Socio-Technical Dynamics of Election Technology Adoption in Nigeria: A Comprehensive Analysis

Submitted in fulfilment of the requirements of the degree of Doctor of Philosophy in Creative Technologies

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Abstract

This thesis examines the socio-technical dynamics of election technology adoption in Nigeria, employing mixed-methods research to understand how technological innovation intersects with socio-political factors in electoral processes. Drawing on socio-technical systems theory, the study investigates the complex relationships between political, cultural, infrastructural, and social factors shaping election technology implementation.

The research surveyed 550 stakeholders across Nigeria and analyzed election technology publications from 2002-2025. Findings reveal that while 74.6% report moderate to high technology familiarity, trust remains predominantly moderate (46.9%), with 29.5% expressing low or no trust. Ordinal regression identified political influence as the strongest trust inhibitor (OR=0.153), while voter education emerged as a critical enabler (OR=2.670). Document analysis confirmed socio-technical dynamics dominate discourse (70.7%), surpassing technical considerations (62.5%).

Key challenges include frequent technical failures (experienced by 78.1% of respondents) and perceived political interference (75.9% report moderate to strong influence). These factors significantly impact trust and adoption. However, 80.9% emphasize voter education's importance, while 74.9% support increased infrastructure funding, indicating pathways for improvement.

The study contributes to socio-technical theory by demonstrating how election technologies are socially constructed rather than neutral tools. Evidence-based recommendations include strengthening legal frameworks, implementing independent audits, establishing stakeholder consultation forums, and comprehensive voter education. A phased implementation approach is proposed: optimizing current systems short-term, piloting emerging technologies (blockchain, AI) medium-term, and considering e-voting only after addressing infrastructure and trust deficits.

The findings underscore that successful election technology requires holistic approaches addressing political independence, stakeholder engagement, infrastructure reliability, and public trust. This research provides critical insights for policymakers and electoral bodies seeking to leverage technology for credible, inclusive elections in Nigeria's evolving democracy.

Keywords: Election technology, socio-technical systems, Nigeria, electoral integrity, trust, political influence, digital democracy

Ethics Approval

This research was subject to AUT Ethics Committee approval, which was granted on May 4, 2022 with the approval number 21/10

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List of Major Abbreviations

Abbreviation	Full Name
AFIS	Automated Fingerprint Identification System
AI	Artificial Intelligence
APC	All Progressives Congress
PDP	People Democratic Party
A4AI	Alliance for Affordable Internet
BVAS	Bimodal Voter Accreditation System
CSRVS	Collation Support and Result Verification System
CDD	Centre for Democracy and Development
DDCM	Direct Data Capture Machine
INEC	Independent National Electoral Commission
IReV	INEC Result Viewing Portal
IVED	INEC Voter Enrollment Device
LLMs	Large Language Models
PVC	Permanent Voter Card
SCR	Smart Card Reader

Attestation of Authorship

I affirm that the present submission is an original piece of work authored solely by myself. To the best of my understanding and conviction, it does not incorporate any previously published or written material by any other individual, unless explicitly acknowledged in the acknowledgements section. Furthermore, it does not include material that has been substantially submitted for the purpose of obtaining any other academic degree or diploma from a university or other institution of higher education. The ownership of all images utilised in this dissertation rests with the author, unless explicitly indicated otherwise.

Oluwaseun David ADEPOJU

1/03/2025

CHAPTER 1

INTRODUCTION

1.0 Research Motivation

The integration of technology into electoral processes has the potential to significantly enhance transparency, efficiency, and credibility (Vinayachandra et al., 2020). This technological transformation of elections represents a global trend toward digitization of democratic processes, with varied implementation approaches across different political contexts (Janci et al., 2023). In Nigeria, a country with a complex socio-political landscape characterized by deep ethnic divisions, regional disparities, and a history of political instability, the adoption of technological innovations in elections presents both unique challenges and opportunities (Okwueze, 2022; Agbu, 2016). Despite the optimism surrounding these technologies, their implementation has been hindered by significant socio-technical failures that range from system malfunctions to institutional resistance (Iwuoha, 2018, p.3; Olurode, 2017).

It is worthy of note that despite legislative dialogues and stakeholders call for the adoption of e-voting in Nigeria as a future possible alternative to solving electoral frauds in Nigeria, it has not been adopted except in a few regional trials such as its use in the Kaduna state local government elections in May 12, 2018 (Premium Times, 2018). This limited adoption reflects broader concerns about technical readiness, stakeholder buy-in, and the absence of comprehensive legal frameworks necessary for nationwide implementation (Iwuoha,2018). The hesitancy to fully embrace electronic voting systems persists despite successful implementations in comparable developing democracies such as Brazil and India (Cheeseman et al., 2018).

Nigeria's electoral history is marked by fraud, violence, and logistical problems, all of which undermine the democratic process and citizens' confidence in electoral outcomes (Steve.al, 2019). These persistent challenges have contributed to declining voter turnout and growing political apathy among the electorate (Chukwunenye & Funmilayo 2024). Technological innovations, such as biometric verification, digital voter registers, and permanent voters' cards, have been introduced to address these issues and restore public trust (Ayeni & Esan, 2018, p. 3). However, their success is not solely contingent on technical capabilities but also on the interplay between social constructs, which are collectively referred to as socio-technical factors. These factors encompass institutional readiness, cultural attitudes toward technology, digital literacy, and political will (Dode,2007). Sociotechnical systems theory is where this idea comes from. This theory says that for a system to work at its best, both the technical and social parts must be fully integrated and considered as interdependent elements within a cohesive system (Trist, 1951, p. 35; Baxter & Sommerville, 2011).

The socio-technical framework underscores the importance of considering social, cultural, and institutional factors in the adoption of technology (Sianipar et al., 2015; Davis et al., 2014). This approach recognizes that technological systems do not exist in isolation but are embedded within complex social environments that shape their implementation and effectiveness (Geels, 2019). Despite the introduction of election technologies in Nigeria, covering voter registration, biometric verification, results transmission, and vote counting, major challenges persist that highlight the gap between technological potential and practical implementation (Chukwuma, 2022). Some of the problems that have made them less useful are poor infrastructure, including unreliable electricity supply and limited internet connectivity in rural areas, a lack of knowledge about technology among both electoral officials and voters, and social and political opposition from stakeholders who benefit from the status quo (Fatai, 2020, Emmanuel et al., 2013, Osho et al., 2015).

Past attempts to utilise technology for electoral reform have yielded mixed results, emphasising the need for a more nuanced approach that accounts for sociotechnical dimensions (Uzodike & Onapajo, 2019). Notable examples include the partial implementation of the Smart Card Reader in the 2015 general elections, which faced technical glitches and resistance from political actors (Nwangwu, 2019), and the controversial rollout of the Bimodal Voter Accreditation System (BVAS) that promised improved verification but encountered significant operational challenges in practice (Ogbadebo,2025).

Due to the issues highlighted above, I have done this research study on socio-technical analysis of the factors that affect how technology is used and integrated in Nigerian elections. Through examining the interactions between social dynamics and technical systems within Nigeria's unique context, I provided a holistic understanding of the factors shaping the deployment and effectiveness of election technologies in Nigeria. This research contributes to the growing body of literature on election technology in developing democracies and offers practical insights for policymakers seeking to leverage technological innovations to strengthen electoral processes while navigating complex socio-political realities.

1.1 Research Gap

Although numerous studies have explored the use of technology in Nigerian elections, there is a notable gap in the literature concerning the role of socio-technical frameworks in technology adoption. Previous research by Unufe & Justine (2019) and Adeshina & Ojo (2020), and others has examined challenges and opportunities linked to technologies such as electronic voting systems and biometric registration. However, these studies often treat technology adoption as a purely technical issue, overlooking the critical role that social, institutional, and cultural factors play in the process.

The technical determinism that dominates existing scholarship (Okoye et.al, 2015; Shuaibu et. al 2017) fails to account for the complex interplay between technological systems and the social

environments in which they operate. Iwuoha (2018) examines biometric voter registration but neglects how local power dynamics affect implementation. Similarly, Tunmibi et.al (2023) document infrastructure challenges without adequately addressing how these challenges intersect with institutional capacities and social expectations. Even when researchers like Omotola (2010) acknowledge implementation difficulties, they rarely employ robust socio-technical frameworks to analyze these challenges holistically.

This gap is particularly significant in Nigeria, where the successful deployment of election technologies is often hindered by infrastructural shortcomings, limited digital literacy, and political interference. As Obiefuna-Oguejiofor (2018) argues, technology deployment in Nigerian elections represents "solutions in search of problems" when divorced from social realities. Current existing research lacks an in-depth exploration of how socio-technical factors, including social norms, institutional dynamics, and cultural contexts shape the adoption and integration of these technologies. Akah et. al (2024) examination of BVAS (Bimodal Voter Accreditation System) utilization highlights technical successes but fails to adequately explain resistance among certain stakeholders and implementation disparities across regions.

Unlike countries such as Estonia, where digital voting technologies have been successfully integrated within a compatible socio-technical ecosystem (Vassil et al., 2016; Tsahkna,2013), Nigeria's experience reveals the limitations of technology-first approaches that neglect social dimensions. To address this gap, I adopted a socio-technical lens, focusing on how perceptions, infrastructure, and institutional structures affect the uptake of election technologies in Nigeria. This approach builds upon foundational socio-technical systems theory (Emery & Trist, 1973; Geels, 2004) and more recent applications to electoral systems by scholars such as McGrath & Maiye (2010).

The socio-technical lens offers a more comprehensive understanding of the challenges and opportunities surrounding technology adoption in elections in Nigeria, where technology implementation faces significant socio-technical hurdles. Following Orlikowski's (2000) concept of "technologies-in-practice," this research examines how election technologies are actually used, rather than how they were designed to function. Bond et.al (2014) have recently demonstrated how Smart Card Readers were repurposed and circumvented in ways that designers never anticipated, highlighting the gap between technological design and implementation.

Policymakers, election officials, and technology providers will benefit from the insights discussed in the following chapters on how socio-technical factors influence the success or failure of election technologies. As Ahmed & Mwandosya (2024) comparative analysis of electoral technologies across West Africa demonstrates, purely technical solutions often fail without corresponding attention to the social dimensions of implementation. This research

therefore offers a crucial correction to technically deterministic approaches that have dominated both academic literature and policy discussions around election technology in Nigeria.

1.2 Objectives of the Study

The primary objective of this research study is to critically investigate the socio-technical factors influencing the adoption, integration, and effectiveness of technological applications in Nigerian elections. Specifically, the study aims to;

1. Critically evaluate the socio-technical factors that significantly affect the adoption and efficacy of technological interventions in electoral processes in Nigeria.
2. Rigorously investigate the socio-technical challenges and opportunities in the deployment and scaling of election technologies within the Nigerian context.
3. Explore how socio-technical frameworks shape the design, implementation, and impact of technological applications in Nigerian elections, with the goal of providing strategic recommendations for future deployments.
4. Develop evidence-based socio-technical policy recommendations for Nigerian policymakers and election stakeholders to optimize the deployment and use of technology in elections.

1.3 Research Questions

This study explores the socio-technical factors of technology adoption in Nigerian elections through the following research questions;

1. What are the critical socio-technical determinants influencing the adoption and integration of technological innovations in Nigerian electoral processes, and how do these determinants interact within Nigeria's unique socio-political context?
2. What are the predominant socio-technical challenges and opportunities presented by the deployment of election technologies in Nigeria, and how do they impact electoral integrity, transparency, and public trust?
3. How do socio-technical frameworks shape the design, implementation, and evaluation of technological systems in Nigerian elections, and what are their implications for achieving democratic outcomes?
4. What evidence-based, socio-technical guidelines can be developed for Nigerian policymakers and election stakeholders to optimize the deployment and use of technology in the electoral process, considering both local and global best practices?

1.4 Significance of the Research

This research holds significant academic and practical value. Through the critical examination of the socio-technical factors influencing technology adoption in Nigerian elections, it sheds light on the complex interplay between social, technical, and institutional factors. The understanding of this interplay is vital for improving the effectiveness of election technologies and for designing interventions that account for the realities of the Nigerian socio-political environment.

The study's unique contribution lies in its holistic approach to electoral technology assessment, moving beyond purely technical evaluations to consider how technologies function within Nigeria's distinct cultural, political, and institutional ecosystems. By examining both the technical functionality of electoral systems and their social embeddedness, this research provides a comprehensive framework for understanding why certain technologies succeed or fail in the Nigerian context.

Importantly, this work addresses a critical gap in our understanding of technology adoption in emerging democracies, where contextual factors often create implementation challenges not experienced in more established democratic systems. The Nigerian case study offers valuable lessons about how local power dynamics, infrastructure limitations, and trust deficits can significantly impact the deployment and acceptance of electoral technologies.

The study provides policymakers, election officials, and technology providers with actionable insights, grounded in socio-technical frameworks, for the successful design and implementation of electoral technologies. Such informed decision-making is crucial for enhancing transparency, security, and inclusivity in Nigerian elections, thereby reinforcing democratic governance and public trust.

These practical implications extend to capacity building and institutional strengthening, offering guidance for developing technical competencies among electoral stakeholders while simultaneously addressing social barriers to technology adoption. By identifying specific socio-technical barriers and enablers, the research enables more targeted interventions that can effectively bridge the gap between technological potential and operational reality in Nigerian elections.

From an academic perspective, this study contributes to the growing body of knowledge on socio-technical systems and electoral technology. Its findings provide both empirical evidence and theoretical insights that can be applied to other contexts, supporting the broader integration of socio-technical frameworks in studies of technological adoption in elections.

The research advances scholarly understanding of how socio-technical approaches can be effectively applied to analyze electoral systems in developing democracies, where unique challenges of infrastructure, literacy, and institutional capacity require specialized analytical

frameworks. By demonstrating the efficacy of socio-technical analysis in this context, the study provides a methodological template that researchers can adapt to examine similar phenomena in comparable settings across Africa and beyond.

Furthermore, the insights generated on stakeholder engagement, institutional adaptation, and public trust dynamics contribute to theoretical conversations about technology-enabled democratic processes in transitional political systems. This enriches both the fields of election studies and socio-technical systems theory, creating new pathways for interdisciplinary research at their intersection.

1.5 Novel Research Contribution

This research offers a unique contribution by applying a socio-technical lens to the study of technology adoption in Nigerian elections. While previous studies have examined various technological applications in Nigerian elections, this study's focus on the interrelated social, cultural, and institutional factors is novel. The socio-technical framework emphasizes the need to go beyond technical considerations and engage with the broader social context in which technology operates.

The research study contributes theoretically to the body of knowledge on technology use in elections in Nigeria by advancing socio-technical systems theory in electoral research and empirically by offering insights into election technology adoption in Nigeria. Practically, the study recommends not putting the "cart before the horse" by strengthening digital infrastructure, improving election officials' preparedness and enhancing stakeholder engagement. The study further advocates for phased deployment, pilot programs, and legal backing for mandatory adoption of elections technology.

1.6 Definition of Terms

Socio-Technical Systems refer to an analytical framework that emphasizes the mutual shaping of social and technical elements. In the context of this study, it is used to understand how people, institutional processes, infrastructure, technology, and culture interact to determine the effectiveness of election technologies in Nigeria.

Election Technology encompasses digital or electronic tools deployed by electoral management bodies to improve different stages of the electoral process. In this study, it includes biometric systems, smart card readers, result transmission platforms, and voter authentication devices such as BVAS and SCR.

The Independent National Electoral Commission (INEC) is the statutory body responsible for conducting and overseeing elections in Nigeria. The commission plays a central role in the

adoption, deployment, and regulation of election technologies. Its organizational capacity and credibility significantly influence how technology is perceived and used.

The Bimodal Voter Accreditation System (BVAS) is a biometric device introduced by INEC to accredit voters through both fingerprint and facial recognition. It replaced earlier systems like the Smart Card Reader and is intended to reduce impersonation and enhance the credibility of voter verification on election day.

The INEC Result Viewing Portal (IReV) is an online platform that allows the public to view scanned polling unit results in real time. It was introduced to increase transparency in the collation and announcement of election results and to help prevent result manipulation at higher collation levels.

The Permanent Voter Card (PVC) is a biometric-based ID card issued to registered voters. It contains encrypted demographic and biometric data and must be presented and authenticated during voter accreditation. The PVC is a core component of the biometric election architecture.

The Smart Card Reader (SCR) was a handheld device first introduced in the 2015 elections to authenticate voters by reading data from the PVC and matching it to live fingerprint input. Though later replaced by BVAS, it was a foundational innovation in biometric voter verification.
The Collation Support and Result Verification System (CSRVS) is a digital tool used by INEC to validate and crosscheck election results during collation. It automatically detects inconsistencies and errors in result entries, thereby enhancing the reliability of the final tallies. However, its effectiveness is contingent on user training, digital infrastructure, and institutional enforcement.

Digital Literacy refers to the ability of election stakeholders, voters, officials, and observers to interact meaningfully with technology. It includes understanding how devices work, troubleshooting basic issues, and making informed judgments about the credibility of digital tools. In this study, digital literacy is treated as a key variable influencing trust and adoption.

Electoral Integrity is defined as the degree to which elections are conducted in accordance with international democratic norms and standards, ensuring that processes are free, fair, and credible. The adoption of technology is expected to improve integrity by reducing manual fraud, ensuring transparency, and enhancing accountability.

CHAPTER 2

SOCIO-TECHNICAL THEORY REVIEW

2.0 Introduction

This section of the research study critically examines the deployment of technology in Nigeria's electoral process through a socio-technical systems lens. This provides a comprehensive understanding of the interaction between social, institutional, and technical factors that shape the adoption and effectiveness of electoral technologies. The review is organized into sections that explore these dynamics within Nigeria's socio-political environment.

In this section, I began by introducing socio-technical systems theory, the study's theoretical foundation, which emphasizes the need for alignment between social and technical systems for optimal outcomes. Following this, I analyzed how technology influences Nigeria's socio-political context, particularly the role of digital technologies in political engagement and participation. Some of the highlights show that while these technologies have fostered greater mobilization, they have also presented challenges, such as misinformation, ethnic polarization, and public distrust in the electoral process.

Next, I reviewed and examined the historical evolution of Nigeria's electoral system, from colonial times to the Fourth Republic, highlighting key reforms and the role of stakeholders like the Independent National Electoral Commission (INEC). This historical analysis contextualizes the deployment of election technologies in an environment marked by political resistance and institutional challenges.

In the subsequent sections, I examined the opportunities and challenges of electoral technology adoption, including infrastructural inadequacies and gaps in digital literacy among voters and officials. In addition, I looked at the feasibility of emerging technologies such as Blockchain and Artificial Intelligence in Nigerian elections. I concluded the review by drawing insights from countries that have successfully integrated election technologies, offering valuable lessons for Nigeria. I also looked at the regional trial of e-voting in 2018 and its implication for the future of e-voting in Nigeria, the financial implications of election technologies and the dilemma that comes with technology procurement for elections.

In summary, the literature review underscores the socio-technical landscape of election technology deployment in Nigeria, showing that success depends not only on technological tools but also on the broader social, infrastructural, and political context. This sets the stage for addressing the research questions by detailing the challenges and opportunities in the Nigerian context.

2.1 Socio-Technical Systems Theory

Socio-technical theory is a comprehensive framework that examines the intricate interplay between social and technical components within organizations. Developed in the early 1950s by Eric Trist and his colleagues at the Tavistock Institute of Human Relations, this theory emerged from empirical studies in industrial settings, particularly coal mining, where it became evident that both human and technological elements significantly influence organizational performance. Socio-technical theory posits that organizations are complex systems composed of interrelated social and technical subsystems, and understanding their interaction is crucial for optimizing performance, enhancing employee satisfaction, and fostering innovation (Trist & Bamforth, 1951). Below are the key components of the Socio-technical Systems Theory;

1. **Social System:** The social system encompasses the people within an organization, including their roles, relationships, values, norms, and behaviors. It emphasizes the importance of human factors in organizational effectiveness. The social system includes elements such as teamwork, communication styles, leadership dynamics, and organizational culture. These factors influence how individuals collaborate, share information, and engage with technology. For instance, a supportive organizational culture can enhance employee motivation and productivity, while poor communication may lead to misunderstandings and conflict.

2. **Technical System:** The technical system consists of the tools, technologies, processes, and techniques used to achieve organizational goals. This includes machinery, software applications, workflows, and operational procedures. The design of the technical system should support the social system by enhancing productivity and facilitating effective communication among employees. For example, user-friendly software can improve task efficiency and reduce frustration among workers.

3. **Interdependence:** A fundamental aspect of socio-technical theory is the recognition that social and technical systems are interdependent. Changes in one subsystem can significantly impact the other. For instance, introducing new technology may require changes in workflows or training for employees to adapt to new processes. Conversely, shifts in organizational culture may necessitate updates to technical systems to align with new practices. This interdependence highlights the need for a holistic approach to organizational design that considers both social and technical factors.

Furthermore, according to Baxter & Somerville (2011), in recent years, the emergence of agile methodologies and collaborative work environments has further shaped the evolution of this theory. The recognition that modern organizations must be flexible and responsive to rapidly changing environments has led to an emphasis on stakeholder engagement and participatory design processes. This shift underscores the importance of considering not only technological capabilities but also human behaviors and organizational culture in achieving effective outcomes.

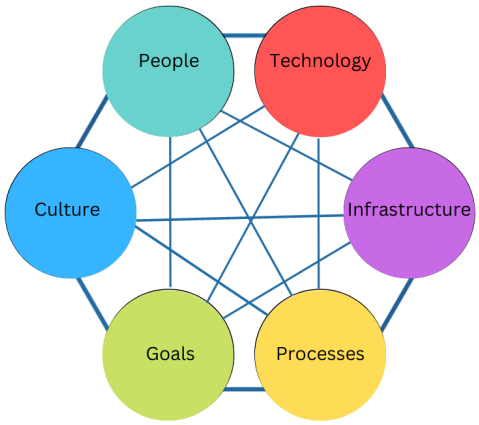
Moreover, contemporary adaptations of socio-technical systems theory now incorporate insights from fields such as information systems, organizational behavior, and change management. This interdisciplinary approach allows for a more comprehensive understanding of how socio-technical systems operate in practice. As organizations continue to navigate challenges posed by globalization, digital transformation, and evolving workforce expectations, the ongoing evolution of socio-technical theory remains crucial for developing effective strategies that align social and technical elements for enhanced performance and innovation (Baxter & Sommerville, 2011).

In light of the evolution that has occurred to the theory, this current research study applies the version of the theory modified by the Social Technical Center at Leeds University Business School in 2020. According to them, a systems-based approach to organizations is central to socio-technical thinking, represented visually by a hexagon model (represented in Figure 1 below). This hexagon serves as the core of the theoretical framework, illustrating how various subsystems within an organization interact and function together.

In this modified socio-technical systems perspective, any organization or its components are viewed as a collection of interconnected subsystems. These subsystems include people with specific capabilities, working collectively towards shared goals, following established processes, utilizing technology, and operating within a physical infrastructure. Additionally, these subsystems are embedded within a cultural environment that shapes the organization's assumptions, values, and norms. This holistic approach emphasizes the integration and interaction of these elements in achieving organizational effectiveness.

Figure 1

Socio-technical systems theory by Trist and Bamforth (1951) as amended by the Social Technical Center, Leeds University Business School (2020).



The socio-technical systems theory has been adopted in this study because it offers a comprehensive framework for analyzing the interaction between technological innovations and the social, political, and institutional contexts in which they are deployed. This theory aligns well with the research questions the research study seeks to answer as it enables a thorough examination of both the technological and human factors involved in the electoral process. Below are the highlight of how the socio-technical theory flows into the research questions in the research study;

Theoretical Connection to RQ 1

The socio-technical systems theory is an ideal theory for addressing the first research question, which seeks to identify and analyze the critical socio-technical determinants influencing the adoption and integration of technology in Nigerian elections. This theory emphasizes the interconnectedness of social and technical components within a system, positing that optimal performance and successful adoption of any technology can only be achieved when both these elements are in alignment. In the context of Nigerian elections, this approach is crucial because the deployment of election technologies such as biometric voter registration and digital results transmission cannot be considered in isolation from the broader socio-political environment in which they are implemented.

At the core of socio-technical theory is the belief that technological innovations do not operate in a vacuum. They require supportive infrastructures, skilled human operators, cultural acceptance, and institutional backing for successful integration. Nigeria's socio-political landscape, characterized by political instability, infrastructural deficiencies, and varying levels of digital literacy, poses significant challenges to the effective adoption of these technologies. The socio-technical theory helps unpack these challenges by highlighting how technical components interact with social determinants such as the digital skills of electoral officers, the trust and perceptions of voters, and the political culture that shapes the behavior of key stakeholders like political parties and government institutions.

For instance, the theory's focus on human capabilities is especially pertinent in the Nigerian context, where technological literacy varies significantly across regions and demographic groups. The successful operation of biometric and electronic systems depends not only on the technical specifications of the machines but also on the training, knowledge, and motivation of those who operate them. In a system where election officials may lack adequate training or where voters may be unfamiliar with how to engage with new technologies, socio-technical theory explains why mere technological advancement is insufficient for seamless adoption.

Moreover, cultural norms and political attitudes significantly shape the reception and adoption of technological innovations. In Nigeria, where electoral processes have long been marred by fraud, corruption, and political violence, public trust in election technologies is often low. The socio-technical framework allows for an analysis of how these cultural and institutional factors

such as skepticism towards new systems or resistance from political actors who may benefit from the status quo affect the adoption of technology. The theory underscores that the success of technological interventions is contingent on their acceptance by users and stakeholders, thus requiring a cultural and institutional shift in attitudes toward transparency and accountability in the electoral process.

Corroborating the above is the hypothesis for the research question 1 which specifically seeks to understand whether demographic factors influence how familiar individuals are with election technologies. The hypothesis ($H1_1$) proposes that there is a significant association between demographic characteristics such as age, gender, education, and electoral role—and the level of familiarity respondents have with these technologies.

Breaking this down further, four sub-hypotheses guide the investigation. First ($H1_{1a}$), younger respondents are expected to demonstrate higher familiarity with election technology compared to older respondents, reflecting the assumption that digital natives are more comfortable with technology. Second ($H1_{1\beta}$), gender is not anticipated to create significant differences in familiarity, suggesting that both male and female respondents have relatively similar levels of awareness. Third ($H1_{1\gamma}$), the study hypothesizes that higher educational attainment correlates positively with greater familiarity with election technology, as education often enhances digital literacy. Finally ($H1_{1\varrho}$), the role individuals play in the electoral process whether as voters, election officials, or civil society members will significantly influence their familiarity with these technologies, given the varying levels of exposure and engagement required by these roles.

Theoretical Connection to RQ 2

The second research question, which focuses on the challenges and opportunities presented by election technologies and their impact on electoral integrity, transparency, and public trust, can be effectively explored through the lens of socio-technical systems theory. This theory emphasizes that technology's effectiveness is not solely based on its technical sophistication but also on the social systems in which it operates, offering a comprehensive framework to analyze the socio-technical dynamics that shape the success or failure of election technologies.

One of the primary challenges in deploying election technologies in Nigeria is the readiness of both the technology and its supporting infrastructure. Socio-technical systems theory posits that for technologies to be successful, they must be adequately integrated with the social and institutional environments in which they are used. In the context of Nigerian elections, this means that while technology may offer advanced solutions to fraud and inefficiencies in elections, their effectiveness is hindered by infrastructural deficiencies, such as unreliable power supply, poor network connectivity, and outdated technical systems. Socio-technical theory highlights the need to consider these infrastructural limitations as part of the broader technological ecosystem and calls for a balanced approach where social readiness and technological capacity are aligned.

Moreover, the theory underscores the importance of public trust in the successful deployment of election technologies. Public trust is a critical social determinant that can either facilitate or obstruct the adoption of new systems. In Nigeria, where the electoral process has historically been plagued by manipulation and fraud, the introduction of new technologies is often met with skepticism. Socio-technical theory provides a structured way to analyze how the interplay between technology and trust affects electoral outcomes. It explains that while technological innovations like digital voter systems can enhance transparency, their success depends on whether the public perceives these systems as trustworthy and free from manipulation. Without this trust, even the most advanced technologies can fail to deliver meaningful improvements in electoral integrity.

The opportunities presented by election technologies are also illuminated by socio-technical systems theory, particularly in how these innovations can foster greater transparency and efficiency in elections. When socio-technical factors are properly aligned, technologies can significantly reduce electoral fraud and streamline the voting process. These innovations have the potential to enhance electoral integrity by providing more accurate and transparent mechanisms for voter verification and vote counting. However, socio-technical theory reminds us that these opportunities can only be fully realized when the social and technical components are integrated. This requires not only functional technology but also political will, adequate training for election officials, and a broader societal understanding and acceptance of the role these technologies play in promoting fairness and accuracy.

Another important aspect that socio-technical systems theory addresses is the role of stakeholder engagement in ensuring the successful deployment of election technologies. The theory advocates for participatory design and collaborative approaches, where all relevant actors including the government, election officials, political parties, and civil society are actively involved in the design, implementation, and monitoring of these technologies. In the Nigerian context, the lack of stakeholder engagement has often resulted in resistance from key political actors who perceive election technologies as a threat to their vested interests. Socio-technical theory suggests that overcoming these challenges requires building consensus and ensuring that all stakeholders understand how these technologies can contribute to electoral integrity, thereby reducing resistance and increasing buy-in.

Supporting the above are the hypotheses focussing on the relationship between trust in election technologies and their perceived effectiveness, as well as how this trust varies across groups. The first hypothesis ($H2_1$) posits that there is a significant association between the level of trust in election technologies and how effective people believe these systems are in reducing electoral fraud. This assumes that the more individuals trust the technology, the more likely they are to view it as an effective tool for ensuring credible elections.

The second hypothesis ($H2_2$) examines variations in trust levels across different demographic groups, suggesting that factors such as age, gender, education, or electoral roles may influence how much confidence people place in these technologies. Lastly, the third hypothesis ($H2_3$) asserts that higher familiarity with election technology is positively correlated with trust in these systems, meaning that people who understand and interact more with the technology are likely to trust it more.

Theoretical Connection to RQ 3

The third research question, which focuses on how socio-technical frameworks influence the design, implementation, and evaluation of election technologies in Nigerian elections, finds strong theoretical support in socio-technical systems theory. This theory emphasizes the need for a balanced alignment between technological solutions and the social systems in which they operate, providing an ideal framework to critically analyze the processes involved in deploying election technologies.

In the design phase of election technologies, socio-technical theory underscores the importance of participatory design, which involves integrating the perspectives of various stakeholders, voters, election officials, political parties, and civil society into the development of technological systems. The theory advocates for a collaborative approach where the needs, behaviors, and expectations of all social actors are considered alongside the technical capabilities of the system. In the Nigerian context, where electoral technologies are often introduced without sufficient stakeholder consultation, socio-technical theory highlights the risks of exclusion and misalignment between the system's design and its users' needs. This theory thus promotes a holistic design process where technical and social elements coalesce to create systems that are both functional and contextually appropriate.

The implementation of election technologies is another area where socio-technical systems theory plays a crucial role. The theory posits that technological solutions must be integrated into the broader social and institutional structures to be effective. In Nigeria, the introduction of technologies such as biometric verification and electronic result transmission must be done in ways that align with existing social systems, including training for election officials, public education campaigns, and political support for technological reforms. If these social factors are neglected during implementation, the technology might face resistance or misuse, undermining its effectiveness. Socio-technical theory suggests that successful implementation requires not just the deployment of hardware and software but also the adaptation of social systems to accommodate new technological processes. This might involve revising legal frameworks, improving logistical support, and ensuring adequate oversight and accountability mechanisms.

Evaluation, the final phase, is similarly enriched by socio-technical systems theory, which stresses that the success of technology cannot be measured in purely technical terms. Election technologies must be evaluated not only based on their technical performance such as speed,

accuracy, or scalability but also on how well they fit within the social and cultural landscape in which they are used. For example, a biometric system might technically reduce voter fraud, but if it creates delays or is perceived as invasive by certain communities, its overall effectiveness may be compromised. Socio-technical systems theory provides a framework for comprehensive evaluation by considering factors such as user satisfaction, institutional support, and public perception alongside the technical metrics. This multidimensional evaluation ensures that election technologies are assessed in terms of their broader impact on electoral integrity, public trust, and democratic participation.

Moreover, socio-technical systems theory advocates for iterative feedback loops in the evaluation process, where continuous monitoring and adjustments are made based on how the technology interacts with its social environment. In Nigerian elections, this means that after every election cycle, there should be mechanisms in place to assess not just the functionality of the technology but also how it has affected voter behavior, trust in the electoral process, and the efficiency of election management. Feedback from these evaluations can then inform future design and implementation strategies, creating a dynamic and responsive system that evolves with the socio-political landscape.

Supporting the above are the third group of hypotheses that investigate contextual and socio-cultural factors that shape trust in election technologies. The first hypothesis ($H3_1$) suggests that political influence on the deployment of these technologies negatively impacts public trust, implying that when citizens perceive political interference in the process, confidence in the technology decreases.

The second hypothesis ($H3_2$) posits that the perceived importance of voter education positively influences trust, emphasizing that informed citizens are more likely to trust and accept technological systems in elections. Similarly, $H3_3$ asserts that frequent technical failures undermine trust in election technologies, as repeated malfunctions can reinforce doubts about system reliability.

In addition to these technical and institutional factors, socio-cultural dimensions are also considered. Hypothesis $H3_4$ proposes that cultural beliefs significantly affect the acceptance of election technologies, reflecting how local norms and traditional views shape attitudes toward modern systems. Lastly, $H3_5$ highlights infrastructural realities, stating that rural accessibility challenges are linked to lower trust in election technologies, given that limited connectivity and infrastructure gaps can create barriers to smooth technology use in rural areas.

Theoretical Connection to RQ 4

The fourth research question focuses on developing evidence-based, socio-technical guidelines for optimizing the deployment of election technologies in Nigeria. Socio-technical systems theory, which emphasizes the interdependence between social and technical components, provides an ideal foundation for generating comprehensive recommendations tailored to Nigeria's unique electoral landscape.

In crafting guidelines for policymakers and stakeholders, socio-technical theory stresses the importance of integrating both technical capabilities and the social context in which election technologies operate. This means that any recommendations must consider not only the hardware and software involved but also the human elements such as voters, election officials, political parties, and civil society who interact with these technologies. The theory suggests that evidence-based guidelines should draw from empirical data on how these technologies perform in real-world settings, including insights into public perceptions, institutional readiness, and cultural attitudes. By using a socio-technical lens, these guidelines can provide a more nuanced approach that takes into account both the strengths and weaknesses of the electoral system.

One of the key contributions of socio-technical systems theory is its emphasis on participatory design and stakeholder engagement, which can inform the development of guidelines that are both practical and sustainable. Policymakers and stakeholders must be involved in the process of designing and implementing election technologies, as their insights are crucial for ensuring that the systems are aligned with Nigeria's social and political realities. Guidelines informed by socio-technical theory would therefore encourage collaborative decision-making processes that include diverse actors, from technology providers to community leaders, and from election officials to political representatives. This participatory approach helps ensure that election technologies are not imposed in a top-down manner but are co-developed with the people who will use and be affected by them. Such guidelines would also emphasize the need for continuous stakeholder consultation throughout the election cycle, ensuring that feedback is incorporated to address any emerging challenges.

In addition to stakeholder engagement, socio-technical systems theory also highlights the need for a flexible, iterative approach to the deployment of election technologies. This is especially relevant in Nigeria, where the socio-political landscape is complex and constantly evolving. Evidence-based guidelines should advocate for the phased introduction of technologies, with pilot programs and regular assessments to identify potential issues before full-scale implementation. Moreover, socio-technical systems theory underlines the importance of evaluating the impact of technology on public trust and electoral integrity, which should be a central focus of the guidelines. Technological solutions must not only perform their intended functions but also inspire confidence in the electoral process. For Nigerian policymakers, this means that evidence-based guidelines should prioritize transparency in the design and

implementation of election technologies. For example, guidelines could recommend public education campaigns to raise awareness about how new systems work, thereby reducing skepticism and building trust.

Supporting the above are hypotheses focusing on the research question 4. The first hypothesis ($H4_1$) asserts that trust in election technology is a significant predictor of support for its implementation, indicating that confidence in the system is essential for policy acceptance and sustainability. The second hypothesis ($H4_2$) emphasizes the role of education, proposing that higher educational attainment positively influences support for election technology, as education often enhances understanding and appreciation of technological innovations. Similarly, $H4_3$ argues that belief in stakeholder co-creation processes—where multiple actors participate in designing and deploying the technology positively affects support, reflecting the importance of inclusivity in building legitimacy.

Further, $H4_4$ suggests that perceived government support strongly correlates with overall endorsement of technology implementation, as official backing can signal reliability and institutional commitment. Finally, $H4_5$ highlights a practical consideration, positing that experience with technical failures negatively influences support for continued technology use, as repeated glitches or breakdowns can erode confidence and discourage adoption.

2.1.1 Notable Studies in Socio-Technical Research

The articles listed below represent key contributions to the evolution of socio-technical systems theory, each providing unique insights into the interaction between social and technical elements in various organizational contexts.These references span from the early 1970s through the 2010s and represent diverse theoretical perspectives that have contributed significantly to the evolution of socio-technical theory, including science and technology studies, organizational design, activity theory, network analysis, and resilience engineering approaches.

Table 1

Studies in Socio-Technical Research

Reference	**Key Focus**	**Contribution to Socio-Technical Theory**
Baxter and Sommerville (2011)	Evolution of socio-technical systems from design to systems engineering	Explores how socio-technical design principles are applied in systems engineering, bridging the gap between human and technical aspects for better systems development.
Carayon (2006)	Human factors in complex socio-technical systems	Focuses on human factors in the context of complex socio-technical systems, emphasizing ergonomics and the interactions between humans and technology in workplace design.

Cherns (1987)	Principles of socio-technical design	Introduces and revisits foundational principles of socio-technical design, advocating for the alignment of social and technical systems in organizational design to improve efficiency and worker satisfaction.
Emery (1959)	Characteristics of socio-technical systems	Discusses the core characteristics of socio-technical systems, particularly in the context of industrial work environments, and how the interaction between social and technical elements impacts productivity and worker well-being.
Walker et.al (2008)	Socio-technical systems model of work systems	Explores the socio-technical systems model within work systems, focusing on ergonomics and human factors, and the design of systems that optimize the interaction between people and technology.
Kleiner (2006)	Socio-technical systems analysis	Provides a detailed analysis of socio-technical systems, emphasizing the need for a balanced approach to system design that takes both technical efficiency and social needs into account.
Leavitt (2013)	Applied organizational change and socio-technical approaches	Discusses the impact of organizational change on socio-technical systems, including structural, technological, and humanistic approaches to managing change in organizations.
Mumford (1987)	Evolving theory and practice of socio-technical design; successes, failures, and potential	Reflects on the development of socio-technical design theory and its practical applications, assessing both the successes and challenges of implementing these systems in organizational settings.
Trist and Bamforth (1951)	Social and psychological consequences of the longwall method of coal getting	Foundational work in socio-technical systems theory, focusing on the impact of new coal mining technologies on worker morale, social relations, and organizational effectiveness.
Rice (1953)	Productivity and social organization in an Indian weaving shed	Examines how socio-technical systems affect productivity and social organization in an industrial setting, using an Indian weaving shed as a case study to explore how technology and social structure interact.

Eason (1989)	Information technology and organizational change	Investigates the relationship between IT implementation and organizational changes, emphasizing socio-technical approaches to managing technological transitions and reducing resistance to change.
Law & Callon in Bijker (1997)	Social construction of technology	Develops the concept that technological systems are shaped by social factors and human choices rather than following a predetermined technological logic, influencing socio-technical understanding of technology development.
Woods & Hollnagel (2017)	Resilience engineering in socio-technical systems	Introduces resilience engineering as a new paradigm for safety management in complex socio-technical systems, focusing on the ability of systems to anticipate and adapt to potential failures.
Orlikowski (1992)	Duality of technology in organizational contexts	Presents a structurational model of technology, exploring how technology is both socially constructed and shapes social practices within organizations.
Parker & Cordery (2012)	Design of jobs and work organizations	Examines how socio-technical principles can be applied to job design and work organization to enhance productivity while improving worker satisfaction and well-being.
Bostrom and Heinen (1977)	MIS problems and failures from a socio-technical perspective	Analyzes information systems implementation failures through a socio-technical lens, arguing that many problems stem from focusing on technical aspects while neglecting social dimensions.
Muller & Pasmore (1989)	Designing effective organizations: The socio-technical systems perspective	Provides a comprehensive framework for applying socio-technical principles to organizational design, emphasizing the importance of joint optimization of social and technical subsystems.
Engeström (2000)	Activity theory and expansive learning in work organizations	Applies activity theory to understand complex socio-technical work systems, focusing on contradictions and tensions as sources of change and development.
Geels (2004)	Multi-level perspective on socio-technical transitions	Develops a multi-level framework for understanding large-scale socio-technical transitions, analyzing how niche innovations can transform existing socio-technical regimes over time.

Callon (1998)	Actor-network theory and socio-technical change	Contributes actor-network theory to socio-technical understanding, treating social and technical elements as equally important actors in networks that shape technological development and implementation.

The socio-technical literature on the table 1 above displays a clear intellectual lineage that traces back to the pioneering work of Trist & Bamforth (1951) and Rice (1953). These foundational studies emerged from the British coal mining industry and Indian textile manufacturing, establishing the core premise that technological systems cannot be optimized without considering their social context. What's particularly striking about this evolution is how the field has maintained its core principles while expanding into increasingly complex domains.

Early works focused primarily on industrial settings with relatively straightforward production technologies. As the timeline progresses, we see the theory's application broaden to encompass information systems (Bostrom & Heinen, 1977), digital technologies (Orlikowski, 1992), and eventually complex adaptive socio-technical systems (Woods & Hollnagel, 2006). This evolution reflects the changing nature of work and technology itself from mechanical systems with clear boundaries to digital infrastructures that blur the lines between technical and social elements.

Across these diverse works spanning over 70 years, the principle of joint optimization remains remarkably consistent. From Cherns' (1976) explicit principles to Baxter & Sommerville's (2011) systems engineering approach, there is widespread agreement that optimal system performance requires simultaneous attention to both social and technical subsystems. This principle appears to be non-negotiable in socio-technical theory, even as methodologies for achieving it vary considerably. Another consistent thread is the rejection of technological determinism, the notion that technology follows its own inevitable logic independent of social factors. Bijker's (1997) social construction of technology makes this argument explicit, but even early works like Trist & Bamforth (1951) implicitly challenge deterministic views by demonstrating how the same technology (longwall coal mining) can have different outcomes depending on social organization. This anti-deterministic stance has become foundational to socio-technical thinking.

From Emery's (1959) focus on worker well-being to Carayon's (2006) human factors approach, the literature consistently centers human experience. This humanistic orientation distinguishes socio-technical theory from purely engineering-focused or efficiency-driven approaches. The implicit assertion across these works is that technical systems should serve human needs and values, not vice versa. Below are the critical analysis of the positions and methodological alignments of the literatures;

Methodological Approaches

A significant divergence is noticed in methodological approaches. Early works (Trist, Rice, Emery) relied heavily on case studies and ethnographic methods, maintaining close connections to actual work practices. As the field matured, more abstract theoretical frameworks emerged, such as Geels' (2004) multi-level perspective or Engeström's (2000) activity theory. This tension between grounded, empirical approaches and more theoretical frameworks remains unresolved in the literature.

Scale of Analysis

The appropriate scale of socio-technical analysis has shifted over time. Earlier works focused primarily on specific work sites or organizations (coal mines, weaving sheds). Later contributions like Law & Callon (1997) and Geels (2004) expanded to consider larger socio-technical networks and transitions at societal levels. This expansion raises questions about whether core socio-technical principles remain applicable across these dramatically different scales, or whether fundamentally different dynamics emerge at larger scales.

Normative vs. Analytical Orientations

Some works, particularly those in the design tradition (Mumford, 1987; Cherns, 1976), take explicitly normative positions about how socio-technical systems should be designed. Others, especially those from science and technology studies (Law & Callon, 1997), adopt more analytical stances that seek to understand socio-technical phenomena without prescribing ideal configurations. This creates a productive tension between descriptive and prescriptive approaches within the broader field.

Design Principles vs. Emergent Properties

One fascinating juxtaposition emerges between design-oriented perspectives (Muller & Pasmore, 1989; Parker & Cordery, 2012)) that presume socio-technical systems can be intentionally designed according to principles, and perspectives that emphasize the emergent, unpredictable nature of socio-technical interactions (Woods & Hollnagel, 2006; Orlikowski, 1992). This raises fundamental questions about human agency in shaping socio-technical systems: can they truly be "designed" in conventional ways, or must we develop new approaches that account for emergence and adaptation?

Technological Change vs. Social Stability

Another critical tension appears between perspectives that emphasize technological change as a driver of socio-technical evolution (Eason, 2014; Baxter & Sommerville, 2011) and those that highlight the stabilizing force of social structures (Leavitt, 2013; Bostrom & Heinen, 1977). The

literature reveals competing temporalities: technical systems often change rapidly, while social systems tend to change more slowly. This mismatch creates ongoing challenges for socio-technical integration that no single theoretical perspective has fully resolved.

Expert Design vs. Participatory Approaches

Early socio-technical works often positioned researchers and consultants as experts who could design optimal socio-technical configurations. Later contributions, particularly Mumford's (1987) reflection on successes and failures, increasingly recognized the importance of participatory approaches that involve workers in design decisions. This shift reflects broader epistemological questions about whose knowledge counts in understanding and shaping socio-technical systems technical experts, social scientists, or the people who live and work within these systems daily.

As digital technologies increasingly permeate every aspect of work and social life, the socio-technical perspective has gained renewed relevance. The expanded literature suggests several promising directions for future research:

1. **Integration with Complex Adaptive Systems Theory**: Works like Woods and Hollnagel (2006) point toward greater integration with complexity science, recognizing that modern socio-technical systems often exhibit emergent properties that cannot be reduced to simple cause-effect relationships.
2. **Multilevel Analysis**: Geels' (2004) multi-level perspective offers a framework for connecting micro-level socio-technical interactions with macro-level transitions, potentially addressing the scale tensions identified earlier.
3. **Ethical Dimensions**: While implicit in many works, explicit attention to ethical dimensions of socio-technical systems remains underdeveloped across this literature. As technologies like AI raise profound ethical questions, socio-technical theory may need to more directly engage with normative frameworks.
4. **Integration of Global Perspectives**: The literature remains heavily weighted toward Western industrial contexts, despite early international work like Rice's (1953) study in India. More systematic integration of diverse cultural perspectives on the relationship between technology and society would strengthen the field.

The socio-technical literature, taken as a whole, provides powerful conceptual tools for understanding and shaping technological change in human contexts. Its enduring relevance stems from an unwavering commitment to considering both social and technical dimensions as fundamentally inseparable aspects of the systems that increasingly define modern work and life.

CHAPTER 3

REVIEW OF TECHNOLOGY AND THE NIGERIAN SOCIO-POLITICAL CONTEXT

3.0 Introduction

Globally, digital technology has redefined political mobilization, as demonstrated in various social movements. Bennett & Segerberg (2015) introduced the concept of "connective action," where digital media facilitates personalized, yet collective political engagement. The personalization of politics through digital platforms allows individuals to engage in movements in a way that aligns with their personal identities and values, fostering wider participation. Similarly, Castells (2015) noted how digital networks, by allowing rapid information dissemination and coordination, enable political movements to bypass traditional hierarchies, creating what he calls "networks of outrage and hope."

In Nigeria, social media platforms like Twitter, Facebook, and WhatsApp have played a critical role in political mobilization. Amnesty International (2021) argues that social media has reshaped public opinion and political participation in Nigeria, particularly among youth, who are traditionally marginalized in electoral processes. The #EndSARS protests of 2020 are a poignant example, where social media was instrumental in mobilizing widespread protests against police brutality. This digital mobilization provided a new avenue for Nigerians, especially the youth, to demand accountability and challenge political structures, often in ways that were not possible through conventional political mechanisms. Building on this phenomenon, Omilusi (2025) analyzes how young Nigerians utilize social media platforms to advocate for political reforms and challenge established power structures. Their research indicates that digital platforms have created new avenues for youth political engagement while also fostering a more critical political consciousness.

