

A COMPARATIVE ANALYSIS OF BIOMETRIC TECHNOLOGY IN GHANA AND
NIGERIA'S ELECTORAL SYSTEMS: PRE- AND POST-IMPLEMENTATION



A Research Report submitted at the Faculty of Humanities, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Arts in International Relations

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Declaration

I declare that this Research Report is my own unaided work, and I have acknowledged, cited and referenced all the sources used. It is submitted for the degree of Master of Arts in International Relations, in the Faculty of Humanities, School of Social Sciences at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree at any other university.

Candidate: Keletso Winnie Ngwanaamonna

A handwritten signature in black ink, appearing to read 'Ngwana', written over a horizontal line.

Signature

Date: March 2025

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Abstract

The adoption of biometric technology (BT) in African nations aims to enhance electoral integrity, but its effectiveness remains debated. This study examines the effectiveness of BT in improving the integrity of electoral systems in Ghana and Nigeria. It argues that while BT has improved voter registration accuracy, reduced fraud, and strengthened public trust, its impact remains contingent on the broader electoral governance framework. The study adopts a qualitative comparative case study approach, analysing data from election observation reports, peer-reviewed literature, and official election documents. It applies Mozaffar and Schedler's electoral governance framework to assess BT within the broader contexts of rule-making, rule application, and rule adjudication. Ghana and Nigeria's electoral systems are analysed across three phases— pre-implementation, implementation, and post-implementation years. The findings reveal that BT has significantly improved electoral integrity in both countries by reducing multiple registrations, increasing voter roll accuracy, reducing multiple voting and impersonation, and enhancing public trust in elections. However, the study found that some challenges persist, including technical failures, susceptibility to political manipulation, and accessibility issues. The study contributes to existing literature by offering a comparative perspective on how similar technologies may yield different outcomes across distinct political environments. It recommends strengthening legal frameworks, improving technical infrastructure, and enhancing voter education to maximise BT's effectiveness. By addressing these gaps, the study advances scholarly discussions on electoral governance and provides policy insights for electoral management bodies in Africa.

Keywords: Biometric Technology; Voter Registration; Voter Verification; Electoral Integrity; Electoral Governance; Electoral Fraud; Public Trust; Electoral Reform; Ghana; Nigeria.

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Abbreviations

AFIS	Automated Fingerprint Identification System
BT	Biometric Technology
BVD	Biometric Verification Device
BVR	Biometric Voter Registration
BVV	Biometric Voter Verification
CODEO	Coalition of Domestic Election Observers
COG	Commonwealth Observer Group
CPC	Congress for Progressive Change
CSO	Civil Society Organisation
DDC	Direct Data Capture
EC	Electoral Commission
ECG	Electoral Commission of Ghana
ECOWAS	Economic Community of West African States
EMB	Electoral Management Body
EOM	Election Observation Mission
EU EOM	European Union Election Observation Mission
EVR	Electronic Voter Register
INEC	Independent National Electoral Commission
IPAC	Inter-Party Advisory Committee

MSSD	Most Similar Systems Design
NDC	National Democratic Congress
NDI	National Democratic Institute
NDPR	Nigerian Data Protection Regulation
NPP	New Patriotic Party
OMR	Optical Mark Recognition
PVC	Permanent Voter Card
RATech	Registration Area Technical Support
SCR	Smart Card Reader

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Chapter 1: Introduction and Background

1.1. Introduction

In the context of African democracies, where maintaining electoral integrity and transparency is crucial for upholding democratic principles, the role of technology has gained increasing significance in election management and democratic development (Idowu, 2021). Among these technological advancements, biometric technology (BT) stands out as a significant tool deployed to enhance the quality of elections and democratic processes (Wolf et al., 2017). As contemporary democracies continue to grapple with safeguarding the integrity of their electoral systems, BT has emerged as a potential solution, offering both promise and controversy (Timcke & Hlomani, 2023). Various African nations, including Kenya, Zimbabwe, Ghana and Nigeria, have adopted diverse forms of BT for election administration to tackle the myriad challenges within their electoral frameworks, such as voter impersonation, multiple voting and bloated voter registers (Effah & Debrah, 2018; Fatai & Adisa, 2017; Idowu, 2021).

Ghana initiated the deployment of BT in 2012. Nigeria embraced it earlier in 2007, but it was later abandoned in the elections due to insufficient supply and technical failures, resulting in the Independent National Electoral Commission (INEC) resorting to manual registration procedures (Braimah et al., 2017; National Democratic Institute [NDI], 2008; Wolf et al., 2017). Despite Ghana's commendable democratic trajectory since 1992, its subsequent elections were frequently marred by allegations of fraud (Krawczyk, 2019). On the other hand, Nigeria has faced significant challenges regarding electoral integrity, particularly due to a history marked by military coups between 1966 and 1999 (Ajayi & Ojo, 2014). Post-military rule, Nigerian elections have been characterised by pervasive issues, including violence, intimidation, bribery, vote rigging, and corruption (Ogbeidi, 2010). However, BT has contributed positively to fostering cleaner, freer, and fairer elections, as evidenced by Nigeria's 2015 general elections, where the utilisation of smart card readers (SCRs) and biometric voter registration (BVR) played a pivotal role in ensuring success (Idowu, 2021). Moreover, the deployment of BT in Ghana has notably enhanced electoral credibility and peace (Mahama, 2020). A 2012 report by the Coalition of Domestic Election Observers (CODEO), cited in Idowu (2021), found a substantial increase in citizens' trust in the electoral system, with 78% of sampled Ghanaians acknowledging that BT has significantly improved elections, and 87% regarding BT as a crucial tool for fostering credible and peaceful electoral processes.

