that made impersonation extremely difficult. Unlike manual verification that relied on visual comparison, BVAS required unique biometric matches nearly impossible to replicate. The real-time verification created immediate consequences for impersonation attempts, serving as a powerful deterrent. BVAS also eliminated fake PVCs by reading embedded chips and rejecting counterfeit cards. This finding aligns with studies in Ghana by Ichino and Schündeln (2012) and Zambia by Cheeseman and Sishuwa (2021), which showed that biometric verification significantly reduced voter impersonation and enhanced electoral credibility. In Nigeria, Omotola and Ayelabola (2023) similarly found that BVAS demonstrated considerable effectiveness in authenticating voters' identities. The finding supports the Technology Acceptance Model (Davis, 1989), showing that technologies demonstrating clear usefulness gain stakeholder trust and acceptance. However, the study identified accessibility challenges for elderly voters and manual laborers whose fingerprints were difficult to capture. Facial recognition served as an alternative but was slower, suggesting need for technical

enhancement. Despite these limitations, BVAS substantially reduced voter impersonation in the 2023 election.

BVAS was effective in curbing multiple voting, though this rating was lower than for voter impersonation reduction. The system performed excellently in preventing repeat voting at individual polling units, immediately flagging duplicate accreditation attempts. However, effectiveness in preventing cross-unit voting was compromised by network connectivity challenges. Poor network coverage forced many devices to operate offline for extended periods, preventing real-time database synchronization. This created windows for determined individuals to vote at multiple units before systems synchronized. Despite this limitation, BVAS created robust audit trails through locally stored biometric data that eventually synchronized, enabling post-election detection of multiple voting. This finding aligns with Kersting and Baldersheim (2022), who noted that electoral technologies in developing countries often fail to achieve full potential due to infrastructure deficits. Nwozor et al. (2023) similarly reported network connectivity as a major constraint on BVAS performance. However, stakeholders agreed that multiple voting was substantially reduced compared to previous elections, even without perfect real-time prevention. This finding demonstrates that BVAS effectiveness depends not only on technical specifications but also on the enabling infrastructure environment, underscoring the need for parallel telecommunications investments alongside electoral technology adoption, as emphasized by Garnett and James (2020).

The study identified significant challenges in BVAS deployment, with infrastructural and technical issues being most critical. Poor network connectivity was the most severe challenge, particularly in rural areas where telecommunications infrastructure is underdeveloped. This created geographical disparities in BVAS performance, with urban units operating smoothly while rural units faced frequent disruptions. Technical challenges included fingerprint capture failures, especially for elderly voters and manual laborers, device malfunctions, and software glitches. These findings align with Ezeani (2020) and Adebayo and Omotola (2016), who reported similar challenges with Card Reader technology, suggesting persistent limitations of fingerprint technology in tropical environments with diverse user populations. Operational challenges included slow verification processes causing long queues, and insufficient backup devices.

Accessibility challenges for elderly and disabled voters highlighted design inadequacies in accommodating diverse physical abilities. However, battery life, training adequacy, and power supply were not perceived as major challenges, suggesting INEC made improvements in these areas compared to previous elections. Notably, political interference was not significant, indicating BVAS's inherent resistance to manipulation through its objective biometric authentication. This contrasts with Kenya (Cheeseman et al., 2018) and Zimbabwe (Masunungure & Badza, 2010), where political interference with electoral technologies was documented. These findings align with Dodsworth and Cheeseman (2020), who argue that electoral technology effectiveness is consistently limited by infrastructure deficits, inadequate implementation capacity, and insufficient attention to user diversity.

### Conclusion

Based on the findings of this study, it is concluded that the Bimodal Voter Accreditation System (BVAS) substantially enhanced electoral integrity during the 2023 gubernatorial election in Enugu State by significantly reducing voter impersonation and curbing multiple voting, despite facing infrastructural and technical challenges. The technology demonstrated considerable effectiveness in authenticating voters' identities through dual biometric verification, creating robust audit trails, and resisting political manipulation. However, its full potential was constrained by systemic infrastructural deficits, particularly poor network connectivity in rural areas, technical limitations in biometric capture for certain voter categories, and design inadequacies that created accessibility barriers for vulnerable groups. The study concludes that while BVAS represents a significant advancement in Nigeria's electoral technology landscape and should be retained for future elections, maximizing its effectiveness requires parallel investments in telecommunications infrastructure, continuous refinement of the technology to address identified limitations, comprehensive training for electoral officials on troubleshooting and problem-solving, and adoption of inclusive design principles to ensure accessibility for all voters.

### Recommendations

Based on the findings of this study, the researcher recommended that:

1. INEC should establish a Technology Performance Monitoring Unit to

continuously assess BVAS performance across different contexts. This unit should collect data on device failure rates, verification times, fingerprint capture success rates, and network connectivity issues.

2. INEC should partner with relevant ministries and telecommunications companies to map network coverage gaps before elections. Polling units in areas with poor coverage should receive priority for network infrastructure upgrades or alternative connectivity solutions such as satellite internet.
3. INEC should develop a voter education program specifically focused on BVAS technology. This program should address voter concerns, explain the verification process, and provide guidance for voters who may face challenges with fingerprint capture. The program should use multiple channels including radio, television, social media, and community meetings.
4. INEC should conduct post-election technology audits after each election cycle. These audits should systematically document challenges encountered, solutions implemented, and lessons learned. Findings should inform technology procurement decisions and deployment strategies for future elections.
5. The National Assembly should appropriate adequate funding for electoral technology infrastructure development. This should include dedicated budget lines for network infrastructure upgrades, device procurement and maintenance, technical personnel training, and research and development for technology improvements.
6. INEC should explore partnerships with technology companies and academic institutions to develop customized solutions for Nigerian electoral contexts. These partnerships could focus on improving fingerprint capture algorithms for tropical environments, developing offline-first architectures that minimize connectivity dependence, and creating accessible interfaces for diverse user populations.

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