The rise of digital influencers in Nigerian politics, as documented by Uwalaka & Enyindah (2024), further demonstrates how technology has created new forms of political leadership and communication. These influencers, often young and tech-savvy, have established themselves as important political voices, bridging the gap between traditional political structures and youth constituencies. Their emergence represents a significant shift in Nigeria's political landscape, where traditional gatekeepers of political information and influence are increasingly being challenged by digitally-empowered voices. While social media can facilitate democratic participation, it also presents significant challenges. Chan & Yi (2024) highlight that while digital media can enhance political engagement, it can also lead to misinformation and polarized discourse. According to Elsaesser et al. (2021), social media can exacerbate existing social and political tensions. To corroborate this statement, Johnsos (2019) noted that false narratives spread rapidly, as observed during the 2019 general elections, where misinformation campaigns targeted political candidates and parties, undermining public trust in the electoral process. The rapid

dissemination of information through digital channels thus has a dual effect: it empowers political participation but also risks fueling division and misinformation, creating new challenges for Nigeria's fragile democracy.

Technology has also transformed governance structures in Nigeria, creating new pathways for transparency and accountability. Hope (2017) examines how e-governance initiatives in Nigeria have attempted to streamline administrative processes and reduce corruption. Their research indicates that while digital platforms have the potential to enhance governmental efficiency, their implementation is often hampered by infrastructural limitations and institutional resistance. Despite these challenges, there have been notable successes in leveraging technology for governance reform. The Nigerian government's adoption of the Treasury Single Account (TSA) system, as analyzed by Udoh(2016), illustrates how technology can be leveraged to enhance fiscal transparency and reduce corruption in public finance management, representing a significant step toward digital governance reform. However, William & Ceci (2022) argues that technological solutions alone are insufficient without addressing underlying governance issues, including a lack of political will and entrenched corrupt practices. This suggests that while technology can facilitate governance reforms, its effectiveness ultimately depends on broader institutional and political factors. This complex interplay between technology and governance underscores the need for a holistic approach to digital transformation in Nigeria's public sector, (Savignin et. al. 2024).

Despite technological advancements, significant disparities in access persist, creating what scholars term a "digital divide." Okoye et.al (2015) document how socioeconomic factors, including income, education, and location, influence access to and use of digital technologies in Nigeria. Rural communities, low-income households, and women are particularly disadvantaged, limiting their participation in the digital political sphere. Morris & Morris (2013) further demonstrate how this digital divide reinforces existing political inequalities, as those with limited access to technology remain marginalized in technology-mediated political processes. This creates a paradox where digital technologies, while ostensibly democratizing, may inadvertently amplify existing socio-political disparities, highlighting the need for inclusive digital development policies (Milner,2006).

Nigerian electoral processes have increasingly incorporated technological tools to enhance transparency and reduce fraud. Iwuoha (2018) evaluates the impact of the Bimodal Voter Accreditation System (BVAS) introduced in the 2023 elections, noting its contribution to reducing electoral fraud while highlighting implementation challenges. The Independent National Electoral Commission's (INEC) use of technology in electoral management has been both praised and criticized. Sibe & Kaunert (2022) analyze how INEC's digital portals for result collation enhanced transparency but faced technical difficulties and resistance from political actors, demonstrating the complex interplay between technology and electoral politics in Nigeria.

While technology can enhance political participation, it can also serve as a tool for surveillance and political control. Chiamogu & Chiamogu, (2022) document instances where the Nigerian government has employed digital technologies to monitor citizens, particularly political activists and journalists. This raises concerns about digital rights and civil liberties in an increasingly technology-mediated political environment. The temporary Twitter ban in Nigeria in 2021, as examined by Ologunebi & Taiwo (2025), exemplifies how governments can restrict digital platforms to control political narratives and limit opposition voices. This case highlights the tension between technological empowerment and state control in Nigeria's political landscape, revealing how digital tools can be weaponized to restrict political expression as readily as they can be used to facilitate it (Rillo,2016).

The integration of technology into Nigeria's socio-political landscape presents both opportunities and challenges. While digital platforms have enhanced political mobilization, transparency, and citizen participation, they have also introduced new forms of inequality, misinformation, and potential for surveillance (Madgin, 2025). Understanding these dynamics is crucial for harnessing technology's potential to strengthen democratic processes while mitigating its risks. As Nigeria continues to navigate its complex socio-political challenges, the role of technology will remain significant. Future research should focus on how technological innovations can be harnessed to address Nigeria's specific governance challenges while ensuring that the benefits of digital political participation are accessible to all citizens, regardless of socioeconomic status, location, or gender (Zouridis & Bekkers, 2003).

3.1 Technology, Ethnicity, and Political Mobilization

Ethnicity has long been a defining factor in Nigerian politics, shaping political alignments and voting patterns. According to Osaghae (2003), who discusses how ethnicity drives political mobilization in Nigeria, political parties and leaders often appeal to ethnic identities to secure votes. This ethnic mobilization strategy has deep historical roots, dating back to pre-independence politics when regional parties emerged along ethnic lines (Osaghae, 2003). As Angerbrandt (2016) notes, Nigeria's over 250 ethnic groups create a complex political landscape where identity politics often overshadows issue-based campaigning.

While technology offers the potential to transcend these divisions, it has, in some cases, reinforced them. Social media platforms, for example, often serve as echo chambers, where individuals are exposed to content that aligns with their pre-existing beliefs. In the Nigerian context, this can mean that ethnic and political divisions are deepened rather than bridged (Olasunkanmi, 2019). Ziccardi (2020) found that online political discussions frequently devolve into ethnic slurs and hate speech, particularly during election periods. The algorithmic nature of content distribution on platforms like Facebook and Twitter tends to amplify divisive content, creating what Rathje et. al (2022) terms "digital tribes" that mirror offline ethnic divisions.

At the same time, digital technologies provide a platform for new forms of political participation that are less bound by ethnic divisions. For instance, the #NotTooYoungToRun movement, which sought to reduce age barriers for political office in Nigeria, gained momentum through social media (Akinyetun. 2022). This movement, largely led by youth, transcended ethnic boundaries and focused on democratic inclusion, showing how technology can promote broader civic engagement (Chukwuma & Agbim, 2025). Similarly, Zisengwe (2024) highlights how civic tech initiatives like BudgIT have enabled citizens from different ethnic backgrounds to collaboratively monitor government spending and advocate for accountability.

Furthermore, the intersection of technology and governance in Nigeria is particularly significant in the context of democratic development. Amuwo (2010) argues that political parties play a crucial role in shaping Nigeria's democracy, yet their operations are often opaque and exclusive. The advent of digital technologies offers opportunities to enhance transparency and accountability within political parties and governance structures. Technologies such as online platforms for political engagement, e-voting, and real-time election monitoring have the potential to reduce corruption and foster more inclusive political processes. As Mba (2022) points out, the Independent National Electoral Commission's (INEC) adoption of biometric voter registration has somewhat improved electoral integrity by reducing instances of multiple voting and identity fraud. Omotola (2010) further suggests that digital tools have empowered civil society organizations to more effectively monitor electoral processes and expose malpractices.

However, the deployment of technology in governance is not without its challenges. The Nigerian political landscape is marked by corruption, as highlighted by Atelhe & Agada (2014), who argues that corruption has permeated every aspect of Nigeria's socio-political fabric. The introduction of technology, such as the Biometric Verification System (BVAS), while aimed at reducing electoral fraud, faces significant hurdles. For example, Iwuoha (2019) discusses how political elites, who benefit from the status quo, often resist reforms that would increase transparency and reduce corruption. Moreover, technological solutions, while promising, are often undermined by infrastructural deficiencies and digital illiteracy, particularly in rural areas, where access to technology is limited. Research by Ejikeme & Ifeoma (2018) reveals significant urban-rural disparities in internet access, with less than 20% connectivity in many rural communities, effectively excluding millions from digital political participation. Additionally, they highlight how intermittent electricity supply and prohibitive data costs create barriers to technology adoption even in areas with network coverage.

In addition, digital platforms can be vulnerable to manipulation. Thomson (2018) discussed how digital media, while fostering political mobilization, can also be used by authoritarian regimes to surveil, censor, or disrupt opposition movements. In Nigeria, concerns have been raised about the government's attempts to regulate social media platforms, which critics argue could stifle free expression and dissent (Coker, 2022). These dynamics underscore the complex role of technology in governance; while it has the potential to democratize political processes, it also

presents new challenges related to control, surveillance, and manipulation (Weber, 2017). Global Voices Avox (2025) documents several instances where Nigerian authorities have leveraged technology to monitor activists and journalists, particularly those covering sensitive political issues. Furthermore, analyzes Global Voices Avox(2025) how sophisticated disinformation campaigns, often ethnically targeted, have been deployed during recent elections to manipulate voter sentiment and suppress turnout in opposition strongholds.

The impact of technology on Nigeria's political landscape is further complicated by the digital divide, which reflects and potentially exacerbates existing socioeconomic inequalities. Adeleke (2020) found that access to digital platforms correlates strongly with education level, income, and urban residence. This suggests that technology-mediated political participation may inadvertently privilege already advantaged groups. Nevertheless, as Asongu & Nwachukwu (2016) observe, the rapid proliferation of mobile phones with penetration exceeding 80% nationwide offers potential pathways for more inclusive digital citizenship if deliberately harnessed through policy interventions. Looking forward, Ineji & Ineji (2023) argue that Nigeria's democratic future will depend significantly on how technology is governed and deployed. They advocate for a regulatory framework that balances innovation with protection against manipulation and exclusion. Community-based digital literacy programs, as described by Elekwachi & Amadi (2021), show promise in bridging divides and enabling more citizens to meaningfully engage with political processes online.

3.2 Technology and Political Change in Nigeria

Technology's role in political change in Nigeria is both promising and fraught with challenges. As Silva & Kemer (2022) noted, digital technologies can catalyze political turbulence by rapidly mobilizing large numbers of people. The #EndSARS movement is a clear example of how technology can drive political change, uniting Nigerians across socio-economic and ethnic lines to challenge state violence and demand reform. However, the sustainability of such movements remains in question. Eltantawy & Wiest (2011) observe in their study of the Egyptian revolution that while digital platforms can spur rapid mobilization, they often lack the organizational structure necessary to sustain long-term political change.

In Nigeria, technology has undoubtedly created new opportunities for political participation, but it has also exposed the limitations of digital activism. While movements like #EndSARS have shown the power of social media in raising awareness and mobilizing protest, the transition from online activism to tangible political outcomes is fraught with challenges. The Nigerian government’s swift response to the protests, shutting down social media platforms and deploying security forces, illustrates the fragility of digital movements in the face of state repression (Greiten, 2013).

The literature review above provides an overview of Nigeria’s techno-political landscape, highlighting how digital technologies have reshaped political mobilization, participation, and

governance. It explores both the opportunities and challenges that technology presents, such as enhancing democratic engagement, while also exacerbating issues like misinformation, digital exclusion, and ethnic divisions. This review sets the tone for the subsequent sections by offering a critical understanding of how technology interacts with Nigeria's socio-political context, laying the groundwork for deeper exploration of specific exploration of technology deployment in elections in Nigeria.

3.3 Nigerian Electoral System - Historical Development

The Nigerian electoral system has evolved significantly since the country gained independence in 1960. Initially shaped by colonial authorities, elections have transitioned through various phases, each influenced by Nigeria's socio-political dynamics (Omotola, 2010). This evolution reflects the challenges and adaptations within a democratic framework aimed at facilitating citizen representation across multiple levels of government. Understanding the historical development of Nigeria's electoral system is crucial for grasping the broader socio-technical factors that impact the integration of technology in elections.

The origins of the Nigerian electoral system trace back to colonial rule, where elections were first conducted under limited franchise, predominantly favoring the elite (Okoye et al., 2015). Electoral politics began formally in 1922 with the introduction of the Clifford Constitution, which allowed limited voting rights in Lagos and Calabar (Obiagu, 2023). The subsequent Richards Constitution of 1946 expanded political participation while maintaining colonial control, followed by the Macpherson Constitution of 1951 which introduced a quasi-federal structure.The first major national election, held in 1959, preceded Nigeria's independence in 1960. This election, conducted under the Lyttleton Constitution, established the framework for Nigeria's parliamentary democracy at independence. The post-independence electoral system initially retained many colonial features, including the first-past-the-post voting system and constituency-based representation (Iwuchukwu, 2013).

After independence, Nigeria's electoral processes were frequently interrupted by military coups, which hindered democratic governance. The First Republic (1960-1966) collapsed under ethnic tensions and political corruption, leading to military intervention (Falola & Heaton, 2008). The Second Republic (1979-1983), marked by the adoption of a presidential system modeled after the United States, was short-lived due to another military coup (Nwokike & Chidolue, 2017). This period introduced significant innovations, including the Federal Electoral Commission (FEDECO) and requirements for geographic spread of votes for presidential candidates. Although the Third Republic attempted to restore democracy in the early 1990s, it was again disrupted. The transition program initiated by General Ibrahim Babangida created new electoral bodies and a two-party system, but culminated in the annulment of the June 12, 1993 presidential election, widely considered Nigeria's freest and fairest election to that point (Rotimi &

Ihonvebere, 1994). This annulment triggered a political crisis that extended military rule under General Sani Abacha until 1998 (Omotola, 2010).

The Fourth Republic, established in 1999, has marked the longest uninterrupted period of democratic governance in Nigeria. This era introduced significant reforms under the 1999 Constitution, which forms the legal backbone of the current electoral system. Key features of this system include federalism, checks and balances, and the separation of powers (Gberevbie, 2014). The Independent National Electoral Commission (INEC) was established as the principal electoral management body, responsible for conducting elections at federal and state levels (Agbu, 2016). Electoral reforms have been continuous throughout the Fourth Republic. The Electoral Act of 2002, subsequently amended in 2006, 2010, and 2022, has progressively strengthened the legal framework for elections (Ijim-Agbor, 2007). The 2010 Electoral Act, in particular, introduced important reforms including the continuous voter registration system and enhanced INEC independence (Onapajo, 2015). The most recent Electoral Act of 2022 has legalized electronic transmission of results and early release of election materials, addressing long-standing vulnerabilities in the electoral process.

The integration of technology into Nigeria's electoral system represents one of the most significant developments in recent years. The introduction of the Smart Card Reader in 2015 marked a watershed moment, enhancing voter verification and reducing impersonation (Olurode, 2017). The Bimodal Voter Accreditation System (BVAS) and INEC Results Viewing Portal (IReV) introduced in 2021-2022 further advanced technological applications in the electoral process (Akah et.al 2024). Despite these innovations, the Nigerian electoral system continues to face significant challenges. Electoral violence remains prevalent, with incidents reported in virtually every general election since 1999 (Omede & Ngwube, 2021). Vote buying and selling have evolved into sophisticated practices that undermine electoral integrity (Onapajo et al., 2015). Logistical challenges, including the timely distribution of election materials and ensuring access in remote areas, continue to affect electoral operations (Adeniran, 2023).

Furthermore, the judiciary has played an increasingly prominent role in determining electoral outcomes, raising questions about the balance between legal dispute resolution and popular sovereignty (Ibani & Jacobs, 2024). The phenomenon of "election petition tribunals" has become a standard feature of Nigerian elections, sometimes resulting in the reversal of initially announced results (Suberu, 2007). This judicial involvement, while necessary for resolving disputes, has sometimes been criticized for undermining the will of voters and extending uncertainty about electoral outcomes, often for months after elections have been conducted.

In a regional context, Nigeria's electoral system shares similarities with other African democracies but has some distinctive features. Like Ghana and Kenya, Nigeria has embraced technological solutions to address electoral fraud, but implementation challenges remain more pronounced (Omoleke, 2019). The concentration of powers in the presidency and the

winner-takes-all system have intensified electoral stakes, contributing to the high levels of competition and contestation. These structural features create a political environment where electoral outcomes can have profound consequences for access to resources and power, further raising the stakes of each election cycle.

Looking forward, several reform proposals have emerged to address persistent challenges. These include the adoption of electronic voting, diaspora voting rights, independent candidacy, and proportional representation elements (Hamalai et.al., 2015). The decentralization of INEC and the establishment of an Electoral Offences Commission have also been proposed to enhance efficiency and accountability (Oyeshola & Ubani, 2021). These potential reforms seek to address both the technical and political dimensions of electoral challenges, recognizing that technological solutions alone cannot resolve deeply rooted issues of political culture and institutional design.

The evolution of Nigeria's electoral system reflects broader patterns of democratization, characterized by progress, setbacks, and adaptations. While significant improvements have been made, particularly in the Fourth Republic, structural challenges persist (Fayemi, 2023). The continued development of this system will depend on addressing these challenges while building on recent technological and institutional innovations. Understanding this complex historical trajectory provides essential context for evaluating current reforms and anticipating future developments in Nigeria's democratic journey. The experience of Nigerian elections demonstrates that while formal rules and technological tools are important, equally crucial are the political will and civic engagement necessary to ensure that elections genuinely reflect the will of citizens and contribute to democratic consolidation (Ahanihu, 2010).

CHAPTER 4

REVIEW OF NIGERIAN ELECTORAL PROCESSES AND CRITICAL SOCIAL-TECHNICAL ANALYSIS

4.0 Introduction

A robust understanding of the electoral processes in Nigeria is essential to contextualize the socio-technical challenges faced in implementing election technologies. These processes are detailed below;

Table 2

Nigerian Electoral Processes (INEC,2023).

Voter Registration	Continuous voter registration is conducted by the Independent National Electoral Commission (INEC) to ensure an up-to-date voter registry. The introduction of biometric technologies, including fingerprint and facial recognition, has reduced fraud by verifying voter identity. However, technical issues such as system failures during registration have raised concerns about the socio-technical challenges of ensuring access, particularly in rural areas with limited infrastructure.
Candidate Nomination	Political parties conduct internal processes to nominate candidates. This stage is governed by legal requirements, including eligibility based on age and education. However, issues such as internal party democracy and candidate imposition often limit the fairness of the process, pointing to socio-technical barriers such as political manipulation and inadequate institutional reforms.
Campaigning	Campaigning is regulated by INEC to ensure fair competition. The introduction of social media has amplified political communication, but it also presents challenges related to misinformation. Balancing free expression

	with electoral integrity showcases the tension between technological opportunities and socio-political constraints.
Voting	Voting processes in Nigeria employ the Permanent Voter Card (PVC), which enhances transparency by preventing multiple voting. However, the success of this system is often undermined by logistical challenges such as card distribution and technological breakdowns on election day, exacerbating concerns around Nigeria's socio-technical readiness.
Vote Counting and Results Announcement	Results are counted in the presence of observers to maintain transparency, but irregularities in result collation and transmission have led to public distrust. The socio-technical environment, including technological failures and political interference, complicates efforts to ensure credible elections.
Electoral Dispute Resolution	Post-election disputes are addressed through tribunals, which uphold democratic principles by resolving electoral irregularities. However, delays in dispute resolution and perceptions of judicial bias underscore the need for socio-technical reforms to enhance the fairness and speed of the judicial process.

4.1 Key Stakeholders in the Nigerian Electoral System

This section provides an in-depth analysis of the major entities that play crucial roles in the electoral process of Nigeria. Central to this discussion is the Independent National Electoral Commission (INEC), which is tasked with organizing and overseeing elections across all levels of government. INEC's mandate includes ensuring that elections are free, fair, and credible by implementing various measures such as voter registration, electoral constituency delineation, and campaign finance monitoring. The section also highlights the significant contributions of political parties in Nigeria, particularly the roles of the All Progressives Congress (APC) and the People's Democratic Party (PDP). These parties are instrumental in shaping the political landscape through candidate nominations, voter mobilization, and policy advocacy. Furthermore, the section examines the challenges and reforms within INEC, as well as the dynamics and influence of political parties, providing a comprehensive understanding of the stakeholders that underpin Nigeria's electoral system.

(a) Independent National Electoral Commission (INEC)

The Independent National Electoral Commission (INEC) is the primary body responsible for organizing and overseeing elections in Nigeria. Its origins can be traced back to the pre-independence era when the Electoral Commission of Nigeria (ECN) was established in 1958 to conduct the 1959 elections. After independence in 1960, the Federal Electoral Commission (FEC) was tasked with organizing the 1964 federal and 1965 regional elections (Independent National Electoral Commission ,2023).

However, the electoral body was dissolved following the military coup of 1966. It was not until 1978 that a new Federal Electoral Commission (FEDECO) was constituted under the regime of General Olusegun Obasanjo. FEDECO organized the 1979 elections, which ushered in the Second Republic under the leadership of Alhaji Shehu Shagari, and also conducted the 1983 general elections. After the military takeover in 1983, the electoral body was again dissolved. It was not until 1987 that the National Electoral Commission (NEC) was established by the regime of General Ibrahim Babangida. NEC organized the 1991 local government elections and the 1992 parliamentary and presidential elections. However, the 1993 presidential election, which was widely regarded as the fairest in Nigeria's history, was annulled by the military regime (Nwokedi, 1994).

Following the transition to civilian rule in 1999, the Independent National Electoral Commission (INEC) was established by the 1999 Constitution. INEC has since conducted several general elections, including the 1999, 2003, 2007, 2011, 2015, and 2019 elections. The commission has also overseen numerous state and local government elections during this period (INEC, 2023).

INEC's mandate, as outlined in the 1999 Constitution and the Electoral Act 2010 (as amended), includes;

1. **Voter registration:** INEC is responsible for compiling and maintaining the national voters' register, which is used to determine the eligibility of citizens to vote in elections.
2. **Constituency delineation:** INEC is tasked with dividing the country into constituencies for the purpose of elections, ensuring that each constituency has a roughly equal population.
3. **Political party registration:** INEC is responsible for registering and regulating political parties in Nigeria, ensuring that they adhere to democratic principles and the rule of law.
4. **Campaign finance monitoring:** INEC monitors the campaign financing activities of political parties and candidates, ensuring that they comply with the relevant laws and regulations.
5. **Conduct of elections:** INEC is responsible for organizing and overseeing the conduct of elections at the federal, state, and local government levels, ensuring that they are free, fair, and credible.

Despite constitutional guarantees of independence, Nigeria's Independent National Electoral Commission (INEC) confronts numerous operational challenges that significantly impact its performance. Inadequate funding and logistical limitations severely hinder the Commission's ability to effectively deploy personnel and materials, particularly in remote and conflict-affected areas across the country, as Daniel et. al (2023) have extensively documented. Equally concerning are the subtle and overt attempts by political actors to influence INEC's decisions, which fundamentally undermine public confidence in its independence. This interference manifests in various forms, including manipulation of appointment processes, strategic restrictions in budget allocations, and intense pressure during critical electoral periods, as revealed in recent research by

The security landscape presents another formidable challenge, with INEC struggling to conduct credible elections in regions affected by insurgency, banditry, and communal conflicts. These security threats significantly impact voter participation and complicate electoral administration across multiple geopolitical zones, creating democratic deficits in affected areas (Nwankwo & Tsuwa & Agaigbe, 2022). Furthermore, despite their potential benefits, technological solutions implemented by INEC have occasionally experienced critical failures during deployment, resulting in voter disenfranchisement and disputed outcomes. These technical shortcomings highlight the urgent need for robust contingency planning and comprehensive testing of electoral technologies before widespread implementation (Ahmad, 2021).

Political parties in Nigeria exhibit profound structural and operational weaknesses that diminish their effectiveness as democratic institutions (Agara, 2022). Party primaries and candidate selection processes are frequently characterized by manipulation, imposition of preferred candidates, and excessive monetization, directly contradicting fundamental democratic principles and alienating grassroots members who feel excluded from meaningful participation (Ashe,2019). Most parties also suffer from ideological ambiguity, lacking clear philosophical distinctions and focusing instead on personality politics and regional or ethnic mobilization. This ideological deficit severely hampers policy-based competition and undermines meaningful accountability mechanisms that should connect elected officials to specific programmatic commitments (Ahuja, 2019).

The increasing financial demands of political participation effectively exclude qualified but resource-constrained candidates and distort representation in favor of wealthy elites, creating a plutocratic tendency within Nigeria's democratic experiment (Adeogun & Isola, 2020). Adding to these challenges is the phenomenon of cross-carpeting and political nomadism, where politicians frequently switch party affiliations based on opportunistic calculations rather than principled disagreements on policy or ideology. This practice weakens party cohesion, undermines ideological consistency, and contributes to citizen disillusionment with the political process (Omotola, 2010).

Ongoing reform efforts aim to address these identified weaknesses in Nigeria's electoral ecosystem. Recent amendments to the Electoral Act have sought to strengthen INEC's independence and introduced significant innovations, such as electronic transmission of results (Samuel, 2024). Further constitutional reforms regarding campaign finance regulations and internal party democracy remain under active consideration by lawmakers and civil society advocates (Sule, 2023). Nigerian civil society organizations have become increasingly active in electoral reform advocacy, independent election observation, and comprehensive voter education programs. Their involvement substantially enhances transparency and facilitates more meaningful citizen participation in the democratic process (Chidi & Anikelechi, 2021).

International partners provide valuable technical assistance, capacity building initiatives, and financial support for electoral reforms in Nigeria (Imoh-Ita, 2025). These collaborative efforts introduce global best practices while respecting Nigeria's sovereignty and unique sociopolitical context. Within political parties themselves, progressive elements advocate for meritocracy, youth inclusion, and gender equity in party structures and candidate selection processes. These internal reform movements hold significant potential for broader democratic renewal if they gain sufficient traction within major political organizations (LeBlanc, 2008).

The effective functioning of INEC and political parties remains fundamental to the consolidation of Nigeria's democracy. While significant progress has been made in institutionalizing electoral processes and expanding political competition since the return to civilian rule, persistent challenges require sustained reform efforts across multiple fronts. Strengthening these key stakeholders will enhance the quality of representation, improve governance outcomes, and advance democratic development in Africa's most populous nation. The complex interplay between electoral management, political competition, and citizen engagement will continue to shape Nigeria's democratic trajectory in the coming years, determining whether the country can overcome its current challenges to achieve a more inclusive, responsive, and accountable democratic system.

(b) Political Parties in Nigeria

Nigeria, Africa's most populous country, operates a robust multi-party system that forms the bedrock of its democratic governance (Krishnan, 2020). This system allows for the representation of diverse political ideologies and interests, reflecting the country's rich cultural, ethnic, and socio-economic landscape. Political parties in Nigeria are pivotal in the political process, playing essential roles in candidate nomination, voter mobilization, policy formulation, and public discourse (Yagboyaju & Simbine, 2020). The competition and collaboration among various political entities ensure a dynamic political environment where the electorate's voices can be heard and their interests represented (Adeforiti, 2018). As of the 2019 general elections, there were 91 registered political parties, although many of these parties are relatively minor compared to the dominant ones (Agara,, 2022).

The multiparty system in Nigeria is not just a theoretical construct but a living, breathing framework that shapes the nation's political dynamics. The system is bolstered by state funding, which aims to create a level playing field for all registered political parties (Amuwo, 2010).This support is crucial in fostering healthy political competition and enhancing democratic participation. Among the plethora of political parties, the All Progressives Congress (APC) and the People's Democratic Party (PDP) stand out as the dominant players, having significant influence over the country's political landscape. These major parties, along with numerous smaller parties, contribute to the vibrant and sometimes tumultuous political climate of Nigeria (Sule,2024).

However, the Nigerian political party system is not without its challenges. Issues such as internal democracy, transparent funding, and the role of money in politics have been long-standing concerns that require urgent attention and reform (Nasiru & Ali, 2020). Allegations of candidate imposition, lack of internal party democracy, and the corrosive influence of wealthy individuals or groups have undermined the credibility of the political process at times. Addressing these challenges is crucial for strengthening Nigeria's democratic institutions and ensuring that the will of the people is truly reflected in the country's governance.

In the broader context, the evolution of Nigeria's electoral system and the role of political parties are inextricably linked to the country's complex political history. From the colonial era to the present-day Fourth Republic, the Nigerian electoral system has undergone numerous transformations, adapting to the country's changing political landscape (Yagboyaju & Simbine, 2020). The establishment of the Independent National Electoral Commission as the primary body responsible for organizing and overseeing elections has been a significant step in ensuring the integrity and transparency of the electoral process (Omotola, 2010).

Understanding the dynamics of Nigeria's political party system and its historical development is crucial for comprehending the broader political landscape in the country. This section of the literature delves into the intricacies of political parties in Nigeria, examining their roles, functions, and impact on the nation's democracy (Amuwo, 2010). While Nigeria's political landscape boasts a multitude of registered political parties, the All Progressives Congress (APC) and the People's Democratic Party (PDP) stand out as the dominant forces shaping the country's political dynamics. These two major parties have been pivotal in Nigeria's democratic journey, influencing governance, policy-making, and political discourse (Awotokun & Okotoni, 2020).

The All Progressives Congress (APC) was formed in February 2013 through the strategic merger of four prominent opposition parties: the Action Congress of Nigeria (ACN), the Congress for Progressive Change (CPC), the All Nigeria Peoples Party (ANPP), and a faction of the All Progressives Grand Alliance (APGA) (Nwobu et. al., 2024). This coalition emerged in a political environment dominated by the People's Democratic Party (PDP), which had maintained a stronghold on Nigerian politics since the return to civilian rule in 1999. The fragmentation of

opposition parties had previously hindered any significant challenge to the PDP's dominance, making the formation of the APC a pivotal moment in Nigeria's political landscape. By uniting these parties, the APC aimed to create a formidable opposition capable of contesting national power effectively (Premium Times, 2013).

The APC's formation marked a significant turning point in Nigerian politics, culminating in a historic electoral victory in the 2015 general elections. The party's candidate, Muhammadu Buhari, won the presidency, marking the first time in Nigeria's history that an incumbent president was defeated by an opposition candidate. This victory was not only a milestone for the APC but also a transformative moment for Nigerian democracy, symbolizing a shift in political power and the potential for more competitive elections. According to Leadership Editorial (2022), the successful transition of power from the PDP to the APC represented a significant achievement in the country's democratic evolution, as it demonstrated the possibility of political change through the ballot box rather than through violence or coercion.

Emphasizing the key issues that resonate with many Nigerians, Premium Times (2013) stated that issues such as economic reform, anti-corruption, and improvements in security are crucial. The party has focused on diversifying the economy, enhancing infrastructure, and addressing the persistent threat posed by the Boko Haram insurgency in the northeast. The APC's governance approach has aimed to foster a more transparent and accountable government, positioning itself as a party committed to addressing the pressing challenges facing the nation.

Regionally, the APC has established a strong base in the northern and southwestern regions of Nigeria, which has been instrumental in its electoral successes. This regional support has shaped the party's policy priorities, reflecting the interests and concerns of its constituents. The APC's ability to mobilize support across diverse demographics has been critical in its electoral victories, allowing it to maintain a significant presence in both the House of Representatives and the Senate (Nwobu et. al., 2024).

Further commenting on APC, Leadership Editorial (2022) stated that in the aftermath of Buhari's two-term presidency, the APC faced the challenge of selecting a new candidate for the 2023 presidential election. Bola Tinubu, a veteran opposition leader and former governor of Lagos State, emerged as the party's nominee in June 2022. In the subsequent election, he faced 17 other candidates and was declared the winner, securing approximately 37 percent of the vote and extending the party's hold on the presidency. The APC's continued success in national elections underscores its position as a dominant force in Nigerian politics, reflecting the party's ability to adapt and respond to the evolving political landscape.

The formation of the All Progressives Congress represents a significant chapter in Nigeria's political history. By uniting various opposition factions, the APC has successfully challenged the long-standing dominance of the PDP, achieving notable electoral victories and shaping the country's governance landscape. As the party continues to navigate the complexities of Nigerian

politics, its commitment to addressing key issues such as economic reform, security, and anti-corruption will be critical in maintaining its relevance and support among the electorate. The APC's journey illustrates the dynamic nature of Nigeria's political environment and the potential for change through organized political action. The second major political party in Nigeria is the People's Democratic Party (PDP).

The People's Democratic Party (PDP), established in 1998, is one of Nigeria's oldest and most influential political parties. It emerged in the wake of years of military rule, playing a crucial role in the country's transition to civilian governance (Nwobu et. al., 2024).The PDP quickly became the dominant political force in Nigeria, holding power at the federal level from the return to civilian rule in 1999 until 2015, making it the longest-ruling party in Nigeria's recent democratic history. The party's formation was a response to the political climate of the time, characterized by widespread dissatisfaction with military governance and a yearning for democratic reforms.

Historically, the PDP's significance lies in its role during Nigeria's transition from military to civilian rule. Under its leadership, the country experienced substantial political and economic reforms, including the liberalization of the telecommunications sector, which spurred growth and innovation, and efforts to stabilize the economy. These reforms were pivotal in laying the groundwork for a more open and competitive political environment, contributing to Nigeria's economic development during the early 2000s (Onolememen, 2020). Electoral performance has been a defining feature of the PDP's history. Despite losing the presidency in 2015 to the All Progressives Congress (APC), the PDP remains a significant force in Nigerian politics. In the 2019 general elections, the party maintained a strong presence in the National Assembly, winning 43 out of 109 Senate seats and 147 out of 360 House of Representatives seats. Furthermore, the PDP continues to control several state governments, particularly in the southeastern and south-south regions of Nigeria, demonstrating its enduring influence in those areas (Musa & Yahaya, 2024).

The PDP's policy and ideology often focus on social welfare, economic development, and national unity. The party advocates for policies that promote inclusive growth, poverty reduction, and infrastructure development. It has also been vocal about the need for electoral reforms and strengthening democratic institutions, emphasizing transparency and accountability in governance (PDP, 2023). This ideological stance has resonated with many Nigerians, particularly in regions where social welfare programs are crucial for improving living standards.

The dynamics of electoral competition in Nigeria are significantly shaped by the rivalry between the APC and the PDP. This competition has led to more robust electoral campaigns, greater scrutiny of candidates, and heightened political engagement among the electorate. The presence of these two dominant parties ensures that voters have clear alternatives, contributing to the vibrancy of Nigeria's democracy (Abou-Chadi, 2018). The rivalry has also prompted both parties to form alliances with smaller parties and political groups to strengthen their electoral chances.

These coalitions are critical during elections, particularly in Nigeria's diverse and fragmented political landscape, as they help to pool resources, broaden support bases, and enhance the parties' ability to govern effectively (Husaini, 2023).

However, both the PDP and the APC face challenges, including issues of internal democracy, corruption allegations, and governance shortcomings. Ensuring transparency in candidate selection, reducing the influence of money in politics, and addressing internal factionalism are ongoing challenges that impact their credibility and effectiveness in governance (Adawiah & Putra, 2024). These issues have led to public disillusionment with both parties, affecting their ability to maintain trust among the electorate. In the words of Awotokun & Okotoni (2020), the impact of the PDP and APC on governance in Nigeria is profound. Their policies and legislative priorities shape the country's development trajectory, influencing public perception and trust in democratic institutions. The performance of these parties in office has significant implications for Nigeria's political stability and economic growth. As the PDP continues to navigate its role in a competitive political landscape, its historical significance and influence remain vital to understanding the dynamics of Nigerian politics today.

The competition between the APC and PDP illustrates the broader socio-technical challenges facing Nigerian politics. On one hand, technological advancements such as voter biometric systems and digital campaign strategies offer new avenues for enhancing electoral transparency and voter engagement. On the other hand, the deeply entrenched socio-political dynamics, including regionalism, party financing, and the role of elites, often undermine these innovations (Fatai, 2020). This contrast highlights the importance of considering not just the technical solutions but also the social structures that either enable or hinder their effective implementation.

While the Nigerian electoral system has incorporated various technologies to improve transparency, the socio-political context marked by corruption, wealth concentration, and regionalism continues to pose significant challenges. Bridging the gap between technology and social systems is essential for the future of Nigerian democracy.

4.2 Technology Deployment in Nigerian Elections

The integration of technology into electoral processes has gained global significance, with Nigeria being no exception (Abdullahi & Tunwase, 2021). Technological innovations such as online voter databases and biometric card readers have played crucial roles in enhancing the transparency, efficiency, and credibility of Nigerian elections (Ayeni & Esan, 2018). This section of the literature review critically examines the current body of work on the application of technology in Nigerian elections, focusing on developments, challenges, and socio-technical impacts observed in recent years. The table below provides an overview of the technologies implemented in Nigerian elections and the corresponding years of their introduction.

Table 3

Technologies applied in Nigerian elections along with the years they were introduced

S/N	Technology	Year Introduced	Description
1.	Automated Fingerprint Identification System (AFIS)	2011	Used to prevent multiple voter registrations by capturing biometric data during the registration process.
2.	Permanent Voter Card (PVC) and Smart Card Reader	2015	Used to verify voter identities at polling units by matching biometrics to the voter card.
3.	Collation Support and Result Verification System (CSRVS)	2020	Used for collation and verification of election results.
4.	Online Nomination and Accreditation Platforms	2020	Simplifies the nomination and accreditation processes for political parties and observers.
5.	Direct Data Capture Machine (DDCM)	2021	Used for voter registration before being replaced by the IVED.
6.	INEC Voter Enrollment Device (IVED)	2021	A compact and efficient Android-based device for voter registration that captures biometric data.
7.	Bimodal Voter Accreditation System (BVAS)	2022	Uses fingerprint and facial recognition for voter identity verification and captures polling unit result sheets.
8.	INEC Result Viewing Portal (IReV)	2023	An online platform for real-time viewing of polling unit results to promote transparency.

4.3 Online Voter Databases

The implementation of online voter databases represents a critical step toward modernizing Nigeria's electoral process. The establishment of a centralized electronic voter register has played a significant role in reducing electoral fraud, such as multiple registrations and voter impersonation. While the establishment of a centralized electronic voter register in Nigeria has been touted as a significant step in reducing electoral fraud, such as multiple registrations and voter impersonation, some argue that this system may not be a panacea (Godwin, 2019).

Critics contend that the reliance on technology can introduce new vulnerabilities, such as potential hacking or manipulation of the voter database, which could undermine the integrity of the electoral process if not properly secured and monitored (Gerber, 2011). Furthermore, the continuous successful implementation of this system is contingent on the technical capacity of INEC to manage and maintain it effectively, as well as the level of digital literacy among the populace, which remains a concern in certain regions of Nigeria. The disparities in technological infrastructure and education can hinder the effective use of the online voter database, particularly in rural and underserved areas (Aderibigbe & Gumbo, 2024). Efforts to bridge this digital divide include targeted voter education programs and the provision of support services to assist voters in navigating the system (Iwuoha, 2018).

Moreover, empirical studies have highlighted both the benefits and limitations of online voter databases. During the 2011 general elections, the online voter database facilitated more accurate and efficient voter verification processes. The system's ability to quickly cross-reference voter details helped to prevent cases of double voting and ghost voters, which were rampant in previous elections (INEC, 2023). In his analysis, Fatai (2020) argues that while the online voter database has improved the overall integrity of the electoral process, its effectiveness is closely tied to the broader context of Nigeria's political and socio-economic environment. He suggests that for the technology to reach its full potential, there must be a concerted effort to address underlying issues such as political corruption, inadequate funding, and infrastructure deficits. Worton, (2012) confirms that technical adoption should not only focus on the use of the system but also on the socio-technical contexts in which the system is implemented. Considering the socio-technical context helps adopters anticipate and address potential challenges that could undermine the effectiveness of the technology.

Beyond the implementation of voter databases, another significant technological innovation in Nigerian elections has been the introduction of biometric card reader technology.

4.4 Biometric Card Reader Technology

The introduction of biometric card readers has been a transformative development in Nigerian elections, significantly enhancing the integrity and credibility of the electoral process (James, 2016). These devices, which authenticate voters' identities by capturing and verifying biometric data such as fingerprints, have played a crucial role in curbing electoral malpractices, including ballot stuffing, result sheet manipulation, and over-voting (Ayeni & Esan, 2018). The deployment of this technology during the 2015 general elections marked a significant advancement in Nigeria's electoral framework, as it aimed to ensure that only registered voters could cast their ballots, thereby reinforcing the democratic process.

The impact of biometric card readers on the electoral landscape has been profound. According to Asemah (2017), the use of these devices during the 2015 elections resulted in a notable reduction in instances of electoral malpractice, such as voter impersonation and ballot stuffing. However,

the initial deployment faced challenges, including technical glitches and insufficient training for electoral staff, which sometimes led to delays and confusion at polling stations. These challenges highlighted the need for comprehensive training and support for electoral officials to ensure the smooth operation of the technology (Ajah et. al, 2020). Despite the overall positive impact of biometric card readers, the adoption of this technology has been met with mixed reactions. Some studies have pointed out the difficulties faced by rural voters in adapting to the new system, particularly due to poor infrastructure and a lack of digital literacy (Iwuoha, 2018). In many rural areas, inadequate access to electricity and unreliable internet connectivity hinder the effective use of biometric devices, creating barriers to participation for a significant segment of the population. This digital divide raises concerns about the inclusivity of the electoral process and the potential disenfranchisement of voters in less accessible regions (Tuorto,2022)

The 2015 general elections were a crucial test for the biometric card reader technology. As noted by Alebiosu (2016), while the card readers improved the overall credibility of elections, their effectiveness was contingent upon proper implementation and adequate support infrastructure. They emphasized the importance of continuous training and capacity building for electoral officials, along with periodic updates and maintenance of the technology, to sustain its benefits. The successful integration of biometric technology into the electoral process requires not only the devices themselves but also a robust support system that addresses the logistical and operational challenges associated with their use (Gelb & Diofasi, 2019).

The experience of the 2015 elections set the stage for subsequent elections in Nigeria, including the 2019 general elections, where biometric technology continued to play a significant role (Nwanolue et.al., 2019). The lessons learned from the initial deployment of biometric card readers have informed ongoing efforts to improve the electoral process. For instance, the introduction of the Bimodal Voter Authentication System (BVAS) in 2022 further enhanced the biometric verification process, allowing for more reliable authentication of voters during elections (Agbu, 2016). The introduction of biometric card readers in Nigerian elections has been a game-changer, significantly enhancing the integrity of the electoral process. While the technology has successfully reduced instances of electoral malpractice, challenges remain, particularly regarding accessibility for rural voters and the need for ongoing training and support for electoral officials (Emmanuel et al., 2013). As Nigeria continues to refine its electoral processes, addressing these challenges will be essential for ensuring that all citizens can participate meaningfully in the democratic process, thereby strengthening the foundations of Nigeria's democracy.

4.5 Bimodal Voter Accreditation System (BVAS)

The Independent National Electoral Commission (INEC) of Nigeria has taken a significant step towards enhancing the integrity of its electoral process by introducing the Bimodal Voter Accreditation System (BVAS). This cutting-edge technology utilizes both fingerprint and facial

recognition to verify the identities of voters at polling units, effectively preventing identity fraud and ensuring that only registered voters can cast their ballots (Ayeni & Esan, 2018; Chukwuma, 2022). The implementation of BVAS has been widely praised for its ability to curb electoral malpractices, such as underage voting and multiple voting, which have plagued Nigeria's elections in the past. By relying on biometric data to authenticate voters, BVAS ensures that each individual can only vote once, thereby strengthening the democratic process and instilling greater confidence in the electoral outcomes.

INEC's decision to deploy BVAS machines for the 2023 general elections and subsequent governorship polls underscores its commitment to improving the credibility of the electoral process. The commission has announced plans to utilize 11,355 BVAS devices across the country, a significant increase from the initial deployment during the 2021 Anambra State gubernatorial election (Vanguard Newspaper, 2023). However, despite the numerous benefits of BVAS, some researchers have highlighted potential drawbacks that must be addressed. One concern is the risk of disenfranchising legitimate voters due to technical failures or difficulties in capturing biometric data, particularly among older individuals or manual laborers whose fingerprints may be worn down (Vanguard Newspaper, 2023). To mitigate these challenges, INEC must ensure that the BVAS devices are well-maintained, regularly updated, and supported by a robust technical team capable of resolving any issues that may arise during the voting process.

As Nigeria continues to refine its electoral framework, the successful integration of BVAS will be crucial in ensuring free, fair, and credible elections (Obakhedo, 2011). However, the challenges associated with this technology must be proactively addressed to ensure that it serves its intended purpose of enhancing the integrity of the electoral process without compromising the rights and privacy of voters. INEC must work closely with stakeholders, including civil society organizations and technology experts, to continuously improve and adapt the BVAS system to meet the evolving needs of Nigeria's democracy (Ogunmade, 2023).

4.6 INEC Voter Enrollment Device (IVED)

The INEC Voter Enrollment Device (IVED) represents a significant advancement in Nigeria's electoral process, replacing the older Direct Data Capture Machine (DDCM) with a more compact and efficient Android-based device designed for voter registration. This transition, announced by the Independent National Electoral Commission (INEC) in June 2021, aims to streamline the voter registration process and enhance the overall efficiency of electoral operations (INEC, 2023). The IVED is not only a technological upgrade but also a strategic move to address the challenges faced in previous voter registration exercises, ensuring a more reliable and accessible system for all Nigerians (BBC News Pidgin, 2021).

According to INEC (2023), IVED is designed to capture and store biometric data, including fingerprints and facial recognition; the IVED is essential for authenticating voters during

elections. This technology facilitates a seamless registration experience, allowing individuals to register efficiently while minimizing the risk of errors and fraud. By utilizing an Android operating system, the IVED integrates with INEC's online registration portal, enabling a more user-friendly interface and enhancing the accessibility of the registration process. One of the key advantages of the IVED is its ability to reduce instances of multiple voter registrations, a significant issue that has plagued Nigeria's electoral landscape. By ensuring that each voter's biometric data is uniquely captured and stored, the IVED helps maintain the integrity of the voter registry, making it more difficult for individuals to register multiple times under different identities. This capability is crucial for enhancing the credibility of elections and fostering public trust in the electoral process.

While the IVED has been lauded for its potential to enhance the voter registration process, there are inherent challenges that must be addressed to ensure its effectiveness. Some researchers have highlighted concerns regarding the risk of disenfranchising legitimate voters due to technical failures or difficulties in capturing biometric data, particularly among older individuals or those engaged in manual labor whose fingerprints may be less distinct (Osho et al., 2015). These challenges underscore the importance of adequate training for electoral officials and the need for contingency plans to address any technical issues that may arise during the registration process. Moreover, the reliance on biometric technology raises significant concerns about data privacy and security (Liu, 2008).

The introduction of the IVED is expected to have a profound impact on the integrity of Nigeria's electoral process. By improving the accuracy of the voter registry and reducing opportunities for fraud, the IVED enhances the overall credibility of elections. INEC Chairman, Professor Mahmood Yakubu, has emphasized the importance of this technology in ensuring transparent and accountable electoral practices, stating that the IVED will play a critical role in the upcoming elections. Furthermore, the IVED is designed to function not only as a voter registration tool but also as a device for voter accreditation during elections. This dual functionality underscores INEC's commitment to leveraging technology to improve electoral processes and ensure that only registered voters are able to participate in elections. By integrating the IVED with the Bimodal Voter Accreditation System (BVAS), INEC aims to create a seamless experience for voters, further enhancing the integrity of the electoral process.

The INEC Voter Enrollment Device (IVED) marks a significant step forward in Nigeria's efforts to modernize its electoral system. By replacing the older DDCM with a more efficient and compact device, INEC is addressing longstanding challenges in voter registration and enhancing the overall integrity of the electoral process. While the IVED presents numerous benefits, including improved accuracy and reduced fraud, it is essential for INEC to remain vigilant in addressing potential challenges related to technical failures and data privacy. As Nigeria prepares for future elections, the successful implementation of the IVED will be crucial in ensuring that

all citizens can participate meaningfully in the democratic process, thereby strengthening the foundations of Nigeria's democracy.

4.7 INEC Result Viewing Portal (IReV)

According to INEC (2023), the INEC Result Viewing Portal (IReV) is a crucial technological innovation introduced by the Independent National Electoral Commission (INEC) in Nigeria to enhance the transparency and credibility of the electoral process. Launched for the 2023 general elections, the IReV platform allows for the real-time transmission of election results from polling units to a central collation center, thereby reducing the incidence of vote rigging and election manipulation. The IReV portal provides voters and other stakeholders with the ability to monitor the electoral process and view results as they come in. It features images of the election results from each polling unit, detailing the number of votes cast for each candidate and the percentage of total votes. Accessing the IReV is straightforward. Users can visit the dedicated website, create an account if they are first-time users, and log in to view the results. The functionality of the IReV is closely linked to the Bimodal Voter Accreditation System (BVAS), which serves a dual purpose: it verifies the identity of voters using biometric data and captures images of the result forms at polling units. These images are then uploaded to the IReV, making the results accessible online as viewable PDF files.