Nonetheless, it is essential to acknowledge the utility of other non-technological election methods. For instance, The Gambia's unique marble voting system, used since 1965, offers a transparent and accessible approach, especially in low-literacy contexts. In this system, voters drop a single marble into a color-coded metal drum representing their candidate, triggering a bell sound that ensures one vote per person without compromising secrecy (BBC, 2021; Africanews, 2021; Omotosho, 2020). Marbles are then counted using trays with pre-drilled holes, allowing quick and verifiable results (International IDEA, 2021). Despite some calls for reform, international observers have praised the system's integrity and simplicity (EU EOM, 2021). While these methods present valuable alternatives in understanding electoral dynamics, this study narrows its scope to explore the specific implications and outcomes associated with the implementation of BT. In particular, it aims to analyse how BT has influenced electoral processes, emphasising aspects such as transparency, voter participation, and electoral outcomes within the frameworks of Nigeria and Ghana's electoral systems pre- and post-implementation. Therefore, the core research question driving this study is: *How effective is biometric technology in improving the integrity of electoral systems in Ghana and Nigeria?* This study contends that the appropriate implementation of BT can substantially augment the integrity of electoral processes in African countries facing challenges, such as fraudulent voter registration, multiple voting, and voter impersonation. However, its effectiveness can be undermined by broader electoral governance challenges.

The subsequent sections of this paper delve into the background of the subject matter, articulating the problem statement and rationale. A preliminary literature review is conducted to elucidate existing arguments and identify research gaps to be addressed by this study. Furthermore, the conceptual framework guiding this study focuses on electoral governance, electoral integrity, and the role of BT. The methodology encompasses qualitative research methods, deductive reasoning, process-tracing techniques, before-after analysis, and case study investigations. Case studies analysing Ghana and Nigeria's elections pre- and post-BT implementation are conducted, followed by a comparative analysis, leading to the formulation of recommendations based on the findings.

1.2. Background

Since Africa's third wave of democracy in the 1990s, there have been growing concerns regarding the real democratic nature of elections, particularly over whether their results truly

represent the voters' wishes (Ibeanu, 2022; Makulilo & Henry, 2017). Scholars and citizens have also expressed concerns about the increasing number of blatantly flawed electoral processes, the ruling parties' apparent permanent hold on power, and the neutrality of Electoral Management Bodies (EMBs) (Gyekye-Jandoh, 2017; Ibeanu, 2022). As a result, Ibeanu (2022) posits that election observers have increasingly focused on assessing the democratic nature of African elections rather than merely measuring the quantity and frequency of elections. To address challenges and ensure free, fair, and credible elections, countries such as Kenya, Nigeria and Ghana have launched various strategic initiatives such as amending legal frameworks, adopting more inclusive and transparent processes, improving relationships with citizens, and professionalising EMBs. However, some of these efforts have not fully resolved persistent issues such as electoral interference and vote rigging, which remain significant concerns across the continent. In these situations, a party, particularly the incumbent party, regularly rigs election results with all its rich resources to hold onto power for an extended period, especially when the constitution allows for extended terms (Alam et al., 2020; Fundisi & Atanga, 2023). Nigeria is a notable example of this, whereby incumbents have used violence, voter suppression, bribery and other forms of corruption to rig elections (Afolabi, 2020; Oyekanmi et al., 2024; Peter, 2024).

The long history of military rule on the continent institutionalised a culture of authoritarianism. For instance, Ghana's post-colonial history experienced numerous political upheavals, including military coups and periods of authoritarian governance (Abass, 2024). Between 1981 and 1992, Jerry John Rawlings led a military junta formed by the Provisional National Defence Council. However, Ghana transitioned to multiparty democracy in 1992, resulting from external pressures from civil society organisations (CSOs), the international community, the International Monetary Fund, and the World Bank (Haruna, 2022). The 1992 elections were perceived as a significant step towards democratic governance. However, they were contentious, with the opposition party, the New Patriotic Party (NPP), alleging electoral fraud and calling for a system overhaul (Van Gyampo, 2017). In response, several reforms were implemented, including the establishment of the Electoral Commission of Ghana (ECG) in 1993, which marked a significant milestone in Ghana's electoral history. Supported by the 1992 Fourth Republic Constitution, the ECG was established as an independent body responsible for conducting and safeguarding electoral integrity (Owusu-Ansah, 2023).

In 1994, the Inter-Party Advisory Committee (IPAC) was established to address issues related to electoral processes and improve training for election officials responsible for voter registration. Additionally, ahead of the 2012 elections, biometric registration and verification systems were introduced to prevent electoral fraud and enhance the integrity of the elections and results. This included the use of both photo and fingerprint identification cards, rather than fingerprints alone (Van Gyampo, 2017). These reforms have contributed to improving the integrity and transparency of Ghana's electoral system.

However, challenges remain, as demonstrated by the protracted election petition process following the 2012 elections. The NPP contested the narrow victory of the National Democratic Congress (NDC) in court, alleging unfair electoral practices. Although the Supreme Court rejected the NPP's appeal, mistrust between the NPP and NDC grew due to acknowledged electoral irregularities during the hearings, including unverified voters, over-voting, and unsigned result declarations. These issues raised concerns about potential voter fraud and the integrity of future elections (Kumah-Abiwu, 2017). While widespread electoral violence has not been prevalent in Ghana, isolated instances of violent harassment and voter intimidation have occurred during elections (Asunka et al., 2017).

In Nigeria, the 1979 and 1999 constitutions were developed and implemented during periods of military rule. The military ethos significantly influenced the democratic politics of post-military governments, prioritising force over reasoning and persuasion, which are essential elements of democracy (Afolabi, 2020). The cycle of electoral violence in Nigeria has deep roots in the colonial legacy, which established an unstable post-colonial state marked by ethnic competition, power concentration, and a "do or die" mentality among political leaders. Post-independence leaders inherited a tradition of centralised, autocratic rule that intensified competition for resource control, resulting in widespread electoral violence. Moreover, ethnicity has often been manipulated as a political tool, leading to the appointment of leaders based on ethnic loyalty rather than merit (Monday & Simon, 2013). Electoral practices in Nigeria have thus often been characterised by violent clashes and a zero-sum political climate. The political elite's focus on power has driven undemocratic behaviours, as they use elections to exert economic influence and engage in patronage politics. Consequently, electoral fraud and violence have become pervasive features of the country's democratic process (Duruji et al., 2021; Fatai & Adisa, 2017).