The effectiveness of the IReV platform is contingent upon the reliability of Nigeria's internet infrastructure. Challenges such as network outages and connectivity issues can hinder the transmission of results, potentially undermining the credibility of the electoral process. The success of the IReV is thus dependent on the availability of a stable internet connection across the country, particularly in rural areas where access may be limited.

The INEC Result Viewing Portal (IReV) is a landmark development in Nigeria's electoral landscape. By enabling real-time access to election results and promoting transparency, the IReV aims to bolster public confidence in the electoral process and reduce the potential for electoral malpractice. As Nigeria continues to evolve its democratic practices, the successful implementation of the IReV and its integration with other technological innovations like the BVAS will be crucial in ensuring free, fair, and credible elections in the future

CHAPTER 5

SOCIO-TECHNICAL ANALYSIS OF THE ELECTION TECHNOLOGIES

5.0 Introduction

The table 4 below provides a socio-technical analysis of the key electoral technologies discussed above, introduced over the past decade in Nigeria. It highlights the rationale behind each technology, its performance, the challenges encountered during implementation, and lessons learned. The analysis underscores the importance of a holistic approach that considers both technical and social factors, such as infrastructure, digital literacy, and stakeholder engagement, to improve the integrity and transparency of the electoral process in Nigeria.

Table 4

Technologies applied in Nigerian elections (2011 - 2023).
Source (Independent National Electoral Commision)

Technology	Year	Rationale	Performance	Challenges	Lessons
Automated Fingerprint Identification System (AFIS)	2011	Combat electoral fraud, particularly multiple voter registrations using biometric data.	Improved voter register accuracy, but hindered by unreliable electricity and poor internet connectivity in rural areas.	Limited digital literacy and insufficient training for electoral staff. Poor data entry during registration caused inaccurate voter data.	Proper infrastructure and extensive training are necessary for effective biometric systems, particularly in regions with technological limitations.

Permanent Voter Card (PVC) and Smart Card Reader	2015	Strengthen voter identity verification and prevent impersonation with biometric matching at polling units.	Enhanced voter identification accuracy, increased transparency, but card reader malfunctions in some locations.	Logistical issues with PVC distribution, technical malfunctions of card readers, and regional disparities in digital infrastructure.	Investment in infrastructure and proper maintenance of voter identification systems are critical. Card readers must be tested and prepared in advance.
Collation Support and Result Verification System (CSRVS)	2020	Address result collation discrepancies by digitizing verification to reduce human errors.	Streamlined result collation , reduced manipulation, but not adopted in all domains.	Resistance from stakeholders favoring manual processes, cybersecurity concerns, and limited digital infrastructure in rural areas.	Stakeholder buy-in and strong cybersecurity measures are essential for technology adoption in elections.
Online Nomination and Accreditation Platforms	2020	Simplify nomination and accreditation processes, reducing manual inefficiencies and manipulation opportunities .	Improved efficiency and oversight but limited by accessibility issues in certain regions.	Inadequate internet access, particularly in rural areas, and reluctance of stakeholders to transition from traditional methods.	Reliable internet infrastructure and a phased adaptation approach are crucial for the success of digital platforms.

Direct Data Capture Machine (DDCM)	Prior to 2021 and evolved into the 3-in-1 machine in 2023	Ensure accurate voter registration by capturing biometric data.	Initially effective but became outdated, with limitations in scalability and data accuracy.	Struggled with data storage issues and was inefficient for large voter registration volumes, leading to its phase-out.	Regular technological updates are necessary for handling larger populations and improving voter registration efficiency.
INEC Voter Enrollment Device (IVED)	2021 (consolidated on one device with BVAS and IReV in 2023)	Modernize voter registration with better scalability and user-friendliness using an Android-based device.	Improved speed and accuracy of voter registration, addressing inefficiencies in DDCM, but limited by technical malfunctions in areas with poor electricity and internet.	Unstable electricity and internet access in rural areas affected the device's full potential.	Technological improvements must be accompanied by infrastructure investments to ensure efficiency across all regions.
Bimodal Voter Accreditation System (BVAS)	2022 (consolidated on one device with BVAS and IReV in 2023)	Strengthen voter verification using both fingerprint and facial recognition for a more robust accreditation process.	Highly effective in reducing voter fraud and ensuring accurate voter verification through dual biometrics, but faced regional technical failures.	Inadequate staff training and inconsistent performance in certain areas contributed to technical failures.	Comprehensive training and technical support are essential for the successful deployment of advanced verification systems like BVAS.

INEC Result Viewing Portal (IReV)	2023 (consolidated on one device with BVAS and IReV in 2023)	Promote transparency by allowing real-time online viewing of polling unit results to address concerns over result manipulation.	Increased public trust in the electoral process through real-time result viewing, but access was limited in regions with poor internet connectivity.	Disparities in internet access, especially in rural areas, and cybersecurity vulnerabilities.	Ensuring nationwide access to digital platforms and strengthening cybersecurity measures are crucial for transparency in electoral processes.

5.1 Automated Fingerprint Identification System (AFIS)

The integration of automated fingerprint identification systems in Nigerian elections represents a significant shift in how electoral credibility is pursued through technological means. This approach, largely operationalized through biometric voter accreditation technologies such as the Bimodal Voter Accreditation System (BVAS), offers a technically sophisticated method for verifying voter identity and minimizing electoral fraud. However, an analysis grounded in socio-technical theory reveals that the effectiveness of such technology is not rooted solely in its functionality but in its interaction with broader human, organizational, and infrastructural systems.

The people component of the socio-technical framework emphasizes the centrality of individuals who interact with the system. In the electoral context, this includes voters, electoral officers, and ad hoc staff. The successful deployment of fingerprint authentication depends on users' ability to understand, trust, and operate the technology effectively. Where electoral officers lack sufficient training or fail to interpret system prompts correctly, technical reliability is compromised. Similarly, voter experiences with the system vary significantly. Fingerprint capture can be hampered by worn prints due to aging, occupation, or health conditions. These human-technology misalignments do not reflect technological failure per se, but rather a system design that insufficiently accounts for the diversity of its users.

Culture shapes how individuals and communities engage with technologies. In Nigeria, elections are often viewed with suspicion due to historical manipulation and institutional distrust. The introduction of fingerprint authentication does not automatically resolve these perceptions. Rather, it can deepen them if technological processes appear opaque or inconsistent. In areas

where sociocultural norms limit women's participation or where biometric practices clash with religious or local customs, adoption can be uneven. Moreover, narratives around digital manipulation, rigging through technology, or disenfranchisement due to failed authentication further complicate cultural acceptance.

From a technological standpoint, the system's logic is grounded in biometric uniqueness and machine verification. Yet this logic meets practical limits in field conditions. Devices must function in real-world environments marked by poor connectivity, extreme weather, and irregular electricity supply. These conditions test the robustness of fingerprint scanners and the reliability of data transmission. Additionally, when devices are imported or externally configured, local adaptability becomes constrained. The inability to tailor systems to local needs, whether in terms of language, terrain, or usage pattern points to a socio-technical disjuncture between system design and context.

Infrastructure, both digital and physical, is integral to system performance. Fingerprint identification systems rely on stable electricity, secure data storage, and responsive technical support. Inconsistent power supply and weak network coverage in many polling locations can delay or prevent voter accreditation. The logistical chain supporting the movement, maintenance, and replacement of devices is often fragile, with limited redundancies built into the system. Infrastructural limitations do not merely hinder technology use but also influence perceptions of its reliability and fairness, particularly when failures occur more frequently in certain regions.

The goals embedded in technological interventions often diverge across actors. While the electoral commission may promote fingerprint authentication as a path to transparency, political stakeholders may interpret or manipulate the technology to suit partisan interests. This divergence complicates accountability and performance evaluation. When the goals of system designers, implementers, and users are not aligned, the outcomes become less about technology's capacity and more about how power, legitimacy, and procedural fairness are negotiated within the electoral process.

Processes, the structured practices surrounding technology use, determine how systems respond to variability and uncertainty. The procedures for biometric accreditation, exception handling, and post-election audits are crucial to maintaining trust. If the process allows manual overrides without robust documentation or if there is limited recourse for voters denied accreditation due to technical failure, the integrity of the broader system is weakened. Rigid protocols that cannot accommodate on-ground realities may produce inequitable outcomes, especially in marginalized communities where technical literacy and infrastructure are limited.

The deployment of fingerprint authentication in Nigerian elections is not simply a technical exercise but a socio-technical system in action. The interaction between people, culture,

technology, infrastructure, goals, and processes reveals both the potential and limitations of biometric innovation in democratic governance. Each component influences the system's ability to achieve credible, inclusive, and transparent elections. Understanding this interplay is critical for designing electoral technologies that do not merely function, but that are embedded meaningfully within the political and social fabric they aim to reform.

5.2 Permanent Voter Card (PVC) and Smart Card Reader

The introduction of the Permanent Voter Card (PVC) and the Smart Card Reader (SCR) into Nigeria's electoral process reflects a socio-technical reconfiguration of voter authentication and electoral accountability. These tools function not only as technological artefacts but as active components within a broader system comprising people, culture, infrastructure, goals, and processes. The interaction between these components defines how such technologies operate within the realities of democratic practice.

People occupy a central role in the operation and reception of both the PVC and the SCR. Voters engage with these technologies as bearers of identity, while electoral officers function as mediators between the devices and the electorate. This relational dynamic between human actors and technical artefacts informs how technology becomes socially embedded. Ad hoc staff interface with the SCR to validate the biometric identity encoded on the PVC, and the effectiveness of this interaction relies on their familiarity with procedural steps, comfort with digital tools, and confidence in the system's feedback.

Culture shapes the interpretive frames through which the PVC and SCR are understood and normalized. These tools have become symbolic of modern, rule-based elections in Nigeria, reinforcing a shift from informal methods of identity confirmation to a standardized, technology-mediated approach. Voter interactions with the PVC are often situated within broader social discourses around civic duty, trust in public institutions, and the credibility of electoral outcomes. The SCR, as a visible technological checkpoint, adds to the ritual of voting, instilling a sense of formality and process-oriented participation. Over time, these cultural cues contribute to the internalization of digital accreditation as a normative electoral practice.

The technological dimension of this system includes the encoding of biometric data within the PVC and the digital logic of the SCR designed to read and verify it. The interoperability between these components reflects an integrated design aimed at ensuring unique identification. The SCR's role in capturing live fingerprints and matching them against stored data introduces a computational verification process into the voting procedure, enhancing the precision of identity authentication. This configuration marks a shift toward biometric governance, where individual identity is no longer affirmed through recognition by officials but through data consistency and algorithmic comparison.

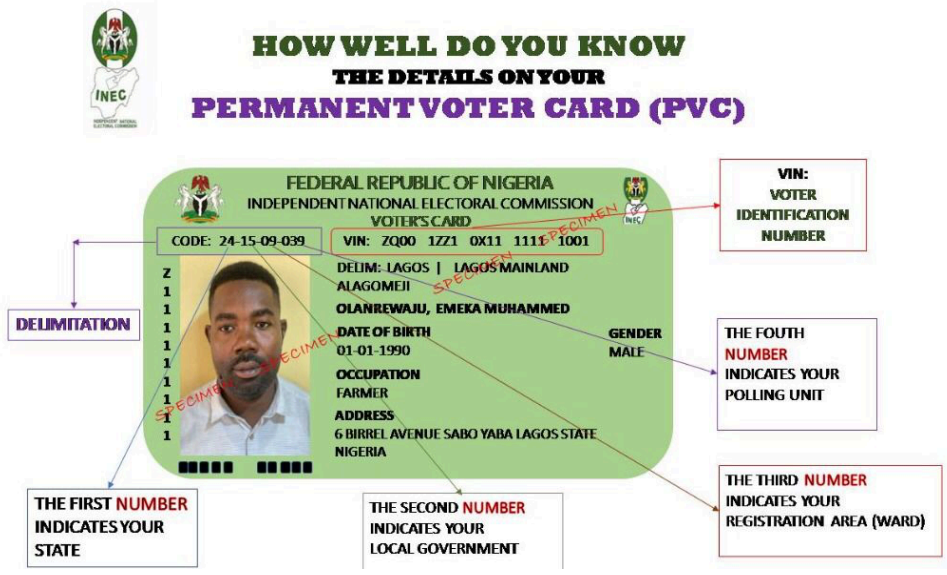
Infrastructure supports the spatial and temporal functionality of the system. The distribution of PVCs to registered voters, the deployment of SCRs across thousands of polling units, and the logistics involved in powering, transporting, and maintaining the devices all contribute to the structural integrity of the socio-technical arrangement. The infrastructure serves as the enabling layer that anchors technical procedures in physical space, ensuring continuity between pre-election registration, election-day verification, and post-election data reconciliation.

The goals embedded in the design and implementation of the PVC and SCR reflect an institutional commitment to transparency, credibility, and inclusiveness. These technologies embody the intention to standardize voter accreditation and to construct an auditable trail of participation. The socio-technical logic here aligns identity verification with broader democratic aims, positioning technology as both a practical instrument and a performative assurance of institutional legitimacy.

Processes operationalize this system by providing structured pathways for how each component should interact. From voter registration and PVC collection to biometric verification and data collation, each stage is governed by a set of defined actions and expectations. These procedural flows guide human-technology interactions, coordinate institutional actions, and embed repeatability into the electoral cycle. Over time, these processes contribute to system memory, learning, and incremental refinement of electoral operations.
Viewed through the socio-technical lens, the PVC and SCR are more than election tools—they are elements of a coordinated system where people, technologies, structures, and intentions are interdependent. Their integration reflects a deliberate shift toward embedding identity, accountability, and trust within a socio-technical framework that evolves with each electoral cycle.

Image 1

The Permanent Voters Card (INEC, 2023)



The **Permanent Voter Card (PVC)** and the **Smart Card Reader (SCR)** work together as a biometric-based voter authentication system introduced by Nigeria's Independent National Electoral Commission (INEC) to enhance the credibility and transparency of elections.

Here's how they function in combination:

1. **PVC Functionality**:
    - The **PVC** is a tamper-proof card issued to every registered voter.
    - It contains the voter's **biometric data** (including fingerprints and facial image), **unique voter identification number (VIN)**, and **demographic information** (such as name, age, gender, and polling unit).
    - The card uses **embedded microchip technology** to store this encrypted data securely.
2. **Smart Card Reader (SCR) Role**:
    - The **SCR** is a handheld electronic device used at polling units on election day.
    - It is programmed to recognize only the PVCs assigned to that specific polling unit.
    - The SCR does **two main tasks**:
        - **Authenticate the PVC**: It reads the card's chip to confirm that it is genuine and valid.
        - **Verify the Voter**: It prompts the voter to place their thumb or finger on a scanner. The SCR then compares the fingerprint captured live with the one stored on the PVC.
3. **Step-by-Step Process on Election Day**:
    - Voters present their **PVC** at the polling unit.
    - INEC officials insert the PVC into the **SCR** to read and authenticate the card.
    - If the card is valid, the voter places a finger on the device's fingerprint scanner.
    - The SCR verifies the **match** between the fingerprint and the stored biometric data.
    - Upon successful verification, the voter's details are **marked in the voters' register**, and the voter is cleared to vote.
    - If fingerprint verification fails, the voter may still vote, but only after filling an **Incident Form** and being manually accredited (a process prone to scrutiny).
4. **Security and Anti-Fraud Features**:
    - The SCR is **GPS-enabled**, allowing INEC to track its deployment.
    - It **logs every action**, making it possible to audit its usage after the election.
    - It cannot be used outside its designated polling unit and cannot function without preloaded election data.

In essence, the PVC and SCR system was designed to eliminate impersonation, reduce multiple voting, and ensure that only duly registered voters could cast ballots, linking the **digital identity of the voter** to their **physical presence** at the polling station.

Image 2

INEC Smart Card Reader (INEC, 2019)

The Permanent Voter Card (PVC), the Smart Card Reader (SCR), and Automated Fingerprint Identification technology, though distinct in function, represent interconnected components of Nigeria's broader effort to digitize and secure its electoral process. A comparative reflection on these technologies through a socio-technical lens reveals how each one plays a specific role in shaping the dynamics of electoral participation, legitimacy, and institutional trust within the Nigerian context.

All three technologies are underpinned by biometric data, positioning the individual voter as both a political subject and a data object. The PVC encodes biometric and demographic information, serving as a portable identity token. The SCR acts as the verifying instrument that reads the PVC and performs live authentication at the polling unit. Automated Fingerprint Identification, in contrast, is a back-end system that matches biometric data during registration or post-election audits. While the PVC and SCR are outward-facing, engaging directly with voters on election day, fingerprint identification operates more in the background, contributing to the integrity of voter records and detection of duplicate registrations.

From the perspective of people, these technologies demand different types of interaction. Voters primarily interface with the PVC and SCR at the polling station, which introduces a physical and procedural rhythm to voting, presenting the card, undergoing biometric verification, and receiving clearance to vote. This ritual reaffirms the formal status of citizenship. In contrast, the fingerprint identification process, although not immediately visible to voters, requires

compliance during voter registration and contributes to institutional trust by ensuring database integrity.

Culturally, each technology embodies a narrative about order, control, and modernity. The PVC has gained symbolic weight as a marker of democratic inclusion, it is both a legal credential and a badge of political engagement. The SCR, with its beeping feedback and real-time results, reinforces a perception of objectivity and transparency, shaping public confidence through visible technical procedures. Automated fingerprint identification is more abstract, representing a layer of surveillance and data integrity that is less visible but no less critical to the public imagination of credible elections.

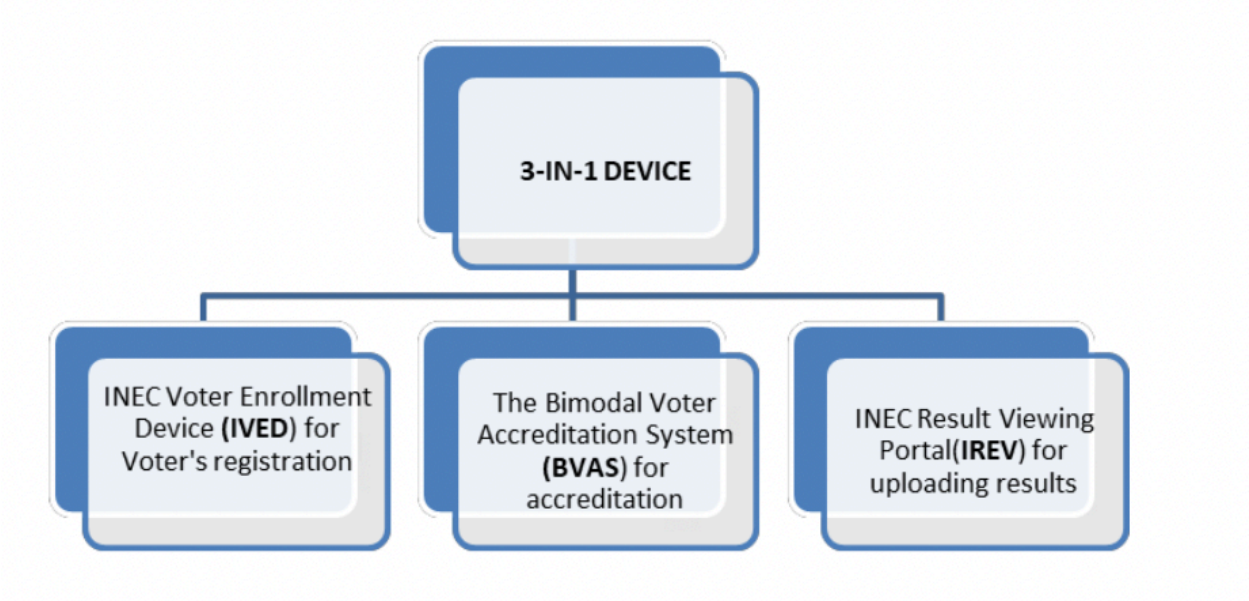
Technologically, these tools differ in complexity and operational visibility. The PVC is a passive storage device; the SCR is an active, event-based verifier; fingerprint identification systems rely on algorithmic processing and secure databases. Their combined architecture reflects a multi-layered approach to identity management, from registration and verification to audit and validation, each reinforcing the other's function within a socio-technical system. Infrastructurally, PVC and SCR deployment depends on logistics and conditions at polling units, availability of electricity, network access, and physical security, while fingerprint identification systems rely more heavily on centralized infrastructure like databases, servers, and secure facilities. This contrast reflects the spatial distribution of socio-technical dependencies, with some technologies demanding on-site coordination and others requiring centralized robustness. Together, these technologies reflect a system-wide orientation toward embedding biometric identity into electoral processes. Their combined implementation showcases how technological instruments, when integrated into a socio-technical framework, contribute to the shaping of democratic legitimacy and institutional credibility in a complex electoral environment.

5.3 The three in one device (IVED, BVAS and IReV)

The 2023 general elections in Nigeria witnessed a critical evolution in the integration of technology with electoral management processes through the deployment of a consolidated three-in-one device by the Independent National Electoral Commission (INEC). This single hardware performed three pivotal functions across the electoral cycle: as the INEC Voter Enrolment Device (IVED) during registration, the Bimodal Voter Accreditation System (BVAS) on election day, and a tool for uploading results to the INEC Result Viewing Portal (IReV). This fusion of technologies represents a significant stride in Nigeria's digital electoral transformation, but it also underscores the continuing tension between technological advancement and socio-institutional realities.

Image 3

3-in-1 Voter Support Device Process (Ayeni et.al, 2023)

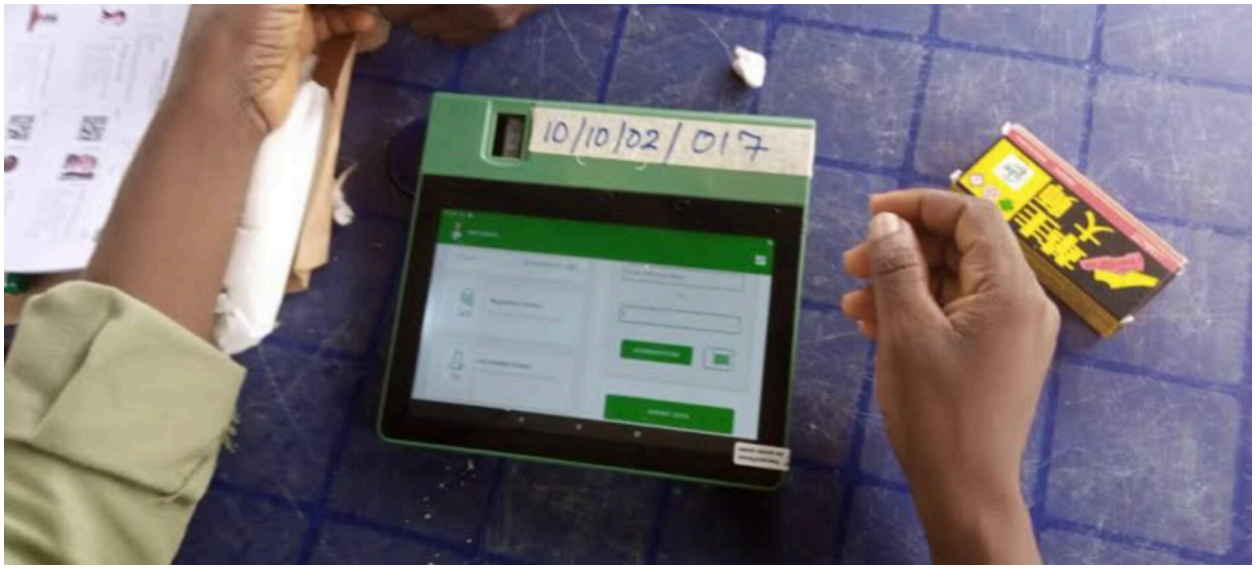


In its IVED configuration, the device enabled biometric voter registration both online and offline. In areas with limited or no internet access, data was stored locally and later synchronized to central servers when connectivity became available. Beyond mere registration, IVED also allowed for facial-authenticated services such as incident reporting (e.g., PVC loss, voter transfer) from remote locations (Ayeni et al., 2023). This decentralization of voter services was a pragmatic response to Nigeria's infrastructural disparities and a step toward enhancing inclusion. However, its success hinged on the digital literacy of both INEC officials and voters. Inadequate user training, especially in remote areas, risked misregistration, poor data capture, and exclusion, an irony for a system designed to promote enfranchisement.

On election day, the same device functioned as BVAS, tasked with authenticating voters through fingerprint or facial recognition. Its dual-mode biometric verification aimed to prevent voter impersonation and multiple voting, two long-standing challenges in Nigerian elections (Ayeni et al., 2023). BVAS also allowed real-time accreditation data capture, including the Voter Identification Number (VIN), which was transmitted to INEC's backend. Yet, despite its theoretical robustness, the system faced several limitations. Elderly voters often experienced authentication failures, facial recognition technology was unable to distinguish between identical twins, and network-related issues delayed verification (Ayeni et al., 2023). These failures exposed the vulnerabilities of biometric technologies when deployed in demographically and infrastructurally complex environments.

Image 4

The INEC 3-in-1 Machine (INEC, 2023)



After voting, the same device was used to upload signed Form EC8A result sheets to the IReV portal for public access. This function was intended to bolster transparency by enabling real-time result sharing. The IReV system, introduced as a tool for public accountability, was central to INEC's vision of curbing post-poll manipulations at collation centers. However, during the 2023 elections, result uploads were delayed or failed due to low bandwidth, malfunctioning SIM cards, and inadequate training of officials (Ayeni et al., 2023). Some presiding officers even mistakenly uploaded irrelevant content, including personal photos, to the portal. These incidents not only undermined the transparency promise of IReV but also dented public confidence in the integrity of the digital system.

Viewed through a socio-technical lens, these challenges are not purely technical, they are embedded in a larger web of human, organizational, and infrastructural factors. Socio-technical theory, as originally articulated by Trist (1981), insists that technological systems must be co-designed and co-adapted with social structures and human agents. The three-in-one device exemplifies this dynamic. Its technical sophistication, seen in its ability to combine voter registration, biometric accreditation, and results transmission is undermined when the institutions operating it lack the capacity to train personnel, maintain connectivity, and manage contingencies.

For instance, while the design of BVAS introduced strong authentication protocols, it also concentrated authority and technical knowledge in the hands of specific electoral officials. In the event of operator absence or device failure, there was often no fallback, leading to delays or

disenfranchisement. Similarly, IReV's reliance on real-time internet access, without adequate nationwide bandwidth investment, created systemic bottlenecks in areas with poor connectivity. These are not design flaws in a narrow technical sense; they are failures of institutional anticipation and socio-organizational integration. Despite these limitations, the introduction of the unified device remains a major milestone in Nigeria's electoral modernization. It streamlined electoral operations, reduced the logistical burden of carrying and configuring multiple devices, and centralized data flows in a more manageable way. The real value of a socio-technical perspective lies in its ability to highlight the need for balance between innovation and usability, security and accessibility, automation and human judgment.

Looking forward, the success of such integrated electoral technologies depends on how well INEC and other stakeholders address not just technical glitches, but the social conditions in which the technology is deployed. This includes better training for ad hoc staff, inclusive voter education, infrastructural upgrades (particularly in network-poor areas), and robust feedback mechanisms to identify and address human-machine interaction failures. Ultimately, as Ayeni et al. (2023) conclude, the potential of electoral technologies to improve transparency, reduce fraud, and foster trust in elections can only be realized if they are embedded within systems that are inclusive, resilient, and adaptable. The three-in-one device represents a promising step but its future efficacy will depend less on its technical architecture and more on the socio-institutional ecosystem that surrounds it.

5.4 Collation Support and Result Verification System (CSRVS)

The Collation Support and Result Verification System (CSRVS) represents a significant technological advancement by the Independent National Electoral Commission (INEC) aimed at enhancing the integrity and transparency of Nigeria's electoral process. Introduced to address longstanding issues associated with manual collation, CSRVS integrates digital tools to streamline result aggregation and verification. However, its implementation and effectiveness must be critically examined through a socio-technical lens, which considers the interplay between technological systems and the social contexts in which they operate.

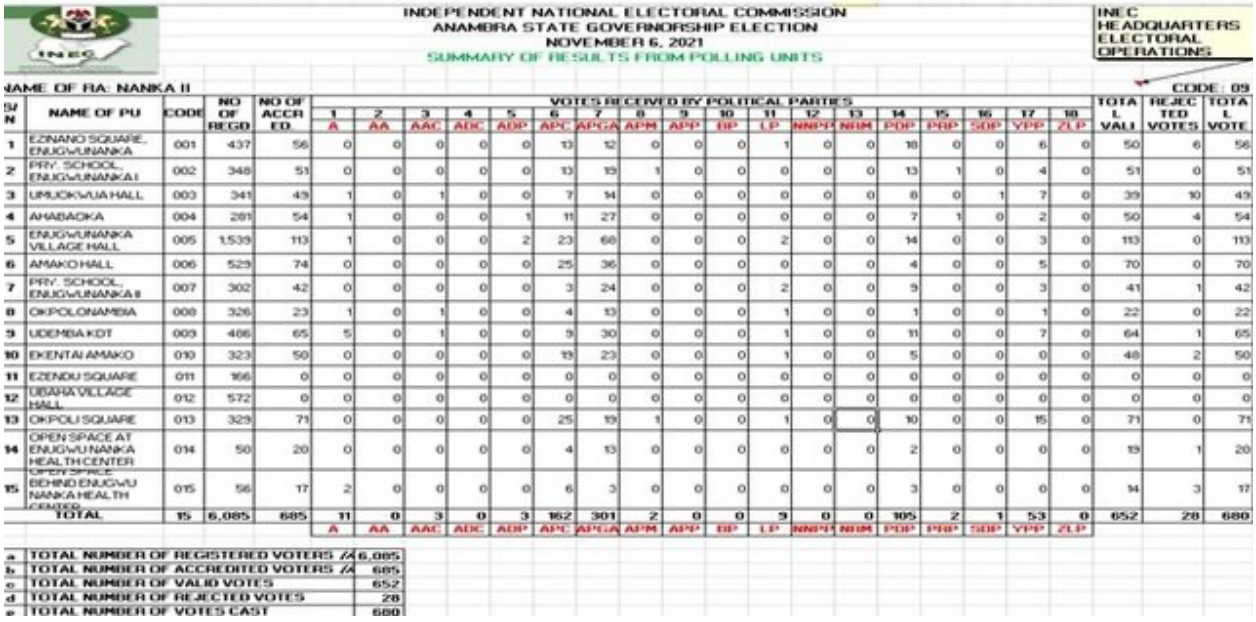
CSRVS functions by enabling collation officers to input election results into a digital platform, typically using Microsoft Excel, which then automatically checks for inconsistencies such as discrepancies between the number of accredited voters and the total votes cast. This system was developed in collaboration with the International Foundation for Electoral Systems (IFES) and aims to reduce human errors and expedite the collation process (Ayeni, 2023). By providing immediate feedback on data anomalies, CSRVS serves as a tool for real-time verification, thereby enhancing the accuracy of election results (INEC, 2023).

From a socio-technical perspective, the effectiveness of CSRVS is not solely dependent on its technical capabilities but also on the social structures and human actors involved in its

deployment. The system's success hinges on factors such as the training and proficiency of electoral staff, the reliability of infrastructure like electricity and internet connectivity, and the broader political environment. For instance, inadequate training of ad hoc staff and logistical challenges have been identified as significant impediments to the effective use of CSRVS. Moreover, the system's reliance on digital infrastructure poses challenges in regions with limited technological resources, potentially exacerbating existing inequalities.

Image 5

The Collation and Verification Page (INEC, 2023)



INDEPENDENT NATIONAL ELECTORAL COMMISSION
ANAMBRA STATE GOVERNORSHIP ELECTION
NOVEMBER 6, 2021
SUMMARY OF RESULTS FROM POLLING UNITS

INEC HEADQUARTERS ELECTORAL OPERATIONS

NAME OF RA: NANKA II — CODE: 09

S/N	NAME OF PU	CODE	NO OF REGD	NO OF ACCRED	VOTES RECEIVED BY POLITICAL PARTIES																		TOTAL VALI	REJECTED VOTES	TOTAL VOTE
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
					A	AA	AAC	ADC	ADP	APC	APGA	APM	APP	BP	LP	NNPP	NRM	PDP	PRP	SDP	YPP	ZLP			
1	EZINANO SQUARE, ENUGWUNANKA	001	437	56	0	0	0	0	0	13	12	0	0	0	1	0	0	18	0	0	6	0	50	6	56
2	PRY. SCHOOL, ENUGWUNANKA I	002	348	51	0	0	0	0	0	13	19	1	0	0	0	0	0	13	1	0	4	0	51	0	51
3	UMUOKWUA HALL	003	341	49	1	0	1	0	0	7	14	0	0	0	0	0	0	8	0	1	7	0	39	10	49
4	ANABAOKA	004	281	54	1	0	0	0	1	11	27	0	0	0	0	0	0	7	1	0	2	0	50	4	54
5	ENUGWUNANKA VILLAGE HALL	005	1,539	113	1	0	0	0	2	23	68	0	0	0	2	0	0	14	0	0	3	0	113	0	113
6	AMAKO HALL	006	529	74	0	0	0	0	0	25	36	0	0	0	0	0	0	4	0	0	5	0	70	0	70
7	PRY. SCHOOL, ENUGWUNANKA II	007	302	42	0	0	0	0	0	3	24	0	0	0	2	0	0	9	0	0	3	0	41	1	42
8	OKPOLONAMBIA	008	326	23	1	0	1	0	0	4	13	0	0	0	1	0	0	1	0	0	1	0	22	0	22
9	UDEMBA KDT	009	406	65	5	0	1	0	0	9	30	0	0	0	1	0	0	11	0	0	7	0	64	1	65
10	EKENTAI AMAKO	010	323	50	0	0	0	0	0	19	23	0	0	0	1	0	0	5	0	0	0	0	48	2	50
11	EZENDU SQUARE	011	166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	UBAARA VILLAGE HALL	012	572	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	OKPOLI SQUARE	013	329	71	0	0	0	0	0	25	19	1	0	0	1	0	0	10	0	0	15	0	71	0	71
14	OPEN SPACE AT ENUGWUNANKA HEALTH CENTER	014	50	20	0	0	0	0	0	4	13	0	0	0	0	0	0	2	0	0	0	0	19	1	20
15	OPEN SPACE BEHIND ENUGWU NANKA HEALTH CENTER	015	56	17	2	0	0	0	0	6	3	0	0	0	0	0	0	3	0	0	0	0	14	3	17
	TOTAL	15	6,085	685	11	0	3	0	3	162	301	2	0	0	3	0	0	105	2	1	53	0	652	28	680
					A	AA	AAC	ADC	ADP	APC	APGA	APM	APP	BP	LP	NNPP	NRM	PDP	PRP	SDP	YPP	ZLP			

a	TOTAL NUMBER OF REGISTERED VOTERS /A	6,085
b	TOTAL NUMBER OF ACCREDITED VOTERS /A	685
c	TOTAL NUMBER OF VALID VOTES	652
d	TOTAL NUMBER OF REJECTED VOTES	28
e	TOTAL NUMBER OF VOTES CAST	680

Despite its potential, CSRVS has faced several challenges that highlight the complexities of integrating technology into electoral processes. Technical issues, such as software glitches and server errors, have disrupted the timely transmission and collation of results. For example, during the 2023 general elections, INEC reported that a system error prevented the upload of presidential election results, leading to delays and undermining public confidence (Nairaland, 2023). These incidents underscore the need for robust technical support and contingency planning to mitigate the risks associated with technological failures (Premium Times, 2023).

Furthermore, the socio-political context in which CSRVS operates significantly influences its effectiveness. Issues such as political interference, intimidation of collation staff, and the presence of security personnel at collation centers can compromise the integrity of the process. Reports have indicated that in some instances, collation centers were disrupted by political thugs and that observers were denied access, raising concerns about transparency and accountability (Premium Times, 2019). These challenges highlight the importance of addressing not only the

technical aspects of election management systems but also the social and political dynamics that affect their implementation.

Looking forward, the future of CSRVS and similar technologies in Nigeria's electoral process depends on a holistic approach that integrates technical improvements with social and institutional reforms. This includes investing in infrastructure to support digital systems, providing comprehensive training for electoral staff, and fostering a political culture that values transparency and accountability. Moreover, continuous evaluation and adaptation of the system are necessary to address emerging challenges and to ensure that technological innovations effectively contribute to the integrity of elections.

CHAPTER 6

REVIEW OF CHALLENGES AND OPPORTUNITIES OF TECHNOLOGY DEPLOYMENT IN NIGERIAN ELECTIONS

6.0 Introduction

The deployment of election technologies in Nigeria presents a complex interplay of socio-technical challenges and opportunities that significantly impact electoral integrity, transparency, and public trust. The integration of technology into the electoral process has been met with both enthusiasm and skepticism, reflecting the broader socio-political landscape of Nigeria. One of the predominant challenges is the infrastructural inadequacies that hinder the effective implementation of election technologies. Issues such as poor power supply, limited internet access, and inadequate technical skills among electoral staff have been documented as significant barriers to the successful deployment of technologies like biometric voter registration and electronic voting systems (Sibe & Kaunert, 2022).

These infrastructural deficits not only impede the operational efficiency of electoral technologies but also raise concerns about their reliability and effectiveness in enhancing electoral integrity. For instance, the Independent National Electoral Commission (INEC) has faced recurrent logistical challenges that have undermined the credibility of elections, as highlighted by Ehimare's exploration of unmanned aircraft systems as a potential solution to these challenges (Ehimare et al., 2023). Moreover, the socio-political context in Nigeria complicates the deployment of election technologies. Historical precedents of electoral malpractices, including rigging and violence, have fostered a culture of distrust among the electorate (Uzodike & Onapajo, 2014). The introduction of technologies such as smart card readers and biometric authentication has aimed to curb these malpractices; however, the effectiveness of these technologies is often questioned due to the potential for human manipulation and the lack of comprehensive training for electoral personnel (Namayengo et al., 2023).

This skepticism is further exacerbated by the perception that election technologies can be exploited for political gain, as noted in the analysis of election technology's role in political violence and disputes (Odote & Kanyinga, 2020). Conversely, the deployment of election technologies also presents significant opportunities for enhancing electoral transparency and public trust. Technologies such as blockchain have been proposed as viable solutions for ensuring electoral integrity by providing immutable records of votes and reducing the potential for fraud (Isibor, 2023; Ikuero et al., 2021). The potential of blockchain technology to enhance transparency in electoral processes has garnered attention, with recommendations for its integration into Nigeria's electoral framework to bolster public confidence (Isibor, 2023). Additionally, the successful implementation of technologies in previous elections, such as the 2015 general elections, demonstrated that technological interventions could lead to more credible

electoral outcomes, thereby improving public trust in the electoral process (Agbu, 2016; Alebiosu, 2016).

Furthermore, socio-technical theory emphasizes the need for a holistic approach to the design and implementation of election technologies. Adeshina & Ojo (2014) argue for the conceptualization of e-voting systems as socio-technical systems, which necessitates considering both the technological and social dimensions of electoral processes. This perspective underscores the importance of stakeholder engagement, capacity building, and the establishment of a robust legal and regulatory framework to support the effective deployment of election technologies (Nabiebu, 2022). In conclusion, while the deployment of election technologies in Nigeria is fraught with socio-technical challenges, it also offers substantial opportunities for enhancing electoral integrity, transparency, and public trust. Addressing the infrastructural and socio-political barriers, coupled with the strategic integration of innovative technologies, could pave the way for a more credible and trustworthy electoral process in Nigeria. This literature review explores the predominant socio-technical challenges and opportunities presented by the deployment of election technologies in Nigeria and how they impact electoral integrity, transparency, and public trust.

6.1 Data Security and Cybersecurity Vulnerabilities

Data security and cybersecurity concerns in the deployment of election technologies in Nigeria present a multifaceted socio-technical challenge. Both aspects emphasize the interactions between technological systems, human behaviors, and institutional frameworks, which ultimately affect transparency, electoral integrity, and public trust. Understanding these challenges is critical to addressing how technological advancements in elections can both enhance and undermine democratic processes.

The deployment of election technologies such as the Bimodal Voter Accreditation System (BVAS) and the INEC Result Viewing Portal (IReV) under the 2022 Electoral Act represents a significant leap forward in Nigeria's electoral system. These innovations were introduced to improve transparency by enhancing voter authentication and enabling real-time result dissemination. However, this progress is accompanied by substantial cybersecurity risks, including the possibility of hacking, unauthorized access, and data manipulation, which threaten the confidentiality and integrity of electoral data. A comprehensive socio-technical approach to securing election systems is essential, as vulnerabilities in these systems are not merely technical but are deeply connected to human and organizational factors.

During the 2023 Nigerian elections, cybersecurity incidents, such as attempts to clone BVAS hardware and infiltrate INEC systems, underscored the fragile state of Nigeria's electoral infrastructure (Imoh-Ita, 2025). These attacks revealed the system's vulnerability to data breaches, which can lead to contested election results and ultimately undermine public trust. The socio-technical approach emphasizes that robust cybersecurity measures are essential to protect

sensitive electoral data. These measures include technical safeguards as well as organizational processes such as rigorous training and clear protocols to reduce human error (Atelhe & Agada (2014). Without these provisions, human factors whether negligence, oversight, or intentional misconduct can exacerbate the technical vulnerabilities, leading to breaches that erode electoral integrity (Chukwuma, 2022).

Furthermore, the reliance on digital platforms for electoral processes has introduced new risks. The use of blockchain technology has been proposed as a solution to enhance data security and transparency in electoral processes. For instance, research suggests that blockchain-enabled voting systems could reduce the risk of manipulation and unauthorized access (Berenjestanaki et al., 2023). Blockchain technology, with its decentralized and tamper-resistant nature, provides a more secure framework for transmitting and storing electoral data, making it harder for external actors to interfere with the process (Kuye,2024). However, while these technologies hold promise, their successful implementation requires an alignment of human and organizational factors, including training and public acceptance.

The socio-technical impact of cybersecurity vulnerabilities extends beyond technical failures to include human errors and the proliferation of misinformation. For instance, during the 2023 elections, delays in uploading results to IReV due to technical issues led to widespread accusations of manipulation, even though no breach was confirmed (BBC News, 2023). These delays show how a failure to meet public expectations regarding data security can contribute to mistrust. The spread of misinformation on social media further exacerbated the situation, with rapid dissemination of false narratives tarnishing the credibility of the electoral process (Mwangi, 2023).

To further buttress the issue of trust, Joseph & Vashchanka (2022) reinforces the idea that transparency is crucial in electoral processes, especially in combating corruption and ensuring that electoral bodies are perceived as trustworthy. Without transparent communication strategies to address system vulnerabilities or delays, public perception of fairness and integrity is likely to decline. This is why electoral bodies such as the Independent National Electoral Commission (INEC) must prioritize clear communication with the public during and after elections to counter misinformation and assure voters of the system's reliability (BBC News, 2023).

From a legal and institutional perspective, the complexities introduced by digital election technologies require stronger legal frameworks and judicial capacities (Momanyi. 2016). Studies have shown that the effectiveness of election technologies is not only dependent on technical fixes but also on how well the legal and institutional systems can handle disputes arising from digital manipulation or data security breaches (Ayeni & Esan, 2018). For example, Nigeria's legal system has struggled to keep pace with the rapid digitalization of electoral processes, particularly in adjudicating cases related to cybersecurity breaches and electoral integrity (Toros, 2024). These legal gaps exacerbate the socio-technical challenges of deploying election

technologies, as they undermine the ability of the system to protect democratic outcomes and further erode public trust.

In contrast, countries with well-defined legal frameworks that address cybersecurity in elections have experienced fewer disputes related to digital manipulation. The need for robust legal structures is further highlighted by Malempati, (2020), who argues that the election clause obligates governments to implement federal-level policies that secure electoral processes from cyberattacks. Nigeria's situation demonstrates that without legal reinforcement, technology-based solutions will struggle to gain public trust and legitimacy.

The technical infrastructure supporting election systems in Nigeria also presents significant vulnerabilities. Inadequate power supply and internet connectivity in rural areas create disparities in the implementation of digital electoral technologies .These infrastructural deficiencies not only limit the reach of electronic voting systems but also create opportunities for manipulation where manual processes must still be employed. According to Dosunmu (2024), the inconsistent application of technology across different regions undermines the standardization necessary for secure electoral procedures and opens avenues for targeted attacks on less-protected areas.

Security experts have also raised concerns about supply chain vulnerabilities in election technologies. The reliance on foreign vendors and components for electoral equipment introduces risks related to hardware tampering and backdoor installations (Okoye et.al 2015). These vulnerabilities could be exploited by state and non-state actors with interests in manipulating electoral outcomes. As highlighted by Aniche (2021), this dependency on external suppliers necessitates rigorous procurement standards and security assessments to ensure the integrity of election hardware and software.

The human dimension of cybersecurity in Nigerian elections is particularly evident in the training and capacity of electoral officials. A study by Sibe & Kaunert (2022) found significant gaps in the cybersecurity awareness and technical competencies of poll workers and INEC staff. These human factors create what security experts call "the weakest link" in the electoral security chain, where even sophisticated technical safeguards can be compromised through social engineering attacks or procedural oversights. Enhancing the technical literacy of electoral stakeholders is therefore as crucial as upgrading the technology itself.

Public education also plays a vital role in the socio-technical ecosystem of election security. The complexity of digital voting systems often creates a knowledge gap that can be exploited to spread distrust. According to research by Chidi & Anikelechi (2021), voter education programs that explicitly address how election technologies work and the safeguards in place significantly improve public confidence in electoral outcomes. This educational component is essential for building resilience against misinformation campaigns designed to undermine faith in the electoral system.

International standards and best practices offer valuable frameworks for addressing these challenges. The Council of Europe's recommendations on electronic voting standards emphasize a comprehensive approach that encompasses technical specifications, procedural safeguards, and transparency measures (Gritzalis & Gritzalis, 2001). Similarly, the International Foundation for Electoral Systems (IFES) advocates for risk assessment methodologies that consider the entire electoral ecosystem rather than isolated technological components (Kammerrud, 2011). These international benchmarks provide important reference points for strengthening Nigeria's electoral security posture. The financial implications of robust cybersecurity measures cannot be overlooked. Budgetary constraints often limit the implementation of comprehensive security protocols, creating vulnerabilities that adversaries can exploit. A cost-benefit analysis conducted by Erol (2017) suggests that the long-term economic and political costs of compromised elections far outweigh the initial investment in securing digital electoral infrastructure. This economic perspective reinforces the argument for prioritizing cybersecurity in electoral budget allocations.

6.2 Infrastructure and Digital Divide

The infrastructural disparity between urban and rural areas in Nigeria presents a significant socio-technical challenge in the deployment of election technologies (Omilusi, 2019). While the Bimodal Voter Accreditation System (BVAS) and the INEC Result Viewing Portal (IReV) were introduced to modernize the electoral process by enhancing transparency and reducing fraud, their functionality heavily depends on stable electricity, reliable internet connectivity, and sufficient technological infrastructure. These resources, however, are unevenly distributed across Nigeria's six geopolitical zones (Ojo & Ihemeje, 2019). This unequal access to critical infrastructure contributes to a widening digital divide, which significantly hampers the effectiveness of election technologies, thereby exacerbating systemic inequities in the electoral process (Fuchs & Horak, 2008). Fuchs & Horak, (2008) further emphasizes that this technological gap creates a "dual democracy" where urban voters experience enhanced electoral processes while rural communities remain marginalized by technological failures.

The infrastructure gap between urban and rural regions is not unique to Nigeria; it is a pervasive issue across much of sub-Saharan Africa. In their study, Sypok (2021) noted that infrastructural deficiencies, especially in rural areas, are a major obstacle to economic and technological development across Africa. Similarly, Knutsen (2011) emphasizes that infrastructure inadequacies limit economic growth and technological innovation, which are essential for ensuring a functional, transparent, and inclusive electoral system. The specific challenges faced in rural areas, where unstable power supply and unreliable internet connectivity are common, further highlight the gravity of the digital divide (Chakamera & Alagidede, 2017). These areas often experience system malfunctions, delays in voter accreditation, and difficulties in transmitting election results (Nwangwu, 2016). For instance, during the 2023 elections, several regions encountered issues uploading results to the IReV platform due to unstable internet

connections and power shortages. Such delays fueled suspicions of result manipulation, amplifying concerns about electoral fraud (Chukwuma, 2022). Ademola (2023) documented that over 43% of polling units in Nigeria's North-East and North-West regions experienced significant technical failures during the 2023 presidential elections, compared to less than 15% in the South-West region, highlighting the geographical dimensions of this technological inequality.

This infrastructural imbalance illustrates the socio-technical complexities that arise when technology is unevenly distributed. In urban centers where infrastructure is relatively reliable, election technologies like BVAS and IReV tend to function smoothly, leading to higher confidence in the electoral process. Conversely, in rural areas where infrastructure is inadequate, the same technologies frequently fail, generating distrust and suspicion of electoral manipulation (Ojo & Ihemeje, 2019). This phenomenon aligns with findings from the World Bank (2018), which suggests that infrastructure deficiencies, particularly in developing countries, often result in an uneven distribution of technological benefits, thereby deepening social and economic inequalities. Siyanbola& Olamide (2016) argue that this technological disparity reinforces what they term "democratic stratification," where the quality of democratic participation becomes directly correlated with infrastructural development, creating tiers of citizenship based on geographic location.

Furthermore, the digital divide also has broader implications for marginalized communities, who are disproportionately affected by the lack of technological infrastructure. In regions where election technologies fail, voters may face delays in accreditation or be disenfranchised entirely due to system malfunctions. This creates a perception of systemic bias, where marginalized communities are more vulnerable to having their votes inaccurately recorded or counted. In their argument on infrastructural access, Siyanbola et. al (2012) argues that infrastructure deficiencies in Nigeria not only hinder economic development but also reinforce existing social inequalities, as these communities are excluded from full participation in democratic processes. This deepens public mistrust in the electoral system, eroding confidence in its fairness and transparency. In the same vein, Ragnedda et al., (2019) similarly highlight the role of the digital divide in reinforcing social inequality, particularly in terms of access to technology and information. The digital divide, they argue, is not merely a matter of infrastructure but also of social capital and digital literacy, which are often unevenly distributed across populations (Ragnedda & Laura, 2017). This perspective adds a critical dimension to understanding the socio-technical challenges of election technologies in Nigeria. While infrastructure is a primary factor, addressing the digital divide requires a broader approach that includes digital education and the cultivation of digital skills, particularly in marginalized communities (Sani, 2024). Udemezue, (2023) expanded on this by introducing the concept of "techno-exclusion" in Nigerian electoral processes, whereby the introduction of advanced technologies without adequate infrastructure and education effectively creates barriers to political participation for already marginalized groups.

In contrast, some researchers argue that digital literacy and infrastructure are interdependent, with improvements in one potentially leading to improvements in the other. For example, Norris (2001) suggests that closing the digital divide involves not only expanding access to technology but also fostering civic engagement and digital competence. Without such comprehensive efforts, investment in technology alone is unlikely to bridge the gap in regions lacking adequate infrastructure. This is particularly relevant in the context of Nigerian elections, where the failure of election technologies in rural areas is not just a result of poor infrastructure but also a reflection of limited digital literacy among both voters and election officials (Kerr, 2024). Agumagu & Angba (2016) provide empirical evidence that educational interventions focused on digital literacy increased effective participation with electronic voting systems by 27% in pilot programs across rural communities in Kwara State, suggesting that educational approaches can partially mitigate infrastructural deficiencies.

Having highlighted the different implications of infrastructural deficiencies, addressing these disparities requires more than just technical solutions. Socio-technical theory emphasizes that overcoming the digital divide demands a comprehensive approach, integrating technical, social, and institutional considerations. Investments in rural infrastructure, such as improving internet connectivity and providing reliable electricity, are essential for ensuring the functionality of election technologies in all regions (Tranos, 2013). However, these investments must be accompanied by policies that address broader social factors, such as education, economic inequality, and regional disparities in government investment (Arambel,2024). As Ryan & Nanda (2022) argues, sustainable infrastructure development must be coupled with institutional reforms that address the underlying social and economic inequities exacerbating the digital divide. Fletcher et.al.,(2013) propose a "whole-of-society" framework for electoral technology deployment that incorporates community engagement, localized technical support systems, and phased implementation based on infrastructural readiness assessments.

From a policy perspective, the Aysu (2023) highlights the importance of digital skills development in bridging the digital divide. It points out that while technological infrastructure is critical, the ability of individuals and communities to effectively engage with these technologies is equally important. In the context of Nigerian elections, this means not only improving the physical infrastructure but also ensuring that voters and election officials possess the digital skills needed to interact with new technologies. Huateng et.al., (2021) echoes this view, arguing that without targeted efforts to improve digital literacy, investments in technology will not yield the intended results, particularly in marginalized areas.

Moreover, addressing the digital divide is essential for maintaining public trust and ensuring the integrity of future elections. As highlighted in Research Question 3, "How do socio-technical frameworks shape the design, implementation, and evaluation of technological systems in Nigerian elections, and what are their implications for achieving democratic outcomes?" Successful deployment of election technologies requires an understanding of the broader social

and infrastructural contexts in which these technologies are implemented. Without addressing the digital divide, Nigeria risks perpetuating systemic inequalities that undermine electoral integrity and public confidence in democratic processes (Ojo & Ihemeje, 2019).

As Nigeria continues to integrate technology into its electoral processes, it is important that it takes the importance of adopting a "contextually aware" approach to technology deployment seriously due to regional variations in infrastructure and digital literacy. This approach recognizes that a one-size-fits-all implementation of election technologies may inadvertently deepen existing democratic deficits rather than alleviating them.

6.3 Digital Literacy and Human Factors

Digital literacy and human factors represent significant socio-technical challenges in the effective deployment of election technologies in Nigeria. Limited digital literacy among both electoral officials and voters has emerged as a major barrier to the effective use of these technologies. As Nwangwu et al. (2018) highlight, technical errors, delays, and the mishandling of sensitive voter data during elections have collectively threatened the integrity of Nigeria's electoral process. Olawole, (2023) further identifies a "competency gap" in Nigeria's electoral system, where the rapid adoption of technology has outpaced the development of necessary skills among election stakeholders.

Human factors, particularly inadequate training and poor digital literacy among electoral officials, contribute significantly to technical failures during elections. For example, in the 2023 elections, poorly trained officials struggled to use the BVAS, resulting in a high number of verification failures. This led to delays in accreditation and the disenfranchisement of eligible voters, particularly in rural areas where technical competence was lower. This challenge underscores the socio-technical nature of election systems; while the technology itself may be robust, its success hinges on the capability of human actors to operate it effectively. Without adequate digital literacy, even the most advanced technologies are prone to failure, jeopardizing the fairness and credibility of the electoral process (Levine, 2015).

Digital literacy goes beyond mere technical competence and touches on broader social and institutional factors that shape how technology is utilized. As Jenkins & Plasencia (2017) argues in their examination of Convergence Culture, digital literacy is a critical skill that enables individuals to engage with new media and technology effectively. In the context of Nigerian elections, the lack of comprehensive training programs for electoral officials has exacerbated these challenges. Often, electoral staff receive minimal instruction on how to operate complex systems like BVAS and IReV, increasing the likelihood of operational errors . This gap highlights the importance of a socio-technical framework that integrates both the technical aspects of the systems and the social dimensions of their use. As Ryland (2018) asserts, digital literacy encompasses not just technical skills but also responsible, ethical engagement with technology, which is crucial for safeguarding the integrity of electoral processes.

The lack of sufficient training and digital literacy has profound implications for electoral integrity. According to Al-Chalabi, (2020), digital literacy plays a key role in ensuring that individuals can navigate complex technologies effectively. In the case of Nigerian elections, the inconsistent operation of technological systems such as BVAS not only leads to technical failures but also casts doubt on the legitimacy of election results. When voters are unable to verify their identities due to technical errors, it raises significant concerns about the fairness and accuracy of the election process (Ayeni & Esan, 2018). This undermines public trust in democratic institutions and creates widespread disillusionment with the electoral system.

Another critical aspect of the human factor challenge is the uneven distribution of digital literacy among Nigeria's electorate. Voters in rural and underserved areas often lack the digital skills required to interact effectively with election technologies, contributing to delays and confusion during the voting process. These disparities in digital competence exacerbate socio-technical challenges, particularly in regions where technological failures are more likely to occur due to lower levels of digital literacy (Ojo & Ihemeje 2019). Digital literacy is not an inherent skill, even among so-called "digital natives," and thus must be actively cultivated through education and training. In Nigeria, urban voters tend to have better access to digital resources and training, whereas rural voters are often left behind, increasing frustration with the electoral system and lowering voter turnout. Nnaemeka (2024) identify what they term "digital exclusion zones" in Nigeria, predominantly rural areas where over 78% of residents lack basic digital literacy skills necessary for engaging with modern electoral technologies, effectively creating two-tiered electoral participation based on geographic location.

This gap between urban and rural digital literacy levels mirrors the broader digital divide that exists within the country. According to Pasupuleti, (2024), the digital divide is not simply about access to technology but also about the social capital necessary to use technology effectively. In Nigeria, this divide manifests in the form of disparities between voters who are more familiar with digital systems and those who are not. The digital divide complicates the electoral process, as voters with limited digital skills struggle to engage with election technologies, leading to higher incidences of technical failure and disenfranchisement. As Karamagioli (2013) argues, addressing digital literacy is a critical component of broader digital inclusion efforts, which are necessary to ensure equitable participation in democratic processes. Anzar, (2024) conducted a comparative analysis of digital literacy rates and electoral participation, finding that constituencies with below-average digital literacy experienced voter participation rates 23% lower than the national average during the 2023 elections, highlighting the direct impact of digital competence on democratic engagement.

The generational dimension of digital literacy presents another challenge in Nigeria's electoral landscape. As Patterson & Wale (2024) notes, there exists a significant "digital generation gap," with younger voters generally demonstrating greater comfort with election technologies compared to older citizens. This disparity creates uneven patterns of electoral participation and

potentially skews representation. According to their research, voters over 50 years of age were three times more likely to report difficulties with biometric verification systems than those under 35, contributing to age-based disparities in voter participation. They further elaborates that this generational divide is particularly pronounced in semi-urban areas, where younger voters often act as unofficial "technology interpreters" for older community members, creating bottlenecks in the voting process and raising concerns about ballot secrecy.

Overcoming the socio-technical challenges related to digital literacy and human factors addressed in the preceding paragraphs requires a holistic approach that integrates technical training with broader social and institutional reforms. Comprehensive training programs for electoral officials are essential to ensuring the effective use of election technologies. As Gummer & Mandinach (2018) argues, digital literacy must be treated as an ongoing process, with education and training embedded within institutional frameworks to foster continuous improvement. In the case of Nigeria, such programs should not only focus on the technical operation of systems like BVAS and IReV but also emphasize the broader electoral process and the critical role technology plays in ensuring transparency and integrity.

Moreover, public education campaigns aimed at increasing digital literacy among the electorate are equally important, particularly in rural areas. As the Dubow et.al., (2017) suggests, media and digital literacy are tools for civic engagement and democracy, allowing citizens to interact meaningfully with digital technologies in a way that strengthens democratic institutions. In Nigeria, targeted public education efforts can help bridge the digital divide and ensure that all voters, regardless of their geographic location, can engage effectively with election technologies.

The establishment of community technology hubs in underserved areas could also play a crucial role in addressing digital literacy gaps. As Sani (2025) suggests, these hubs can serve as centers for digital skills development, providing community members with opportunities to familiarize themselves with technology in a supportive environment. By integrating these hubs into broader community development initiatives, Nigeria can work towards closing the digital divide and ensuring that all citizens have the skills needed to participate fully in democratic processes. Their research demonstrates that communities with access to such hubs reported 40% higher confidence in their ability to navigate electronic voting systems than those without similar resources.

From a policy perspective, incorporating digital literacy into Nigeria's education curriculum represents a long-term solution to the challenges of technological adoption in elections. According to Sani (2025), early exposure to digital technologies in educational settings can foster a generation of digitally literate citizens who are better equipped to engage with election technologies. Addressing the human factors in election technology implementation also requires attention to user interface design. As Okolie (2024) points out, many of the usability challenges associated with systems like BVAS stem from interfaces that fail to account for varying levels of

digital literacy among users. By adopting user-centered design principles that prioritize simplicity, accessibility, and cultural relevance, Nigeria can develop election technologies that are more intuitive for both electoral officials and voters to use. Their comparative analysis of voting system interfaces across six African countries revealed that systems incorporating local language support, visual cues, and step-by-step guidance demonstrated 45% lower error rates among election officials and voters.

6.4 Rural vs Urban Dynamics

The deployment of election technologies in Nigeria has consistently revealed a divide between urban and rural areas, influenced by infrastructural limitations, social dynamics, and varying degrees of political engagement. Scholars have pointed to Nigeria's structural imbalances, but international perspectives offer valuable insight into these issues, suggesting potential remedies for bridging these divides. Studies from Kenya and India, for example, mirror Nigeria's challenges, showing that technological deployment in rural areas is often compromised by weak infrastructure, leaving them vulnerable to manipulation or failures during elections (Temple et.al, 2024). Similarly, India's experience with electronic voting systems has shown that rural areas face significant technical difficulties during elections, such as machine malfunctions due to unreliable electricity (Nagarajan & Pradhan, 2011). These international examples underscore the importance of robust infrastructural investment in rural areas to ensure equal access to election technologies.

In Nigeria, urban centers have access to better resources, fostering a perception of electoral technology as a trustworthy means of ensuring transparency. Foreign studies, such as those conducted in Brazil and Estonia, show how technological systems like biometric voting have gained public trust due to reliable infrastructure and widespread digital literacy (Cho, 2013). Conversely, Nigeria's rural voters, many of whom lack the necessary digital skills, remain skeptical of such technologies. This skepticism is deepened by experiences of failed technology rollouts in past elections, contributing to fears of disenfranchisement. In a comparative study, Adams & Asante (2019) highlights the importance of trust-building strategies, such as voter education and community involvement, which have proven crucial in increasing rural voter acceptance of new technologies in countries like Ghana. Ukpong & Ominikari (2019) further elaborate on this urban-rural trust disparity through their research spanning three Nigerian election cycles, finding that urban voters were 2.8 times more likely to express confidence in electronic voting systems than their rural counterparts, with the gap widening rather than narrowing over successive elections despite increased familiarity with the technologies.

The socio-cultural factors influencing technology adoption cannot be overlooked either. In many Nigerian rural communities, traditional power structures shape voter attitudes towards electoral reforms. For instance, as Liebman (1998) observes, local elites or community leaders often serve as intermediaries between voters and electoral technologies, either facilitating or obstructing the

implementation of such systems based on their political allegiances. This trend is seen in other African contexts as well, such as Tanzania, where local leaders can sway voter perceptions of electronic voting systems depending on their political affiliations (Gasuku, 2023). Consequently, addressing these socio-political dynamics through engagement with local leaders is crucial to the success of election technology deployment in Nigeria. Soroka & Carbone (2016) introduce the concept of "technological gatekeeping" in their analysis of six Nigerian states, documenting how traditional leaders in rural communities function as crucial mediators of technological acceptance, with polling stations where local leaders endorsed election technologies experiencing 43% higher rates of successful voter verification compared to areas where such endorsement was absent.

Cybersecurity concerns also emerge as a significant issue, particularly in rural areas where technological infrastructure is weaker. While urban centers may boast stronger cybersecurity measures, rural polling stations are more susceptible to hacking, fraud, or system failures, further undermining trust in the electoral process. Siampondo & Chaansa (2023) discusses the challenges Zambia faced with election cybersecurity, arguing that developing comprehensive national cybersecurity strategies is essential for safeguarding rural votes. Nigeria could learn from such experiences, as effective cybersecurity is fundamental to ensuring the integrity of election technologies in both urban and rural contexts.

Additionally, logistical issues have been highlighted as a key challenge in rural election technology deployment. For instance, the use of unmanned aerial systems (UAS) for election logistics in geographically challenging areas has been proposed as a solution in Nigeria. Ehimare (2023) suggests that UAS can improve the timely and secure transport of electoral materials to rural and hard-to-reach locations, mitigating the risks of logistical delays and tampering that are common in Nigeria's rural elections. Although this technology presents opportunities, significant investment is required to adapt these systems to Nigeria's complex terrain and political environment.

Power supply disparities represent another critical dimension of the urban-rural divide affecting election technology. Adebayo (2015) conducted a comprehensive analysis of power supply patterns during Nigeria's 2023 elections, finding that urban polling stations experienced an average of 1.7 hours of power outage during voting hours, compared to 5.3 hours in rural areas. These outages directly impacted the functionality of electronic voting systems, with rural stations four times more likely to resort to manual backup processes due to depleted battery reserves in voting machines. This power supply gap creates electronic inequality, where rural voters' ballots are subject to different, often less secure processing methods than their urban counterparts, raising fundamental questions about electoral equity.

The deployment of election technologies in Nigeria must consider both the infrastructural and socio-cultural contexts of rural and urban regions. While urban areas benefit from better access

to and familiarity with electoral technologies, rural voters face significant barriers that undermine their participation and trust. International case studies provide valuable lessons for Nigeria, particularly in areas such as infrastructure development, cybersecurity, voter education, and the importance of engaging local communities. By addressing these issues, Nigeria can work towards creating a more inclusive and credible electoral process that ensures equal access to technological advancements for all voters.

CHAPTER 7

ELECTORAL INTEGRITY IN NIGERIA THROUGH SOCIAL TECHNICAL LENS

7.0 Introduction

Electoral integrity is a fundamental component of democratic processes worldwide, ensuring that elections are conducted fairly, transparently, and free from manipulation. In Nigeria, as in many other nations, maintaining electoral integrity is crucial for upholding democracy and ensuring the legitimacy of election outcomes (Mattes, 2014). The concept of electoral integrity encompasses multiple dimensions, including voter registration accuracy, equal opportunity for candidates, unbiased media coverage, and transparent vote counting procedures (Norris, 2014). In the Nigerian context, these dimensions are particularly critical given the country's history of contested elections and the diverse sociopolitical landscape that characterizes its federal system.

Studies have examined electoral integrity both globally and specifically within the Nigerian context. The correlation between electoral integrity and political regimes underscores the significance of fair electoral processes in diverse political environments (Daniller & Mutz, 2019). Different political systems impact the integrity of elections, with democracies that have strong institutional frameworks typically demonstrating higher electoral integrity compared to autocratic regimes, where elections are often manipulated to maintain power (Garnett & James, 2022). This highlights the importance of robust democratic institutions in ensuring fair electoral processes. The role of impartial electoral management in safeguarding electoral integrity is also significant. To further corroborate the above, van Ham & Garnett (2019) stated that effective institutional design and independence are crucial for ensuring free and fair elections. This suggests that Nigeria should focus on strengthening the independence and capacity of its electoral management bodies to enhance the credibility of its elections.

In the analysis of voter participation and electoral integrity in Nigeria's 2019 general elections, the importance of transparency, accountability, and adherence to electoral laws is highlighted as essential for promoting credible electoral processes (Omilusi, 2019). The active involvement of various stakeholders such as the judiciary, civil society organizations, and political parties is critical in enhancing the credibility and integrity of elections. When these stakeholders are engaged and hold electoral bodies accountable, the overall integrity of the electoral process is significantly improved. Amnesty International (2018) further emphasizes that civil society organizations in Nigeria have become increasingly sophisticated in their election monitoring capabilities, deploying over 100,000 observers during the 2023 elections and utilizing parallel vote tabulation systems that contributed to increased transparency. Additionally, Mohammed & Bulama (2023) document how judicial activism through pre-election litigation has emerged as a crucial mechanism for safeguarding electoral integrity, with Nigerian courts issuing over 2,000 election-related judgments between 2019 and 2023, many of which addressed violations of electoral laws and procedures.

Challenges related to electoral integrity in Nigeria include vote buying, electoral fraud, and violence. Issues of elite manipulation, operational deficiencies, and security problems have significantly impacted the electoral process in the country (Backer & Long, 2015). Elite manipulation and vote buying undermine electoral integrity, leading to outcomes that do not reflect the will of the people. Operational deficiencies and security challenges disrupt the electoral process and erode public confidence in election outcomes. The impact of illegitimate electoral financing on political power contestation in Nigeria sheds light on how adherence to electoral protocols can influence the integrity of electoral contests (Nwozor et.al.,, 2021). Illicit funding sources and financial improprieties skew the electoral playing field, giving undue advantage to certain candidates and parties, which undermines the fairness of elections and the overall democratic process (Itodo, 2024). Additionally, Kerr (2024) identifies what they term "systemic integrity deficits" in Nigeria's electoral system, including the proliferation of ghost voters, with their audit revealing over 4 million potentially duplicate registrations in the voter registry, and widespread irregularities in result collation processes.

The phenomenon of electoral violence presents another significant challenge to integrity. According to Biometric Update (2023), electoral violence incidents increased by 42% in the lead-up to the 2023 elections compared to 2019, with 890 documented incidents resulting in over 400 deaths. BBC News (2023) stated that this violence creates a participation paradox, where citizens' desire for democratic expression is counteracted by fear for personal safety, particularly affecting women and marginalized groups.

In addressing some of the issues that hinder electoral integrity raised in the previous paragraphs, the application of technology in enhancing electoral integrity has garnered significant interest and research in recent years. One of the key technologies explored for this purpose is blockchain, which has been proposed to secure and enhance the transparency of elections. The incorporation of blockchain in electronic voting systems is aimed at improving the security and accuracy of the voting process, addressing concerns such as ballot manipulation and ensuring result integrity (Srivastava et.al, 2025). Efforts to integrate blockchain in voting systems are viewed as a method to foster trust in the electoral process and reduce election costs. In addition to blockchain, recommendations have been made for other technologies such as information governance frameworks and digital literacy initiatives to bolster electoral integrity. Suggestions include adopting comprehensive information governance frameworks to ensure data integrity and transparency, expanding pilot blockchain projects to enhance election security measures, and increasing efforts to educate the electorate on the role of technology in securing elections. These strategies aim not only to enhance the technical aspects of electoral processes but also to cultivate trust and confidence among stakeholders involved in the electoral process.

The potential of technology to enhance the credibility and stability of electoral systems has been acknowledged. Studies indicate that technological advancements can contribute to improving the integrity of the electoral process, leading to more dependable and transparent elections (Odote &

Kanyinga, 2020). However, it is stressed that the introduction of technology in elections must be accompanied by well-designed policies, adequate safeguards, and appropriate legislation to tackle potential challenges and issues (Cheeseman et al., 2018). Agbo et.al (2024) echo this perspective in their analysis of Nigeria's INEC Result Viewing Portal (IReV), noting that while the technology successfully published 87% of polling unit results in real-time during the 2023 elections, public trust remained limited due to discrepancies between uploaded results and final tallies, highlighting the importance of procedural integrity alongside technological innovation.

Moreover, the impact of technology on electoral transparency, as it relates to electoral integrity, has been examined, emphasizing how technology can influence public perceptions of the fairness and impartiality of electoral management (Ondiek & Onyango, 2024). Election transparency is deemed crucial for upholding trust in the electoral process, with technology playing a significant role in enabling access to information and ensuring accountability in electoral procedures Through the utilization of technologies like blockchain and electronic voting systems, electoral transparency can be enhanced, fostering increased public trust in the electoral process (Osho et.al, 2015). Furthermore, the integration of advanced digital technologies into election procedures has been advocated to enhance the legitimacy of electoral processes and the resulting authorities. Digitalization is seen as a factor that can legitimize the formation of legislative bodies and electoral systems, thereby enhancing the overall credibility and trust in the electoral process. Biometric Update (2024) documents how the introduction of biometric voter verification reduced instances of multiple voting by 64% compared to previous elections, though they note persistent challenges with equipment functionality in rural areas.

Incorporating technological innovations into election procedures is believed to improve the transparency and efficiency of electoral systems, ultimately strengthening democratic practices (Kofi Annan Foundation, 2020). In the context of developing countries, the adoption of technology in electoral processes has been shown to positively impact voter participation and trust. Electronic voting technologies have the potential to rejuvenate interest in the voting process and make voting more accessible to a broader range of citizens. Through the implementation of scalable blockchain-based electronic voting systems, governments can not only increase voter turnout but also enhance the overall integrity and security of elections (Berenjestanaki et al., 2023). However, Itodo (2024) caution that the digital divide in Nigeria poses significant equity concerns, as their research indicates that constituencies with limited digital infrastructure experienced 31% more technical failures during electronic voting processes, potentially disenfranchising vulnerable populations and paradoxically undermining the integrity that technology seeks to enhance.

7.1 The Role of Transparency and Accountability in Elections

Transparency and accountability serve as fundamental elements for electoral integrity. Research demonstrates that public perception of electoral processes correlates strongly with the

transparency demonstrated by electoral management bodies. In Nigeria specifically, the Independent National Electoral Commission (INEC) has worked to enhance transparency through technological implementations like the IReV system, which enables real-time viewing of election results. However, the 2023 elections saw technical failures that prevented proper result uploads to the IReV system, significantly undermining public confidence in the process. Chatham House research from 2022 revealed a stark contrast in voter confidence: 67% of those who experienced IReV upload failures reported decreased trust in the electoral process, compared to only 23% among those who didn't encounter such issues. This data demonstrates the direct relationship between technological performance and public trust.

To rebuild this trust, INEC must prioritize transparent communication with the public, providing regular updates about measures taken to ensure electoral integrity, including clear explanations of security features and risk mitigation strategies. The Electoral Act of 2022 has provided legal legitimacy for technological integration in Nigeria's electoral process, establishing a framework for systems like BVAS and IReV. However, the effectiveness of these laws depends heavily on consistent application and enforcement by INEC and relevant stakeholders. During the 2023 elections, INEC's failure to transmit results in accordance with Electoral Act provisions led to legal challenges from opposition parties (Agbo et.al., 2024)

The successful implementation of electoral technologies requires robust institutional capacity. Research has shown that inadequate training of election officials and logistical challenges can significantly impede the effective deployment of technologies like BVAS. Agbo et.al. (2024) highlights a critical gap in INEC's organizational structure, noting that only 12% of senior management positions are held by individuals with formal technology backgrounds. Ibrahim proposes a "techno-governance framework" that integrates technical specialists into strategic planning roles while maintaining political neutrality. This structural reform could address many of the implementation challenges that have plagued recent electoral cycles.

Stakeholder engagement, including political parties, civil society organizations, and media, plays a crucial watchdog role in promoting electoral integrity. Merhi & Bregu (2020) argue that fostering collaboration and dialogue among these stakeholders can build trust in the electoral process and enhance the legitimacy of outcomes. This collaborative approach creates multiple layers of accountability and ensures that different perspectives are considered in the design and implementation of electoral technologies. While technologies like BVAS and IReV can reduce electoral fraud and improve transparency, they are vulnerable to technical failures, cybersecurity threats, and potential manipulation. According to Itodo (2024), electoral management bodies must prioritize security and reliability through robust cybersecurity measures, regular system testing, and comprehensive training for officials. The National Information Technology Development Agency documented over 3,400 cybersecurity incidents targeting Nigerian electoral systems during the 2023 election cycle, ranging from DDoS attacks to sophisticated

phishing campaigns directed at election officials. Their report recommends establishing a dedicated Electoral Cyber Security Operations Center for real-time threat monitoring throughout electoral periods, demonstrating the scale and sophistication of threats to electoral technology systems.

Electoral technologies must be designed and deployed with consideration for each country's specific context, including infrastructure, literacy levels, and cultural norms. Okoye & Okafor (2015) introduced the concept of "contextual technology adaptation," arguing that Nigeria's federal structure, with 36 states having vastly different infrastructural and social characteristics, requires a differentiated approach rather than a one-size-fits-all model. This contextual adaptation would allow for more effective implementation of technologies across diverse regions with varying levels of technological readiness.

The financial aspects of electoral technology deployment significantly impact transparency and accountability. BudgIT's analysis revealed that INEC's technology budget for the 2023 elections represented only 18% of total electoral expenditure, falling short of international best practices that suggest 25-30% for technology-intensive elections (Thompson et.al., 2022). This underfunding contributed to inadequate testing, insufficient backup systems, and limited staff training, ultimately undermining the effectiveness of technological solutions. Addressing these financial constraints is essential for building robust technological infrastructure that can withstand the pressures of electoral cycles and maintain public trust in the process. As Nigeria continues to navigate the complex intersection of technology and electoral integrity, a holistic approach that addresses legal frameworks, institutional capacity, stakeholder engagement, cybersecurity, contextual adaptation, and financial considerations will be essential. By addressing these interconnected dimensions, Nigeria can harness the potential of technology to enhance electoral integrity while mitigating associated risks, ultimately strengthening its democratic processes and institutions.

7.2 Lessons from Other Countries

The adoption of technology in electoral processes has become increasingly prevalent across the globe, with many countries implementing various technological solutions to enhance electoral integrity, transparency, and efficiency. This section examines the experiences of several countries in adopting technology for elections, highlighting best practices and lessons learned that could be applicable to Nigeria. Through the analysis of these global examples, we can identify key factors that contribute to successful technology adoption in electoral systems.

7.2.1 Global Experiences in Electoral Technology Adoption

According to the ACE Project (n.d), various countries around the world have adopted different forms of electronic voting (e-voting) technologies to improve the efficiency, transparency, and

accessibility of their electoral processes. These technologies range from electronic voting machines (EVMs) and remote internet voting to biometric voter identification systems. The introduction of technology on the electoral process in these countries is driven by goals such as reducing electoral fraud, increasing voter participation, and streamlining the voting process. However, the implementation of these systems has also faced challenges related to security, infrastructure, and public trust. The table 5 below provides an overview of 15 countries that have integrated e-voting technologies, detailing the type of technology used, its purpose, and the year it was introduced.

Table 5

Global Experiences in Electoral Technology Adoption. Source (ACE Project,n.d)

Country	**Technology Adopted**	**Purpose of Technology**	**Year Introduced**
Brazil	E-Voting Machines	To enhance voter identification, prevent fraud, and speed up vote counting.	1996
Canada	Remote Internet Voting	Implemented at municipal and provincial levels to offer alternative voting methods and increase voter participation.	2003 (municipal)
Estonia	Remote Internet Voting	Allows citizens to vote online using ID cards, digital IDs, or mobile IDs to increase voter accessibility and participation.	2005
Germany	DRE Voting Machines (now suspended)	Introduced for vote casting and counting, but later suspended due to concerns about transparency and public scrutiny.	2005 (suspended 2009)
India	Electronic Voting Machines (EVMs) & Remote Internet Voting	To improve vote counting speed, prevent tampering, and enhance transparency. Remote internet voting is in experimental stages.	1982 (EVMs)
Norway	Remote Internet Voting (trial ended)	Tested e-voting to make voting more accessible, particularly for overseas voters, but halted due to lack of political support.	2011 (trials)

Switzerland	Remote Internet Voting (vote électronique)	Developed to allow remote voting for Swiss citizens abroad and improve accessibility in elections and referendums.	2000
Netherlands	Voting Machines (suspended)	Voting machines were used for nearly two decades before being suspended due to concerns about security and manipulation.	1990s (suspended 2008)
USA	Voting Machines (DRE, Optical Scan Systems)	Used to modernize voting systems and ensure accurate vote counting, with most states moving towards systems with paper trails.	2002 (HAVA Act)
Finland	Internet Voting (pilot projects)	Aimed to provide convenient voting options and increase voter turnout, particularly through pilot programs.	2011 (pilots)
Norway	Remote Internet Voting (trials ended)	E-voting trials aimed to improve accessibility for voters, especially overseas voters, but were discontinued due to security concerns.	2011
Sweden	Electronic Voter Registration	To reduce errors in voter registration and improve accuracy in voter lists.	2014
Denmark	Electronic Poll Books	To ensure accurate voter verification and reduce wait times during the voting process.	2010
Switzerland	Remote Internet Voting (Vote Electronique)	Developed to allow Swiss citizens, particularly those abroad, to vote remotely in federal and cantonal elections.	2000
Netherlands	Voting Machines (discontinued)	Used for vote casting and counting, but discontinued after concerns over manipulation and security vulnerabilities were raised.	1990s (discontinued 2008)

The table 5 above provides a comprehensive view of how various countries have incorporated technologies into their electoral processes, showcasing a range of innovations aimed at improving efficiency, transparency, and accessibility. However, an insightful reflection on the experiences of these countries reveals critical challenges that highlight the importance of adopting a socio-technical approach, where technological systems are designed and implemented

with careful consideration of the social, political, and infrastructural contexts in which they operate.

In the quiet polling stations of Estonia in 2005, a revolution in democratic practice began taking shape. Citizens logged in using digital IDs, cast their votes remotely, and within 30 minutes could verify through a smartphone application that their choices had been properly recorded. This Baltic nation of just 1.3 million people had become the first country in the world to implement binding nationwide internet voting, a system that would eventually see more than half its electorate participating electronically. Yet this digital transformation of democracy's most sacred ritual didn't emerge from nowhere, nor has it spread uniformly across the global landscape. The journey toward electronic voting began decades earlier in the vastness of India. In 1982, as most of the world still used paper ballots, Indian election officials introduced the first Electronic Voting Machines (EVMs) to address the logistical challenges of conducting elections in the world's largest democracy. These standalone devices, though primitive by today's standards, represented a significant departure from centuries of paper-based voting traditions. They promised faster counting, reduced opportunities for ballot stuffing, and greater accessibility for illiterate voters through simple button interfaces and visual symbols.
Brazil followed in 1996, developing its own electronic voting machines to enhance voter identification, prevent fraud, and accelerate vote counting across its challenging geography of dense urban centers and remote Amazonian communities. The Brazilian system would go on to become one of the most enduring success stories in electronic voting implementation, gradually improving security and verification measures while maintaining public confidence.By the turn of the millennium, a distinct expansion phase had begun. Switzerland started developing its "vote électronique" system in 2000, initially focused on enabling Swiss citizens abroad to participate in the country's frequent referendums and elections. The Netherlands had already been using voting machines since the 1990s, and Canada began implementing remote internet voting at municipal and provincial levels in 2003.

The United States, jolted by the controversial 2000 presidential election with its infamous "hanging chads," formalized the use of electronic voting systems through the Help America Vote Act (HAVA) in 2002. This legislation accelerated the adoption of Direct Recording Electronic (DRE) voting machines and optical scan systems across the country, though implementation varied significantly between states.Yet as these electronic systems proliferated, so too did concerns about their security and reliability. Computer scientists and security experts began identifying vulnerabilities that threatened the integrity of elections conducted with these new technologies. The transparency that characterized traditional paper-based elections—where citizens could observe ballots being counted and physically recounted if necessary—was not easily replicated in the digital realm. Code running on voting machines remained largely inscrutable to voters, creating what critics called "black box" systems that required trust in technology few understood.

The Netherlands provided perhaps the most dramatic example of this growing skepticism. After using voting machines for nearly two decades, the country abruptly suspended their program in 2008. Security researchers had demonstrated that electromagnetic radiation from the machines could be intercepted from a distance to determine how people voted, fundamentally compromising ballot secrecy. What had seemed like technological progress suddenly appeared as a threat to democracy's foundational principles. Germany reached a similar conclusion in 2009 when its Constitutional Court ruled that DRE voting machines violated the constitutional principle of public scrutiny in elections. The court determined that ordinary citizens should be able to verify essential steps in the electoral process without specialized technical knowledge,a standard that purely electronic systems struggled to meet.

Norway's experience with internet voting further illustrated these challenges. Despite conducting technically successful trials in 2011, Norway discontinued its internet voting program due to political concerns about security and the absence of broad political support. Finland similarly limited its internet voting initiatives to pilot projects around the same time, hesitant to fully commit to the technology. In this context, Estonia's continued success with internet voting appears exceptional. Several factors have contributed to Estonia's unique position: the country had already built a robust digital identity infrastructure, with citizens accustomed to using electronic ID cards for a wide range of government services. This provided strong authentication for voters and created a foundation of familiarity with digital governance. Estonia also maintained traditional paper voting alongside electronic options, allowing voters to override their electronic votes with paper ballots if desired, a crucial safety valve that addressed concerns about coercion or technical failures.

Moreover, Estonia implemented verification mechanisms that allow voters to confirm their vote was correctly recorded, addressing one of the fundamental challenges of remote electronic voting. The country's high level of digital literacy and general trust in e-governance created favorable cultural conditions for acceptance that many other nations lacked.
Nevertheless, even Estonia's system has faced criticism from international security experts who argue that any system transmitting ballots electronically is inherently vulnerable to sophisticated attackers. In 2014, a team of security researchers identified various attack vectors that could potentially compromise the integrity of Estonia's system, though these vulnerabilities have not been shown to affect actual election results.

The security challenges facing electronic voting systems are substantial and multifaceted. Distributed denial of service attacks could make voting platforms unavailable during critical periods. Malware on voters' personal devices could alter votes before transmission. Authentication systems might be compromised, allowing unauthorized access. Even if these technical challenges are addressed, the problem of coercion in uncontrolled voting environments remains, when people vote from home or private locations, there's no guarantee they aren't being

pressured or observed. Perhaps most fundamentally, electronic voting systems struggle with a verification paradox: how to provide voters with confirmation that their vote was correctly recorded and counted while maintaining ballot secrecy. Creating audit trails that can detect errors or manipulation while preserving anonymity presents significant cryptographic and procedural challenges that continue to engage researchers.

The experiences of these various countries from 1982 to 2014 reveal distinct patterns in electronic voting adoption and implementation. Europe has generally taken a cautious approach, with several countries suspending their programs after initial adoption, while Estonia has pushed forward with its internet voting system. The Americas have shown more sustained commitment, with Brazil maintaining its electronic voting program and the United States continuing to use various electronic systems, though with increasing emphasis on paper audit trails. In Asia, India has maintained and expanded its EVM program despite controversies, reflecting its commitment to technological solutions for managing elections across its massive and diverse electorate.

Several key lessons emerge from this global experiment. First, the balance between security and trust remains the central challenge—systems must not only be secure but must be perceived as secure by voters and political stakeholders. Second, successful implementations have typically been incremental rather than revolutionary, integrating new technologies with existing electoral practices rather than replacing them entirely. Third, the cultural and institutional context significantly influences acceptance and success; countries with higher digital literacy and pre-existing trust in government technology have generally had more positive experiences. As we look at the trajectory of electronic voting from 1982 to 2014, a clear evolution in technological approaches becomes apparent. Early systems focused primarily on replacing paper ballots with electronic interfaces, often with little consideration for verification or auditing. Over time, there has been a shift toward hybrid systems that produce paper records for verification and auditing purposes combining the efficiency of electronic voting with the tangibility and verifiability of paper.

Similarly, system architecture has evolved from centralized to increasingly distributed designs, incorporating cryptographic techniques and multiple layers of verification to reduce reliance on trust in any single authority. Modern systems increasingly provide voters with ways to verify that their votes were correctly recorded and counted, addressing a key limitation of early electronic voting machines. The global experience with electronic voting during this period reveals both promise and peril. Electronic systems offer potential benefits in accessibility, particularly for voters with disabilities or those living abroad. They can increase efficiency in vote counting and, potentially, increase participation by making voting more convenient. Yet they also introduce significant security and verification challenges that have caused several countries to abandon their programs after initial adoption.

The lessons from this period suggest that successful electronic voting systems require strong security measures, transparent processes, independent oversight, and careful integration with existing electoral traditions. As technology continues to evolve, finding the right balance between innovation and electoral integrity remains the central challenge for the future of voting systems worldwide.Countries considering electronic voting must carefully weigh the benefits of modernization against the fundamental requirement to maintain public confidence in electoral processes—the bedrock of democratic legitimacy. The history of electronic voting from 1982 to 2014 does not provide a simple verdict on whether digital democracy is superior to traditional methods, but rather illustrates the complex tradeoffs that must be navigated as societies attempt to bring ancient democratic practices into the digital age.

CHAPTER 8
ANALYSIS OF EMERGING TECHNOLOGIES IN ENHANCING ELECTION TRANSPARENCY AND SECURITY

8.0 Introduction

The integrity of elections remains a cornerstone of democratic governance in Nigeria. As Africa's most populous nation continues to navigate its democratic journey, emerging technologies have increasingly been deployed to address persistent challenges in electoral transparency and security. The 2023 general elections represented a significant technological milestone in Nigeria's electoral history, offering valuable lessons on the potential and limitations of digital solutions in enhancing electoral processes.

Nigeria's journey with election technology has evolved significantly over the past decade. The Independent National Electoral Commission (INEC) has progressively introduced various technological innovations, culminating in the 2023 elections which featured the most advanced technological deployment to date (Chatham House, 2023). Central to these innovations has been the Bimodal Voter Accreditation System (BVAS), which replaced the previous Smart Card Reader system, and the INEC Results Viewing Portal (IReV). The BVAS represents a significant advancement in voter verification, utilizing dual biometric authentication methods, fingerprint scanning and facial recognition to verify voter identity (M2SYS, 2023). This two-factor biometric authentication system was designed to eliminate persistent electoral malpractices such as multiple voting and impersonation that had plagued previous elections. Complementing the BVAS, the IReV portal was implemented to enhance transparency in results transmission, allowing real-time viewing of polling unit results.

According to INEC, approximately 200,000 BVAS devices were deployed for the 2023 elections across 176,846 polling units nationwide, representing a substantial investment in electoral technology (Biometric Update, 2021). This technological shift received backing from Nigeria's Electoral Act of 2022, which legally validated the use of technology in various aspects of the electoral process and gave INEC broad powers for technological deployment (Side & Kaunert, 2023). The implementation of these technologies has had measurable impacts on Nigeria's electoral processes. Political scientist Abiodun Fatai argues that the BVAS significantly enhanced the credibility of the 2023 elections by eliminating multiple voter registrations and ensuring that only biometrically verified voters could cast ballots (Biometric Update, 2023). Unlike previous elections, particularly the controversial 2007 polls where some states reported voter turnout exceeding registered voters, the biometric verification systems helped prevent such statistical anomalies.

The technologies also contributed to greater transparency in the electoral process. As noted by Techloy (2023), INEC introduced approximately 22 new technological innovations for the 2023 elections, including the BVAS, IReV, Collation Support and Results Verification System, and the Election Monitoring and Support Centre. These systems collectively aimed to enhance

transparency and public confidence in the electoral process by making polling unit-level results more accessible to the public. From a security perspective, the biometric systems helped mitigate certain types of electoral fraud. The BVAS's two-step authentication process enhanced the security of the voting process by decreasing the possibility of impersonation and other fraudulent activities (YMonitor, 2023). The system's ability to accurately capture and verify voter identity represented a significant advancement in electoral security measures.

Despite these promising developments, Nigeria's implementation of election technology has faced significant challenges. The Commonwealth Observer Group's final report on the 2023 elections noted that failures of the BVAS biometric devices and the IReV portal negatively affected the overall credibility and transparency of the polls (Biometric Update, 2024). According to the report, "The lack of adequate testing of the technologies, and the limited training of polling staff, were likely contributing factors in the failure of some Bimodal Voter Accreditation System (BVAS) devices and the IReV portal on election day." Infrastructure limitations presented another significant challenge. Nigeria continues to struggle with inconsistent internet connectivity, unreliable power supply, and other technical constraints that affect the optimal performance of the deployed technologies. These limitations were particularly pronounced in rural areas, potentially widening the digital divide in electoral participation (GIGA Hamburg, 2023).

Security vulnerabilities have also raised concerns. Reports highlighted Nigeria's weak cybersecurity infrastructure and obsolete computing resources, with INEC alleging attempts to clone BVAS hardware and hack its computer systems from both within and outside the country (Chatham House, 2023). The digital rights community has also expressed concerns regarding the safety and security of biometric data collected from millions of Nigerian voters (Biometric Update, 2023b). Perhaps most significantly, the 2023 elections demonstrated that technology alone cannot guarantee electoral integrity. While the BVAS and IReV systems were designed to enhance transparency and credibility, operational failures and implementation challenges undermined their effectiveness. As Chatham House (2023) aptly noted, "technology alone is not a guarantee of credibility and security. It's also a new frontier for election fraud amid concerns over vulnerabilities to hacking and manipulation."

The aftermath of the 2023 elections has seen technology become a central element in post-election litigation. Various election tribunals across Nigeria have admitted BVAS machines as evidence in electoral disputes, highlighting the increasingly central role of technology in adjudicating electoral outcomes (Biometric Update, 2023c). This judicial recognition of election technology represents a significant evolution in Nigeria's electoral jurisprudence. Interestingly, the relationship between technology and electoral outcomes has produced a paradoxical effect. As Muhammad Edita observes, "technology – the key element enhancing the transparency and acceptability of electoral results – is now being weaponized by defeated opposition parties to

question the fairness of the electoral process itself" (ECPR, 2023). This paradox underscores the complex interplay between technological innovation and electoral trust. The technology discourse has also extended beyond national boundaries, with comparisons being drawn to other digital democracy initiatives across Africa. The Atlantic Council (2025) notes that Nigeria, along with South Africa, Kenya, and Ghana, has developed comparatively robust policies for emerging technologies, though implementation capacities remain limited by infrastructure constraints, policy fragmentation, and digital literacy gaps.

Looking forward, several key considerations emerge for enhancing the role of technology in Nigeria's electoral processes. As recommended by the Commonwealth Observer Group, INEC should consider greater training on BVAS for polling agents and introduce alternative offline back-up options for the system (Biometric Update, 2024). Comprehensive pre-election testing of all technological systems would help identify and address potential issues before they impact the electoral process. Given the increasing digitization of electoral processes, Nigeria needs to prioritize election cybersecurity by developing comprehensive frameworks to protect electoral systems from internal and external threats. This should include regular security audits and partnerships with cybersecurity experts (GIGA Hamburg, 2023). Building local technical expertise is essential for sustainable technological implementation. Nigeria should invest in developing indigenous capacity for the design, implementation, and maintenance of electoral technologies rather than relying heavily on foreign expertise and solutions.

Greater transparency in the procurement, testing, and deployment of electoral technologies would help build public trust. This includes clear communication about the capabilities and limitations of these systems to manage public expectations effectively. While embracing technological innovation, Nigeria must maintain a balanced approach that recognizes the complementary role of human oversight and robust procedural safeguards. As noted by Side & Kaunert (2023), technology should enhance rather than replace essential human elements of the electoral process. Further development of Nigeria's legal and regulatory framework for election technology is needed to address emerging challenges related to data protection, cybersecurity, and technology-enabled electoral processes.

The deployment of emerging technologies in Nigeria's electoral processes represents a significant step toward enhancing transparency and security in the country's democratic system. The BVAS and other digital innovations have demonstrated potential in addressing longstanding challenges such as multiple voting and result manipulation. However, the 2023 elections also highlighted the limitations of technology as a solution to electoral challenges. As Nigeria continues its democratic journey, the focus should be on developing a balanced approach to election technology, one that leverages technological innovations while acknowledging their limitations and complementing them with strong institutional frameworks and human oversight. By addressing the technical, institutional, and human dimensions of electoral technology

implementation, Nigeria can work toward an electoral system that truly enhances democratic participation, transparency, and security. In the final analysis, while technology offers powerful tools for improving electoral processes, the integrity of Nigeria's elections will ultimately depend on the commitment of political stakeholders, electoral institutions, and citizens to the fundamental principles of democratic governance. Technology can support but cannot substitute for this essential commitment to democratic values and practices.

8.1 Blockchain and its feasibility in Nigerian elections

Nigeria's electoral processes have historically been marred by allegations of malpractice, with the manual voting system criticized for vulnerabilities to rigging, double voting, ballot snatching, and result manipulation (Ogunwale, 2023). These challenges have contributed to declining voter confidence and participation, as evidenced in the 2023 general elections where voter turnout reached only 26.72%. Against this backdrop, blockchain technology's inherent features of decentralization, immutability, and transparency offer potential solutions to these longstanding issues.

Blockchain technology, at its core, is a distributed ledger system that allows for secure, transparent, and tamper-resistant record-keeping without reliance on a central authority. When applied to voting systems, this decentralized architecture could theoretically address several critical issues plaguing Nigeria's electoral process. Unlike traditional centralized databases, blockchain creates an immutable chain of transactions (votes) that, once recorded, cannot be altered without consensus from the network, potentially reducing opportunities for manipulation and fraud (StemFocus, 2022).

Several research initiatives and proposals have emerged exploring blockchain's application in Nigerian elections. A study by Ogunwale (2023) proposed a blockchain-based electronic voting system utilizing smart contracts to ensure the integrity and security of the voting process while providing a transparent record of votes cast. Similarly, initiatives like i-Elect, a blockchain voting platform created for the Covenant University Alumni Association election, demonstrated blockchain's potential for enabling remote voting while maintaining security (Techpoint Africa, 2021).

The potential benefits of implementing blockchain technology in Nigerian elections are substantial. First, the technology could enhance transparency by creating a publicly verifiable record of votes that all stakeholders can access, potentially reducing disputes over results. The immutability feature ensures that once votes are recorded, they cannot be altered, addressing concerns about post-election manipulation. Furthermore, blockchain could enable more accessible voting options, including remote or mobile voting, potentially increasing participation rates, particularly among younger, tech-savvy voters and Nigerians in the diaspora (Culture Custodian, 2023).