Electoral integrity remains a central concern in Nigeria's democratisation debate, consistently eroded by corruption within electoral governing bodies. This erosion began with the Federal Electoral Commission during Obasanjo's military rule in 1979 and persisted after its transformation into the Independent National Electoral Commission (INEC). These institutions have faced ongoing allegations of electoral misconduct (Ezeonwuka, 2021; Monday & Simon, 2013). For instance, under Obasanjo's administration, the INEC demonstrated partisanship by favouring the ruling party and allowing the executive to predetermine electoral outcomes (Ezeonwuka, 2021). Odusote (2014) asserts that Nigeria's political and electoral systems were plagued by issues such as banditry, vote rigging, candidate imposition, and ballot box stuffing, all stemming from the desperation of leaders to maintain their grip on power.

In this context, many African nations have recognised the potential of BT to improve electoral integrity and foster sustainable democratic practices. Biometric systems have become prominent tools for voter registration, authentication, and identification across various African electoral processes (Idowu, 2021). For instance, Nigeria's INEC first implemented biometric registration systems in 2007 to combat issues related to multiple registrations and impersonation, which have historically undermined electoral legitimacy (Yakubu, 2023). Similarly, Ghana adopted BT during its 2012 general elections, marking a significant advancement in its electoral framework (Idowu, 2021). Research indicates that the implementation of biometric systems can not only enhance the integrity of elections but also increase public confidence in democratic processes (von Spakovsky, 2012). By leveraging this technology, nations can mitigate the risks of electoral malfeasance and cultivate a more inclusive and participatory democratic environment, ultimately contributing to the long-term stability and effectiveness of governance in the region (Afolabi, 2020).

Implementing biometric voter registration and identification technologies is imperative because voter registration is a critical electoral process that helps to ensure the integrity of elections through authentication measures such as verifying citizenship at registration and identity at the polls. These measures increase public confidence in the electoral process while preserving the opportunity for all eligible voters to participate. BT can thus help prevent fraud such as impersonation, duplicate voting, and voting by ineligible individuals (von Spakovsky, 2012). Isong et al. (2013) argue that problems with voter registration compromise the credibility and integrity of elections and, subsequently, the overall quality of democracy. Therefore, it is crucial to maintain the integrity of elections through a credible voter registration

and authentication system. A study by Snyder (2013) also found a causal relationship between voter registration problems and the increase in the probability of electoral violence. He contends that issues with voter registration can serve as catalysts for violence by heightening perceptions of electoral fraud, as evidenced by the voter disenfranchisement and civil unrest during the 2003 Guatemalan elections caused by flawed voter rolls.

Therefore, this research underscores the necessity of implementing robust biometric technology to ensure the integrity of voter registration and, by extension, the electoral process as a whole. Moreover, given the historical context of electoral challenges faced by both Ghana and Nigeria, it is imperative to critically assess the role of biometric technology in fostering electoral integrity using these cases as examples.

1.3. Problem statement

The electoral systems of Ghana and Nigeria have faced persistent challenges related to electoral integrity, including fraud, irregularities, and a lack of public trust. In response, both countries have adopted biometric technology (BT) to enhance election credibility and transparency. However, despite these efforts, concerns remain about the technology's effectiveness in addressing issues such as fraudulent voter registration, multiple voting, and voter impersonation. While existing literature has explored the successes and limitations of biometric voter registration (BVR) systems, there is a lack of comparative studies assessing the impact of BT across African electoral contexts. Additionally, limited research has focused on the relationship between BT implementation and electoral integrity.

1.4 Aim of the study

This study examines the role of biometric technology in improving electoral processes in Ghana and Nigeria, focusing on the pre-, during, and post-implementation phases of key elections— an approach that has not been fully explored in previous research. By doing so, it seeks to identify BT's strengths, weaknesses, and potential for enhancing electoral transparency and trust, paving the way for a deeper exploration of the central research question.

1.5 Main Research Question

The overarching research question that this study seeks to answer is: *To what extent has biometric technology improved the integrity of electoral processes in Ghana and Nigeria?*

Sub-questions:

- i. What are the strengths and weaknesses of biometric technology in addressing electoral challenges such as multiple registrations, multiple voting, and impersonation in Ghana and Nigeria?
- ii. How have the different phases of biometric technology adoption (pre-, during, and post-implementation) influenced electoral transparency, electoral outcome credibility, and public trust in Ghana and Nigeria?
- iii. What lessons can be learned from Ghana and Nigeria's experiences with biometric technology to inform future applications in electoral processes of other African countries (i.e. strengths, weaknesses, opportunities and threats of BT in electoral systems of other African countries)?

1.4. Hypotheses

Main hypothesis (H1): Biometric technology improves the integrity of electoral systems in Ghana and Nigeria by reducing fraudulent practices such as multiple registrations, multiple voting, and voter impersonation.

H2: Biometric technology enhances the efficiency and accuracy of voter registration and verification, and strengthens public trust in the electoral process in Ghana and Nigeria.

H3: Despite its benefits, biometric technology faces challenges such as technical issues, vulnerabilities to manipulation, and accessibility barriers for marginalised populations.

1.5. Rationale

This study's rationale is rooted in the essential role of electoral integrity in sustaining democratic governance and fostering public trust in electoral processes. As representative democracies in Africa, both Ghana and Nigeria have confronted significant challenges regarding the credibility and transparency of their electoral systems. Issues such as allegations of fraud, irregularities, and a pervasive lack of public confidence in electoral outcomes have persisted. In response, adopting BT in these countries has been perceived as a promising approach to enhancing electoral integrity.

However, despite the implementation of BT, there remain critical questions regarding the extent to which BT has effectively mitigated electoral fraud, ensured accurate voter

registration, and bolstered the overall credibility of elections. This study aims to contribute to the existing body of knowledge on electoral governance and the application of technological interventions in electoral processes by examining the efficacy of biometric technology within the electoral systems of Ghana and Nigeria. It will identify the strengths and weaknesses of BT implementation, assess its impact on reducing instances of fraudulent practices, and evaluate its role in fostering public trust and confidence in electoral outcomes.

Understanding the degree to which BT has succeeded or encountered challenges in improving electoral integrity in these countries is vital for policymakers, electoral authorities, civil society organisations (CSOs), and researchers. The findings of this study will provide insights that can inform evidence-based decision-making, guide future policy interventions, and improve electoral practices not only in Ghana and Nigeria but also in other democracies globally that face similar challenges. Importantly, while the introduction of BT is aimed at minimising corrupt practices, it is crucial to recognise the irreplaceable value of human capital in ensuring a fair and transparent electoral process.

1.6. Methodology

The study employs a multi-method qualitative approach, combining deductive reasoning, process tracing, and before-after analysis to assess the effectiveness of BT implementation. Moreover, it utilises a small-N case study design, which allows for a detailed examination of a limited set of cases (Panke, 2018). The small-N design is particularly suited for exploring complex processes and contextual factors in depth. In this study, Ghana and Nigeria are selected as case studies using John Stuart Mill's Method of Difference, more commonly referred to in comparative politics as the Most Similar Systems Design (MSSD). This design compares cases that are similar in many relevant aspects, such as political history, geographic location, institutional structures, and regional commitments, but differ in the outcome of interest, allowing researchers to isolate and examine the effects of a particular variable (George & Bennett, 2005a; Mill, 1843). Rooted in Mill's *System of Logic*, the MSSD assumes that if two cases are alike in all relevant ways except for the phenomenon being studied, then the factor that differs may help explain the observed variation in outcomes (Mill, 1843).

Ghana and Nigeria share several key characteristics: both are located in West Africa, have implemented biometric technology (BT) in their electoral systems, and are signatories to regional frameworks such as the African Charter on Democracy, Elections and Governance and the ECOWAS Protocol on Democracy and Good Governance. These shared traits make them ideal for exploring how BT may differentially influence electoral integrity and public trust within similar governance contexts (African Union, 2023; ECOWAS, 2001). By applying Mill's logic of comparison, the study isolates and examines how differences in implementation, institutional robustness, or political will may account for divergent outcomes between the two countries.

1.6.1. Data Collection

Data is collected from primary and secondary sources, including government reports, election observation reports from international organisations and regional bodies, journal articles, and reports from the European Union Election Observation Mission, The Carter Center, and The Commonwealth Group.

1.6.2. Data Analysis

The analysis involves:

- **Thematic Analysis:** Identifying key themes and patterns regarding the implementation and effectiveness of biometric technology in electoral systems. Data will be coded to highlight strengths, weaknesses, and the overall impact of BT.
- **Process Tracing:** Examining the causal relationships between BT implementation and changes in electoral integrity, public trust, and instances of fraud or irregularities. This method will help understand the dynamics at play before and after the introduction of BT.
- **Before-After Analysis:** Comparing electoral data and outcomes from elections conducted before and after the implementation of BT in both countries. This analysis will identify any significant changes in electoral integrity and public perception.

The identified key variables that explain the relationship between BT and electoral integrity are as follows:

1.6.3. Independent and dependent variables

Panke (2018) defines a dependent variable as a phenomenon that embodies an effect of interest, whereas an independent variable is a phenomenon that causes changes in the dependent variable. In this study, the dependent variable is “improvement in integrity” in electoral systems, while the independent variable is “the implementation of biometric technology in electoral systems.” The relationship between these variables is explored through multiple hypotheses, which will be detailed and operationalised later in this chapter.

Panke (2018) also defines x-centred research as one that aims to explain an observed variance in the effects of an independent variable. This also indicates that the study will be deductive (theory-testing) and explanatory. X-centred explanatory research projects focus on an independent variable and attempt to determine the effects a change in this variable is likely to create (Panke, 2018). Scientifically answering a research question deductively requires selecting theories and developing hypotheses based on those theories, which are then methodologically examined. In this way, the researcher can find empirical support for one or more hypotheses or reject them. Deductive research also allows for refinements, for instance, by defining scope conditions or causal mechanisms of the initial theories, resulting in generalised insights (Panke, 2018). Therefore, this paper is x-centred, explanatory, and deductive as it assesses the implementation of biometric technology in electoral systems to improve electoral integrity.

Additionally, this paper explores Ghana and Nigeria’s elections before and after the implementation of BT. The before-after research design will help answer the research question more effectively. George and Bennet (2005a) argue that splitting one longitudinal case into two (before and after) gives the investigator more control and allows them to better understand the effects of a change in a variable.

The variables in this study are operationalised as follows:

Table 1: Main hypothesis (H1)

Hypothesis	H1: Biometric technology improves the integrity of electoral systems in Ghana and Nigeria by reducing fraudulent practices such as multiple registrations, multiple voting, and voter impersonation.
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Variables	Independent Variable: Implementation of Biometric Technology (BT) Dependent Variable: Improvement in Electoral Integrity
Operationalisation:	
Independent Variable: Implementation of BT	
Indicators	• Adoption of Biometric Voter Registration (BVR) and Biometric Voter Verification (BVV) • The process and strategies employed by Electoral Management Bodies (EMBs) for BT implementation • The legal and regulatory frameworks supporting BT implementation
Measurement	Data is collected from academic sources (journals, books, reports) and election observation reports, analysing the efficiency, transparency, and procedural integrity of EMBs in implementing BVR and BVV.
Dependent Variable: Improvement in Integrity	
Indicators	• A decrease in electoral fraud and irregularities, such as fraudulent voter registration, multiple voting, voter impersonation, and ballot stuffing.
Measurement	Qualitative analysis of election observation reports and academic literature (journal articles, books, reports) assessing detection and reduction in multiple and duplicate registrations, and multiple voting.