Cost reduction represents another potential advantage. According to blockchain developer Jerry Ojumah, blockchain-powered voting could significantly reduce election expenses by eliminating many logistical and security costs associated with traditional elections (Techpoint Africa, 2021). Given that Nigeria allocated ₦245 billion for the 2019 elections, with substantial portions directed to logistics and security, blockchain could offer a more economical alternative.

Despite these promising prospects, several significant challenges must be addressed before blockchain voting becomes feasible in Nigeria. The digital divide presents a primary obstacle, with uneven internet access and digital literacy across the country, particularly in rural areas. Implementation of blockchain voting without addressing these disparities could inadvertently disenfranchise significant portions of the population, undermining the very democratic principles the technology aims to enhance.

Security concerns also persist, despite blockchain's reputation for robustness. As highlighted by the U.S. Vote Foundation, blockchain systems are not immune to cyber threats. While blockchain itself may be secure, the end-user devices used for voting remain vulnerable to malware that could change votes before they reach the blockchain or compromise voter privacy (U.S. Vote Foundation, 2023). Additionally, the MIT Digital Currency Initiative warns that "any turnout increase derived from Internet- or blockchain-based voting would come at the cost of losing meaningful assurance that votes have been counted as they were cast, and not undetectably altered or discarded" (MIT, 2021).

Scalability represents another significant technical challenge. Research indicates that current blockchain architectures may struggle to handle the volume of transactions required for national elections in a country with Nigeria's population. The technology's resource-intensive nature, particularly for certain consensus mechanisms like Proof of Work, raises questions about its environmental impact and operational sustainability in the Nigerian context. Regulatory and legal frameworks for blockchain implementation in elections are also underdeveloped. Nigeria lacks comprehensive legislation governing electronic voting in general, let alone blockchain-specific regulations. Addressing these legal gaps would be essential before any large-scale implementation could proceed. Additionally, public trust and acceptance remain crucial factors. Many Nigerians, particularly older generations or those with limited technology exposure, may be skeptical of blockchain-based voting systems, necessitating extensive education and awareness campaigns.

Several practical considerations must guide Nigeria's approach to blockchain voting. A phased implementation strategy would be prudent, beginning with smaller-scale elections such as local government or organizational polls before considering national deployment. This approach would allow for testing, refinement, and gradual building of public confidence in the technology.

Additionally, hybrid models combining traditional voting methods with blockchain elements might offer a transitional solution, allowing for gradual technology adoption while maintaining accessibility for all voters. Nigeria can draw valuable lessons from international experiences with blockchain voting. In West Virginia, USA, a pilot program used a blockchain-based mobile voting application for military personnel overseas in 2018. However, subsequent security analyses identified vulnerabilities in the implementation, highlighting the importance of rigorous testing and independent security audits (U.S. Vote Foundation, 2023). Similarly, experiments in countries like Japan and Sierra Leone have produced mixed results, underscoring both the potential and limitations of the technology in different contexts.

For Nigeria to successfully implement blockchain voting, several key recommendations emerge. First, significant investment in digital infrastructure and literacy programs would be essential to ensure equitable access to the technology. Second, developing a robust legal and regulatory framework specific to blockchain voting would provide necessary governance guardrails. Third, implementing rigorous security protocols and independent auditing mechanisms would help address cybersecurity concerns. Fourth, adopting a multi-stakeholder approach involving electoral authorities, political parties, civil society organizations, and technology experts would ensure diverse perspectives inform system design and implementation.

In conclusion, while blockchain technology offers promising solutions to some of Nigeria's electoral challenges, its successful implementation would require addressing significant technical, infrastructural, legal, and social hurdles. Rather than viewing blockchain as a panacea for all electoral problems, Nigerian policymakers should consider it as one component of a broader electoral reform strategy. A thoughtful, phased approach that prioritizes accessibility, security, and public trust would be essential for harnessing blockchain's potential to strengthen Nigeria's democratic processes.

8.2 Artificial Intelligence and its feasibility in Nigerian elections

Artificial Intelligence (AI) has emerged as a transformative technology in electoral processes worldwide, offering possibilities for enhancing transparency, security, and efficiency in elections. However, its feasibility within the Nigerian electoral system remains a subject of debate due to socio-technical complexities. This literature review critically examines AI's potential applications in Nigerian elections, juxtaposing optimistic and skeptical perspectives while grounding the analysis in the socio-technical framework developed by Eric Trist. The socio-technical systems theory, as elaborated by Trist and Bamforth (1951), emphasizes the interdependence of social and technical elements in organizational systems, providing a crucial lens for understanding how AI technologies might interact with Nigeria's unique electoral ecosystem.

In an era of digital transformation, artificial intelligence (AI) stands at the threshold of revolutionizing electoral processes globally. For Nigeria, Africa's most populous democracy with

over 200 million citizens, AI presents both unprecedented opportunities and significant challenges (IDEA, 2024). This article explores how Nigeria can leverage AI technologies to enhance its electoral system while drawing valuable lessons from international case studies.Nigeria has made strides in election technology adoption, particularly with the Bimodal Voter Accreditation System (BVAS) and the Independent National Electoral Commission's (INEC) Results Viewing Portal (IReV). These systems were designed to enhance transparency and accessibility of election results while curbing electoral fraud (Chatham House, 2023).

However, despite technological advancements, public trust remains an issue with 78% of Nigerians reporting little or no trust in the election management body (Chatham House, 2023). A recent Yiaga Africa survey revealed that AI is already being deployed for voter register management in Nigeria along with automated chatbots for voter engagement in South Africa, voter authentication in Eswatini, and cyber threat detection in Madagascar (IDEA, 2024). These applications represent just the beginning of AI's potential role in African elections.

AI can significantly improve Nigeria's voter registration processes through automated data verification and authentication systems. Such systems can streamline the registration process, reducing bureaucratic hurdles and increasing accessibility. Facial recognition and biometric technologies powered by AI can enhance voter authentication at polling stations, minimizing incidents of impersonation and multiple voting. AI-powered systems can also analyze voting data in real-time, detecting anomalies and patterns that may indicate fraudulent activities. This capability is particularly valuable in Nigeria, where electoral malpractice has historically undermined confidence in election outcomes.

Misinformation poses a significant threat to Nigerian elections. During the 2023 presidential election, the UK-based fact-checking organization Full Fact partnered with several African fact-checking agencies in Nigeria, offering its AI suite to expand fact-checking capacity (Poynter, 2023). These tools helped fact-checkers search for claims and identify persistent spreaders of falsehood, significantly enhancing their ability to hold politicians accountable and help voters access accurate information. AI can monitor social media platforms and news outlets in real-time to identify misinformation, fake news, or attempts to disrupt the election process (StemFocus, 2023). Given Nigeria's vibrant but sometimes polarized social media landscape, AI tools can help electoral authorities and civil society organizations respond swiftly to false narratives that could otherwise undermine public trust in elections.

Beyond combating misinformation, AI can analyze past election data to predict voter behavior and identify potential swing areas, aiding in more strategic resource allocation (StemFocus, 2023). For INEC, this could mean more efficient distribution of polling materials and personnel, particularly in Nigeria's geographically diverse and sometimes logistically challenging terrain.

AI technologies have also made significant strides in improving accessibility for voters with disabilities through speech recognition, text-to-speech, and other assistive technologies (StemFocus, 2023). In Nigeria, where accessibility remains a challenge for many citizens with disabilities, these technologies could enable more inclusive participation in the democratic process.

Looking at global case studies, in the U.S., the Election Assistance Commission (EAC) has developed resources to help election officials navigate AI's opportunities and threats. They acknowledge that while AI-powered tools can benefit election offices, they can also accelerate false information and undermine fair elections if used inappropriately (EAC, 2024). Nigeria's INEC could adopt similar practices, developing comprehensive guidelines for AI deployment in electoral processes. The European Union has taken a regulatory approach with their AI Act approved in May 2024, which aims to harmonize rules on AI by categorizing systems based on risk (UNRIC, 2024). Under this legislation, high-risk AI systems face strict requirements, while extreme practices like cognitive behavioral manipulation and predictive policing are banned. Nigeria could benefit from studying this risk-based regulatory framework and adapting it to electoral contexts.

Closer to home, Ghana's experience offers valuable lessons. In 2016, Ghana's opposition party used a data analytics system to accurately predict election results before the electoral commission's official announcement. They hired a Ghanaian Telecommunications Service Manager at NASA to develop an innovative system that allowed them to input data from electoral centers via pictures of election results sheets (Democracy in Africa, 2020). This system enabled real-time transmission of results to regional and national party offices. Nigeria could implement similar transparent systems to build trust in election results.
Despite these promising opportunities, Nigeria faces several challenges in implementing AI in elections. The country continues to grapple with a digital divide, including limited internet penetration, unreliable electricity supply, and varying levels of digital literacy. Any AI implementation must account for these infrastructural limitations and not inadvertently disenfranchise voters without access to digital resources (Chatham House, 2023). Data privacy concerns also loom large, as Nigeria has yet to pass its data protection bill into law, raising concerns about the collection of electronic registration data (Chatham House, 2023). As INEC continues to collect vast amounts of biometric and personal data, robust data protection frameworks become increasingly critical.

The potential for manipulation and misuse of AI in elections cannot be overlooked. The scandal of Cambridge Analytica's significant role in African politics, notably in Kenyan and Nigerian elections, exemplifies how politicians and economic elites have colluded with foreign AI firms to capture sensitive data of citizens (Democracy in Africa, 2020). This history underscores the need for ethical guidelines and oversight in AI deployment. When adopting AI systems, election

authorities should integrate them with necessary human oversight, ensuring transparency and documentation (Brennan Center for Justice, 2024). Nigeria must strike the right balance between technological automation and human judgment to maintain public trust in election outcomes.AI holds tremendous potential to transform Nigeria's electoral landscape, addressing persistent challenges of transparency, efficiency, and trust (Tribune Online, 2024). By learning from global case studies and taking a thoughtful, context-sensitive approach to implementation, Nigeria can leverage AI to strengthen its democratic processes while mitigating associated risks. The journey toward AI-enhanced elections requires concerted efforts from electoral authorities, technology experts, civil society, and citizens. As Nigeria's stakeholders have recognized, the focus should be on deploying AI tools to improve the electoral system rather than undermine it (Tribune Online, 2024).

With proper planning, regulation, and implementation, AI can help Nigeria achieve more credible, transparent, and inclusive elections, ultimately strengthening the foundation of its democracy and setting a precedent for other African nations navigating similar digital transformations in their electoral processes.

8.3 The future of e-voting in Nigeria through the lens of Kaduna state 2018 regional trial

The adoption of electronic voting (e-voting) in Nigeria remains a subject of ongoing debate, driven by concerns around infrastructure, political will, security, and public trust (Adesina, 2020). While Nigeria's electoral system has witnessed technological interventions such as biometric voter accreditation and electronic result transmission, full-scale e-voting remains largely unimplemented. The country has progressively incorporated technology into its electoral process, primarily through the Independent National Electoral Commission (INEC). Additionally, the electronic transmission of results, piloted in select polling units during the 2019 elections, demonstrated the potential of digital systems in minimizing electoral fraud and enhancing transparency.

Despite these advances, full e-voting faces several barriers, including inadequate digital infrastructure, cybersecurity threats, and concerns over electoral manipulation (Aladekomo, 2023). There is also a notable digital divide, as rural communities may lack the technological literacy and internet connectivity necessary for seamless adoption. These factors contribute to skepticism regarding the readiness of Nigeria for e-voting at a national scale (Adeshina & Ojo, 2020).

The Kaduna State Independent Electoral Commission (KADSIEC) piloted e-voting during the local government elections in 2018, marking Nigeria’s first significant attempt at deploying e-voting machines (Premium Times, 2018). The initiative was designed to eliminate ballot box snatching, reduce human errors, and ensure credible elections through automated processes. The e-voting machines allowed voters to make their choices on electronic screens, with results

automatically computed. Reports from observers indicated that the system improved the speed of collation and reduced incidences of electoral fraud. However, challenges such as machine malfunctions, voter education gaps, and allegations of result manipulations in some areas exposed weaknesses in the system.

The Kaduna trial demonstrated that e-voting could enhance electoral credibility but also highlighted key infrastructural and political challenges. For instance, the system's success was dependent on a stable power supply and efficient biometric verification, both of which remain problematic in many parts of Nigeria. Furthermore, the need for widespread voter sensitization became apparent, as some voters were unfamiliar with digital voting interfaces. The future of e-voting in Nigeria hinges on addressing systemic challenges while leveraging existing technological advancements (Obiefuna-Oguejiofor, 2018). Experts argue that a phased implementation approach, beginning with more pilot programs at subnational levels, could provide valuable insights into scalability and security concerns. Legal reforms will also be necessary to institutionalize e-voting and establish clear frameworks for cybersecurity and electoral transparency.

Moreover, investments in digital public infrastructure, such as a robust national identification system and secure digital voting platforms, could facilitate e-voting adoption. The role of blockchain technology has been explored in global contexts as a means to enhance election security and transparency, presenting a potential pathway for Nigeria's electoral modernization (Uzodike & Onapajo, 2019). The Kaduna e-voting trial in 2018 provided a crucial test case for the viability of electronic voting in Nigeria, revealing both opportunities and obstacles. Reports from observers indicated that the system improved the speed of collation and reduced incidences of electoral fraud, though challenges such as technical glitches and voter education gaps were noted (Premium Times, 2018). While technological interventions have gradually improved electoral integrity, full e-voting implementation requires substantial infrastructural investments, legal adjustments, and public trust-building. A gradual, regionally phased approach could provide a realistic roadmap for achieving nationwide e-voting in the future (INEC 2023)

CHAPTER 9
THE FINANCIAL IMPLICATIONS OF TECHNOLOGY USE IN ELECTIONS

9.0 Introduction

Electoral technology has increasingly become a central component of election management across Africa as countries strive to enhance the integrity, transparency, and efficiency of their electoral processes. From biometric voter registration systems to electronic voting and results transmission technologies, African democracies have embraced various technological solutions, often at significant financial cost. Nigeria, as Africa's most populous democracy, represents a critical case study in examining the financial implications and practical challenges of electoral technology adoption. This review critically assesses the literature on technology costs in Nigerian elections within the broader African context, exploring the tension between the promise of technological solutions and their financial sustainability, particularly in resource-constrained environments.

A report by (ECONEC, 2019) and later updated by International Mo Ibrahim Foundation (2024) revealed significant variations in election costs across Africa, with technology often representing the largest single expenditure category. The cost per registered voter for elections including significant technological components ranged from $5 in Ghana to over $20 in Kenya during the 2017 elections. This variance reflects not only differences in procurement practices but also in the extent of technology deployment and the efficiency of implementation processes. The African Union's studies on electoral costs highlight that countries with higher GDP per capita do not necessarily conduct more cost-effective elections. Instead, factors including geographic challenges, institutional capacity, vendor selection processes, and procurement transparency appear more significant in determining cost efficiency.

Within West Africa, a distinct pattern of technology adoption has emerged, influenced by regional organizations like ECOWAS (Economic Community of West African States) and shared electoral challenges. An analysis by (ECONEC, 2019). eight West African countries showed average technology costs constituting 38-65% of electoral budgets between 2010-2019, significantly higher than other regions in Africa. Ghana's Electoral Commission has been cited as a regional success story in cost-effective technology deployment, with its homegrown biometric voter registration system costing approximately $40 million in 2012 considerably less than similar systems in neighboring countries. This contrasts sharply with Côte d'Ivoire's outsourced system, which cost an estimated $266 million for the 2020 elections despite serving a smaller population. Senegal's deliberate approach to technology adoption provides another instructive comparison, as the country rejected full biometric systems on cost grounds, implementing instead a hybrid system that cost approximately $10 million in 2019, representing only 22% of their electoral budget. This approach has been praised for its sustainability while still enhancing electoral integrity.

Research by Keho (2023) demonstrates that West African countries often face pressure from both domestic opposition parties and international donors to adopt "gold standard" technologies, regardless of financial sustainability. This pressure frequently leads to what Cheeseman & Klaas (2024) describe as "over-engineered" electoral systems that create long-term financial burdens. The ECOWAS Network of Electoral Commissions (ECONEC) has highlighted the growing concern about technology dependence, noting that some member states now allocate more than 60% of their electoral budgets to technology procurement and maintenance, often displacing essential operational spending (ECONEC, 2019). This technology-heavy approach has limited sustainability, especially for countries with restricted fiscal space.

Nigeria's Independent National Electoral Commission (INEC) has progressively increased its investment in electoral technology since 2011, making it one of Africa's most technology-intensive electoral environments. The Direct Data Capture (DDC) machines introduced in 2011 cost approximately ₦35 billion ($230 million at 2011 exchange rates), representing about 40% of INEC's budget for those elections (Ayeni, 2019). The subsequent upgrade to the Permanent Voter Card (PVC) and Smart Card Reader (SCR) system for the 2015 elections added approximately ₦27 billion ($138 million) to electoral costs (Ibrahim et al., 2018). For the 2019 elections, INEC's technology-related expenditure grew to approximately ₦86 billion ($242 million), including maintenance of existing systems and procurement of additional verification devices (INEC, 2023). The introduction of the Bimodal Voter Accreditation System (BVAS) and INEC Results Viewing Portal (IReV) for the 2023 elections represented a further significant investment of approximately ₦105 billion ($255 million) (Premium Times, 2022).

The literature reveals several critical concerns regarding Nigeria's technology investments. Ayeni (2019) argues that Nigeria's technology procurement processes have been characterized by opacity and inflated costs, citing instances where similar technologies were procured at significantly lower costs in comparable countries. Olurode (2017) similarly questions whether Nigeria's technology investments represent value for money, given persistent electoral challenges despite increasing expenditure. Ibrahim et al. (2018) suggest that technology has absorbed resources that might have been better allocated to other aspects of election administration, including staff training and voter education. Their study found that while technology spending increased by 320% between 2011 and 2019, spending on training increased by only 60%, creating an imbalance in resource allocation. A longitudinal study by Omilusi (2019) examining five Nigerian election cycles (1999-2019) found limited correlation between increased technology spending and improvements in election credibility ratings by observer missions. This raises fundamental questions about the cost-benefit ratio of technology investments in Nigeria's electoral system.

Beyond the immediate procurement costs, the literature highlights significant hidden costs associated with electoral technology that often escape initial budgetary considerations. Fall (2020) identifies four categories of hidden costs: maintenance, training, storage, and obsolescence management. In Nigeria, these hidden costs have proven substantial, with INEC spending approximately ₦15 billion ($42 million) on maintaining biometric equipment between the 2015 and 2019 elections (INEC, 2020). The challenge of technological obsolescence is particularly acute in Nigeria's case. Jega & Ibeanu (2022) note that the rapid pace of technological change means systems often become outdated within a single electoral cycle, creating pressure for costly upgrades. This pattern was evident in Nigeria's transition from DDC machines to SCRs and subsequently to BVAS within a decade, with each transition requiring significant new investment.

The effective deployment of electoral technology requires substantial investment in human resources and training, yet this critical component is often underfunded. Tsuwa & Agaibe (2022) calculates that INEC spent approximately ₦7.2 billion ($20 million) on technology-related training for the 2019 elections, representing about 8% of the total technology budget. However, Oguine & Loko (2024) found this training inadequate, with many poll workers struggling to operate equipment effectively. This points to a critical challenge of investing heavily in hardware while underinvesting in the human capacity necessary to operate it effectively. Omoleke (2019) cited this imbalance as a significant factor undermining the effectiveness of Nigeria's electoral technology investments.

A recurring theme in the literature is the dependency relationship created between African electoral management bodies and foreign technology vendors. In Nigeria's case, significant contracts have been awarded to foreign companies, creating what Olurode, (2017) describes as "technological dependency." This dependency carries both financial and sovereignty implications. Financially, it often results in higher costs due to limited competition and the need for ongoing vendor support. Olurode (2017) further found that maintenance contracts with original vendors often cost 15-20% of the original procurement price annually. From a sovereignty perspective, Adetula & Jaiyebo (2020) argue that outsourcing critical electoral infrastructure to foreign entities creates potential vulnerabilities in the electoral process that could undermine the integrity of Nigeria's democracy.

The fundamental question emerging from the literature is whether Nigeria's substantial investments in electoral technology have delivered commensurate benefits. Research findings are mixed. Quantitative studies by Omilusi, (2019) found that the introduction of SCRs in 2015 was associated with a 4-8% reduction in reported over-voting incidents compared to 2011. However, the same study questioned whether this modest improvement justified the substantial cost. Qualitative assessments present a similarly nuanced picture. Paki, (2022) concluded that while technology had "improved certain aspects of election integrity," its effectiveness was undermined

by inconsistent implementation and procedural violations. The author questioned whether the substantial investment had delivered value given these limitations.

One potential benefit of technology investment is enhanced public trust in electoral processes. However, survey data from (Alemika & Lewis, 2005) indicates complex public perceptions in Nigeria. While 65% of respondents expressed support for technological innovations in elections, only 43% believed these technologies had actually enhanced election credibility. This trust deficit is particularly pronounced in rural and less educated populations. Omilusi's (2019) field research found that many voters in rural areas viewed technology with suspicion, particularly when technical failures occurred. This suggests that expensive technological solutions may not be achieving their primary goal of building public confidence in electoral processes, particularly among marginalized communities who may already harbor distrust toward government institutions.

Several scholars have proposed alternative approaches that might deliver better value for money. Dimitri, (2013) advocates for an "value for money" model where solutions are tailored to specific contextual needs rather than adopting the most advanced (and expensive) options available. This approach has shown promise in countries like Senegal and Botswana, which have achieved relatively credible elections with more modest technology investments. Ojakorotu & Joseph, (2021) drawing on their experience managing Nigeria's elections, propose a "hybrid approach" that balances technological solutions with strengthened procedural safeguards and enhanced human capacity. They argue that this balanced approach would be more cost-effective while potentially delivering better results than a technology-heavy strategy that neglects fundamental institutional reforms.

Nigeria's substantial investments in electoral technology over the past decade reveal a complex picture regarding costs and benefits. While technology has been positioned as a solution to electoral integrity challenges, the evidence suggests that high costs have not consistently yielded commensurate improvements in electoral outcomes. The comparative analysis demonstrates that Nigeria's approach to electoral technology has been more costly than many peer countries without consistently delivering superior results. This suggests opportunities for more cost-effective strategies that might better balance technological solutions with institutional strengthening and procedural improvements. Several policy implications emerge from this analysis. First, there is a clear need for more transparent technology procurement processes to ensure value for money. Second, greater investment in human capacity development would likely enhance the effectiveness of technological solutions. Third, developing domestic technological capabilities could reduce dependency on foreign vendors and potentially lower long-term costs.

While technology undoubtedly has a role to play in strengthening Nigeria's electoral processes, the evidence suggests a need for a more balanced, cost-conscious approach that considers the full

financial implications of technology adoption and prioritizes sustainable, context-appropriate solutions that serve the fundamental goal of democratic consolidation.

9.1 Election Technology Procurement and its Dilemma

The deployment of technology in electoral processes has become a defining feature of modern democracies across Africa, with Nigeria representing a particularly complex case study. The tension between developing indigenous election technologies and importing foreign solutions presents multifaceted challenges that intersect with issues of sovereignty, capacity development, cost-effectiveness, and integrity of electoral outcomes. This review critically examines the dilemma faced by Nigeria and other African nations in navigating the procurement of election technologies, focusing specifically on the procedural, political, and practical dimensions of these decisions.

The procurement of election technologies in Nigeria reflects broader patterns and challenges evident across the African continent, where the promise of technological solutions often collides with institutional weaknesses, resource constraints, and political interference (Ekpo & Akah, 2023). While technology has the potential to enhance transparency and efficiency in electoral processes, the mechanisms through which these technologies are acquired can significantly impact their effectiveness, sustainability, and public trust.

Across Africa, electoral management bodies (EMBs) have increasingly embraced technological innovations to address persistent challenges in voter registration, identification, and result transmission (Merivaki, 2020). From biometric voter registration in Kenya to electronic voting in Namibia, these technologies have been adopted with varying degrees of success and controversy. The African Union's emphasis on technological solutions as part of its electoral assistance program has further accelerated this trend, though with insufficient attention paid to procurement processes and long-term sustainability. The Economic Community of West African States (ECOWAS) has similarly promoted technological interventions in elections while establishing regional standards for procurement and deployment. However, implementation of these standards has been inconsistent, with procurement processes often vulnerable to political manipulation and corruption (Amnesty International, 2018).

Election technology procurement in Africa has been characterized by several common challenges. Ghana's experience with biometric voter registration revealed issues of timing and hasty implementation, with procurement decisions made too close to election periods, limiting testing and training opportunities (Adams & Asante, 2019). Kenya's procurement of the Kenya Integrated Election Management System (KIEMS) was marred by allegations of corruption and inflated costs, leading to legal challenges and public distrust (Magu,2024). The Democratic Republic of Congo's controversial procurement of voting machines from South Korean firm Miru Systems highlighted concerns about transparency, cost, and foreign influence (Amnesty

International, 2018). These cases demonstrate that procurement challenges are not unique to Nigeria but reflect systemic issues in governance, transparency, and technical capacity across the continent.

Nigeria's journey with election technologies began in earnest with the introduction of electronic voter registration in 2006, followed by the Smart Card Reader in 2015, and most recently, the Bimodal Voter Accreditation System (BVAS) and the INEC Results Viewing Portal (IReV) (Mohammed & Buluma, 2023). Each technological iteration has been accompanied by heated debates about procurement processes, with concerns about cost, transparency, and the balance between indigenous development and foreign acquisition (Aluaigba,2016). The Independent National Electoral Commission (INEC) has repeatedly faced criticism for its procurement decisions, particularly regarding the transparency of bidding processes and contract awards (Nwokeafor & Langmia, 2013). The Commission's defense has typically centered on the need for specialized technologies that meet specific electoral requirements, sometimes necessitating single-source procurement or limited competition (INEC, 2023).

Nigeria's attempts to develop indigenous election technologies have yielded mixed results. The National Agency for Science and Engineering Infrastructure (NASENI) has developed prototypes for electronic voting machines, but these have not been widely deployed in national elections. The case of the Smart Card Reader, procured from abroad but customized for Nigerian conditions, represents a hybrid approach that attempted to balance foreign expertise with local requirements (James, 2016). However, the procurement process was criticized for limited competition and insufficient due diligence regarding vendor capabilities and track records.

Nigeria's Public Procurement Act of 2007 establishes the legal foundation for all government procurements (Florence, 2018). The law emphasizes principles of transparency, competition, and value for money, while providing for exceptions in cases of specialized or security-sensitive acquisitions. INEC operates within this framework but has additional electoral laws and regulations that influence its procurement decisions, sometimes creating tensions between general procurement principles and electoral exigencies (James, 2016). The Electoral Act of 2022 strengthened INEC's mandate to deploy appropriate technologies but provided limited guidance on procurement methodologies or standards for technology assessment. This regulatory ambiguity has sometimes been exploited to justify non-competitive procurement practices, particularly when election timetables create time pressures.

In practice, Nigeria's procurement of election technologies has often deviated from established legal frameworks. Studies by transparency organizations have identified patterns of opacity in decision-making, limited stakeholder consultation, and insufficient technical evaluation of proposed solutions (Kyarem & Omotayo, 2023). These procedural weaknesses reflect broader challenges in Nigerian public procurement, where political considerations frequently override technical and economic factors (Mariz & Abeille, 2014). The timing of procurement decisions

has been particularly problematic, with major technology acquisitions often occurring close to election periods, limiting opportunities for rigorous testing and stakeholder familiarization (Aluaigba, 2016). This compressed timeline has contributed to implementation failures, including system malfunctions during elections and inadequate training of personnel.

The procurement of election technologies in Nigeria reflects complex power dynamics among various stakeholders, including INEC, political parties, civil society organizations, international donors, and technology vendors (Ibrahim & Ariba, 2011). These actors often have divergent and sometimes conflicting interests regarding transparency, cost, functionality, and control of electoral processes, complicating procurement decisions. Political elites have demonstrated selective enthusiasm for election technologies, supporting innovations that might benefit their electoral prospects while resisting those that could constrain their ability to influence outcomes (Benham, 2025). This political interference has sometimes skewed procurement processes toward particular vendors or solutions, regardless of technical merit or cost-effectiveness (Oluwaseun & Damilola, 2025).

The financing of election technologies has introduced additional complexities into procurement processes. Nigeria's election technology acquisitions have been funded through a combination of government budgets and international donor support, with each funding source carrying distinct implications for procurement autonomy and accountability (Aluaigba, 2016). International donors, including bilateral aid agencies and multilateral organizations, have exerted significant influence over technology choices through their financial support, sometimes promoting solutions from their home countries or preferred vendors (Findley & Nielsen, 2017). This donor influence has raised concerns about technological dependency and the sustainability of imported solutions once external funding ends.

Nigeria's capacity to develop indigenous election technologies has grown but remains limited in critical areas. Local technology firms have demonstrated capabilities in software development and systems integration but face challenges in hardware manufacturing and advanced biometric technologies (National Information Technology Development Agency, 2023). Universities and research institutions have contributed to conceptual development but lack resources for large-scale implementation and commercial deployment. The potential benefits of indigenous development include enhanced local ownership, better adaptation to local contexts, and opportunities for technology transfer and capacity building (Wilen, 2012). However, these advantages must be weighed against the higher short-term costs, longer development time frames, and potential reliability issues compared to established international solutions (Lim & Roderick, 2012).

The selection of election technologies, whether indigenous or imported, should be guided by clear and comprehensive evaluation criteria. These include technical reliability, security features, usability in diverse contexts, interoperability with existing systems, cost-effectiveness, and

sustainability (Ebrecht & Horste, 2012). INEC's procurement decisions have sometimes overemphasized certain criteria, particularly technical sophistication, at the expense of others, including usability and context appropriateness (Wilensky, 2014). The evaluation process has also been criticized for insufficient attention to long-term considerations, including maintenance requirements, upgradability, and knowledge transfer provisions. These oversights have contributed to the underutilization of procured technologies and rapid obsolescence requiring new procurement cycles.

Rwanda's approach to election technology procurement has emphasized domestic capacity development alongside strategic international partnerships. The National Electoral Commission has invested in training local technicians and developing customized solutions that reflect Rwanda's specific electoral needs and constraints (Africa Research Bulletin, 2024).In the same vein, Ghana's Electoral Commission has established more transparent procurement processes with robust stakeholder participation, including representatives from political parties, civil society, and technical experts (Aidoo & Botchway, 2021). While not without challenges, this inclusive approach has contributed to greater acceptance of election technologies and more efficient implementation (Gyimah-Boadi, 2021).

Kenya's experience with the procurement of the Kenya Integrated Election Management System (KIEMS) for the 2017 elections illustrates the risks of rushed, non-transparent procurement processes. The controversial single-source procurement from French company OT-Morpho (now Idemia) at an inflated cost contributed to legal challenges and public distrust in the election results (Sum, 2024). The subsequent annulment of the presidential election by the Supreme Court highlighted the high stakes of technology procurement decisions. The Democratic Republic of Congo's procurement of voting machines for the 2018 elections exemplifies similar challenges (Kisangani, 2023). The lack of transparency in the selection of South Korean company Miru Systems, coupled with limited testing and stakeholder familiarization, undermined confidence in the electoral process and fueled allegations of manipulation (Moon, 2022). The high cost of the machines relative to their functionality and the country's economic situation raised additional questions about procurement priorities and value for money.

Nigeria requires a more robust and specialized framework for election technology procurement that addresses the unique challenges of electoral contexts while maintaining core principles of transparency, competition, and value for money (Graells, 2015). This framework should include clear guidelines for technology assessment, stakeholder consultation, and decision documentation to enhance accountability (Yudkin & McCormack, 2016). In addition, the establishment of an independent technology advisory committee comprising electoral officials, technical experts, civil society representatives, and political party delegates could enhance the credibility of procurement decisions and ensure diverse perspectives are considered (Popescu & Hatieganu, 2008). This committee could provide expert input on technology options and procurement methodologies while serving as a check against political interference. A strategic

approach to the indigenous-versus-imported dilemma would involve capacity-building initiatives that enhance Nigeria's ability to develop and maintain election technologies while pragmatically leveraging foreign solutions where necessary (Erinfolami, 2020). This hybrid approach could include knowledge transfer requirements in contracts with foreign vendors, apprenticeship programs for local technicians, and phased transitions from imported to locally developed components (Sud, 2008). Investment in research and development through universities and technology hubs could enhance Nigeria's long-term capability to develop indigenous election technologies (Akinwale, 2017). Collaboration with other African countries facing similar challenges could pool resources and expertise, potentially leading to regionally developed solutions that reflect shared contextual factors and requirements (African Union, 2022).

The dilemma of indigenous versus imported election technologies in Nigeria reflects broader tensions between technological sovereignty and practical functionality, immediate needs and long-term development, and political control and technical integrity. The procurement processes through which these technologies are acquired represent critical junctures where these tensions are negotiated and resolved, often with significant implications for electoral outcomes and democratic legitimacy (Basu & Mitra, 2019). Nigeria's experience, situated within the broader African context, demonstrates that effective procurement of election technologies requires not only robust legal frameworks and technical expertise but also political will, stakeholder inclusion, and strategic vision (Levchenko & Nemchenko, 2023). Moving forward, INEC and other electoral management bodies across Africa must develop more transparent, inclusive, and context-sensitive approaches to technology procurement that balance immediate electoral needs with long-term development goals (Backer & Long, 2015)

The future of election technology in Nigeria and Africa more broadly depends on finding this balance, creating procurement processes that enhance rather than undermine democratic principles, and developing technologies that reflect local realities while meeting international standards of reliability and security (Jezak, 2014). This challenge remains central to the continent's ongoing democratic consolidation and will require continued attention from researchers, policymakers, and practitioners in the years ahead.

9.2 Summary of literature

The literature review provides a comprehensive analysis of the socio-technical dimensions that shape the adoption and integration of technological innovations in Nigerian elections. It centers on the socio-technical systems theory, which highlights the interdependence between technical and social elements, illustrating that technology cannot function effectively without alignment with the social and institutional environment. Key issues explored include public trust, infrastructural deficits, and the political culture that affects the deployment of technologies like biometric voter systems and the INEC Result Viewing Portal (IReV).

One critical factor is the role of digital literacy and the training of electoral officials. Many studies emphasize that the success of election technologies hinges not only on the technology itself but also on the capacity of officials to use these tools effectively. The lack of digital literacy and inadequate training are cited as significant barriers that have led to failures in the use of systems like BVAS (Bimodal Voter Accreditation System), contributing to delays and errors during elections.

The review also addresses data security and cybersecurity vulnerabilities, noting the risks of hacking, unauthorized access, and data manipulation in systems like BVAS and IReV. These vulnerabilities are exacerbated by infrastructural challenges such as unreliable internet access, particularly in rural areas, where technological malfunctions are more common. Another important theme is the digital divide between urban and rural voters, where the disparity in access to technology and digital resources leads to unequal experiences with election technologies. In addition, the issues of financial resources and procurement for election technologies were also covered.

The review draws on international comparisons, such as the successes and challenges of Brazil's e-voting system and the political context surrounding Germany's rejection of electronic voting machines due to transparency concerns. These case studies reinforce the argument that the socio-technical context, including public perceptions, trust, and the political environment, is crucial in determining the success of technological innovations in elections.

Ultimately, the literature points to the need for holistic socio-technical solutions that integrate technological advancements with improvements in infrastructure, training, and public engagement. This review sets the foundation for the research objectives, focusing on the strategic recommendations for future deployments of election technologies in Nigeria.

CHAPTER 10

METHODOLOGY

10.0 Introduction

This research study investigated the socio-technical factors that significantly influence the application of technologies in Nigerian elections. Through the focus on the interplay between social dynamics and technical systems, this research study provides a holistic understanding of the challenges and opportunities in the deployment of election technologies in Nigeria.

This chapter explains all the approaches, designs, data collection methods, and analysis methods that were used to get answers to the research questions that guided the study. This chapter provides a breakdown of the overall design of this study, including the research design, research philosophy, type of research, method for collecting data, and method for analyzing data. Additionally, the variables measured in the study and the methodological constraints of the study are also outlined.

10.1 Research Questions

This research study addressed the following research questions;

RQ 1: What are the critical socio-technical determinants influencing the adoption and integration of technological innovations in Nigerian electoral processes, and how do these determinants interact within Nigeria's unique socio-political context?

RQ 2: What are the predominant socio-technical challenges and opportunities presented by the deployment of election technologies in Nigeria, and how do they impact electoral integrity, transparency, and public trust?

RQ 3: How do socio-technical frameworks shape the design, implementation, and evaluation of technological systems in Nigerian elections, and what are their implications for achieving democratic outcomes?

RQ 4: What evidence-based, socio-technical guidelines can be developed for Nigerian policymakers and election stakeholders to optimize the deployment and use of technology in the electoral process, considering both local and global best practices?

The research questions above are intricately connected to socio-technical theory, which posits that technological systems are not independent entities but must be understood in relation to the social, cultural, and institutional environments in which they are embedded (Trist, 1951). The first research question (RQ1), which investigates the socio-technical determinants influencing the adoption and integration of technology in Nigerian elections, is rooted in this perspective.

This investigation is essential for expanding the theoretical understanding of how socio-technical factors shape the efficacy of technological innovations in sensitive and politically charged environments such as elections.

Moreover, the second research question (RQ2), which focuses on the challenges and opportunities presented by election technologies, aligns with socio-technical theory's emphasis on the co-evolution of technological systems and social structures. Challenges such as technical malfunctions, cybersecurity risks, and infrastructural limitations, alongside opportunities for improving transparency and integrity, are central to understanding how technological systems function within real-world electoral processes (Mumford, 1987). The research not only highlights the socio-technical risks involved but also explores how these dynamics influence public trust in the electoral process, further connecting theory with practical implications in the Nigerian electoral landscape.

Finally, the third and fourth research questions (RQ3 and RQ4) focus on how socio-technical frameworks inform the design, implementation, and evaluation of election technologies. These questions seek to bridge the gap between theoretical constructs and practical applications, offering evidence-based guidelines for policymakers. Through the development of tailored, context-specific recommendations that incorporate both local insights and global best practices, the research contributes to the practical extension of socio-technical theory. It provides a framework for optimizing the deployment of technology in Nigerian elections, echoing the argument by Baxter & Sommerville (2011) that successful technological integration is contingent upon an alignment between technical and social systems. Through these contributions, the research amplifies socio-technical theory by translating theoretical insights into actionable, real-world solutions for improving electoral processes in Nigeria.

10.2 Research Paradigm

This research study uses a mixed-methods approach. A mixed-methods methodology combines both quantitative and qualitative approaches, enabling a more comprehensive exploration of complex research problems by integrating numerical data with contextual insights. This approach is particularly suited for this study because it allows for the examination of both the measurable impacts of election technologies and the nuanced socio-technical interactions that influence their adoption and effectiveness (Creswell & Clark, 2023). Mixed-methods research offers a balanced way to address the multi-dimensional nature of socio-technical systems, ensuring that both technological and human factors are adequately captured, making it the most appropriate methodology for investigating in this research study (Mattia, 2011).

The study is grounded in Eric Trist’s socio-technical systems theory, which provides a framework for examining how technological systems interact with Nigeria's unique socio-political context. This theoretical lens allows the study to focus on the human, organizational, and infrastructural factors that influence the adoption and effectiveness of

election technologies. The research study aims to offer evidence-based recommendations for Nigerian policymakers and stakeholders to enhance electoral integrity, transparency, and public trust (Trist & Bamforth, 1951; Baxter & Sommerville, 2011).

10.2.1 Justification for Mixed Method Design

A mixed-methods design is highly appropriate for this study, given the multifaceted nature of Nigeria's electoral environment. By integrating both quantitative and qualitative approaches, this method provides a comprehensive examination of the socio-technical factors shaping the adoption, integration, and impact of election technologies. The complexity of these dynamics spanning technical, institutional, and social domains necessitates the use of a research design that can capture both statistical data and the nuanced, contextual insights that are often missed by purely quantitative approaches (Creswell & Clark, 2023).

Quantitative methods are useful in identifying patterns, trends, and measurable relationships between variables such as voter participation, technology adoption rates, and electoral outcomes. These quantifiable data points are crucial for understanding the broader impact of technologies like biometric voting systems or electronic transmission of results (Bryman, 2006). However, electoral processes are also deeply embedded within Nigeria's unique socio-political context, where issues such as political culture, institutional capacity, and public trust significantly influence the effectiveness of technological systems. Therefore, qualitative methods through document analysis and other contextual evaluations will provide essential insights into these socio-cultural and political dimensions, offering a more in-depth understanding of the environment in which these technologies operate (Kutsyuruba, 2023).

The mixed-method approach further supports the study’s primary objective of evaluating socio-technical factors by allowing for triangulation. Triangulation enhances the validity of the findings, as it enables the cross-verification of data from multiple sources, thus providing a more reliable and nuanced picture of the challenges and opportunities that arise in the deployment of election technologies in Nigeria (Beebe,2014). This is particularly important when addressing complex issues such as electoral integrity, where both measurable outcomes and intangible factors, like public perception, need to be considered. By employing a mixed-methods design, this study aligns with the growing body of literature advocating for the combination of qualitative and quantitative approaches to explore socio-technical phenomena in complex environments.

In conclusion, the mixed-methods design is justified as it allows for a holistic and robust examination of the socio-technical systems at play in Nigeria’s electoral processes. This approach not only captures the numerical data necessary for broad analysis but also contextualizes these findings within Nigeria's distinctive socio-political landscape, thus providing a well-rounded understanding of how election technologies function in real-world settings.

10.3 Research Methodology

This research study is a mixed method research which has pragmatism as its underpinning research philosophy. In social science research, selecting an appropriate research philosophy is crucial as it underpins the entire study, guiding the methodological choices and shaping the interpretation of findings (Saunders at al., 2019). Pragmatism is particularly a suitable philosophy for research that seeks to address complex, real-world problems through a flexible and pragmatic approach. This is especially pertinent for studies exploring socio-technical dimensions, such as the adoption and integration of technology in Nigerian elections, where multifaceted interactions between social and technical elements are prevalent.

Pragmatism is a philosophical tradition that originated in the late 19th century with thinkers like Charles Sanders Peirce, William James, and John Dewey (Rorty & Ayer, 1971). Unlike other philosophical paradigms that prioritize abstract theoretical constructs, pragmatism emphasizes the practical consequences and applications of ideas. It posits that the truth of a concept or theory lies in its ability to produce desirable outcomes and solve specific problems

10.3.1 Core Tenets of Pragmatism

1. **Practical Consequences:** Pragmatism asserts that the meaning and truth of ideas are determined by their practical effects and utility . This focus on action and outcomes makes it inherently problem-solving.

2. **Pluralism:** Pragmatism acknowledges the existence of multiple perspectives and solutions, advocating for a methodological pluralism that embraces diverse approaches to address research questions.

3. **Anti-Dualism:** It rejects the strict separation between theory and practice, recognizing that theoretical insights are derived from practical experiences and vice versa.

4. **Contextualism:** Pragmatism emphasizes the importance of context in shaping knowledge and understanding, ensuring that research is grounded in the specific circumstances under study.

Pragmatism is particularly a fit to mixed-methods research, which combines quantitative and qualitative approaches to provide a comprehensive understanding of research problems (Creswell & Clark, 2017). This aligns with the pragmatic emphasis on using whatever methods are most effective in addressing the research questions, irrespective of traditional methodological boundaries.

10.3.2 Application of Pragmatism in the Current Study

In examining the socio-technical dimensions of technology adoption in Nigerian elections, pragmatism offers several key advantages as highlighted below;

1. Integration of Diverse Data Sources: The study employs a mixed-methods approach, combining quantitative surveys with qualitative document analysis. Pragmatism supports this methodological diversity, enabling a more holistic examination of the interplay between social and technical factors.
2. Focus on Practical Outcomes: The research aims to provide practical guidelines for policymakers and election stakeholders. A pragmatic approach ensures that the findings are not only theoretically sound but also practically relevant and implementable.
3. Contextual Sensitivity: Understanding the unique socio-cultural and political landscape of Nigeria is essential for effective technology integration in elections. Pragmatism's emphasis on context ensures that the research remains grounded in the specific realities of the Nigerian electoral system.
4. Flexibility in Methodological Choices: As the study progresses, pragmatism allows for adjustments in research methods based on emerging insights and changing circumstances, thereby enhancing the study's responsiveness and relevance.

10.4 Data Collection

In this study, I employed a mixed-methods approach, incorporating both quantitative and qualitative data collection techniques. The quantitative data source is a structured survey which captures the socio-technical factors influencing the adoption, effectiveness, and challenges of election technologies in Nigeria and the qualitative data source was from document analysis (discussed in details in section 3.7). The survey was administered to Nigerian citizens across the six geopolitical zones (within urban and urban rural outskirts) of Nigeria, ensuring a comprehensive understanding of technological applications in Nigerian elections. The instrument was shared via online mediums but also through random physical approach by field officers who supported those who could not fill the survey directly. I appointed one research officer to each geopolitical zone to ensure thoroughness and transparency of data collection. We had a debrief at the end of every week to know the progress and any field challenges they might be having.

The use of surveys in this study was not without limitations. One key challenge encountered was the possibility of social desirability bias, as some respondents may have provided answers they considered socially acceptable rather than their true opinions, especially on sensitive issues relating to political trust and election integrity. There was also the likelihood of non-response bias, given that certain groups such as rural dwellers and individuals with low digital literacy were harder to reach, which may have affected the representativeness of the data.Language diversity and varying literacy levels posed another limitation, as some respondents may have

misinterpreted questions despite efforts to simplify and translate the instrument. Accessibility challenges were also evident during data collection, particularly in areas with poor internet penetration, security concerns, and infrastructural gaps. Finally, as the survey captured responses at a single point in time, it may not fully reflect evolving perceptions or changes in adoption patterns over an electoral cycle. These limitations, though acknowledged, do not diminish the overall validity of the findings but rather provide context for interpreting the results.

As a socio-technical research, I did not employ interviews or focus groups, as the research questions were best addressed through a combination of surveys and document analysis. Given the sensitivity of electoral or electoral technology discussions, particularly with the Independent National Electoral Commission stakeholders and political actors, interviews posed ethical and practical challenges, including reluctance from participants due to fears of misrepresentation or political repercussions (lessons from my initial data collection in 2023).

Instead, the survey enabled scalable, anonymized data collection across Nigeria's geopolitical zones, while document analysis provided institutional and historical trends. This approach aligns with socio-technical research precedents like (Alvarez & Hall, 2008; Orlikowski & Iacono, 2001) where systemic analysis of technology adoption prioritizes broad patterns over individual narratives, especially in politically volatile settings. Prior research in similar contexts (Gibson & Cantijoch, 2019) has demonstrated that surveys and archival analysis can effectively capture socio-technical dynamics when interviews are impractical, provided the design explicitly addresses their limitations through complementary methods.

10.4.1 Survey Instrument

The survey consists of seven sections, each targeting specific socio-technical dimensions of election technology adoption;

Section 1: Demographics and Roles

This section gathered essential demographic information to contextualize responses based on socio-political backgrounds. Variables such as age, gender, occupation, and educational level provided insight into how different population groups interact with election technologies. Additionally, respondents identified their electoral roles (voter, election official, observer, etc.) and their geopolitical location, ensuring balanced representation across Nigeria's six geopolitical zones.

Section 2: Awareness and Adoption of Technology

This section examined respondents' familiarity with election technologies, including BVAS, IReV, and Smart Card Readers. It employed 5-point Likert-scale questions (1 = Not Familiar to 5 = Very Familiar) to assess awareness levels and perceptions regarding the effectiveness of these

technologies in enhancing transparency, reducing fraud, and improving electoral integrity. The scales were adapted from established technology adoption frameworks in;

1. Venkatesh et al. (2003), which provides validated measures for technology familiarity and perceived effectiveness
2. INEC Nigeria (2023), whose post-election report on BVAS and IReV offers context for scaling adoption and trust in Nigerian-specific technologies.

The responses provide a quantitative measure of adoption trends and effectiveness, aligning with socio-technical research on how users engage with electoral innovations.

Section 3: Cultural and Social Factors

This section explored socio-cultural influences on election technology acceptance. Questions assessed trust in election technologies, the perceived impact of political party influence, and the role of regional cultural beliefs in shaping public attitudes. The section also evaluates the importance of voter education as a critical factor in technology adoption.