Source: Author's design/development

Table 2: Hypothesis 2 (H2)

Hypothesis	H2: Biometric technology enhances the efficiency and accuracy of voter registration and verification, and strengthens public trust in the electoral process in Ghana and Nigeria.
Variables	Independent Variable: Implementation of Biometric Technology (BT) Dependent Variables: • Efficiency of voter registration and verification • Accuracy of voter registration and verification • Public Trust in the electoral process
Operationalisation:	
Independent Variable: Implementation of BT	
Indicators	• Adoption of BVR and BVV • The process and strategies employed by EMBs for BT implementation • The legal and regulatory frameworks supporting BT implementation

Measurement	Data is collected from academic sources (journals, books, reports) and election observation reports, analysing the efficiency, transparency, and procedural integrity of EMBs in implementing BVR and BVV.
Dependent Variables: • Efficiency of voter registration and verification • Increased Accuracy of voter registration and verification • Public Trust in the electoral process	
Indicators	1. Efficiency of Voter Registration and Verification: • Streamlining of voter registration and verification processes 2. Accuracy of Voter Registration and Verification: • Detection and elimination of duplicate registrations • Removal of deceased individuals from the voter roll • Reliable voter identification through biometric verification 3. Public Trust in the Electoral Process: • Perceptions of fairness in the electoral process • Belief that BT improves the credibility of voter registration • Reduction in post-election violence and disputes
Measurement	• Voter Registration and Verification Accuracy: Measured by reports on the reduction in duplicate registrations and multiple voting, elimination of deceased voters from the roll, and the reliability of voter verification processes. • Efficiency: Assessed through the number of voters successfully registered within a specific timeframe, and improvements in logistical coordination from election reports and academic studies. • Public Trust in the Electoral Process: Data will be evaluated from election observation reports, academic literature and Afrobarometer surveys on public perceptions of BT and electoral fairness.

Source: Author's design/development

Table 3: Hypothesis 3 (H3)

Hypothesis	H3: Despite its benefits, biometric technology faces challenges such as technical issues, vulnerabilities to manipulation, and accessibility barriers for marginalised populations.
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Variables	Independent Variable: Implementation of BT Dependent Variables: • Technical issues • Vulnerabilities to manipulation • Accessibility barriers for marginalised populations
Operationalisation:	
Independent Variable: Implementation of BT	
Indicators	• Adoption of BVR and BVV • The process and strategies employed by EMBs for BT implementation • The legal and regulatory frameworks supporting BT implementation
Measurement	Data is collected from academic sources (journals, books, reports) and election observation reports, analysing the efficiency, transparency, and procedural integrity of EMBs in implementing BVR and BVV.
Dependent Variables: • Technical issues • Vulnerabilities to manipulation • Accessibility barriers for marginalised populations	
Indicators	• Technical Challenges: System failures, machine breakdowns, power supply issues, connectivity problems, and training deficiencies among election officials. • Vulnerabilities to Manipulation: Exploitable system weaknesses, incidents of human interference, and institutional gaps that undermine process integrity. • Accessibility Issues: Barriers faced by marginalised groups (e.g. elderly, disabled voters or rural populations) in the electoral process.
Measurement	• Technical Challenges: Analysis of qualitative data from academic literature, official reports, and election observation mission reports regarding technical issues encountered during implementation. • Vulnerabilities to Manipulation: Examination of documented cases of manipulation in reports and academic studies, focusing on instances where technological or institutional flaws allowed for electoral interference. • Accessibility Issues: Assessment of election observation reports and studies highlighting challenges such as infrastructure limitations or socio-economic factors affecting accessibility.

Source: Author's design/development

1.6.4. Process-tracing

This study employs process-tracing to attempt to prove causality between the independent and dependent variables. George and Bennet (2005b) define process-tracing as a method that seeks to identify the causal chain and causal mechanism between the outcome of the dependent and an independent variable. The authors find this process useful as it not only produces multiple observations within a case but is also an essential technique for theory development and testing since the observations need to be linked in certain ways in order to provide an explanation for the case. Tracing the processes that could have resulted in the particular outcome will allow this paper to find alternative paths through which the outcome could have occurred, thus providing the opportunity to map out one or more plausible causal paths that are consistent with the outcome and the evidence from process-tracing in this case. These observations are an effective means of drawing conclusions because of their inherent lack of independence (George & Bennet, 2005b).

Consequently, this study assesses electoral integrity in Ghana's 2008 general elections and Nigeria's 2003 general elections before implementing BT in their elections and after they introduced these systems in the 2012 and 2011 elections, respectively. This approach helps understand the motivations behind adopting BT in each country's electoral process, analyse implementation challenges, and assess its impact on voter registration, verification, efficiency, and preventing electoral malpractices such as voter impersonation, multiple voting, and ballot stuffing. It also evaluates the effect of vote counting and public trust on election results.

To manage the wide scope of election years, the study focuses on specific factors related to voter registration and identification/authentication during the pre-election and election-day phases, as BT is applied only during these times. Additionally, the study considers the perceived integrity of the elections as reported by the public, political parties, and election observation missions.

1.7. Significance of the study

By analysing the effect of biometric technology on electoral integrity, this study will provide valuable insights for policymakers and electoral bodies in West Africa, contributing to the improvement of election processes. The findings could also inform future biometric implementations in other African countries facing similar electoral challenges.

1.8. Ethical Consideration

This study on BT in the electoral systems of Ghana and Nigeria received an ethics waiver, as it does not involve human participants or direct interaction. The research utilises qualitative methods, including deductive reasoning, process tracing, before-after analysis, and case studies based on secondary data sources, ensuring no ethical dilemmas related to participant confidentiality or consent.

- **Data Privacy:** All secondary data will be sourced from reputable, publicly accessible materials, maintaining the integrity and confidentiality of the information.
- **Transparency:** The research methodology and analytical techniques will be documented clearly to ensure the replicability and credibility of the findings.
- **Ethical Research Practices:** The study will uphold ethical research practices by conducting a thorough literature review and presenting findings in a balanced manner to support informed decision-making.

By following these ethical considerations, the study seeks to enhance understanding of electoral integrity while promoting best practices in research conduct.

1.9. Limitations of the Study

This research is not without limitations. While providing valuable case studies, the focus on Ghana and Nigeria may limit the generalisability of the findings to other contexts. Furthermore, relying on secondary data, rather than firsthand accounts of experiences from voters and other stakeholders, could introduce biases or gaps in the analysis. Despite these limitations, the study offers a strong foundation for understanding the effect of BT on electoral integrity in developing democracies.

1.10. Structure of the Study

Chapter One introduces the study by providing a brief background, outlining the research problem, aims, research questions, and hypotheses. It also highlights the significance of the study and the methodological approach adopted.

Chapter Two constitutes the literature review, which examines existing scholarship on biometric technology (BT) in elections, focusing on its opportunities and challenges.

Chapter Three outlines the conceptual framework for the study by interlinking electoral governance, electoral integrity, and BT. It begins by defining electoral governance and exploring how its components—such as legal frameworks, institutional capacities, and public perceptions—impact the adoption and implementation of BT.

Chapters Four and Five present the country-specific findings on the implementation of BT in elections in Ghana (2008, 2012, 2020) and Nigeria (2003, 2011, 2019), respectively. Each chapter is organised chronologically, focusing on three phases: pre-implementation, implementation, and post-implementation of BT. Each chapter also includes findings on the role of electoral governance in shaping the implementation process.

Chapter Six provides a critical analysis and interpretation of the findings, addressing the overarching research question, sub-questions, and hypotheses. It includes a comparative analysis of Ghana and Nigeria, identifying patterns, similarities, and differences in the implementation and effectiveness of BT in reducing electoral fraud.

Chapter Seven concludes the study by summarising the key findings and their implications for the research questions and hypotheses. It reflects on the effectiveness of BT in improving electoral integrity in Ghana and Nigeria, highlighting both strengths and limitations. The chapter also discusses the broader significance of the findings for electoral governance and integrity in Africa and offers recommendations for future research and policy. Finally, it addresses the study's limitations and proposes directions for further exploration.

Chapter 2: Literature Review

2.1. Introduction

This chapter offers a detailed review of the existing literature on the application of biometric technology (BT) in elections, with a particular emphasis on biometric voter registration (BVR) and biometric voter verification (BVV) systems. It critically examines global debates surrounding the effectiveness of these technologies in strengthening the integrity of electoral processes, focusing on their ability to reduce voter fraud, ensure accurate voter rolls, and enhance the overall credibility of elections. Additionally, the chapter addresses the challenges, such as the socio-political context, legal and ethical concerns that affect BT deployment. These emphasise the need for comprehensive regulatory mechanisms, political commitment, and institutional capacity to maximise the benefits of BT while addressing its limitations. By examining both the opportunities and challenges of BT, this chapter provides a balanced perspective on its influence on democracy, electoral integrity, and the future of election management worldwide.

2.2. Opportunities of Biometric Technology in Elections

Biometric technology (BT) has many benefits for electoral processes, enhancing the efficiency, credibility, and transparency of elections. These opportunities can be broadly categorised into the creation of accurate voter rolls, the reduction of electoral fraud, the improvement of electoral administration, and the enhancement of public trust in the electoral system. The adoption of BVR and BVV has played a critical role in reinforcing the integrity of elections by providing more secure, efficient, and transparent methods for voter registration, identification, and verification. However, while BT brings several positive transformations, it is crucial to evaluate its challenges and limitations in the electoral context.

2.2.1. Reduced Electoral Fraud

A prominent argument in favour of BT is its potential to reduce fraudulent practices such as multiple registrations, multiple voting, voter impersonation, and ballot stuffing. Several studies highlight its ability to enhance election integrity by addressing these challenges at key stages—registration and voting. During voter registration, it ensures individuals register only once by

eliminating duplicates, while on Election Day, BVV helps prevent voter impersonation or multiple voting. Additionally, comparing the number of verified voters to the number of ballots cast can help detect ballot stuffing, a prevalent issue in many developing countries (Jacobsen, 2019; Krawczyk & Davis-Roberts, 2020; Sibe & Kaunert, 2023). For instance, for Pakistan's 2013 voter roll, BT revealed that approximately 45% of the existing entries were either duplicates or unverified identities, some of which belonged to individuals registered multiple times. This led to a comprehensive clean-up and the registration of 36 million valid voters, resulting in a more accurate, centralised voter list that ensured each citizen had only one vote (Malik, 2014). Similarly, the Kenyan Integrated Elections Management Systems used BT in the 2017 elections to prevent electoral fraud, such as over-voting by automatically rejecting results whereby the total votes cast exceeded the number of voters registered at a polling station (Simiyu, 2022). However, the extent of BT's effectiveness is contested. While cases such as Pakistan show success, others argue that fraud reduction is contingent on broader institutional support. BT may prevent individual-level fraud, but it cannot address systemic manipulation such as vote buying, intimidation, or biased electoral commissions (ECs) (Cheeseman et al., 2018). Therefore, while BT has demonstrated its capacity to reduce certain forms of electoral fraud, its broader impact on electoral credibility may be influenced by the political and institutional context in which it is implemented.

2.2.2. Accuracy of the Voters' Roll

The accuracy of the voters' roll is another major advantage attributed to BT. By eliminating duplicate and ineligible registrations, BVR helps create an updated and reliable voter roll, addressing concerns related to outdated and manipulated registers, such as instances of deceased or duplicate voters (Dziva et al., 2020; Wolf et al., 2017). For example, Bolivia's 2009 elections witnessed a significant improvement in its voter register after BVR was introduced to address concerns about the accuracy of its voter roll, which had increased from 3 million to 5 million by including previously undocumented citizens (Gelb & Clark, 2013; Gelb & Diofasi, 2019). Additionally, in Sierra Leone's 2012 elections, BVR helped identify multiple and duplicate registrations, which occurred due to political parties bringing in foreign nationals to vote in constituencies where they were not eligible (Dziva et al., 2020). Yet, while these examples point to enhanced accuracy, other scholars argue that the technology itself does not eliminate structural weaknesses. Without political will and rigorous oversight, the risk of manipulation persists. In some contexts, BT has been used as a façade to legitimise flawed

elections rather than genuinely improve voter rolls (Debos, 2021), suggesting that BT's ability to improve accuracy is often conditional on the quality of the institutions implementing it.