The scales were adapted from;

1. Mooij & Hofstede (2010), which provides a framework for analyzing how cultural dimensions (e.g., power distance, uncertainty avoidance) affect technology acceptance in diverse societies.
2. Egan (2021), whose trust measurement tools were tailored to evaluate institutional confidence in technologies, aligning with the survey's focus on public perception.

By quantifying these socio-cultural factors, the section identifies barriers and enablers of technology adoption within Nigeria's unique context.

Section 4: Technology and Infrastructure

Given the infrastructural challenges in Nigeria, this section assesses the accessibility and reliability of election technologies, particularly in rural areas. Respondents provide feedback on the frequency of technical failures and the major barriers affecting the optimal use of election technologies, such as power supply and internet connectivity. Open-ended responses allowed participants to suggest potential improvements to Nigeria's electoral infrastructure.

The scales were adapted from;

1. Mutula (2010), Digital Infrastructure for Elections: Best Practices, which provides benchmarks for evaluating technology readiness in developing contexts, including rural accessibility and failure rates.
2. Vogus (2023), which offers standardized metrics for assessing technological accessibility, aligning with the survey's focus on election infrastructure gaps.

By combining quantitative scales with qualitative insights, this section identifies critical infrastructure limitations and opportunities for enhancement in Nigeria's electoral system.

Section 5: Trust, Integrity and Electoral Processes

Public trust in election technologies is crucial for electoral credibility. This section evaluated confidence levels in the ability of election technologies to ensure free and fair elections. It also measured the perceived effectiveness of these technologies in reducing vote manipulation and enhancing electoral transparency. An open-ended question invites respondents to suggest measures to improve trust in technology-based election systems.

The scales were derived from;

1. Norris (2014), Why Electoral Integrity Matters (Cambridge University Press), which provides validated measures for assessing public trust and perceived integrity in electoral technologies.
2. Haque & Caroll (2020), Assessing the impact of information and communication technologies on electoral integrity, which employs similar Likert-scale methodologies to evaluate transparency and public confidence in election technologies.

By combining quantitative assessments with qualitative feedback, this section offers critical insights into how election technologies shape public trust and where improvements are needed to strengthen electoral integrity in Nigeria.

Section 6: Institutional and Policy Framework

This section investigated the role of government support, international organizations, and policy frameworks in sustaining election technologies. Respondents provided perspectives on the adequacy of governmental support and suggested policy reforms necessary for improving the implementation and long-term sustainability of election technologies in Nigeria.

The scales were adapted from;

1. United Nations (2021), Recommendations on Public Sector Innovation, which provides metrics for assessing government support and policy effectiveness in technology-driven initiatives.
2. Bogaards (2009), Election Technology and Policy Frameworks, which outlines best practices for institutional roles in sustaining electoral technologies, particularly in emerging democracies.

By integrating quantitative ratings with qualitative policy suggestions, this section identifies gaps in institutional support and pathways for strengthening Nigeria's electoral technology ecosystem through improved governance and international collaboration.

Section 7: Future of Election Technologies

This section focused on forward-looking insights regarding the evolution of election technologies in Nigeria. It captures respondents' views on emerging technologies, such as blockchain and artificial intelligence, and explores recommended steps for aligning Nigeria's election technology with global best practices.

The qualitative approach was guided by;

1. Mathe (2021) Examining electoral reforms and use of digital technologies for voters participation and their applicability to African electoral contexts.
2. Abizadeh (2017) Global Best Practices for Election procedures which provides a benchmark for evaluating Nigeria's technological readiness against international standards.

By prioritizing participant-generated recommendations, this section identifies actionable pathways for Nigeria to modernize its electoral systems while addressing unique local challenges.

10.5 Sampling strategy

To ensure a representative and methodologically robust study, the sampling process was carefully designed to capture Nigeria's diverse electoral, geographic, and socio-technological contexts. The approach combined stratified and purposive sampling techniques, aligning with the research objectives. The sampling framework began with Nigeria's six geopolitical zones, North Central, North East, North West, South East, South-South, and South West. From each zone, one state was purposely selected. The chosen states, Adamawa (North East), Kaduna (North West), Imo (South East), Edo (South-South), Lagos (South West), and the FCT (North Central) were strategically justified based on their historical electoral significance, urban-rural composition, technological readiness, and security dynamics (see Table 9). For instance, Lagos and Abuja

provided insights into high-tech urban environments, while Adamawa illustrated challenges in conflict-affected regions with limited infrastructure.

Within each state, the capital city was selected as the primary research site, given its concentration of electoral infrastructure, population density, and logistical feasibility. To determine the sample size, the Cochran formula was applied, yielding 400 respondents distributed proportionally by city based on voter population data from the most recent election. This ensured equitable representation. This sampling design prioritized geopolitical balance, urban-rural variation, and socioeconomic diversity (Table 10), addressing potential biases and enhancing the generalizability of findings. By integrating statistical rigor with contextual relevance, the methodology not only strengthens the study's validity but also offers a nuanced lens into how election technologies function across Nigeria's complex electoral landscape.

Stage 1: Division of 36 states into 6

Table 6

Establishment of geopolitical zones

North Central	**North East**	**North West**	**South East**	**South-South (Niger Delta)**	**South West**
Benue State	Adamawa State	Jigawa State	Abia State	Akwa Ibom State	Oyo State
Nasarawa State	Bauchi State	Kaduna State	Anambra State	Bayelsa State	Ekiti State
Kogi State	Borno State	Kano State	Ebonyi State	Cross River State	Ondo State
Kwara State	Gombe State	Katsina State	Enugu State	Rivers State	Ogun State
Niger State	Taraba State	Kebbi State	Imo State	Delta State	Osun State
Plateau State	Yobe State	Sokoto State		Edo State	Lagos State
Federal Capital Territory		Zamfara State			

Stage 2: Selection of States

Table 7

Purposive random sampling: selection of one State per geopolitical zone

North Central	**Northeast**	**Northwest**	**Southeast**	**South-South (Niger Delta)**	**Southwest**

Federal Capital Territory	Adamawa State	Kaduna State	Imo State	Edo State	Lagos State

Stage 3: Selecting a city from the selected States

Table 8

Selected cities

Federal Capital Territory	**Adamawa State**	**Kaduna State**	**Imo State**	**Edo State**	**Lagos State**
Abuja City	Yola City	Kaduna City	Owerri City	Benin City	Lagos City

Table 9

Justification for State and city selections

Geopolitical Zone	**State**	**Capital**	**Key Characteristics**	**Why It's Important**
North Central	Federal Capital Territory (FCT)	Abuja	- Urban focus, high infrastructure - Political relevance (INEC headquarters) - Diverse population (Nigeria's melting pot)	Provides insights into election technology in a well-resourced urban center with high political stakes.
North East	Adamawa State	Yola	- Mixed urban-rural - Security challenges (insurgency) - Ethnic and religious diversity	Highlights challenges of deploying election technology in unstable environments with limited infrastructure.
North West	Kaduna State	Kaduna	- Mixed urban-rural - Historical electoral disputes - Regional prototyping location for e-voting in 2018 - Ethnic and religious tensions	Offers a case study on voter engagement, dispute resolution,e-voting prototype and inclusivity in a diverse, active region.

South East	Imo State	Owerri	- Urban-rural mix - High voter engagement - Moderate technological adoption	Examines how election technologies enhance transparency and trust in a region with high political awareness.
South-South	Edo State	Benin	- Mixed urban-rural - Competitive elections - Resource-rich, diverse economy	Provides insights into addressing electoral competitiveness and transparency in a resource-rich region.
South West	Lagos State	Lagos City	- Urban focus, high tech adoption - Diverse population - Strong internet penetration	Explores optimization of election technologies in a high-tech, urban environment with scalability challenges.

Table 10

How The State Selection Ensures Representativeness

Criterion	**Explanation**	**States Representing This Criterion**
Geopolitical Coverage	Ensures regional diversity and captures unique electoral dynamics across Nigeria.	All six geopolitical zones are represented.
Urban-Rural Balance	Addresses both high-tech urban centers and low-tech rural areas.	Urban: Lagos, Abuja; Rural: Adamawa, Kaduna; Mixed: Edo, Imo.
Historical Relevance	Includes states with a history of electoral disputes, high turnout, or competitive elections.	Kaduna (disputes, e-voting test), Edo (competitive elections), Imo (high engagement).
Infrastructure Variability	Covers states with varying levels of technological readiness and infrastructure.	High: Lagos, Abuja; Moderate: Edo, Kaduna; Low: Adamawa.

Security and Stability	Examines how election technologies function in both stable and unstable environments.	Stable: Lagos, Abuja; Moderate: Edo, Kaduna; Unstable: Adamawa.
Socioeconomic Diversity	Ensures inclusivity by considering states with varying income levels, education, and demographics.	High income/education: Lagos, Abuja; Mixed: Edo, Kaduna; Low income/education: Adamawa.

Stage 4: Sample size determination

Using the Cochran sample size determination formula, the sample size for each city was calculated proportionally based on the city's number of voters in the most recent election. The total sample size of **400 respondents** was distributed as follows;

Table 11

Sample size

City	**Voters Population**	**Proportion**	**City sample size**
Yola	274,632	3.65%	15
Benin	269,519	3.58%	14
Abuja	1,790,656	23.80%	95
Owerri	284,865	3.79%	15
Kaduna	362,048	4.81%	19
Lagos	4,543,596	60.38%	242
Total population	7,525,317		
Percentage	3.65%		
Confidence level	95%		
Marginal error	5% (two sided 2.5%)		
Estimated size			**400**

10.6 Data Analysis Methods

This section outlines the statistical procedures employed to analyze the data collected from 550 respondents through the survey. The analysis was conducted using SPSS version 28 and R version 4.3.0, with results cross-validated between both software packages to ensure accuracy.

10.6.1 Overview of the Analytical Approach

The data analysis followed a systematic four-phase approach designed to comprehensively address the research questions while ensuring statistical rigor. The first phase involved data preparation and quality assurance, including data cleaning, missing value assessment, outlier detection, and variable recoding to prepare the dataset for analysis. The second phase focused on descriptive analysis to understand the distribution and characteristics of key variables, providing a foundation for more complex analyses. The third phase employed inferential statistics appropriate to each research question, with chi-square tests used for examining associations between categorical variables (RQ1 and RQ2), and regression analyses for investigating predictive relationships (RQ3 and RQ4).

The selection of statistical techniques was guided by several key considerations; the measurement level of variables (nominal, ordinal, or continuous), the specific requirements of each research question, the assumptions underlying different statistical tests, and the interpretability of results for stakeholders. For Research Questions 1 and 2, chi-square tests of independence were chosen over more complex ordinal regression models due to their straightforward interpretation and fewer assumptions. For Research Questions 3 and 4, regression analyses were employed to examine multiple predictors simultaneously, with ordinal regression used when the dependent variable was ordinal and binary logistic regression when it was dichotomous.

Throughout the analysis, emphasis was placed on both statistical significance and practical significance, with effect sizes reported alongside p-values to provide a more complete understanding of relationships. Multiple validation techniques were employed, including cross-validation between statistical software packages, assessment of statistical assumptions before each test, and sensitivity analyses to test the robustness of findings. This comprehensive approach ensured that the analysis was not only statistically sound but also meaningful for understanding the complex sociotechnical factors affecting election technology implementation in Nigeria.

10.6.2 Data Preparation and Cleaning

Prior to analysis, the following data preparation steps were undertaken;

1. **Data Import and Formatting**: The raw data was imported from CSV format, with variable names standardized to remove special characters and spaces that could interfere with analysis.
2. **Outlier Detection**: Univariate outliers were identified using boxplots.
3. **Variable Recoding**: Ordinal variables were recoded into numeric scales to facilitate analysis;

- Familiarity levels: 1 (Not Familiar) to 5 (Very Familiar)
- Trust levels: 1 (No Trust) to 5 (Complete Trust)
- Agreement scales: 1 (Strongly Disagree) to 5 (Strongly Agree)

10.6.3 Descriptive Statistical Analysis

Descriptive statistics were computed for all variables to understand the data distribution and central tendencies;

1. **Frequencies and Percentages**: Calculated for categorical and ordinal variables to show response distributions
2. **Measures of Central Tendency**: Mean, median, and mode for ordinal variables
3. **Measures of Dispersion**: Standard deviation and range for continuous variables
4. **Visual Representations**: Bar charts, pie charts, and histograms to illustrate distributions

10.6.4 Chi-Square Tests of Independence

For Research Questions 1 and 2, chi-square tests were employed to examine relationships between categorical variables. This approach was selected over ordinal regression based on;

1. **Simplicity of Interpretation**: Chi-square results are more straightforward to communicate to stakeholders
2. **Fewer Assumptions**: Avoiding the proportional odds and parallel lines assumptions required for ordinal regression
3. **Research Focus**: The primary interest was in associations rather than predictive modeling

The chi-square analysis used the formula;

$\chi 2=\sum E(O-E)2$

Where

- χ^2 = Chi-square statistic
- **O** = Observed frequency (actual count in each cell)
- **E** = Expected frequency (what we would expect if there were no relationship)
- **Σ** = Summation across all cells in the contingency table

10.6.5 Correlation Analysis

Spearman's rank correlation coefficient was used to examine relationships between ordinal variables, particularly for Research Question 2. This non-parametric measure was chosen because;

1. It is appropriate for ordinal data
2. It does not assume linear relationships
3. It is robust to outliers

10.6.6 Multicollinearity Assessment

Before conducting regression analyses for Research Questions 3 and 4, multicollinearity was assessed using;

1. **Correlation Matrix**: Examining Spearman correlations between predictor variables
2. **Tolerance Values**: Values below 0.1 would indicate problematic multicollinearity
3. **Variance Inflation Factor (VIF)**: Values above 10 would suggest multicollinearity issues

The analysis revealed no significant multicollinearity concerns, with all correlations below 0.8 and VIF values under 3.0.

10.6.7 Ordinal Regression Analysis

For Research Question 3, ordinal logistic regression (proportional odds model) was employed to examine factors affecting trust in election technology. This technique was appropriate because;

1. The dependent variable (trust) is ordinal
2. Multiple predictors needed to be examined simultaneously
3. The proportional odds assumption was tested and met

$$\log(P(Y>j)P(Y\leq j))=\theta j-(\beta 1X1+\beta 2X2+\cdots+\beta kXk)$$

Where

- $\log(P(Y\leq j)P(Y>j))\log(P(Y>j)P(Y\leq j))$ is the log-odds (logit) of the dependent variable being in category jj or below versus higher categories.
- $\theta j\theta j$ = threshold (also called the cutpoint) for category jj. Each threshold separates adjacent categories of the dependent variable.
- $\beta 1,\beta 2,...,\beta k\beta 1,\beta 2,...,\beta k$ = regression coefficients for the independent variables $X1,X2,...,XkX1,X2,...,Xk$.
- $P(Y\leq j)P(Y\leq j)$ = cumulative probability of being in category jj or below.
- $P(Y>j)P(Y>j)$ = cumulative probability of being in a category above jj.

10.6.8 Binary Logistic Regression

For Research Question 4, binary logistic regression was used to identify predictors of support for election technology implementation. The dependent variable was dichotomized (support vs. non-support) and the analysis included;

1. **Model Specification**: Entry method with theoretical predictors
2. **Goodness of Fit**: Hosmer-Lemeshow test
3. **Model Evaluation**: Cox & Snell R^2 and Nagelkerke R^2
4. **Classification Table**: Predicted vs. observed classifications
5. **Odds Ratios**: With 95% confidence intervals for interpretation

10.6.9 Multiple Response Analysis

For questions allowing multiple selections (e.g., policy recommendations, technology awareness), multiple response analysis was conducted;

1. Response frequencies for each option
2. Percentage of cases selecting each option
3. Cross-tabulation with demographic variables where relevant

10.6.10 Ethical Considerations in Data Analysis

The analysis adhered to ethical guidelines in the following way;

1. Respondent anonymity was maintained throughout
2. Data was reported in aggregate form only
3. No attempts were made to identify individual respondents

10.7 Document Analysis

I used Python to gather documents and perform Zero Shot Text Classification for the documents. Below are the processes I followed for the document analysis;

Step 1: Data Collection and Processing

In the data collection phase, I leveraged the Google Search API to collect documents on the socio-technical dynamics of election technology adoption in Nigeria, using keywords covering Election Technology and Infrastructure, Socio-Technical Dynamics and Adoption Challenges, Policy, Governance and Legal Framework, Technical Innovation and Security, and Stakeholders, Public Perception, and Engagement. The open ended responses from the survey were cleaned and added to generate a word map (figure 9,p.162). The responses were limited in both depth and volume, only 16% (91 out of 550 surveys) included open-text responses, which is insufficient for meaningful analysis.

Publicly available sources, including reports, academic publications, articles, and policy briefs, were queried. Filtering techniques were applied to prioritize high-quality sources while removing duplicates and low-quality content, then the collected data was structured for analysis.

The dataset was further refined from 1,910 documents to 284 relevant ones using Natural Language Processing (NLP) specifically Large Language Models (LLMs) to classify election-related content. Additionally, key themes were extracted for thematic and quantitative analysis.

Step 2: Natural Language Processing NLP and Thematic Analysis

I employed Facebook **BART-large-MNLI** for zero-shot classification, enabling automated document categorization into predefined socio-technical themes without labeled training data. It is transformer-based architecture, pre-trained on a diverse corpus and fine-tuned for classification, ensuring accurate text-to-category inference.

BART-large-MNLI's multi-label classification, robust generalization, and probability-based scoring allowed precise thematic mapping while maintaining efficiency. Trained on diverse text sources, it handled varied document formats, prioritizing high-relevance content and filtering out low-quality data for scalable classification.

To improve classification for lengthy documents, I integrated LangChain with TextSplitter, segmenting text into meaningful chunks to maintain context and reduce misclassification. LangChain facilitated sequential processing, aggregating chunk-level classifications into a comprehensive document-level theme assignment.

Each document was mapped to themes, Election Technology and Infrastructure, Socio-Technical Dynamics and Adoption Challenges, Policy, Governance and Legal Framework, Technical Innovation and Security, and Stakeholders, Public Perception, and Engagement with probability scores ensuring precise classification and minimal errors.

Zero-Shot Classification Formula

For multi-label zero-shot classification of election-related documents using **facebook/bart-large-mnli**, the formula is:

$$P\left(y_i|x\right) = \sigma\left(f_\theta\left(x, y_i\right)\right)$$

Where:

- x - is the input election-related document text
- y_i - is the assigned label *(e.g., Election Technology and Infrastructure,Policy, Governance and Legal Framework …etc)*
- $f_\theta\left(x, y_i\right)$ - is the entailment score given by the **facebook/bart-large-mnli** model.
- σ - is the sigmoid function that maps the score to a probability between 0 and 1, ensuring each label is independently classified.

Step 4: Quantitative and Qualitative Integration

Primary data insights were analyzed alongside document findings to identify patterns, alignments, and discrepancies, ensuring a comprehensive understanding of socio-technical dynamics by integrating statistical trends with contextual narratives

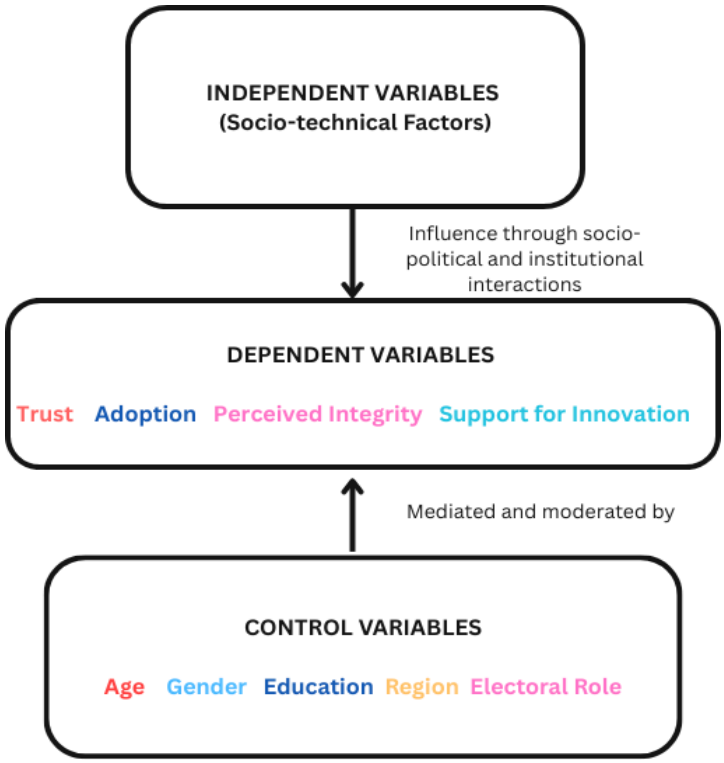
Step 5: Visualization & Reporting

To communicate insights from the document analysis, I employed word clouds, and bar charts to highlight key insights which further summarized the findings to provide a clear understanding and insights.

10.8 Hypotheses and Conceptual Framework

The conceptual framework emphasizes the interaction between technical systems (e.g., infrastructure, devices) and social systems (e.g., trust, culture, institutions, literacy) in shaping electoral technology adoption and effectiveness. The independent variables in this study are the socio-technical factors such as the awareness of election technologies, digital literacy, infrastructure availability, trust in institutions (INEC, judiciary, political actors), cultural beliefs and regional norms, political party influence and manipulation and stakeholder engagement (e.g., civil society, voter education).

The dependent variables in this research study are trust in election technologies, adoption/willingness to use election technologies, belief in technology's ability to reduce electoral fraud, perceived transparency of electoral process and support for emerging technologies. In addition, the control variables are the demographic variables such as Age, Gender, Education Level, Geopolitical Zone/Region, and Electoral Role (voter, official, observer, etc.). Below is the conceptual framework that logical expresses how the variables are connected and how it guides the hypotheses for the research study;



The hypotheses are;

Research Question 1: Technology Familiarity and Awareness

$H1_1$: There is a significant association between demographic characteristics (age, gender, education, electoral role) and familiarity with election technology in Nigeria.

$H1_{1a}$: Younger respondents have higher familiarity with election technology than older respondents.

$H1_{1\beta}$: There is no significant difference in election technology familiarity between male and female respondents.

$H1_{1\gamma}$: Higher educational attainment is associated with greater familiarity with election technology.

$H1_{1Q}$: Electoral role (voter, election official, civil society member, etc.) significantly influences familiarity with election technology.

Research Question 2: Trust and Effectiveness Perceptions

$H2_1$: There is a significant association between trust in election technologies and perceived effectiveness in reducing electoral fraud.
$H2_2$: Trust levels in election technology vary significantly across different demographic groups.
$H2_3$: Higher familiarity with election technology is positively correlated with trust in these systems.

Research Question 3: Sociotechnical Factors and Challenges

$H3_1$: Political influence on technology deployment negatively affects trust in election technologies.
$H3_2$: The perceived importance of voter education positively influences trust in election technologies.
$H3_3$: The frequency of technical failures is negatively associated with trust in election technologies.
$H3_4$: Cultural beliefs significantly impact the acceptance of election technologies.
$H3_5$: Rural accessibility challenges are associated with lower trust in election technologies.

Research Question 4: Policy Support and Implementation

$H4_1$: Trust in election technology is a significant predictor of support for technology implementation.
$H4_2$: Educational level positively influences support for election technology implementation.
$H4_3$: Belief in stakeholder co-creation processes positively affects support for election technology.
$H4_4$: Perceived government support is positively associated with overall support for election technology implementation.
$H4_5$: Experience with technical failures negatively influences support for continued technology implementation.

Null Hypotheses

For each alternative hypothesis above, the corresponding null hypothesis states that there is no significant relationship or association between the variables.

These hypotheses reflect the sociotechnical nature of the research, examining both technical factors (failures, accessibility) and social factors (trust, education, political influence) that affect election technology implementation in Nigeria.

10.9 Study Limitations

While this study provides critical insights into the socio-technical determinants of election technology adoption in Nigeria, several limitations must be acknowledged. The reliance on surveys and document analysis, though methodologically sound for broad trends, may lack the nuanced perspectives that interviews with key stakeholders like INEC technicians or political party operatives could have revealed, particularly on sensitive issues such as electoral manipulation. The forward-looking recommendations around blockchain and AI, though grounded in stakeholder aspirations, global trends and study respondents' suggestions assume significant improvements in Nigeria's digital infrastructure that may not materialize within the next decade due to fiscal or bureaucratic constraints. Additionally, the absence of direct engagement with INEC's technology teams limits insight into institutional capacity gaps.

10.10 Ethics in Data Collection

Ensuring ethical participation was paramount in this study, particularly given the sensitive political context surrounding Nigeria's electoral processes. All survey respondents were presented with a clear, upfront consent statement that explained the research objectives, how their data would be used, and their unconditional right to withdraw at any point without consequence. This transparency was crucial for building trust and encouraging honest responses. To further protect participants, the survey design deliberately avoided collecting any personally identifiable information (PII), guaranteeing complete anonymity. For document analysis, only publicly available reports and properly anonymized records were utilized, with no use of restricted or confidential materials. This approach not only complied with ethical research standards but also helped maintain the integrity of the study while safeguarding participant confidentiality in a high-stakes political environment.

10.11 Conclusion

This chapter has outlined the methodological approach adopted for this research study, which seeks to investigate the socio-technical factors influencing the adoption and integration of election technologies in Nigeria. The mixed-methods approach, underpinned by a pragmatic research philosophy, was chosen to provide a comprehensive understanding of the complex interplay between social, technical, and institutional factors in the Nigerian electoral context. By combining quantitative survey data with qualitative document analysis, this study captured both the measurable impacts of election technologies and the nuanced socio-technical dynamics that shape their effectiveness. The survey instrument was designed to gather data on key socio-technical dimensions, including awareness and adoption of technology, cultural and social factors, infrastructure readiness, and public trust in election technologies. The stratified random sampling strategy ensured a representative sample across Nigeria's six geopolitical zones, with a focus on states that have implemented election technologies in recent elections. The survey data analysis followed a systematic four-phase approach designed to comprehensively address the research questions while ensuring statistical rigor. The first phase involved data preparation and quality assurance, including data cleaning, missing value assessment, outlier detection, and

variable recoding to prepare the dataset for analysis. The second phase focused on descriptive analysis to understand the distribution and characteristics of key variables, providing a foundation for more complex analyses. The third phase employed inferential statistics appropriate to each research question, with chi-square tests used for examining associations between categorical variables (RQ1 and RQ2), and regression analyses for investigating predictive relationships (RQ3 and RQ4).

The document analysis, supported by Natural Language Processing (NLP) techniques, provided additional insights into the socio-technical challenges and opportunities associated with election technology adoption in Nigeria. By leveraging advanced NLP models like BART-large-MNLI, the study was able to classify and analyze a large corpus of documents, identifying key themes and trends related to election technology deployment. The findings from both the survey and document analysis will be integrated to provide a holistic understanding of the socio-technical dynamics at play in Nigerian elections. This approach not only enhances the validity of the findings through triangulation but also ensures that the research addresses both the technical and social dimensions of election technology adoption. In conclusion, the methodological framework adopted in this study is well-suited to address the research questions and objectives. By combining quantitative and qualitative methods, the study provides a robust foundation for understanding the socio-technical factors that influence the adoption and effectiveness of election technologies in Nigeria. The next chapter presents the data analysis and findings from the survey and document analysis, providing a detailed exploration of the socio-technical dynamics of election technology adoption in Nigeria.

CHAPTER 11

DATA ANALYSIS AND FINDINGS

11.0 Survey data

This chapter presents the data analysis and findings from this research study. The chapter first describes the findings from the survey, followed by the results of the document analysis.

11.0.1 Survey return rate

Table 10 below presents the survey return rate across the six States where the survey was administered.

Table 12

Survey return rate

City	**Target**	**Return**
Yola	15	68
Benin	14	54
Abuja	95	87
Owerri	15	87
Kaduna	19	45
Lagos	242	209
Total	**400**	**550**

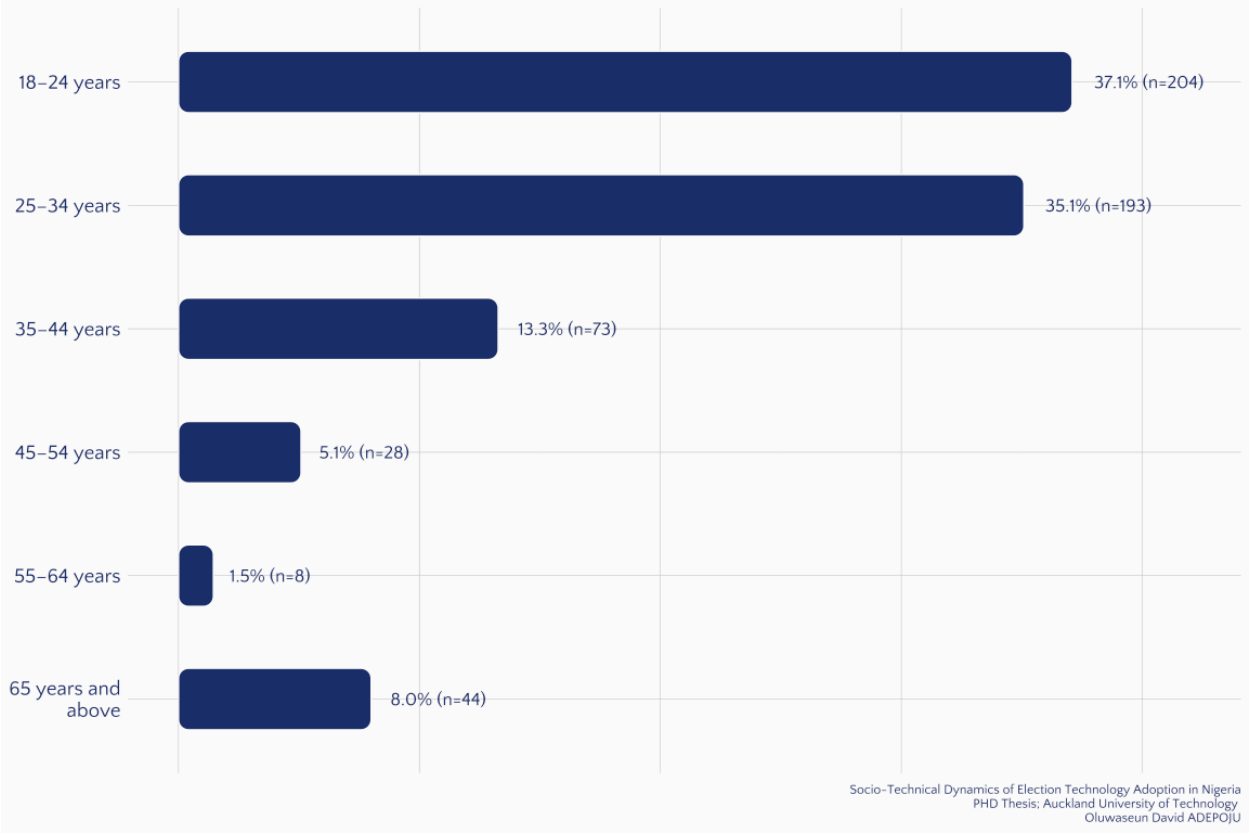
As the data in Table 12 indicates, the questionnaire proved to be a success as the overall return rate surpassed the expectations of the original sample plan. The online survey link was shared across diverse online public and private groups, combined with physical meetings.The additional data collected was analysed because it enhanced the generalisability of the data. Greater quantities of data lead to higher accuracy in results and greater generalisability, particularly with regards to predictive modelling (Sarndal et.al., 1992). The findings from the questionnaire are presented below.

11.0.2 Demographic data (age, gender and education)

(a) Age

Figure 2

The graph below indicates the participants' age in years

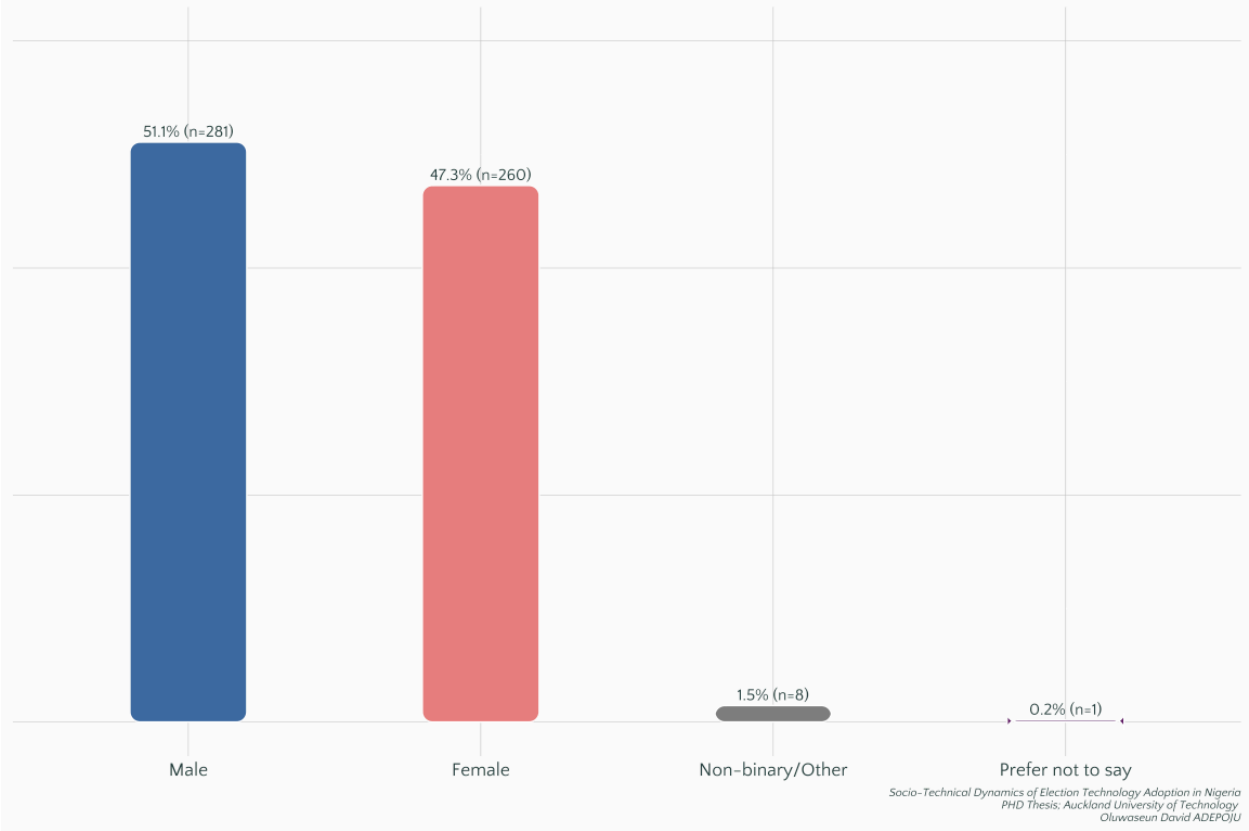


The data reveals that the majority of participants fall within the younger age brackets, with 37% (n=204) aged 18–24 years and 35% (n=193) aged 25–34 years, collectively accounting for over 72% of respondents. The middle-aged group, 35–44 years, represents 13% (n=73), while older demographics are significantly less represented, with 5% (n=28) aged 45–54 years, 1% (n=8) aged 55–64 years, and 8% (n=44) aged 65 years and above.

(b) Gender

Figure 3

The graph below indicates the distribution of the participant's gender.



The survey data reveals a nearly balanced gender distribution with 47.3% (n=260) female and 51.1% (n=281) male participants, indicating that the findings were fairly representative of both genders. The proportion of non-binary/other gender identities was very low (1.5%, n=8), and an even smaller percentage (0.2%, n=1) preferred not to disclose their gender.

(c) Cross Tabulation of Participant's Gender and Age

Table 13

Summary of the participant's age and gender

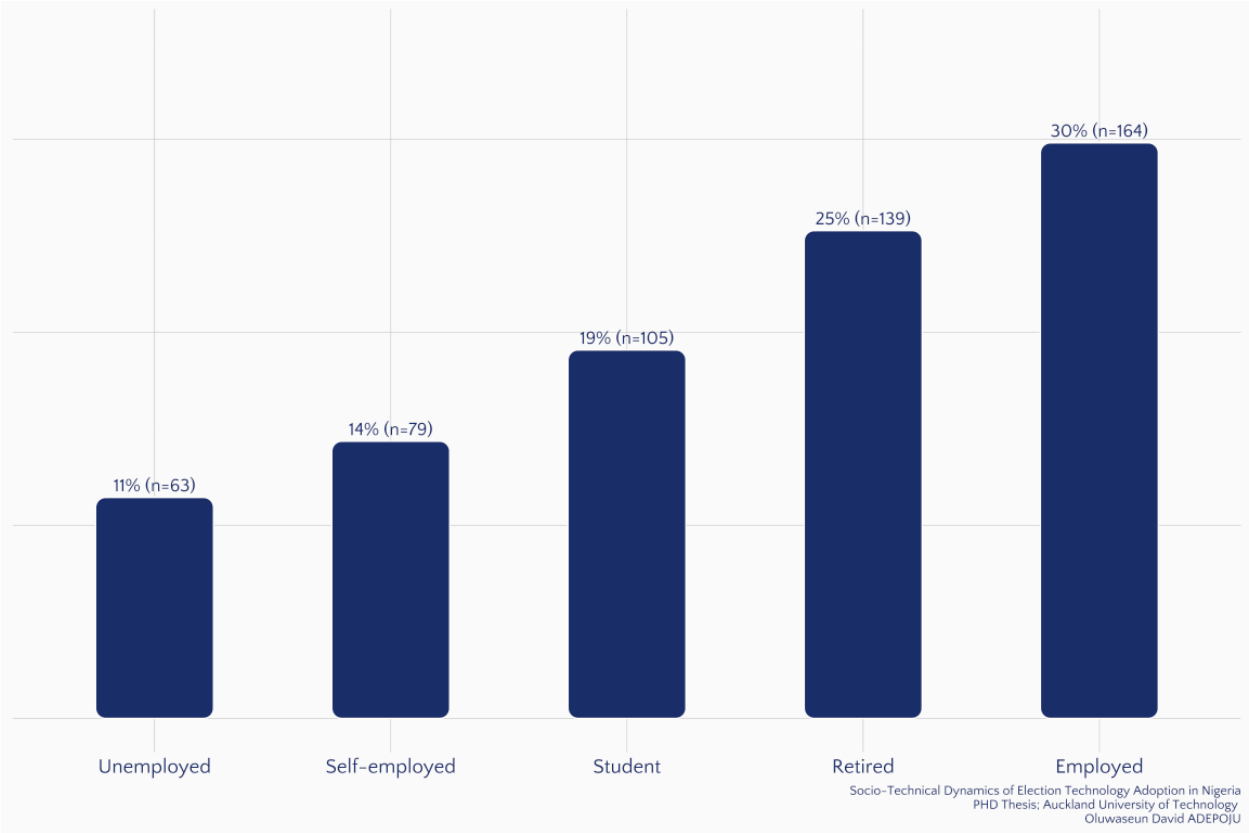
Gender	18–24 years	25–34 years	35–44 years	45–54 years	55–64 years	65 years and above
Male	47.06% (n=96)	51.81% (n=100)	57.53% (n=42)	42.86% (n=12)	62.50% (n=5)	59.09% (n=26)
Female	51.47% (n=105)	47.67% (n=92)	38.36% (n=28)	50.00% (n=14)	37.50% (n=3)	40.91% (n=18)
Non-binary/Other	1.47% (n=3)	0.52% (n=1)	2.74% (n=2)	7.14% (n=2)	0% (n=0)	0% (n=0)
Prefer not to say	0% (n=0)	0% (n=0)	1.37% (n=1)	0% (n=0)	0% (n=0)	0% (n=0)

The gender distribution reveals that males dominate in most age groups, particularly among 55–64 years (62.50%), 65 years and above (59.09%), 35-44 years (57.53%) and 24-35 years (51.81%), while females have higher representation in the 18–24 years group (51.47%) and reach parity at 45–54 years (50.00%). Non-binary/other participants have minimal representation overall, with the highest presence in the 45–54 years group (7.14%). One individual in the 35–44 years group preferred not to disclose their gender. These trends highlight male predominance in older age groups, relatively balanced gender representation in younger and middle-aged categories, and low visibility of non-binary/other identities.

(d) Occupation

Figure 4

Distribution of the participant's occupation.

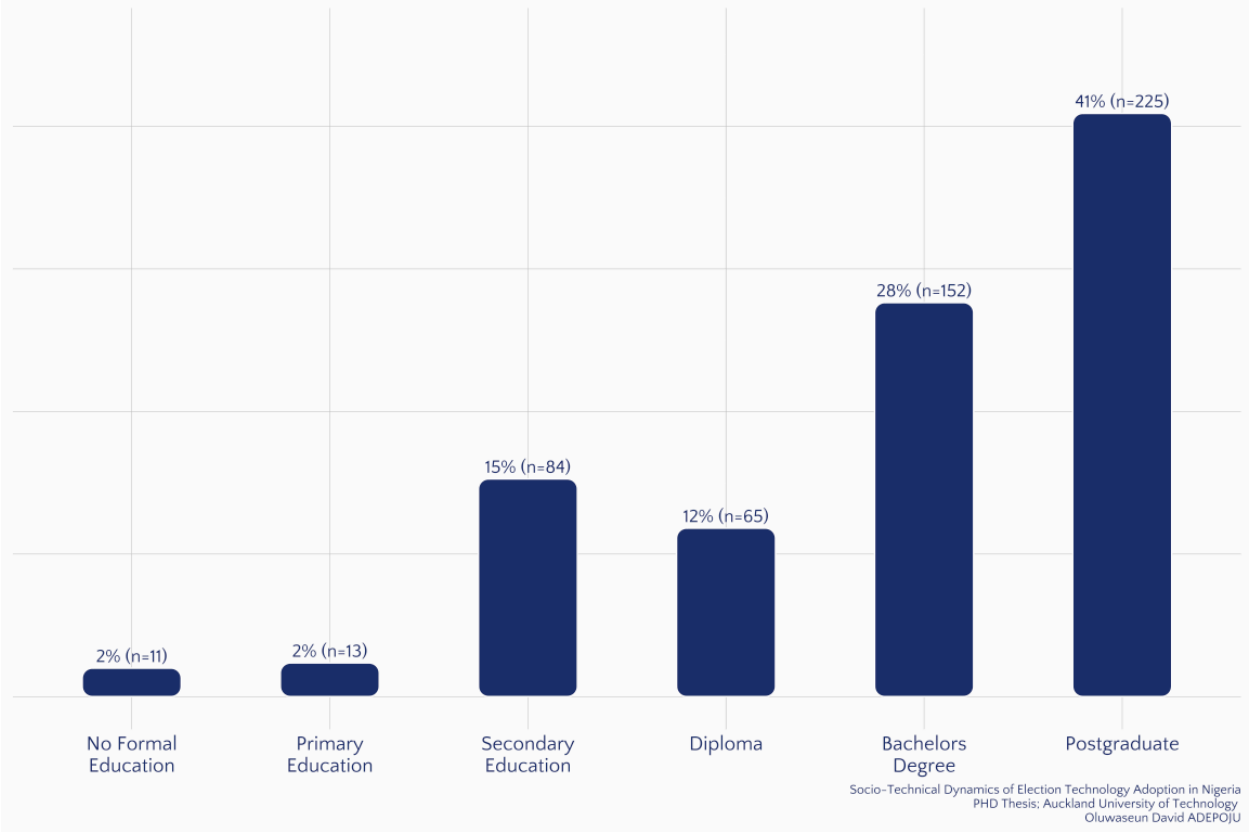


The occupation distribution of survey participants shows that the largest group is employed, making up 30%(n=164) of respondents, followed by retirees at 25% (n=139). Students represent 19% (n=105), while 14%(n=79) are self-employed and 11%(n=63) are unemployed suggesting a diverse range of participants with a significant proportion engaged in work or study, and a smaller, but notable, portion in self-employment and unemployment. Retirees make up a substantial segment, indicating a broad age representation in the survey.

(e) Educational Levels

Figure 5

Highest level of education attained by the participants.



The education levels of survey participants indicate that the majority have either a postgraduate degree (41%, n=225) or a bachelor's degree (28%, n=152), reflecting a highly educated sample. Secondary education follows at 15% (n=84), while diplomas account for 12% (n=65). A small portion of respondents have primary education (2, n=13%) or no formal education (2%, n=11) suggesting a predominantly well-educated group, with higher education being the most common level of attainment and minimal representation of individuals with lower education levels.

(f) Cross Tabulation of Highest Level of Education and Participants Gender

Table 14

Summary of education and participant's gender

Gender	No Formal Education	Primary Education	Secondary Education	Diploma	Bachelor's Degree	Postgraduate
Male	72.73% (n=8)	61.54% (n=8)	48.81% (n=41)	66.15% (n=43)	43.42% (n=66)	51.11% (n=115)

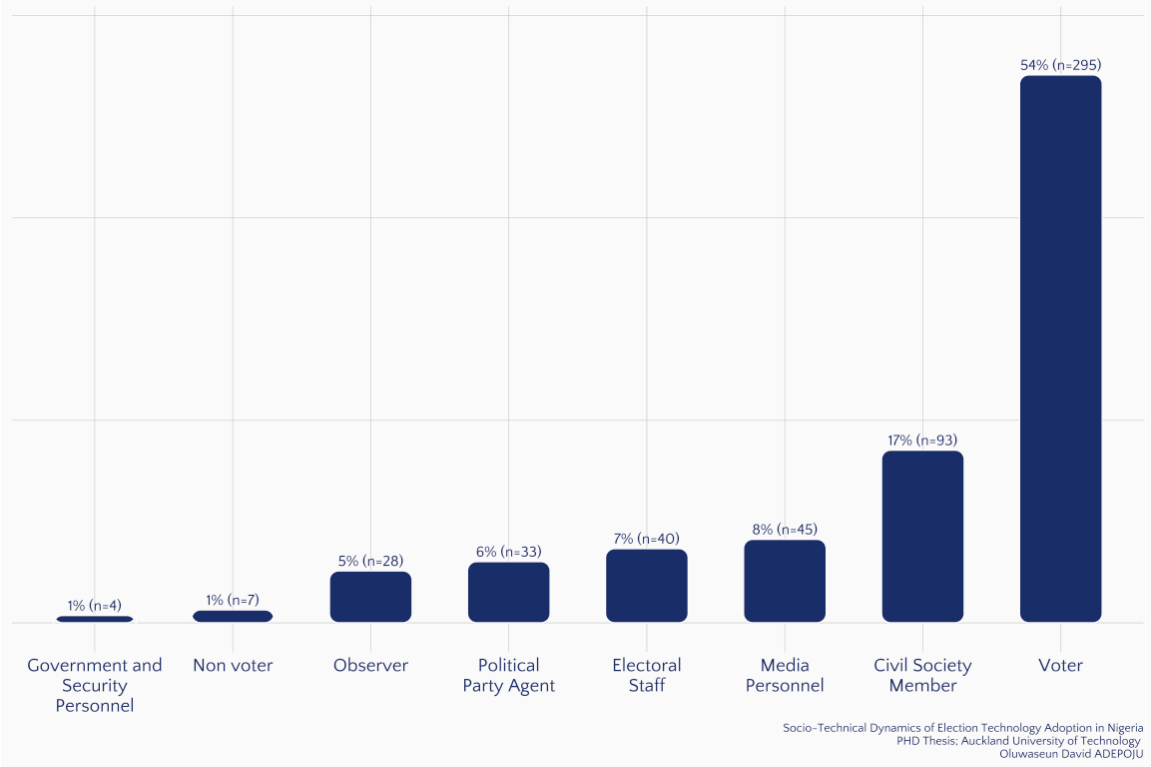
Gender	No Formal Education	Primary Education	Secondary Education	Diploma	Bachelor's Degree	Postgraduate
Female	27.27% (n=3)	30.77% (n=4)	50.00% (n=42)	33.85% (n=22)	55.92% (n=85)	46.22% (n=104)
Non-binary/Other	0% (n=0)	7.69% (n=1)	1.19% (n=1)	0% (n=0)	0.66% (n=1)	2.22% (n=5)
Prefer not to say	0% (n=0)	0% (n=0)	0% (n=0)	0% (n=0)	0% (n=0)	0.44% (n=1)

The distribution of education levels across genders shows that males are more represented in the highest education category, particularly in postgraduate (51.11%, n=115), while females have a slightly higher representation in bachelor's degrees (55.92%, n=85) and a notable presence in secondary education (50.00%, n=42). Males also dominate in the diploma category (66.15%, n=43). Non-binary/other participants are minimally represented, with the most notable presence in postgraduate education (2.22%, n=5) and primary as well as secondary education. Only one individual preferred not to disclose their education level, and a higher proportion of males have no formal education compared to females.