2.2.3. Electoral Credibility

BT is often hailed as a tool to enhance electoral credibility by increasing transparency and deterring malpractice. Proponents argue that BT strengthens the electoral process by lowering opportunities for manipulation and streamlining EC operations (Cheeseman et al., 2018; Haque & Carroll, 2020; Marjorie & Mwikya, 2020). For instance, in Nigeria's 2015 elections, the introduction of Smart Card Readers (SCRs) reduced widespread fraud, leading to a decline in election-related petitions and boosting stakeholder confidence (Afolabi, 2020; Fatai & Adisa, 2017; Nwangwu et al., 2018). However, the extent to which BT enhances credibility depends on broader institutional and political factors. As Cheeseman et al. (2018) argue, technological interventions alone cannot guarantee credibility without strong institutional frameworks and political will. In contexts where ECs are perceived as biased, such as Uganda and Zimbabwe, BT has done little to shift public trust, with persistent allegations of manipulation undermining its potential benefits (Idowu, 2021; Mathe, 2020). This suggests that while BT holds promise, its capacity to enhance electoral credibility is not inherent. Rather, it depends on the broader political environment and the presence of impartial institutions to uphold the integrity of the process.

2.2.4. Improved Efficiency and Electoral Administration

Another significant advantage of BT lies in its ability to streamline electoral processes, making voter registration and verification faster and more efficient (Dziva et al., 2020). Countries such as Ghana and Kenya have reported faster registration and verification processes compared to manual systems, which also reduces the likelihood of human error (Jacobsen, 2019; Micheni & Murumba, 2018; Sibe & Kaunert, 2023). Moreover, BT's scalability makes it ideal for managing large voter populations, as seen in Kenya's upgraded Kenyan Integrated Elections Management Systems in the 2022 elections, which enhanced efficiency and transparency (African Union, 2022). Likewise, Tran (2019) posits that, at their best, voting technologies can help bring countries closer to achieving democratic objectives by increasing voter turnout and streamlining major electoral administration procedures. Garnett and James (2020) also found that technological advancements such as BT offer the potential to improve data management, communication speed, and voter accessibility.

On the contrary, some authors argue that challenges, such as vulnerability to hacking, potential technical issues and high implementation costs, remain. However, despite these obstacles, the system holds significant promise for strengthening election integrity (Hamran et al., 2023; Idowu, 2021). Furthermore, others argue that the success of BT hinges on adequate infrastructure, technical expertise, and funding. In contexts where these prerequisites are lacking, BT can slow down processes and create new vulnerabilities. For example, in Afghanistan, rushed implementation and inadequate training led to failures that undermined electoral integrity (Darnolf, 2017). This suggests that although BT can improve efficiency, it requires proper planning and investment to avoid counterproductive outcomes.

2.2.5. Increased Public Trust and Reduction in Post-Election Disputes and Violence

BT has the potential to foster trust by enhancing the integrity of electoral processes (Idowu, 2021; Krawczyk & Davis-Roberts, 2020). Some scholars posit that by improving the accuracy of voter rolls and effectively identifying duplicate entries, biometric systems bolster the credibility of EMBs. Although the initial costs can be high, investing in BT may also yield significant long-term benefits by reducing the risk of post-election violence and improving overall electoral credibility (Maphephe et al., 2020). For instance, the introduction of BVR in 2012 significantly enhanced public confidence in Ghana's electoral system. A large majority of registered voters, exceeding 75%, considered the biometric system a major improvement over the previous registration method, while 87% believed it contributed to more credible and peaceful elections (Piccolino, 2015).

Additionally, BT has strengthened ballot secrecy, increased voter autonomy, and replaced electoral malpractice with best practices, thus fostering greater public trust in the electoral process (Idowu, 2021). Moreover, in countries such as Niger and Burkina Faso, BVR is perceived as a tool for maintaining social tranquillity by contributing to electoral credibility. Similarly, in Chad, BT has been promoted as an effective means to prevent disputes over voter rolls and minimise electoral fraud. Therefore, the system can be linked to broader democratic and security concerns, as its ability to enhance electoral credibility is expected to reduce the likelihood of violent conflicts over election results (Jacobsen, 2019). Dziva et al (2020) also note that the implementation of BVR has facilitated the faster release of voter registers for public and stakeholder scrutiny, thereby increasing electoral transparency. The prompt release

of the register enhances confidence in the electoral process by enabling the timely identification and correction of errors.

However, other scholars argue that this trust is not always guaranteed. In countries with deep-seated political distrust, BT may not be enough to prevent tensions. In Zimbabwe, despite the adoption of BVR, suspicions of voter roll manipulation persisted, fuelled by reports of ghost voters and delays in releasing voter registers (Dziva et al., 2020). Moreover, in contexts where EMBs lack credibility, BT can become a tool of surveillance rather than a mechanism for trust-building (Munoriyarwa & Mare, 2022). This suggests that BT can enhance trust and reduce post-election violence under favourable conditions. However, its success is contingent on the broader political landscape and the credibility of electoral institutions. In contexts marked by political polarisation and institutional mistrust, BT alone cannot bridge the gap in public confidence.

2.3. Challenges of Biometric Technology in Elections

Although BT offers substantial benefits in improving the transparency and credibility of elections, its application in practice often encounters considerable challenges. This section delves into the socio-political, legal, ethical, technical, and financial hurdles that accompany BT adoption in elections, revealing the limitations of relying solely on technology to address complex electoral issues. These challenges underscore that technological advancements, while valuable, cannot resolve deep-rooted political and institutional weaknesses, nor can they substitute for comprehensive electoral reforms and robust governance frameworks.