(g) Electoral Role

Figure 6

Distribution of electoral roles among participants.



The participants represent a diverse range of roles within the electoral process, with voters constituting the largest group (54%, n=295). Significant representation also comes from Civil Society Members (17%, n=93), Media Personnel (8%, n=45), and Electoral Staff (7%, n=40). The participation of Political Party Agents (6%, n=33) and Observers (5%, n=28) indicates a broad spectrum of engagement in the electoral process. However, the relatively low numbers of Non-voters (1%, n=7) and Government and Security Personnel (1%, n=4)

11.1 Awareness and Adoption of Technology in Nigerian Elections- Research Question 1

This section investigates respondents' familiarity with election technologies, a key socio-technical factor.

The table 15 presents participant responses on awareness and technology adoption, along with chi-square test statistics. These tests assess the significance of the association between awareness, technology adoption, and participant demographics.

11.1.1 Descriptive Statistics

To establish a baseline understanding of respondents' familiarity with election technology in Nigeria, descriptive statistics were calculated for the familiarity variable. This analysis provides initial insights into Research Question 1, offering a clear picture of how knowledgeable the sample population is regarding technological interventions in the electoral process. Table 15 presents the distribution of responses across the five-point familiarity scale, showing both the absolute frequencies and relative percentages. The cumulative percentage column helps identify threshold points in the distribution, allowing for interpretation of how many respondents fall below or above certain familiarity levels. These descriptive findings serve as a foundation for the subsequent inferential analyses and provide context for understanding the broader socio-technical dynamics of election technology awareness.

Table 15

Familiarity with Election Technology

Familiarity Level	***Frequency***	***Percentage***	***Cumulative %***
Not Familiar	*37*	*6.7%*	*6.7%*
Slightly Familiar	*103*	*18.7%*	*25.5%*
Moderately Familiar	*161*	*29.3%*	*54.7%*
Familiar	*193*	*35.1%*	*89.8%*
Very Familiar	*56*	*10.2%*	*100.0%*

Key Insight: The majority of respondents (74.6%) report moderate to very high familiarity with election technology, indicating substantial awareness of technological interventions in Nigeria's electoral process. Only 6.7% report complete unfamiliarity, suggesting successful initial penetration of election technology awareness. However, the relatively small proportion claiming to be "very familiar" (10.2%) indicates room for deeper engagement and education about these systems.

11.1.2 Chi-Square Analysis: Familiarity by Demographics

To examine the relationship between demographic characteristics and familiarity with election technology, chi-square tests of independence were conducted. This analysis addresses a key component of Research Question 1, investigating whether technology familiarity varies significantly across different demographic groups. Chi-square tests were selected as the appropriate statistical method because they allow for the examination of associations between categorical variables without requiring assumptions about the distribution of the data. The results presented in Table 16 reveal whether age, gender, education, and electoral role are significantly associated with respondents' self-reported familiarity with election technology in Nigeria.

Table 16

Chi-Square Test Results for Familiarity and Demographics

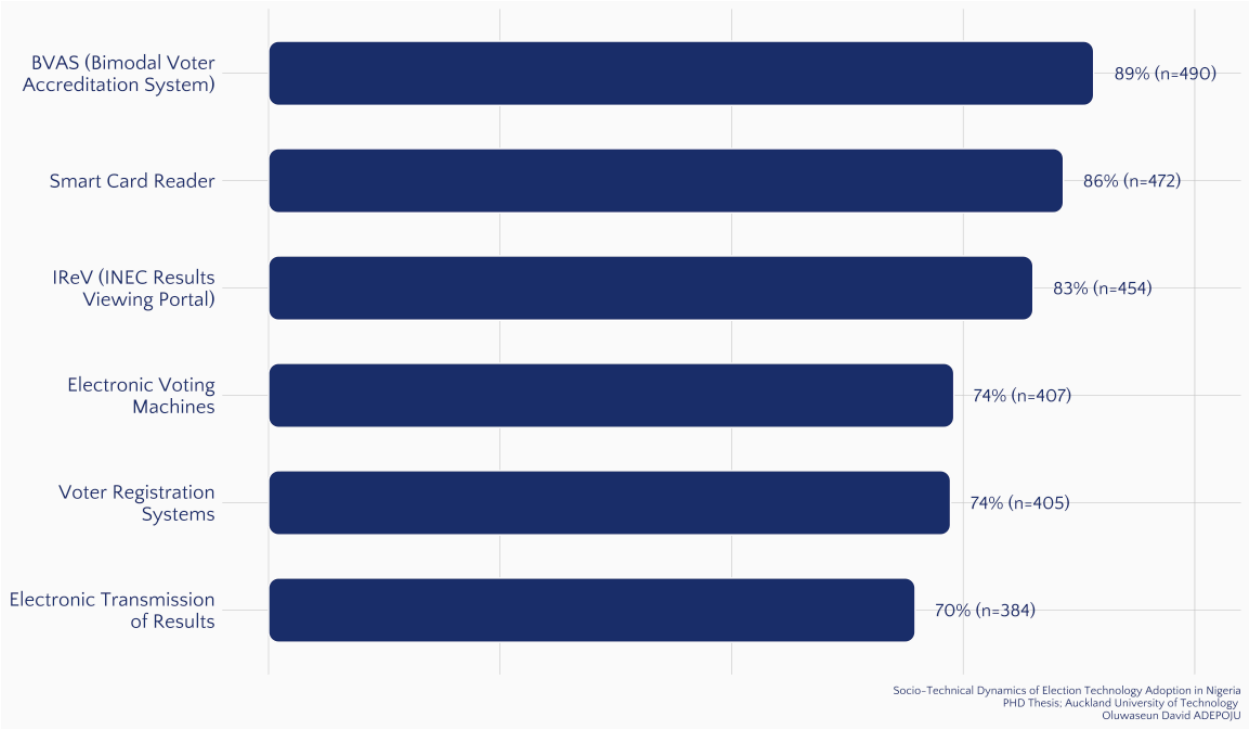
Variable	*χ^2*	*df*	*p-value*	*Interpretation*
Age	*67.432*	*20*	*<0.001*	*Significant association*
Gender	*18.765*	*12*	*0.094*	*No significant association*
Education	*103.219*	*28*	*<0.001*	*Significant association*
Electoral Role	*89.654*	*24*	*<0.001*	*Significant association*

Key Insight: Technology familiarity is significantly influenced by age, education, and electoral role, but not by gender. The strong association with education ($\chi^2 = 103.219$, $p < 0.001$) suggests that formal education plays a crucial role in technology comprehension. The lack of gender-based differences ($p = 0.094$) indicates equitable access to technology knowledge across genders. The significant association with electoral role reveals that those directly involved in election administration possess higher familiarity levels than general voters.

11.1.3 Specific Election Technology Awareness

Figure 7

Election technologies the participants are aware of



Participants demonstrated high awareness of key election technologies, with BVAS (Bimodal Voter Accreditation System) (89%, n=490) and Smart Card Readers (86%, 472) being the most recognized. IReV (INEC Results Viewing Portal) (83%, n=454) also had significant awareness. Electronic Voting Machines (74%, n=407) and Voter Registration Systems (74%, n=405) were moderately known, while Electronic Transmission of Results (70%, n=384) had the lowest awareness among the listed technologies suggesting a strong familiarity with accreditation and results management tools but highlight the need for awareness of electronic transmission processes. This insight confirms the recency of the electronic transmission in the 2023 general election.

11.2 Trust and Effectiveness Perception - Research Question 2

This section examines respondents' trust levels in election technologies, addressing a central component of Research Question 2 concerning perceptions of effectiveness and reliability. Trust represents a critical social dimension within the sociotechnical framework, potentially influencing adoption, acceptance, and perceived legitimacy of technological interventions in electoral processes. Table 17 presents the distribution of trust responses across five levels, from "No Trust" to "Complete Trust." The data provides a nuanced picture of public confidence in election technologies, offering insights into the extent to which stakeholders believe these systems can effectively perform their intended functions. These trust metrics serve as important dependent variables in subsequent analyses examining factors that influence confidence in election technology implementation in Nigeria.

Table 17

Trust Levels in Election Technologies

Trust Level	Frequency	Percentage
No Trust	39	7.1%
Low Trust	123	22.4%
Moderate Trust	258	46.9%
High Trust	114	20.7%
Complete Trust	16	2.9%

Key Insight: Trust in election technologies clusters around the moderate level (46.9%), with concerning levels of low or no trust among 29.5% of respondents. While 23.6% express high to complete trust, the predominance of moderate trust suggests cautious optimism rather than full confidence. The low percentage of complete trust (2.9%) indicates significant skepticism remains about the reliability and integrity of election technologies, highlighting the need for transparency and reliability improvements.

11.2.1 Cross-tabulation: Trust vs Fraud Reduction Perception

To investigate the relationship between trust in election technologies and perceptions of their effectiveness in reducing electoral fraud, a cross-tabulation analysis was conducted. This analysis directly addresses Research Question 2 by examining whether stakeholders who trust election technologies are more likely to believe they mitigate fraud, a key indicator of perceived effectiveness. Table 18 presents the contingency table showing how responses to trust levels correspond with beliefs about fraud reduction. Each cell contains both the absolute count and row percentage, allowing for comparison across different trust categories. This detailed breakdown reveals patterns of association between these two critical variables and forms the basis for the chi-square test of independence that follows. Understanding this relationship is essential for assessing whether trust and perceived effectiveness are mutually reinforcing or potentially disconnected in Nigeria's electoral technology landscape.

Table 18

Trust in Technology vs Perception of Fraud Reduction

Trust Level	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Row Total**
No Trust	9 (23.1%)	17 (43.6%)	11 (28.2%)	2 (5.1%)	0 (0.0%)	39
Low Trust	14 (11.4%)	30 (24.4%)	42 (34.1%)	33 (26.8%)	4 (3.3%)	123
Moderate Trust	7 (2.7%)	34 (13.2%)	87 (33.7%)	120 (46.5%)	10 (3.9%)	258
High Trust	6 (5.3%)	10 (8.8%)	21 (18.4%)	65 (57.0%)	12 (10.5%)	114
Complete Trust	2 (12.5%)	0 (0.0%)	1 (6.3%)	6 (37.5%)	7 (43.8%)	16
Column Total	38	91	162	226	33	550

Chi-square test: $\chi^2 = 153.847$, df = 16, $p < 0.001$

Key Insight: The highly significant association ($p < 0.001$) reveals a strong relationship between trust in technology and belief in its effectiveness for fraud reduction. Notably, 66.7% of those with no trust believe technology has not reduced fraud, while 67.5% of those with high trust

believe it has. This polarization suggests that trust and perceived effectiveness are mutually reinforcing: successful fraud reduction builds trust, while trust may influence perceptions of effectiveness. The moderate trust group shows the most balanced responses, with 46.5% agreeing that technology reduces fraud.

11.3 Socio-technical factors and challenges - Research Question 3

This section addresses Research Question 3: "What socio-technical factors influence the adoption and effectiveness of election technologies in Nigeria?" Drawing on the socio-technical systems framework, the analysis examines how social, political, cultural, and infrastructural factors interact with technical elements to shape the implementation and performance of election technologies. The socio-technical perspective recognizes that technology does not exist in isolation but is embedded within complex human and organizational contexts that significantly influence its effectiveness.

The following subsections explore five critical dimensions: political influence on technology deployment, cultural impact on technology acceptance, voter education importance, technical failures, and multiple regression analysis of factors affecting trust. Each dimension represents an important interface between technological systems and their social environment. By analyzing these factors, we gain a comprehensive understanding of the challenges and enablers affecting election technology adoption in Nigeria.

11.3.1 Political Influence on Technology Deployment

This sub-section examines respondents' perceptions regarding the extent to which political parties influence election technology deployment in Nigeria, addressing a key aspect of Research Question 3 concerning socio-technical factors affecting implementation. Political influence represents a critical institutional factor that may compromise the neutrality and effectiveness of election technologies. Table 19 presents the distribution of responses across five influence levels, from "No Influence" to "Very Strong Influence." The data provides valuable insights into stakeholders' perceptions of political interference in technological processes, which may significantly affect trust and acceptance. These findings contribute to understanding the political dimension of the sociotechnical framework and help identify potential barriers to effective technology deployment. The perceived degree of political influence serves as an important independent variable in subsequent analyses examining factors affecting trust in and support for election technologies.

Table 19

Perceived Political Party Influence

Influence Level	***Frequency***	***Percentage***
No Influence	*42*	*7.6%*
Low Influence	*91*	*16.5%*
Moderate Influence	*189*	*34.4%*
Strong Influence	*151*	*27.5%*
Very Strong Influence	*77*	*14.0%*

Key Insight: An overwhelming 75.9% of respondents perceive moderate to very strong political influence on technology deployment, with only 7.6% believing there is no influence. This widespread perception of political interference suggests concerns about the independence and neutrality of election technology implementation. The concentration of responses in the moderate to strong influence categories (61.9%) indicates this is not a fringe concern but a mainstream perception that could undermine public confidence in the electoral process.

11.3.2 Cultural Impact on Technology Acceptance

This section explores the perceived impact of cultural beliefs on election technology acceptance in Nigeria, contributing to our understanding of the socio-cultural dimension of Research Question 3. Cultural contexts significantly influence how new technologies are interpreted, adopted, and utilized within communities. Table 20 presents respondents' assessments of how cultural beliefs in their regions affect acceptance of election technologies, with responses ranging from "No Impact" to "High Impact." The data reveals the extent to which cultural factors may facilitate or impede technology adoption across different Nigerian communities. These findings are particularly valuable for understanding regional variations in technology acceptance and help identify where culturally sensitive implementation strategies may be necessary. The cultural impact variable represents an important social factor within the socio-technical framework that must be considered alongside technical specifications when designing effective election technology systems for Nigeria's diverse

Table 20

Cultural Beliefs Impact

Impact Level	Frequency	Percentage
No Impact	73	13.3%
Minimal Impact	124	22.5%
Moderate Impact	192	34.9%
Significant Impact	108	19.6%
High Impact	53	9.6%

Key Insight: Cultural factors show a nuanced influence on technology acceptance, with 64.1% reporting moderate to high impact. The relatively even distribution across impact levels suggests cultural considerations vary significantly by region or community. While 35.8% perceive minimal or no cultural barriers, the majority acknowledge some level of cultural influence, indicating the need for culturally sensitive implementation strategies that account for local beliefs and practices.

11.3.3 Importance of Voter Education

This section examines respondents' perceptions regarding the importance of voter education for successful election technology implementation, addressing a key educational component of Research Question 3. Voter education represents a critical social intervention that can bridge the gap between technical systems and user understanding, potentially facilitating adoption and proper usage. Table 21 presents the distribution of responses across five importance levels, from "Not Important" to "Very Important." The data provides insights into respondents' recognition of education's role in the socio-technical ecosystem surrounding election technologies. These findings help assess whether respondents view voter education as a peripheral consideration or an essential prerequisite for effective technology deployment. Understanding the perceived importance of voter education contributes to developing comprehensive implementation strategies that address both technical capabilities and user preparation, ultimately enhancing the likelihood of successful technology adoption across Nigeria's diverse electoral landscape.

Table 21

Voter Education Importance

Importance Level	Frequency	Percentage
Not Important	8	1.5%
Slightly Important	21	3.8%
Moderately Important	76	13.8%
Important	145	26.4%
Very Important	300	54.5%

Key Insight: There is overwhelming consensus on the critical role of voter education, with 80.9% rating it as important or very important. The majority (54.5%) consider it "very important," indicating strong recognition that technology adoption requires comprehensive education programs. Only 5.3% view it as slightly or not important, suggesting near-universal acknowledgment that successful technology implementation depends on informed users. This finding emphasizes the need for substantial investment in voter education initiatives.

11.3.4 Technical Challenges

This section investigates the frequency of technical failures during elections, addressing the technical infrastructure component of Research Question 3. Technical reliability represents a fundamental aspect of the socio-technical framework, as system failures can undermine trust and effectiveness regardless of social acceptance. Table 22 presents respondents' observations of technical failure frequency, with categories ranging from "Never" to "Very Often." The data provides crucial insights into the operational reliability of election technologies as experienced by stakeholders across Nigeria. These findings help quantify the extent of technical challenges and establish whether failures represent isolated incidents or systemic issues. Understanding the prevalence of technical failures contributes to identifying infrastructure gaps and maintenance needs, which are essential considerations for enhancing the performance and credibility of election technologies. The reported failure frequencies serve as an important indicator of current technical readiness and highlight areas requiring improvement within Nigeria's election technology ecosystem.

Table 22

Frequency of Technical Failures

Frequency	Count	Percentage
Never	31	5.6%
Rarely	89	16.2%
Occasionally	207	37.6%
Often	165	30.0%
Very Often	58	10.5%

Key Insight: Technical failures are a significant concern, with 78.1% of respondents reporting failures occur occasionally to very often. The concentration of responses in the "occasionally" (37.6%) and "often" (30.0%) categories reveals systemic reliability issues. Only 21.8% report failures as rare or never occurring, indicating that technical instability is a widespread experience rather than isolated incidents. This high failure rate directly impacts trust and effectiveness perceptions, highlighting the urgent need for improved technical infrastructure and maintenance.

11.3.5 Multiple Regression Analysis: Factors Affecting Trust

This section presents an ordinal regression analysis examining how multiple socio-technical factors simultaneously influence trust in election technologies, providing comprehensive insights for Research Question 3. Ordinal regression was selected as the appropriate statistical method due to the ordinal nature of the dependent variable (trust levels) and the need to control for multiple predictors concurrently. Table 23 displays the regression coefficients, significance tests, and odds ratios for key predictor variables, including political influence, voter education importance, and technical failure frequency.

The analysis quantifies the relative impact of each factor while controlling for others, allowing for identification of the most influential determinants of trust. The odds ratios provide interpretable measures of effect size, indicating how changes in each predictor affect the likelihood of higher trust levels. The model fit statistics assess the overall explanatory power of the socio-technical factors examined. This multivariate approach moves beyond bivariate associations to develop a more nuanced understanding of how various factors interact within Nigeria's election technology ecosystem, providing an empirical foundation for prioritizing interventions to enhance trust and effectiveness.

Table 23

Ordinal Regression Results - Predictors of Trust

Predictor	**Estimate**	**Std. Error**	**Wald**	**p-value**	**Odds Ratio**
Political Influence (Low vs None)	-0.452	0.183	6.102	0.013	0.637
Political Influence (Moderate vs None)	-0.891	0.165	29.141	<0.001	0.410
Political Influence (Strong vs None)	-1.342	0.174	59.586	<0.001	0.261
Political Influence (Very Strong vs None)	-1.876	0.201	87.123	<0.001	0.153
Voter Education (Important vs Not Important)	0.613	0.178	11.856	0.001	1.846
Voter Education (Very Important vs Not Important)	0.982	0.171	32.941	<0.001	2.670
Technical Failures (Rarely vs Never)	0.523	0.245	4.558	0.033	1.687
Technical Failures (Occasionally vs Never)	-0.218	0.229	0.908	0.341	0.804
Technical Failures (Often vs Never)	-0.789	0.234	11.379	0.001	0.454
Technical Failures (Very Often vs Never)	-1.456	0.269	29.295	<0.001	0.233

Model Fit Statistics:

- -2 Log Likelihood: 1342.567
- Chi-square: 198.432, df = 15, $p < 0.001$
- Pseudo R^2 (Nagelkerke): 0.312

Key Insight: The ordinal regression model reveals that political influence is the strongest negative predictor of trust, with those perceiving very strong influence having 85% lower odds of higher trust (OR = 0.153). Conversely, voter education importance shows a strong positive effect, with those rating it very important having 167% higher odds of increased trust (OR = 2.670). Technical failure frequency also significantly impacts trust, with frequent failures reducing trust odds by 77% (OR = 0.233). These findings underscore that building trust requires addressing political interference, investing in education, and improving technical reliability.The

Nagelkerke pseudo R^2 value of 0.312 demonstrates a good fit for our logistic regression model, as it falls solidly within the range of 0.2 to 0.4 that researchers typically considered indicative of substantial explanatory power according to McFadden's guidelines for interpreting pseudo R^2 values in categorical outcome models.

11.4 Policy Support and Implementation - Research Question 4

This section addresses Research Question 4: "What evidence-based, socio-technical guidelines can be developed for Nigerian policymakers and election stakeholders to optimize the deployment and use of technology in the electoral process, considering both local and global best practices?" The analysis examines current policy environments, stakeholder perceptions of government support, co-creation processes, and factors predicting technology implementation support. Understanding these elements is essential for developing actionable, context-appropriate recommendations.

The following subsections explore stakeholders' assessments of existing policy frameworks, perceptions of government commitment, beliefs about inclusive design processes, and the factors that predict support for technology implementation. By identifying policy strengths, gaps, and determinants of support, this analysis provides the empirical foundation necessary for formulating evidence-based guidelines that balance technical possibilities with social realities.

This investigation synthesizes insights from both descriptive and inferential statistics to generate a comprehensive understanding of the policy landscape surrounding election technology. The findings directly inform the recommendations presented in Chapter 6, ensuring that proposed guidelines are grounded in empirical evidence rather than aspirational ideals. This approach recognizes that effective policy must be responsive to Nigeria's unique socio-technical context while incorporating applicable global best practices in election technology implementation.

11.4.1 Government Support and Perception

This section examines respondents' perceptions regarding the adequacy of government support for election technology implementation, addressing a key policy dimension of Research Question 4. Government commitment and resource allocation represent critical enablers for successful technology deployment in electoral processes. Table 24 presents the distribution of responses to whether the government provides sufficient support, ranging from "Strongly Disagree" to "Strongly Agree." The data offers valuable insights into stakeholders' assessments of current government efforts and resource allocation for election technologies. These perceptions help identify potential policy gaps between government initiatives and stakeholder expectations. Understanding the perceived level of government support contributes to formulating realistic policy recommendations that account for current institutional capacities and commitment levels. These findings serve as an important baseline for developing guidelines that can effectively

bridge the gap between existing support structures and the resources required for optimal technology implementation in Nigeria's electoral system.

Table 24
Government Support for Election Technology

Response	Frequency	Percentage
Strongly Disagree	89	16.2%
Disagree	178	32.4%
Neutral	147	26.7%
Agree	108	19.6%
Strongly Agree	28	5.1%

Key Insight: Government support for election technology is perceived as inadequate by the majority, with 48.6% disagreeing that sufficient support exists and only 24.7% agreeing. The high proportion of neutral responses (26.7%) suggests uncertainty or lack of information about government efforts. This widespread perception of insufficient support indicates a critical gap in policy implementation and resource allocation that could hinder the successful deployment and maintenance of election technologies.

11.4.2 Co-creation Process Assessment

This section investigates respondents' perceptions regarding the extent to which election technology in Nigeria was developed through a co-creation process involving various stakeholders, addressing the participatory dimension of Research Question 4. Co-creation and stakeholder involvement represent key principles in socio-technical approaches to technology development, potentially enhancing relevance, acceptance, and effectiveness. Table 25 presents responses to whether respondents believe current technologies were designed without adequate stakeholder participation, with options ranging from "Strongly Disagree" to "Strongly Agree." The data provides critical insights into perceived inclusivity of technology design processes and the degree to which diverse stakeholder perspectives have been incorporated. These findings help assess the gap between socio-technical best practices emphasizing participatory design and the reality of technology development in Nigeria's electoral context. Understanding stakeholder perceptions of co-creation processes contributes to formulating policy recommendations that promote more inclusive, responsive, and contextually appropriate technology design approaches for future electoral innovations.

Table 25

Stakeholder Co-creation in Technology Design

Response	Frequency	Percentage
Strongly Disagree	41	7.5%
Disagree	112	20.4%
Neutral	168	30.5%
Agree	171	31.1%
Strongly Agree	58	10.5%

Key Insight: Opinion is divided on whether election technology design involved adequate stakeholder co-creation, with 41.6% agreeing it did not, 27.9% disagreeing, and 30.5% remaining neutral. This split, combined with the large neutral response, suggests either limited awareness of the design process or mixed experiences across different regions. The perception among a plurality that co-creation was insufficient points to a need for more transparent and inclusive technology development processes that actively involve diverse stakeholders.

11.4.3 Policy Recommendations (Multiple Response)

This section presents respondents' views on necessary policy changes to improve election technology implementation in Nigeria, providing direct stakeholder input for Research Question 4. Understanding stakeholder priorities is essential for developing evidence-based guidelines that address the most pressing concerns. Table 26 displays the multiple-response results showing support for various policy interventions, with respondents able to select multiple options they deemed important. The percentage figures indicate the proportion of respondents endorsing each policy change, revealing clear priority patterns. These findings provide valuable insights into stakeholder preferences regarding resource allocation, capacity building, security measures, and governance structures for election technologies. By identifying which policies receive the strongest stakeholder support, this analysis helps prioritize recommendations and ensures that proposed guidelines align with stakeholder expectations. The multiple-response format captures the multi-faceted nature of policy needs, recognizing that effective implementation likely requires coordinated interventions across several domains rather than singular policy changes.

Table 26

Necessary Policy Changes

Policy Change	Frequency	Percentage*
Increased funding for technology infrastructure	412	74.9%
Comprehensive voter education programs	389	70.7%
Stronger cybersecurity measures	367	66.7%
Regular technology audits	342	62.2%
Multi-stakeholder participation in design	298	54.2%
Legal framework updates	287	52.2%
Technical support in rural areas	401	72.9%

*Percentages do not sum to 100% as respondents could select multiple options

Key Insight: Policy priorities clearly cluster around infrastructure and capacity building, with increased funding (74.9%), rural technical support (72.9%), and voter education (70.7%) emerging as top priorities. The high support for cybersecurity measures (66.7%) reflects awareness of digital threats. Notably, all policy options received majority support (>50%), indicating comprehensive reform is desired rather than isolated interventions. The emphasis on rural support highlights recognition of the digital divide as a critical challenge in election technology implementation.

11.4.4 Logistic Regression: Factors Predicting Support for Technology

This section presents a binary logistic regression analysis examining the factors that predict stakeholder support for election technology implementation, providing crucial insights for Research Question 4. Understanding what drives support is essential for developing policy guidelines that can generate broad-based stakeholder buy-in. Table 27 displays the regression coefficients, significance tests, and odds ratios (Exp(B)) for key predictor variables, including trust levels, educational attainment, co-creation beliefs, and rural accessibility perceptions.

The analysis identifies which factors most significantly influence the likelihood of supporting election technology, while controlling for other variables. The odds ratios provide interpretable measures of effect size, indicating how changes in each predictor affect the probability of technology support. The model fit statistics assess the overall explanatory power of the included predictors. This multivariate approach enables the identification of leverage points for building stakeholder support, informing policy recommendations that address key determinants of acceptance. By empirically establishing which factors most strongly predict support, this analysis helps prioritize interventions that can generate the stakeholder backing necessary for successful technology implementation in Nigeria's electoral context.

Table 27

Binary Logistic Regression - Predictors of Technology Support (N = 420)

Predictor	**B**	**S.E.**	**Wald**	**p-value**	**Exp(B)**
Constant	-2.341	0.512	20.901	<0.001	0.096
Trust (Moderate vs low)	0.892	0.234	14.523	<0.001	2.440
Trust (High vs low)	1.456	0.267	29.743	<0.001	4.289
Education (Bachelor's vs Diploma/Lower)	0.678	0.298	5.175	0.023	1.970
Education (Master's+ vs Diploma/Lower)	0.913	0.289	9.982	0.002	2.492
Co-creation belief	0.567	0.189	9.001	0.003	1.763
Rural accessibility	0.445	0.198	5.055	0.025	1.561

Note: The reference category for *Trust* is **Low**, and for *Education* is **Diploma or Lower**. Odds ratios for other categories are interpreted relative to these reference categories.

Model Summary;

- Cox & Snell R^2: 0.238
- Nagelkerke R^2: 0.329
- Hosmer-Lemeshow Test: $\chi^2 = 7.234$, $p = 0.511$ (good fit)

Key Insight: The logistic regression model successfully identifies key predictors of technology support, explaining 32.9% of variance (Nagelkerke R^2). Trust emerges as the strongest predictor, with high trust increasing the odds of support by 329% (OR = 4.289). Education also plays a

crucial role, with master's degree holders having 149% higher odds of support. The significant effects of co-creation belief (OR = 1.763) and rural accessibility (OR = 1.561) highlight that support depends on both inclusive design processes and equitable access. These findings suggest that building support requires a multi-faceted approach addressing trust, education, participation, and accessibility.

11.5 Document Analysis

To communicate insights from the document analysis on the socio-technical dynamics of election technology adoption in Nigeria, I employed word clouds, and bar charts to highlight key insights to summarize the findings to provide a clear understanding. The gathered documents, publications/articles on technology adoption in the Nigerian election were published between the years 2002 and 2025 (Linked in Annex). The documents used for the analysis in this study were carefully chosen to provide a comprehensive and balanced view of how technology is adopted and integrated into Nigeria's electoral processes. The selection process focused on relevance, credibility, and the need to reflect diverse perspectives.

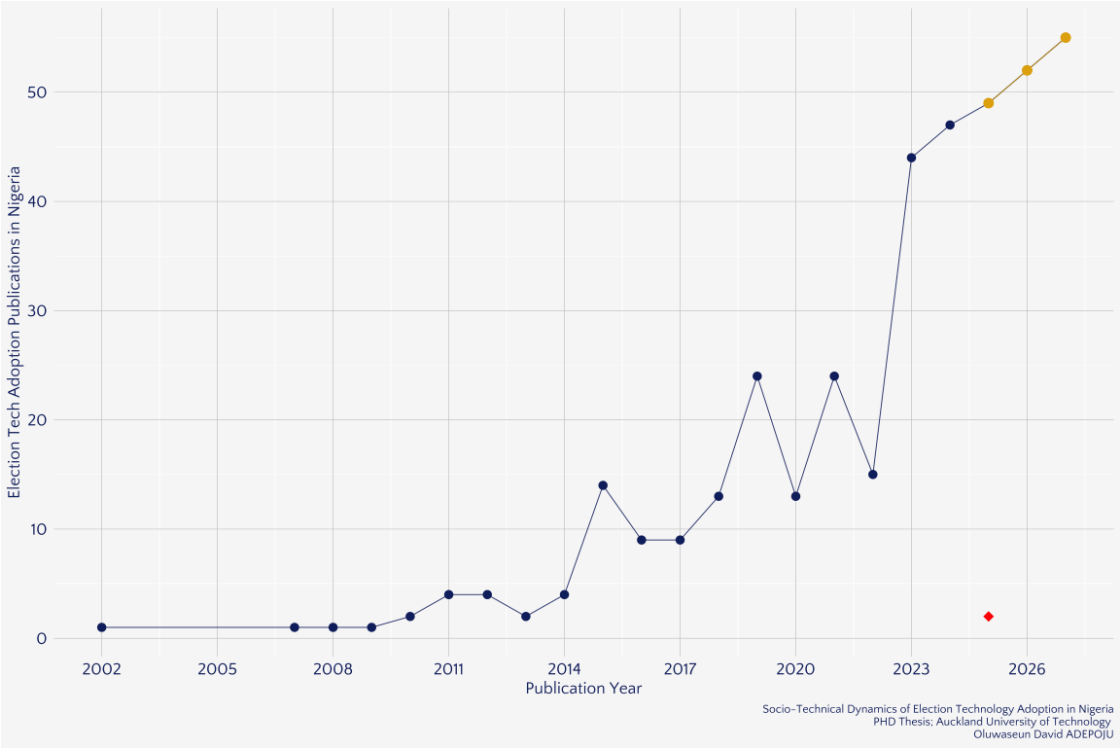
The list included academic journal articles written by Nigerian scholars. These works were essential because they provide context-specific insights into the realities of Nigeria's electoral system, cultural dynamics, and infrastructural challenges. They bring an indigenous understanding of issues that external perspectives might overlook.

In addition, the list incorporated academic publications by foreign authors who have written about Nigerian elections and the use of technology. These works were selected because they often apply comparative or theoretical frameworks, which help situate Nigeria's experience within a broader global conversation on technology and democratic processes.

Also, the analysis included reports and policy documents from both international and local organizations involved in elections and governance. These reports produced by credible institutions such as IFES, ECES, and election monitoring groups, provided empirical data and practical assessments based on firsthand observation of election technology deployment in Nigeria. The inclusion of these three categories of documents allowed for a triangulation of data, combining academic research with policy and practitioner perspectives. Selection criteria included relevance to election technology in Nigeria, credibility of the source, publication within a reasonable time frame to capture contemporary debates, and accessibility for full content review. This approach ensured that the document analysis was holistic, contextually grounded, and theoretically informed.

Figure 8

Trend in Publication on technology adoption in Nigerian elections (2002 - 2026)



There has been a general upward trend in discussions about election technology in Nigeria since 2008, reaching a peak of 47 publications in 2024. This trend, however, follows a cyclical pattern, with the number of publications increasing in the lead-up to elections and decreasing afterward. Before 2011, there were very few publications on the topic. Interest began to grow steadily in 2015, coinciding with the introduction of biometric verification systems.

The discourse gained significant momentum in 2019 and peaked in 2023, fueled by debates around electronic voting and electronic transmission of election results. While a decline in publications was initially observed in 2025, projections using the ARIMA model indicate a rebound, with an expected 49 publications by the end of 2025, 52 in 2026, and 55 in 2027. This anticipated increase reflects growing engagement across various sectors, including media, academia, policymaking, and public discourse, as the 2027 elections approach.

11.5.1 Natural Language Processing and Thematic Analysis

The word plot below represents binary keywords extracted from the focus areas for the articles and publications.

Figure 9

Binary Keywords extracted from the documents

The publications focus on the intersection of electoral processes, technology adoption, and political dynamics in Nigeria. They explore the impact of electronic voting technologies like the Bimodal Voter Accreditation System (BVAS) on election credibility, transparency, and voter participation. Key discussions include electoral integrity, legal frameworks, cybersecurity, and social media's role in political engagement and misinformation. The publications highlight challenges such as infrastructure deficits, voter apathy, and trust in electoral bodies, while also emphasizing reforms, stakeholder collaboration, and emerging technologies like blockchain and AI. Ultimately, the publications underscore the need for technological advancements, robust policies, and inclusive governance to ensure credible and participatory elections.

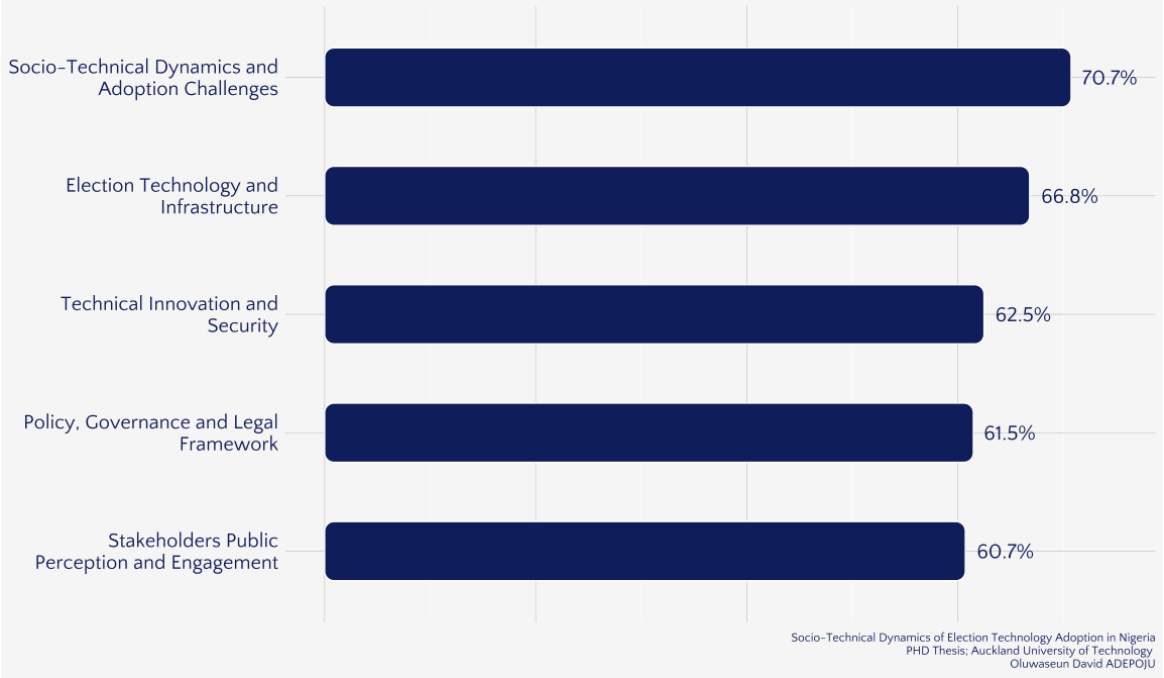
In the next phase, I employed the zero-shot classification on the document's text to classify the documents in the following categories;

- Election Technology and Infrastructure
- Socio-Technical Dynamics and Adoption Challenges
- Policy, Governance, and Legal Framework
- Technical Innovation and Security
- Stakeholders, Public Perception, and Engagement

The following graph highlights the overall scores for the documents based on the labels provided.

Figure 10

Overall scores on labels category



Analyzing the Socio-Technical Dynamics of Election Technology Adoption in Nigeria reveals that socio-technical dynamics and adoption challenges (70.7%) are the most significant factor(s), indicating major socio-technical barriers to election adoption in Nigeria. Election technology and infrastructure (66.8%) follow closely, emphasizing system readiness and reliability concerns. Technical innovation and security (62.5%) highlight the need for stronger safeguards against potential risks. Policy, governance, and legal frameworks (61.5%) play a crucial role in shaping adoption, while stakeholder perception and engagement (60.7%) underscore the importance of public trust and participation in making election technology a success in the country.

I explored each key thematic area in detail to understand the various factors influencing them in the paragraphs that follows.

11.5.2 Thematic Area 1: Elections Technology and Infrastructure

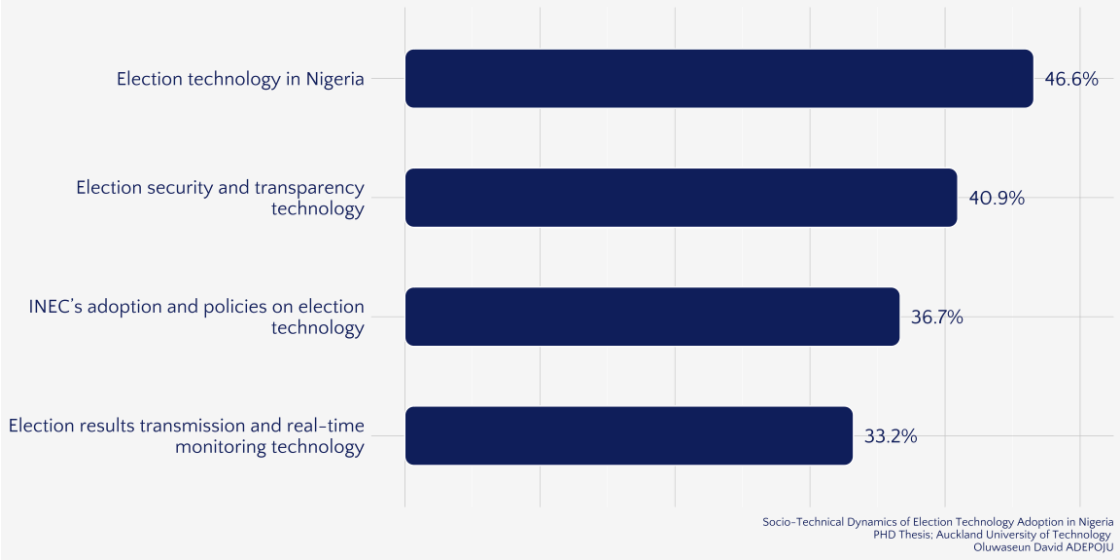
The section below covers the election technology and infrastructure with the following subsections;

- Election technology in Nigeria
- Election security and transparency technology
- INEC's adoption and policies on election technology

- Election results transmission and real-time monitoring technology

Figure 11

Elections Technology and Infrastructure thematic classifications



Analyzing Election Technology and Infrastructure in Nigeria highlights key challenges and developments. Election technology adoption (46.6%) is the most prominent issue, indicating ongoing efforts to integrate digital solutions into the electoral process. Security and transparency technology (40.9%) follow closely, reflecting concerns over safeguarding election integrity. INEC's adoption and policies (36.7%) play a critical role in shaping the implementation and regulation of election technologies. Election results transmission and real-time monitoring (33.2%) rank lowest, suggesting gaps in efficiency and reliability.

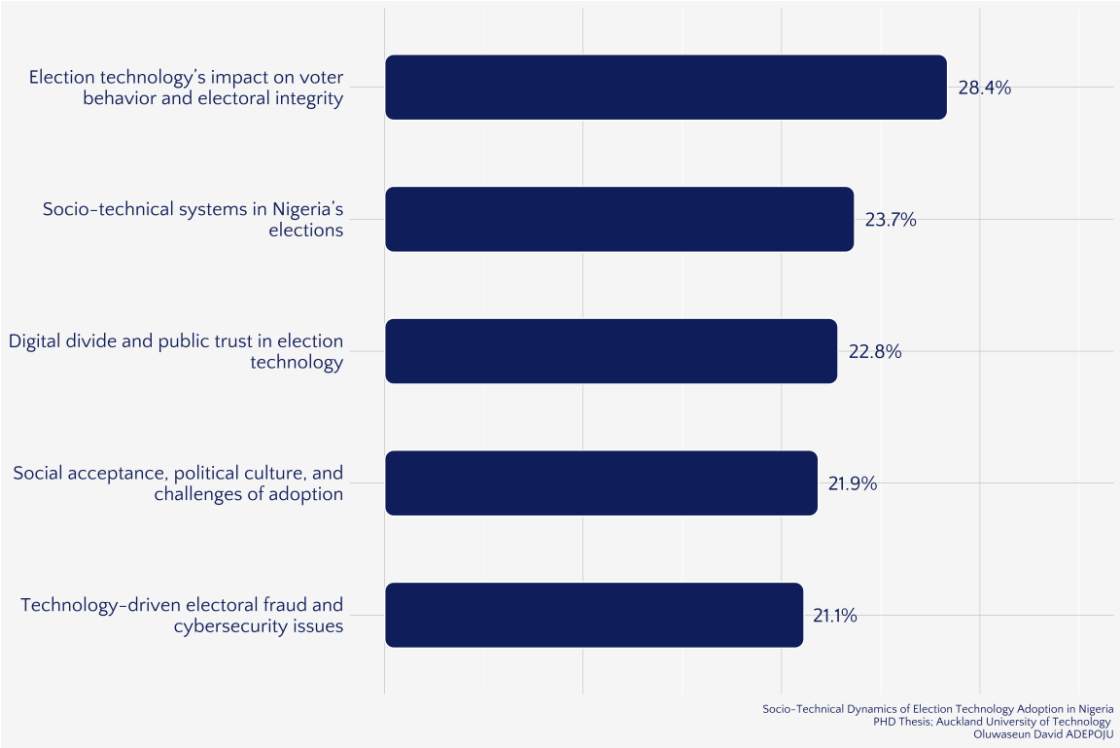
11.5.3 Thematic Area 2: Socio-Technical Dynamics and Adoption Challenges

The following section covers socio-technical dynamics and adoption challenges with the following pointers;

- Socio-technical systems in Nigeria's elections
- Election technology's impact on voter behavior and electoral integrity
- Digital divide and public trust in election technology
- Social acceptance, political culture, and challenges of adoption
- Technology-driven electoral fraud and cyber-security issues

Figure 12

Socio-Technical Dynamics and Adoption Challenges thematic classifications



The analysis of Socio-Technical Dynamics and Adoption Challenges in Nigeria's elections reveals key factors affecting election technology implementation. The impact on voter behavior and electoral integrity (28.4%) is the most significant concern, highlighting how technology influences participation and trust. Socio-technical systems (23.7%) reflect the interaction between technology and human elements in the electoral process. The digital divide and public trust (22.8%) indicate disparities in access and skepticism toward election technology. Social acceptance, political culture, and adoption challenges (21.9%) underscore resistance due to political and societal factors. Lastly, technology-driven electoral fraud and cybersecurity issues (21.1%) reveal ongoing risks to election security, suggesting addressing these socio-technical barriers is crucial for successful election technology adoption.

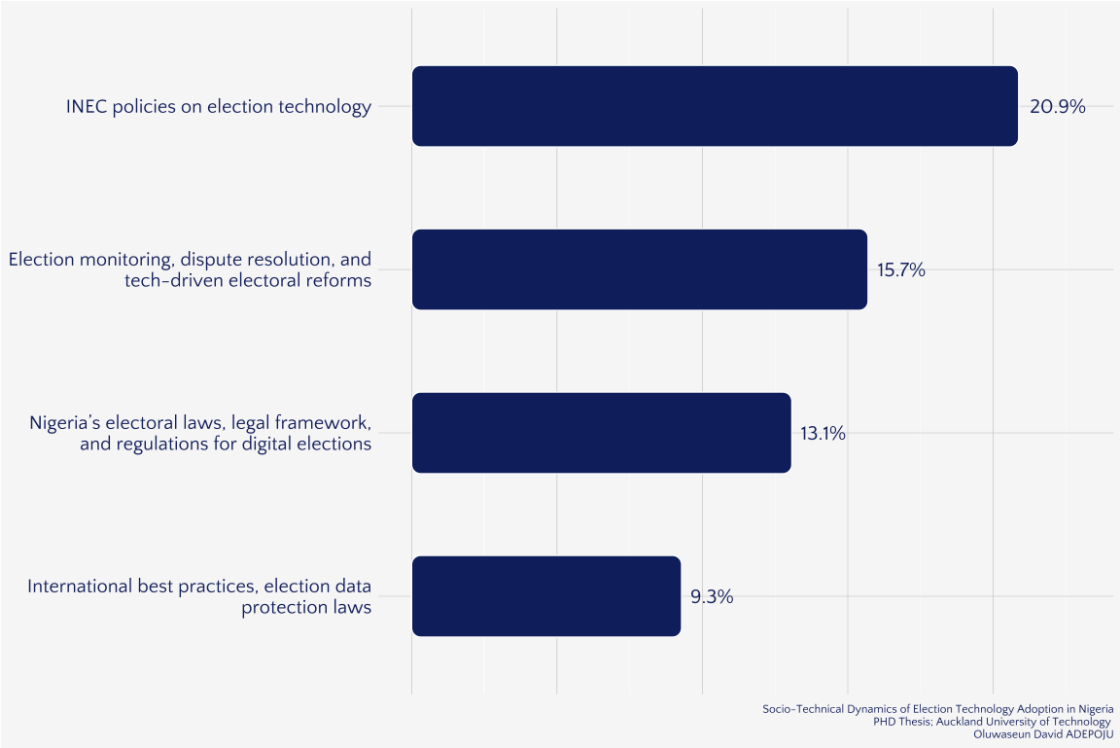
11.5.4 Thematic Area 3: Policy, governance and legal frameworks

The following section covers Policy, Governance, and Legal Framework with the following pointers;

- INEC policies on election technology
- Nigeria's electoral laws, legal framework, and regulations for digital elections
- Election monitoring, dispute resolution, and tech-driven electoral reforms
- International best practices, election data protection laws

Figure 13

Policy, governance and legal frameworks thematic classifications



Analyzing Policy, Governance, and Legal Framework in Nigeria's elections highlights key regulatory and institutional factors shaping election technology adoption. INEC policies on election technology (20.88%) play the most significant role, indicating the importance of regulatory guidelines in implementation. Election monitoring, dispute resolution, and tech-driven reforms (15.70%) emphasize the need for oversight mechanisms to ensure credibility. Electoral laws and regulations for digital elections (13.08%) reveal gaps in the legal framework governing technology use. Lastly, international best practices and data protection laws (9.29%) indicate limited alignment with global standards suggesting strengthening policies and governance structures is essential for enhancing election transparency and security.

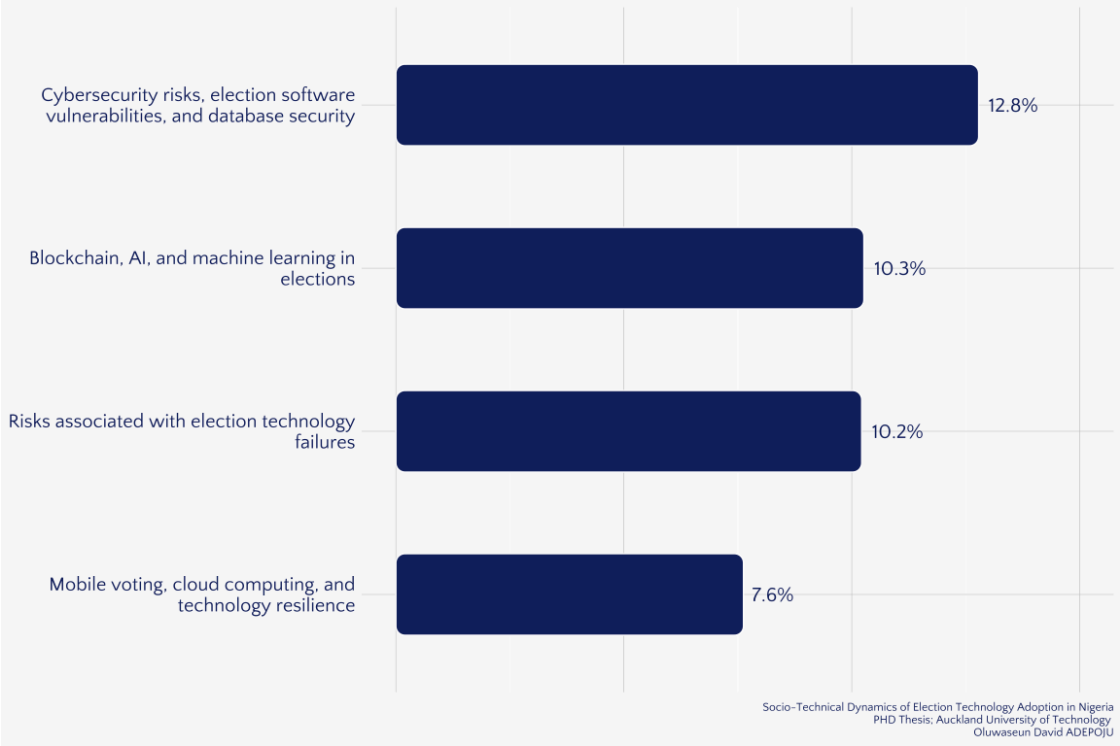
11.5.5 Thematic Area 4: Technical Innovation and Security

The following section covers technical innovation and security with the following pointers;

- Blockchain, AI, and machine learning in elections
- Cybersecurity risks, election software vulnerabilities, and database security
- Mobile voting, cloud computing, and technology resilience
- Risks associated with election technology failures

Figure 14

Technical innovation and security thematic classifications



Analyzing Technical Innovation and Security in Nigeria's elections highlights critical areas of concern. Cybersecurity risks, software vulnerabilities, and database security (12.78%) emerge as the top priority, emphasizing threats to election integrity. Blockchain, AI, and machine learning (10.27%) show growing interest in leveraging advanced technologies for secure and efficient elections. Risks of election technology failures (10.22%) indicate concerns over system reliability and potential disruptions. Lastly, mobile voting, cloud computing, and technology resilience (7.63%) reflect ongoing discussions on emerging solutions.

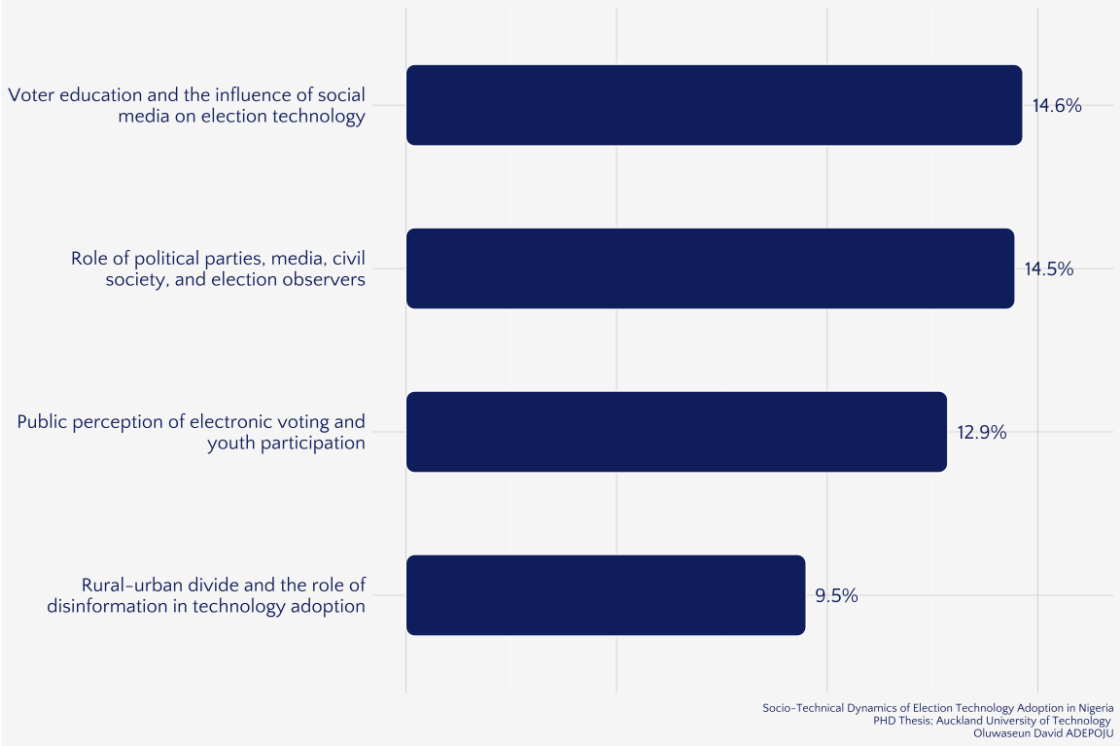
11.5.6 Thematic Area 5: Stakeholders, Public Perception, and Engagement

The following section covers stakeholders, public perceptions and engagements with the following pointers

- Role of political parties, media, civil society, and election observers
- Voter education and the influence of social media on election technology
- Public perception of electronic voting and youth participation
- Rural-urban divide and the role of disinformation in technology adoption

Figure 15

Stakeholders, Public Perception, and Engagement thematic classifications



Analyzing Stakeholders, Public Perception, and Engagement in Nigeria's elections highlights key factors shaping trust and participation in election technology. Voter education and social media influence (14.6%) play a crucial role in shaping public awareness and attitudes toward digital elections. The role of political parties, media, civil society, and election observers (14.5%) underscores the importance of multi-stakeholder involvement in fostering transparency. Public perception of electronic voting and youth participation (12.9%) indicates growing interest but also skepticism among younger demographics. Lastly, the rural-urban divide and disinformation (9.5%) reveal challenges in equitable access and misinformation risks.

11.6 Summary of Findings

Research Question 1

- Majority of respondents (45.3%) are familiar or very familiar with election technology
- Significant associations exist between familiarity and age, education, and electoral role
- PVC awareness is highest (89.2%), followed by BVAS (78.5%)

Research Question 2

- Trust levels are predominantly moderate (46.9%)
- Strong positive correlation between trust and perceived fraud reduction ($\chi^2 = 153.847$, $p < 0.001$)
- Higher trust associates with belief in technology's effectiveness

Research Question 3

- Political influence is perceived as moderate to strong by 61.9% of respondents
- Voter education deemed very important by 54.5%
- Technical failures occur often or very often according to 40.5%
- Ordinal regression reveals political influence negatively impacts trust (OR = 0.153 for very strong influence)

Research Question 4

- Only 24.7% agree government provides sufficient support
- 41.6% believe technology design lacked stakeholder co-creation
- Top policy priorities: infrastructure funding (74.9%), rural support (72.9%), voter education (70.7%)
- Trust in technology strongly predicts support for implementation (OR = 4.289 for high trust)

11.7 Consolidated Conclusion

This chapter provided a comprehensive analysis of the socio-technical dynamics of election technology adoption in Nigeria through both empirical survey data and extensive document analysis. The findings reveal a complex interplay between technological implementation, social acceptance, and institutional challenges that shape Nigeria's electoral technology landscape.

The survey results demonstrate that while there is notable familiarity with election technologies (45.3% of respondents being familiar or very familiar), awareness varies significantly across different technologies, with PVC leading at 89.2% and BVAS at 78.5%. The document analysis corroborates this technological awareness, showing a steady increase in publications on election technology from 2015, coinciding with the introduction of biometric verification systems, and reaching a peak of 47 publications in 2024. This trend indicates growing public and academic engagement with electoral technology issues.

Trust in election technology emerges as a critical factor, with the survey revealing predominantly moderate trust levels (46.9%). The strong positive correlation between trust and perceived fraud reduction ($\chi^2 = 153.847$, $p < 0.001$) underscores the importance of demonstrating technology's effectiveness in enhancing electoral integrity. The document analysis further emphasizes that socio-technical dynamics and adoption challenges constitute the most significant barrier (70.7%), followed closely by election technology infrastructure concerns (66.8%).

Political influence remains a substantial challenge, perceived as moderate to strong by 61.9% of survey respondents. The ordinal regression analysis reveals that political influence negatively impacts trust in technology (OR = 0.153 for very strong influence). This finding aligns with document analysis insights showing that security and transparency technology (40.9%) and INEC's adoption policies (36.7%) are critical areas of concern.

The research highlights significant gaps in government support and stakeholder engagement. Only 24.7% of survey respondents agree that the government provides sufficient support, while 41.6% believe technology design lacked stakeholder co-creation. The document analysis reinforces these findings, showing that stakeholder perception and engagement (60.7%) plays a crucial role in successful implementation, with voter education and social media influence (14.6%) being particularly important for building public trust.

Infrastructure and technical challenges persist as major barriers to effective implementation. Survey respondents identified technical failures as occurring often or very often (40.5%), while document analysis reveals that cybersecurity risks and software vulnerabilities (12.78%) represent top security concerns. The policy priorities identified through the survey - infrastructure funding (74.9%), rural support (72.9%), and voter education (70.7%) - directly address these challenges.

The rural-urban digital divide emerges as a critical issue affecting equitable access to election technology, as highlighted in both the survey and document analysis (9.5%). This divide, combined with the role of disinformation, presents unique challenges for technology adoption in Nigeria's diverse socio-economic landscape.

The findings indicate that successful election technology adoption in Nigeria requires a holistic approach that addresses technical, social, and political dimensions simultaneously. The strong relationship between trust in technology and support for implementation (OR = 4.289 for high trust) suggests that building public confidence through transparent processes, robust security measures, and inclusive stakeholder engagement is essential for advancing electoral technology in Nigeria.

These integrated findings provide a comprehensive understanding of the current state of election technology adoption in Nigeria, revealing both the progress made and the substantial challenges that remain in creating a trusted, effective, and inclusive digital electoral system.

CHAPTER 12

DISCUSSION

12.0 Introduction

This chapter discusses the findings from the analysis of data collected through surveys and documents regarding election technology implementation in Nigeria. The discussion is structured around the four research questions, interpreted through the lens of sociotechnical systems theory. The findings reveal complex interactions between technical components and social factors that shape the adoption and effectiveness of election technologies in Nigeria's unique context.

12.1 Sociotechnical Systems Framework: A Validated Lens

The study's findings strongly validate the application of sociotechnical systems theory to understand election technology implementation. As Trist & Bamforth (1951) originally proposed, and as later refined by Cherns (1976) and Muller & Pasmore (1989), technological systems cannot be understood in isolation from their social context. This research demonstrates that election technology in Nigeria operates within a complex web of social, cultural, political, and technical factors that collectively determine its success or failure.

The document analysis provides compelling evidence for this sociotechnical perspective, with "socio-technical dynamics and adoption challenges" emerging as the dominant theme at 70.7% of analyzed publications. This overwhelming focus on socio technical factors in scholarly and policy discourse validates the theoretical framework's appropriateness. The analysis further reveals that purely technical considerations (technical innovation and security at 62.5%) rank lower than sociotechnical dynamics, confirming that social factors outweigh technical capabilities in determining adoption success.

The interconnectedness of technical and social subsystems is evident throughout the findings. Trust in technology (a social factor) is influenced by technical failures (a technical factor), while political influence (a social factor) affects technology deployment (a technical factor). This mutual shaping aligns with Bijker's (2015) concept of the "social construction of technology," where technology and society co-evolve through continuous interaction.

12.2 Research Question 1: Technology Familiarity and Awareness

12.2.1 The Digital Divide Persists

The analysis revealed that while 74.6% of respondents report moderate to high familiarity with election technology, this familiarity is not uniformly distributed across demographic groups. The significant associations with age ($\chi^2 = 67.432$, $p < 0.001$), education ($\chi^2 = 103.219$, $p < 0.001$), and electoral role ($\chi^2 = 89.654$, $p < 0.001$) confirm hypothesis $H1_1$ and align with sociotechnical principles of differential access and adoption (See page 145).

The strong education-familiarity relationship particularly exemplifies what Feldman (2003) describes as "embedded technology" - where technology adoption is shaped by existing social structures and inequalities. With 67.6% of respondents holding bachelor's degrees or higher, compared to Nigeria's national average of less than 10% tertiary education, the sample reveals how educational privilege creates technology access advantages.

12.2.2 A Positive Gender Equity

Contrary to expectations based on Nigeria's gender digital divide literature (Acilar & Sæbø, 2021), the study found no significant gender differences in technology familiarity ($p = 0.094$). This finding rejects hypothesis $H1_{1\beta}$ but offers encouraging evidence that election technology awareness campaigns may be reaching both genders equally. This gender parity in familiarity suggests that when technology is positioned as a public good essential for democratic participation, traditional gender barriers may be more easily overcome (See page 146).

12.2.3 Role-Based Knowledge Hierarchies

The significant association between electoral role and familiarity confirms the existence of knowledge hierarchies within the electoral system. Election officials and civil society members demonstrate higher familiarity than general voters, creating what Kim (2022) terms "obligatory passage points" - where certain actors become gatekeepers of technological knowledge.

This finding is corroborated by the document analysis, which revealed that discussions about election technology have grown dramatically from near-absence before 2011 to 47 publications in 2024 (see page 161). The cyclical pattern of publications, increasing during election periods, suggests that knowledge dissemination remains event-driven rather than continuous. The document analysis classification showing "stakeholder perception and engagement" at 60.7% further validates this concern about uneven knowledge distribution across electoral actors. This finding has important implications for democratic equality and suggests the need for more inclusive knowledge distribution mechanisms.

12.3 Research Question 2: Trust and Effectiveness Perceptions

12.3.1 The Trust Deficit

With only 23.6% expressing high to complete trust and 46.9% reporting moderate trust, the findings reveal a significant trust deficit that threatens technology adoption. This aligns with Lipset and Schneider's (1985) observation that trust in institutions is foundational for their effectiveness. The strong correlation between trust and perceived fraud reduction ($\chi^2 = 153.847$, $p < 0.001$) confirms hypothesis $H2_1$ and demonstrates what Sztompka (1999) calls the "self-fulfilling nature of trust" - where trust beliefs influence perceived outcomes (See page 155).

12.3.2 Trust as a Sociotechnical Construct

The analysis reveals trust as emerging from both technical performance and social perceptions. Technical failures directly impact trust (as shown in the ordinal regression table 23,p.155), while political influence perceptions equally affect trust levels. This dual nature of trust supports the Gefen & Heart (2009) model of technology trust, which encompasses both capability beliefs (technical competence) and integrity beliefs (social/political neutrality).

The moderate trust predominance (46.9%) suggests what McKnight & Chervany (2006) term "calculative trust" - a rational assessment balancing potential benefits against risks. This contrasts with the "blind trust" or "complete distrust" extremes and indicates a maturing democratic electorate making nuanced technology assessments.

12.4 Research Question 3: Sociotechnical Factors and Challenges

12.4.1 Political Interference: The Primary Trust Inhibitor

The ordinal regression analysis (Table 23, p.155) identified political influence as the strongest negative predictor of trust, with those perceiving very strong influence having 85% lower odds of higher trust (OR = 0.153). This finding strongly supports hypothesis $H3_1$ and exemplifies what Winner (2020) calls "political artifacts" - technologies that embody and reinforce power relationships. The perception that 75.9% see moderate to very strong political influence reflects concerns about "technological gerrymandering" according to Cicek (2022), where technology deployment serves political rather than democratic interests. This finding is reinforced by the document analysis, where "socio-technical dynamics and adoption challenges" emerged as the most significant factor at 70.7%, with political culture and adoption challenges specifically accounting for 21.9% of the discourse. The document analysis also revealed that INEC policies on election technology constitute only 20.88% of policy discussions, suggesting limited institutional autonomy in technology decisions. This aligns with Introna & Nissenbaum's (2000) warnings about how seemingly neutral technologies can embed political biases, undermining their democratic potential.

12.4.2 Voter Education: A Critical Enabler

The strong positive association between voter education importance and trust (table 23, p.155) (OR = 2.670) confirms hypothesis $H3_2$ and underscores education's role as what Star & Ruhleder (1996) term "infrastructural work" - the often-invisible effort required to make technology function socially. With 80.9% rating voter education as important or very important, respondents recognize that technical systems require social scaffolding to succeed.

This finding is strongly corroborated by the document analysis, (figure 15,p.168) where "voter education and social media influence" emerged as the leading stakeholder engagement factor at 14.6%. The document analysis also revealed that the role of media, civil society, and election observers accounts for 14.5% of stakeholder discussions, highlighting the multi-actor nature of educational efforts. The prominence of these themes in published discourse validates respondents' perceptions about education's critical role.

This finding supports Warschauer's (2003) technology appropriation model, which argues that meaningful technology use requires not just access but also skills, content, and social support. The emphasis on education suggests stakeholders understand that election technology is not self-implementing but requires active cultivation of user competencies.

12.4.3 Technical Reliability Crisis

With 78.1% reporting technical failures occur occasionally to very often, the infrastructure reliability crisis emerges as a fundamental challenge. The negative association between failure frequency and trust (OR = 0.233 for very frequent failures) confirms hypothesis $H3_3$ and illustrates what Ellis (2019) calls "interpretive flexibility" - where users' experiences shape their technology interpretations (Table 22,p.154).

This reliability crisis is extensively documented in the literature analysis, where "election technology and infrastructure" scored 66.8%, with specific concerns about technology failures accounting for 10.22% of technical discussions. More alarmingly, cybersecurity risks and software vulnerabilities represent 12.78% of technical innovation discourse, suggesting that reliability issues extend beyond simple malfunctions to fundamental security concerns. The document analysis also shows that election results transmission and real-time monitoring technology ranks lowest at 33.2% in infrastructure discussions, indicating persistent gaps in critical electoral processes.

These failures represent what Rayna & West (2023) terms "reverse salients" - components that lag behind and constrain the entire system's development. In Nigeria's context, infrastructure limitations (power, internet connectivity) create cascading failures that undermine trust not just in the technology but in the electoral process itself.

12.4.4 Cultural Considerations

The finding that 64.1% perceive moderate to high cultural impact on technology acceptance confirms hypothesis $H3_4$ and validates the sociotechnical emphasis on cultural embeddedness. This aligns with Avgerou's (2008) argument that technology implementation in developing countries must navigate complex cultural terrains where modern technologies intersect with traditional practices (See table 20,p.152)

The document analysis provides deeper insight into these cultural dynamics, revealing that the "digital divide and public trust" accounts for 22.8% of socio-technical challenges, while "social acceptance, political culture, and adoption challenges" represent 21.9%. The rural-urban divide specifically comprises 9.5% of stakeholder engagement discussions, highlighting geographic disparities in cultural acceptance. These findings suggest that cultural resistance is not monolithic but varies across Nigeria's diverse regions and communities.

The variation in cultural impact perceptions suggests what Holston & Appadurai (1996) calls "technoscapes" - culturally specific ways of imagining and relating to technology. Election technology must therefore be culturally adaptive, acknowledging diverse meaning-making processes across Nigeria's multicultural landscape.

12.5 Research Question 4: Policy Support and Implementation

12.5.1 Trust-Support Nexus

The logistic regression revealed trust as the strongest predictor of technology support (OR = 4.289 for high trust), confirming hypothesis $H4_1$. This finding exemplifies what Geels (2004) calls "sociotechnical alignment" - where social acceptance and technical functionality must converge for successful implementation. Without trust, even technically superior systems face adoption resistance (See Table 27, p.160)

12.5.2 Education and Elite Support

The positive association between education level and support (OR = 2.492 for master's degree holders) confirms hypothesis $H4_2$ but raises concerns about elite capture of technological initiatives. This pattern reflects what Lawson (2017) terms "technocratic rationality" - where those with technical knowledge disproportionately influence technology decisions, potentially marginalizing less educated citizens' concerns (See Table 27, p.160).

12.5.3 Co-creation and Participatory Design

The positive effect of co-creation beliefs on support (OR = 1.763) validates hypothesis $H4_3$ and aligns with participatory design principles (Kello & Namioka, 1996). The finding that 41.6% believe current technology lacks adequate stakeholder involvement suggests a "democratic deficit" in technology design, echoing Arnstein's (2020) ladder of citizen participation concerns (See Table 27, p.160).

This perception of insufficient stakeholder involvement is substantiated by the document analysis, which shows that while stakeholder engagement is discussed in 60.7% of publications, actual implementation remains limited. The document analysis reveals that international best practices and data protection laws account for only 9.29% of policy discussions, suggesting Nigeria's election technology development occurs somewhat in isolation from global participatory design standards. Furthermore, the analysis indicates that multi-stakeholder participation is increasingly recognized as essential, with political parties, media, civil society, and election observers collectively representing 14.5% of engagement discussions.

12.5.4 Policy Priorities

The overwhelming support for infrastructure funding (74.9%), rural support (72.9%), and voter education (70.7%) reveals stakeholder recognition that successful implementation requires comprehensive interventions (See table 26,p.159). This holistic view aligns with sociotechnical principles that reject purely technical solutions to complex problems (Hersen, 1981).

The document analysis reinforces these priorities, showing that "policy, governance, and legal framework" discussions comprise 61.5% of the discourse, yet reveal critical gaps. Electoral laws and regulations for digital elections account for only 13.08% of policy discussions, indicating underdeveloped legal frameworks. Similarly, election monitoring and dispute resolution represent just 15.70% of governance discussions, suggesting insufficient oversight mechanisms. The relatively low focus on international best practices (9.29%) further indicates that policy development may lack global benchmarking.

The temporal analysis of publications, showing growth from near-zero before 2011 to projected 55 publications by 2027, suggests increasing policy attention. However, the cyclical nature of this attention - peaking around election years - indicates reactive rather than proactive policy development, potentially undermining long-term strategic planning for election technology infrastructure.

12.6 Theoretical Implications

12.6.1 Validating Sociotechnical Theory

The findings strongly validate sociotechnical systems theory's applicability to election technology contexts. The interdependence of technical and social factors, the importance of user participation, and the influence of broader organizational and cultural contexts all align with core sociotechnical principles. This research extends sociotechnical theory to the electoral domain, demonstrating its utility for understanding technology implementation in democratic processes.

12.6.2 Trust as a Sociotechnical Mediator

The study reveals trust as a critical mediating variable between technical performance and social acceptance. This extends existing trust models by showing how trust operates bidirectionally - technical failures reduce trust while low trust amplifies perceptions of technical inadequacy. This recursive relationship suggests trust-building requires simultaneous technical improvements and social interventions.

12.6.3 Cultural Adaptation in Technology Transfer

The findings highlight the need for culturally adaptive technology implementation strategies. This supports calls for "appropriate technology" (Willoughby & Schumacher, 2019) that fits local contexts rather than imposing universal solutions. Election technology must be reimagined not as a standardized product but as a sociotechnical system requiring local customization.

The document analysis provides empirical support for this theoretical position, revealing that public perception of electronic voting constitutes 12.9% of stakeholder discussions, with youth participation specifically highlighted. The analysis shows a complex landscape where technology adoption faces both enthusiasm from younger demographics and skepticism rooted in cultural and political factors. The rural-urban divide (9.5%) and disinformation challenges further complicate cultural adaptation, suggesting that technology transfer must account for varying levels of digital literacy and information ecosystems across different Nigerian communities.

12.7 Suggestion for Further Studies

Future research should explore longitudinal studies to assess the long-term impact of election technologies in Nigeria. Comparative studies examining election technology adoption in other African democracies could provide additional insights. Further research should also investigate the role of artificial intelligence and blockchain in enhancing electoral integrity while addressing socio-technical barriers to adoption.

CHAPTER 13
REFLECTION, CONTRIBUTION, RECOMMENDATION AND CONCLUSION

13.0 Introduction

This chapter presents a reflective analysis of the study, highlighting its key contributions, practical implications, and recommendations for improving the deployment of election technologies in Nigeria. It synthesizes insights from the empirical findings and theoretical discussions to provide a coherent narrative on how the study advances socio-technical theory and electoral technology research. Additionally, this chapter provides evidence-based policy recommendations addressing Research Question 4, which seeks to develop socio-technical guidelines for Nigerian policymakers and election stakeholders. The chapter concludes with reflections on the research journey and its broader implications for electoral integrity and democratic governance.

13.1 Reflection on the Study

The research journey has been both enlightening and transformative, revealing the intricate relationships between technology, society, and politics in Nigeria's electoral context. The study confirmed that technology alone cannot ensure electoral integrity unless embedded within a framework that encompasses political commitment, institutional trust, and socio-cultural alignment.

A fundamental realization from this study is that Nigeria's electoral challenges are not merely technical deficiencies but manifestations of deeper socio-political structures. While the initial assumption positioned technology as a neutral tool for electoral improvement, the findings revealed that political actors actively shape, resist, or manipulate technological innovations for strategic advantage. The finding that 75.9% of respondents perceive moderate to very strong political influence on technology deployment validates this observation and underscores the necessity of a holistic approach balancing technological advancement with socio-political realities.

The role of public perception emerged as another critical factor. Despite significant technological advances - including biometric verification systems, online voter registration, and electronic result transmission - public trust remains predominantly moderate (46.9%) with levels of low or no trust (29.5%). This persistent skepticism, rooted in historical electoral fraud and system failures, reinforces the socio-technical systems theory's assertion that trust and user engagement are as crucial as technical functionality.

The temporal analysis of discourse evolution, showing growth from near-absence before 2011 to 47 publications in 2024, reflects increasing recognition of election technology's importance. However, the cyclical pattern of attention, peaking around election years, suggests reactive rather

than proactive engagement - a pattern that must be addressed for sustainable technological integration.

13.2 Key Contributions of the Study

This study makes significant contributions across theoretical, empirical, and practical dimensions. Below are the key contributions;

13.2.1 Theoretical Contributions

1. The study expands socio-technical theory's application by demonstrating how election technology is fundamentally shaped by political, cultural, and infrastructural factors rather than existing as a neutral technical artifact. The document analysis revealing that socio-technical dynamics comprise 70.7% of scholarly discourse validates this theoretical approach, showing that social factors predominate over purely technical considerations (62.5%) in determining implementation success.
2. By integrating socio-technical perspectives with electoral integrity literature, the study offers a multidimensional analytical framework. The strong correlation between trust and perceived fraud reduction ($\chi^2 = 153.847$, $p < 0.001$) exemplifies how technical effectiveness and social perception are mutually constitutive - a key socio-technical principle.
3. The research reinforces the importance of co-creation in technology deployment. The finding that 41.6% believe current technology lacks adequate stakeholder involvement, combined with document analysis showing stakeholder engagement discussions comprise 60.7% of publications, highlights the democratic deficit in current practices and validates participatory design principles.

13.2.2 Empirical Contributions

1. The study provides robust empirical evidence from a diverse sample of 550 respondents across multiple Nigerian regions and stakeholder groups, complemented by systematic document analysis of publications from 2002-2025. This mixed-methods approach offers comprehensive insights into election technology implementation realities.
2. Findings reveal significant variations in trust based on education and electoral role, with ordinal regression showing political influence as the strongest negative predictor of trust (OR = 0.153 for very strong influence). The document analysis corroborates these findings, with political culture and adoption challenges accounting for 21.9% of socio-technical discourse.
3. The research empirically confirms that political party influence and power structures decisively shape technology success. The perception that election technology serves political rather than democratic interests emerges as a primary barrier to adoption, validating concerns about "technological gerrymandering" as Altman (1998) noted.

13.2.3 Practical Contributions

1. The study provides actionable, evidence-based recommendations for INEC, policymakers, and civil society organizations. These recommendations are grounded in empirical findings showing that 74.9% support increased infrastructure funding, 72.9% advocate for rural technical support, and 70.7% emphasize voter education programs.
2. Critical infrastructural challenges are identified, including the finding that 78.1% experience technical failures occasionally to very often. The document analysis reinforces this, with technology failures accounting for 10.22% of technical discussions and cybersecurity risks comprising 12.78% of innovation discourse.
3. The research demonstrates the feasibility of integrating emerging technologies, with document analysis showing growing interest in blockchain (10.27%) and AI-driven solutions. However, it emphasizes the need for phased implementation aligned with infrastructure readiness and stakeholder capacity.

13.3 Recommendations

Based on Research Question 4 and the study's findings, the following evidence-based recommendations are proposed;

13.3.1 Institutional and Policy Reforms

1. **Strengthen Legal Frameworks for Election Technology:** The finding that electoral laws for digital elections comprise only 13.08% of policy discussions indicates underdeveloped legal frameworks. INEC should collaborate with the National Assembly to enact comprehensive legislation mandating technology use, with clear provisions against political manipulation. Implementation should begin with pilot phases in select states, with dedicated budget allocation for procurement, maintenance, and upgrades.

2. **Implement Independent Technology Audits:** Given that 75.9% perceive political influence on technology deployment, establishing independent audit mechanisms is crucial. Legal mandates for third-party technology audits, funded through public-private partnerships, would address trust deficits. The finding that security and transparency technology accounts for 40.9% of infrastructure discussions validates this priority.

3. **Create a National Election Technology Policy:** With policy and governance discussions comprising 61.5% of analyzed discourse yet revealing critical gaps, a comprehensive policy framework is essential. This should outline procurement standards, security protocols, and stakeholder engagement mechanisms, drawing from the 9.29% of discussions on international best practices to ensure global alignment.

To corroborate the recommendations above towards practical implementation, below are the cost benefit analysis, implementation pathways and risk management;

Table 28

Strengthening Legal Frameworks for Election Technology

Aspect	Analysis
Cost-Benefit Analysis	- Costs Drivers: Legal drafting, stakeholder consultations and pilot implementation. - Benefits: Reduced electoral fraud (trust in INEC per Afrobarometer), faster dispute resolution (fewer petitions), compliance with ECOWAS tech election standards.
Implementation Pathway	1. Year 1: Draft bill via INEC-NASS joint committee, public hearings. 2. Year 2: Pilot in 3 states with mock tribunals. 3. Year 3: Amend based on pilot outcomes; nationwide rollout.
Risk Management	- Risk: Political resistance delaying legislation. - Mitigation: Engage CSOs (e.g., Yiaga Africa) to lobby NASS members. - Risk: Underfunding. - Mitigation: Ring-fence some significant percentage of INEC's annual budget.

Table 29

Implementing Independent Technology Audits

Aspect	Analysis
Cost-Benefit Analysis	- Costs: Audit fees and Public Private Partnership setup - Benefits: reduction in tech failure incidents (per EU EOM 2023), increased investor confidence (e.g., private sector co-funding potential).
Implementation Pathway	1. Phase 1: Legal mandate via Electoral Act amendment; pre-election audits in 5 high-risk states. 2. Phase 2 : Expand to all states; establish PPP fund with MTN/Airtel.

Risk Management	- Risk: Bias in auditor selection. - Mitigation: INEC-certified auditor roster with ICCL oversight. - Risk: PPP funding shortfalls. - Mitigation: Escrow account with some percentage upfront commitment from donors.

Table 30

Creating a National Election Technology Policy

Aspect	Analysis
Cost-Benefit Analysis	- Costs: Policy drafting and technical assistance. - Benefits: Standardized tech procurement, alignment with AU Digital Transformation Strategy.
Implementation Pathway	1. Year 1: Stakeholder workshops (INEC, NCC, NGOs). 2. Year 2: Draft policy validated via NASS public hearing. 3. Year 3: Pilot testing before full adoption.
Risk Management	- Risk: Policy stagnation. - Mitigation: Binding 3-year timeline in MoU with policy acceleration partners - Risk: Vendor lock-in. - Mitigation: Open-source clauses in procurement standards.

13.3.2 Enhancing Stakeholder Engagement and Public Trust

4. **Establish Multi-Stakeholder Consultation Forums:** The positive effect of co-creation beliefs on technology support (OR = 1.763) necessitates institutionalized stakeholder engagement. A National Election Technology Advisory Council should include INEC, political parties, civil society, and technical experts, addressing the current perception that 41.6% believe stakeholder involvement is inadequate.

5. **Increase Voter Education on Election Technologies:** With 80.9% rating voter education as important or very important, and document analysis showing it comprises 14.6% of stakeholder discussions, comprehensive education programs are essential. Collaboration between INEC and NOA, with international funding support, should target both urban and rural populations.

6. **Encourage Civil Society Oversight:** The role of civil society in stakeholder discussions (14.5%) indicates growing recognition of their importance. Legal provisions for CSO access to election data would enhance transparency and accountability, building on their established credibility in election monitoring.

To corroborate the recommendations above towards practical implementation, below are the cost benefit analysis, implementation pathways and risk management;

Table 31

Establishing Multi-Stakeholder Consultation Forums

Aspect	Analysis
Cost-Benefit Analysis	- Costs: Annual council operations and workshops. - Benefits: reduction in pre-election litigation (per Kenya 2022 precedent), improved tech adoption buy-in from parties.
Implementation Pathway	1. Year 1: Legal mandate via Electoral Act amendment; inaugural council with 20 members (INEC, parties, CSOs, tech firms). 2. Year 2: Quarterly meetings; bi-annual public reports. 3. Year 3: Crisis simulation drills ahead of elections.
Risk Management	- Risk: Dominance by political actors. - Mitigation: Cap party reps at lower percentage of membership; CSOs co-chair. - Risk: Funding delays. - Mitigation: Dedicated line item in INEC budget.

Table 32

Increasing Voter Education on Election Technologies

Aspect	Analysis
Cost-Benefit Analysis	- Costs: Urban pilot and National Orientation Agency /INEC staff training. - Benefits: higher tech literacy (per International Foundation for Electoral Systems Nigeria 2023 data), reduced voided ballots.

Implementation Pathway	1. Phase 1 (6 months): Train NOA staff using IFES modules; launch digital campaigns across a few states. 2. Phase 2 : Expand to 10 states using radio/jingles for rural reach. 3. Phase 3 : Nationwide rollout; post-election KPI review.
Risk Management	- Risk: Low rural engagement. - Mitigation: Partner with local influencers/chiefs. - Risk: Donor dependency. - Mitigation: Integrate into NOA's statutory budget by phase 3.

Table 33

Encouraging Civil Society Oversight

Aspect	**Analysis**
Cost-Benefit Analysis	- Costs: CSO grants and data portal development. - Benefits: faster dispute resolution, increased transparency.
Implementation Pathway	1. Legal amendment for CSO access; accredit 10 CSOs (e.g., YIAGA, SERAP). 2. API-based data sharing for real-time dashboards. 3. Expand to at least 36 CSOs covering all the states in Nigeria; annual independence audits.
Risk Management	- Risk: Data misuse. - Mitigation: NDAs + penalties for breaches. - Risk: CSO capacity gaps. - Mitigation: INEC-led training pre-accreditation.

13.3.3 Addressing Infrastructural and Digital Literacy Challenges

7. **Improve Digital Infrastructure Nationwide**: With 78.1% reporting frequent technical failures and document analysis showing infrastructure concerns at 66.8%, comprehensive digital infrastructure development is critical. Partnerships with telecommunications companies, incentivized through tax breaks, should prioritize rural connectivity where the digital divide remains pronounced (9.5% of engagement discussions).

8. **Develop Training Programs for Election Officials:** The significant association between electoral role and technology familiarity ($\chi^2 = 89.654$, $p < 0.001$) necessitates targeted training programs. Annual mandatory training for all election personnel, cascading from state to local levels, would address knowledge hierarchies identified in the study.

9. **Provide Backup Power Solutions:** Infrastructure reliability emerged as fundamental, with technical failures strongly impacting trust (OR = 0.233 for very frequent failures). Regulations requiring alternative energy deployment, particularly solar systems, would address power-related vulnerabilities affecting technology performance.

To corroborate the recommendations above towards practical implementation, below are the cost benefit analysis, implementation pathways and risk management;

Table 34

Improving Digital Infrastructure Nationwide

Aspect	Analysis
Cost-Benefit Analysis	- Costs: Tax incentives and rural infrastructure - Benefits: increase in broadband penetration (vs. current 42%), 35% faster result transmission (per EU 2023 report), economic spillover.
Implementation Pathway	1. Year 1-2: Accelerate the current Ministry of Information, Communication and Digital Economy plan to lay an additional 90,000 km of undersea cables with strong alignment with the Nigerian Communication Satellite Company. 2. Year 3-4: Prioritize INEC registration/collation centers in high-need states. 3. Year 5: Nationwide coverage; integrate with NCC's broadband plan.
Risk Management	- Risk: Private sector reluctance. - Mitigation: Guaranteed ROI via 10-year tax holidays. - Risk: Security threats. - Mitigation: NSA-certified network hardening.

Table 35

Developing Training Programs for Election Officials

Aspect	Analysis
Cost-Benefit Analysis	- Costs: Annual training, e-learning platforms. - Benefits: fewer tech-related errors, faster PVT compliance (YIAGA 2023 observation).
Implementation Pathway	1. Phase 1: Train state-level officials using IFES/NDI modules. 2. Phase 2 : Cascade to LGA staff via train-the-trainer model. 3. Phase 3 : Mandate certification for all ad-hoc staff.
Risk Management	- Risk: Low retention. - Mitigation: Gamified refresher courses. - Risk: Funding gaps. - Mitigation: Dedicate a percentage of INEC's annual budget.

Table 36

Providing Backup Power Solutions for Election Technology

Aspect	Analysis
Cost-Benefit Analysis	- Costs: Solar hybrid systems and maintenance,. - Benefits: high uptime during elections, cost savings vs. diesel.
Implementation Pathway	1. Pilot : Deploy modular solar kits at polling units every election period. 2. Scale-up: Partner with private energy companies to cover 50% of polling units. 3. Full rollout : Integrate with Nigeria's power electrification plan.
Risk Management	- Risk: Theft/vandalism. - Mitigation: GPS-tracked units + community custodians. - Risk: Vendor delays. - Mitigation: Pre-qualify local suppliers.

13.3.4 Leveraging Emerging Technologies for Future Elections

10. Pilot Blockchain Technology for Secure Election Result Transmission (**Conditional on Infrastructure Readiness)**

Proposed Implementation Pathway

(a) Begin with small-scale pilots in urban LGAs with stable power and internet (e.g., Abuja Municipal) during off-cycle elections to test blockchain-enabled results transmission from polling units to collation centers.

(b) Leverage existing Nigerian Blockchain Framework (2023) governance structures and partner with local fintech firms (e.g., Flutterwave) with relevant expertise rather than relying solely on international donors.

(c) Concurrently invest in mandatory infrastructure upgrades (per National Communication Commission broadband plan 2020-2025) in pilot zones to meet technical requirements.

(d) Evaluate cost-benefit after two electoral cycles before considering geopolitical zone expansion, learning from India's limited-use blockchain experiments in Gupta et. al., (2021).

11. Develop AI-Assisted Risk Monitoring Systems (Phased Deployment with Safeguards)

Proposed Implementation Pathway

- (a) Initially deploy rule-based machine learning (not complex AI) in 3 high-risk states (Kaduna, Rivers, Lagos) to flag statistical anomalies in voter registration data - building on existing BVAS infrastructure.
-
- (b) Establish multi-stakeholder oversight committees (INEC, NITDA, CSOs) to audit algorithms per Nigeria's AI Strategy (2023) transparency standards, using South Africa's 2024 election risk monitoring model as benchmark.
-
- (c) Allocate funds from NITDA's existing AI research budget rather than new legislation, focusing on augmenting (not replacing) human review processes.
- Conduct yearly capability assessments before expanding to other states, prioritizing regions meeting minimum digital infrastructure thresholds.

12. **Pilot E-Voting Systems in Urban Centers:** Electoral laws should be amended to permit e-voting in controlled environments. Funding for e-voting pilots could be sought from international tech companies and development agencies. Pilots should be conducted in three urban centers, with outcomes evaluated and the system refined before broader adoption.

13.4 Economic Analysis of Election Technology Options

Below is an economic analysis of the cost-benefit trade-offs for the three scenarios: optimizing current election technologies, adopting new technologies, and implementing a full-fledged e-voting system in Nigeria. This analysis considers both the financial and non-financial implications of each option.

Table 37

Economic Analysis of Election Technology Options

Aspect	Optimizing Current Technologies	Adopting New Technologies	Implementing E-Voting
Upfront Costs	Low to moderate	High	Very high
Long-Term Costs	Moderate	Moderate to low	Low (after initial investment)
Efficiency Gains	Incremental	Significant	Transformative
Public Trust	Moderate improvement	Significant improvement	High potential, but risky
Scalability	Limited	High	High (with infrastructure upgrades)
Cybersecurity Risks	Low	Moderate	High
Implementation Time	Short to medium	Medium to long	Long

Table 38

Detailed Breakdown of Costs and Benefits: ***Optimizing Current Election Technologies***

Category	Costs	Benefits
Financial	- Upgrading existing systems - Training personnel - Maintenance	- Lower upfront costs - Reduced risk of system failure
Non-Financial	- Time for implementation - Stakeholder resistance	- Improved efficiency - Enhanced transparency - Faster results

Table 39

*Detailed Breakdown of Costs and Benefits****: Adopting New Election Technologies***

Category	Costs	Benefits
Financial	- High initial investment - Piloting and testing - Training	- Long-term cost savings - Potential for international funding
Non-Financial	- Risk of technical failures - Public skepticism	- Enhanced transparency - Faster results - Improved voter confidence

Table 40

*Detailed Breakdown of Costs and Benefits****: Implementing a Full-Fledged E-Voting System***

Category	Costs	Benefits
Financial	- Significant investment in hardware/software - Training - Maintenance	- Long-term savings - Faster processes - Increased voter turnout
Non-Financial	- Cybersecurity risks - Public distrust - Scalability challenges	- Greater accessibility - Real-time results - Enhanced credibility

Table 41

Comparative Summary

Option	Best For	Key Challenges
Optimizing Current Technologies	Short-term improvements with limited budget	Limited scalability and long-term impact
Adopting New Technologies	Balancing innovation and risk, with significant long-term benefits	High upfront costs and technical risks
Implementing E-Voting	Transformative change for long-term efficiency and credibility	Very high costs, cybersecurity risks, and infrastructure requirements

Based on the analysis above, a phased approach is recommended;

1. **Short-Term:** Optimize current technologies to address immediate challenges.
2. **Medium-Term:** Pilot and adopt new technologies (e.g., blockchain, AI) in select regions.
3. **Long-Term:**Gradually implement e-voting after addressing infrastructure and cybersecurity concerns.

13.5 Conclusion

This study has demonstrated that election technology adoption in Nigeria represents a complex socio-technical challenge requiring multidimensional solutions. The empirical findings reveal that while election technologies possess transformative potential for enhancing transparency and reducing fraud, their effectiveness remains contingent on addressing interconnected legal, political, infrastructural, and social factors.

The socio-technical systems framework proved invaluable in understanding these dynamics, with 70.7% of analyzed discourse focusing on socio-technical challenges. The research confirms that election technology cannot function in isolation but must be integrated within robust institutional frameworks, stakeholder trust mechanisms, and inclusive policies. Without addressing underlying socio-political issues - particularly the perception of political interference affecting 75.9% of respondents - technological interventions will remain limited in impact.

The path forward requires embracing comprehensive socio-technical principles: recognizing technology as embedded in social contexts, prioritizing stakeholder participation, addressing infrastructure limitations, and building trust through transparency and reliability. The moderate

trust levels (46.9%) combined with recognition of political interference and technical unreliability suggest Nigeria's election technology ecosystem stands at a critical juncture.

Moving forward, this study advocates for continued research, policy innovation, and multi-stakeholder engagement to create a resilient and technologically sound electoral system. By implementing the evidence-based recommendations outlined, policymakers and electoral bodies can enhance the credibility, security, and inclusivity of elections, ultimately reinforcing democratic governance for future generations. The success of election technology in Nigeria will depend not on technical sophistication alone, but on creating socio-technical systems that earn citizens' trust while serving democratic ideals.

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Appendix

1. **Survey Instrument**

A Socio-Technical Examination of Technology Applications in Nigerian Elections

Section 1: Demographics & Roles

This section collects background data relevant to understanding the influence of socio-political contexts and the various stakeholders.

- **Age:**
- **Gender:**
- **Occupation:**
- **Educational Level:**
- **Electoral Role (Voter, Election Official, Observer, etc.):**
- **State/Region (based on the geopolitical zones):**

Section 2: Awareness & Adoption of Technology

This section investigates respondents' familiarity with election technologies, a key socio-technical factor.

1. **How familiar are you with the use of technology in Nigerian elections?**
   (Scale: 1 - Not Familiar to 5 - Very Familiar)
2. **Which election technologies are you aware of?**
   (e.g., BVAS, IReV, Smart Card Reader, etc.)
3. **To what extent do you believe technology improves election transparency and integrity?**
   (Scale: 1 - Very Ineffective to 5 - Very Effective)
4. **Do you think the introduction of technology has reduced electoral fraud?**
   (Scale: 1 - Strongly Disagree to 5 - Strongly Agree)

Section 3: Cultural & Social Factors

This section explores how socio-cultural norms and political influences shape the adoption and perception of technology.

1. **To what extent do you trust election technologies (e.g., BVAS) to ensure accurate results?**
   (Scale: 1 - No Trust to 5 - Complete Trust)

2. **Do you believe the influence of political parties affects the deployment of election technology?**
   (Scale: 1 - No Influence to 5 - Very Strong Influence)
3. **How do cultural beliefs in your region impact the acceptance of election technologies?**
   (Scale: 1 - No Impact to 5 - Significant Impact)
4. **How important is voter education for the successful implementation of election technologies?**
   (Scale: 1 - Not Important to 5 - Very Important)

Section 4: Technology & Infrastructure

This section measures the readiness of technological infrastructure, a critical part of the socio-technical analysis.

1. **How accessible are election technologies like BVAS and IReV in rural areas?**
   (Scale: 1 - Not Accessible to 5 - Very Accessible)
2. **How often do technical failures occur during elections?**
   (Scale: 1 - Never to 5 - Very Often)
3. **What technical challenges do you think hinder the full potential of election technologies?**
   (e.g., Power Supply, Internet Connectivity, etc.)
4. **What improvements do you believe can be made to Nigeria's electoral infrastructure?**
   (Open-ended)

Section 5: Trust, Integrity & Electoral Processes

This section examines how technology impacts public trust and the integrity of election outcomes.

1. **How confident are you in the ability of current election technologies to ensure free and fair elections?**
   (Scale: 1 - Not Confident to 5 - Very Confident)
2. **To what extent do you think election technologies have improved the transparency of the electoral process?**
   (Scale: 1 - Very Ineffective to 5 - Very Effective)
3. **How would you rate the effectiveness of election technologies in reducing vote manipulation?**
   (Scale: 1 - Very Ineffective to 5 - Very Effective)
4. **What measures can improve trust in the use of technology in future elections?**
   (Open-ended)

Section 6: Institutional & Policy Framework

This section aligns with the research's aim to identify guidelines for policymakers.

1. **Do you think the government provides sufficient support for the implementation of election technologies?**
   (Scale: 1 - Strongly Disagree to 5 - Strongly Agree)
2. **What role do you think international organizations or NGOs should play in ensuring the effective use of technology in Nigerian elections?**
   (Open-ended)
3. **What policy changes are necessary to improve the implementation and sustainability of election technologies?**
   (Open-ended)

Section 7: Future of Election Technologies

This section focuses on respondents' perspectives on the future evolution of election technologies in Nigeria.

1. **What additional technologies do you believe could enhance electoral processes in Nigeria?**
2. **What steps should Nigeria take to align election technologies with global best practices?**
   (Open-ended)
   - ---

2. <u>List of documents analyzed</u>