2.3.1. Socio-political Dynamics and the Need for Political Reforms

The effectiveness of BT in enhancing electoral integrity is profoundly shaped by the political context in which it is implemented. While BT can prevent some forms of individual-level fraud, it cannot inherently safeguard elections from systemic manipulation rooted in broader socio-political dynamics. Uganda's 2016 elections exemplify this tension. Despite the successful implementation of BVR and BVV, the elections were marred by intimidation and unequal access to resources. Opposition leader Besigye was arrested, and his supporters faced repression, undermining the legitimacy of the process (Idowu, 2021; Namugera, 2017). Additionally, improbably high voter turnout in the ruling party's strongholds suggested that

technology alone could not create a level playing field or bolster the confidence of the opposition (Cheeseman et al., 2018).

Chad offers another example of BT operating within a politically charged environment. While BVR improved the accuracy of voter rolls, it simultaneously legitimised elections in a militarised political context, where the underlying power dynamics remained unchanged (Debos, 2021). In Zimbabwe's 2018 elections, allegations of bias against the Zimbabwe Electoral Commission persisted, with reports of ghost voters and delays in releasing voter registers contributing to public mistrust (Mude, 2022; The Carter Center, 2018). Rumours that BVR could track voter choices further intimidated rural voters, demonstrating that the mere adoption of BT does not automatically translate to greater electoral credibility (Mathe, 2020). Similarly, the Democratic Republic of the Congo highlights the limitations of BT when institutions lack impartiality. In its 2018 elections, technical irregularities, such as multiple registrations and the inclusion of minors in the voter roll, undermined the credibility of the process. Additionally, 6 million duplicate voter cards were identified, raising concerns about the misuse of technology in the absence of strong oversight (Ali-Diabacté, 2020). Even in contexts where BVR improved some aspects of electoral integrity, such as the Solomon Islands and Senegal, technology alone could not prevent fraudulent behaviours linked to political patronage or manipulation by those in power (Hobbis & Hobbis, 2017; Passanti, 2021).

These cases collectively underscore that BT is not a silver bullet for ensuring electoral credibility. In politically fragile environments, the technology may inadvertently reinforce undemocratic practices, legitimising flawed elections rather than addressing deeper structural issues. Without comprehensive political reforms and impartial electoral institutions, BT risks being co-opted by those in power, serving as a veneer of credibility while systemic challenges persist.

2.3.2. Inadequate Legal and Ethical Frameworks

The absence of robust legal frameworks presents a significant challenge to the effective and ethical implementation of BT in elections. In countries such as Tanzania, which lack systematic data protection frameworks, personal data breaches pose heightened risks, raising ethical concerns (Makulilo, 2017). Similarly, in Zambia and Ghana, BT has been integrated to enhance electoral processes. However, the absence of clear legal oversight has allowed issues such as multiple registrations and allegations of manipulation to persist, undermining the very integrity

BT aims to uphold (Kaaba & Fagbayibo, 2021). Moreover, privacy concerns are compounded by the risk of governmental overreach and surveillance, particularly in politically unstable environments. For instance, Bangladesh's 2008 experience with registering 80 million voters using a national biometric exercise highlighted these concerns as it sparked fears of government misuse (McGrath, 2016). Likewise, other scholars argue these vulnerabilities are exacerbated in regions such as the Southern African Development Community, where inadequate legal frameworks have failed to prevent data abuses. For example, in Zimbabwe, the ruling ZANU-PF party allegedly accessed voters' telephonic databases ahead of election day, raising concerns over the misuse of biometric data for political advantage. Similarly, in Malawi, authorities reportedly intercepted private communications without legal backing, exploiting regulatory gaps to justify these actions. Even in countries with data protection laws, such as South Africa and Botswana, enforcement mechanisms remain weak, which may allow governments to use biometric systems for purposes beyond electoral integrity (Munoriyarwa & Mare, 2022). Therefore, without comprehensive legal safeguards that prioritise data protection and institutional accountability, BT risks becoming a mechanism for exploitation rather than a safeguard for democracy.

2.3.3. Technical and Logistical Limitations

Significant technical and logistical challenges often hinder the implementation of BT in elections. In Kenya's 2013 elections, widespread failures of biometric electronic voter identification devices forced officials to revert to manual verification, raising doubts about electoral integrity. These failures were attributed to inadequate staff training and preparation (Odote & Kanyinga, 2020). Similarly, Maina (2015) notes that failures in biometric identification may provide grounds for legally challenging the election results, as evidenced in Kenya's 2013 elections, illustrating the challenges and ongoing debates surrounding the effectiveness of BT in ensuring electoral credibility. However, Irungu and Girma (2023) argue that improvements in Kenya's 2022 elections, where the electronic voter identification device largely functioned as intended, highlight that with proper training and infrastructure, BT can enhance legitimacy.

Beyond Kenya, technical failures have plagued other countries that have adopted BT. Iwuoha and Doeverspeck (2023) reveal that fingerprint recognition errors and system malfunctions in various contexts created vulnerabilities such as multiple voting and identity theft. These

challenges align with Tran's (2019) argument that malfunctioning biometric technologies can undermine the very integrity they aim to protect. In contrast, Eilu (2017) asserts that BVR minimises errors and eliminates ghost voters when implemented with proper planning, staff training, and adequate funding. Rushed implementations, as seen in Afghanistan, undermine public trust and electoral credibility, showcasing the dangers of introducing BT without comprehensive preparation (Darnolf, 2017). Moreover, Vava (2016) emphasises that late BT implementation and inadequate training during Uganda's 2016 elections fuelled fears of technology misuse. She highlights that without proper voter education and contingency plans, technology risks disenfranchising voters rather than enhancing confidence.

Infrastructure deficits further complicate implementation. Omondi et al. (2024) highlight cases in the Democratic Republic of the Congo, Burkina Faso, and Togo, where unreliable infrastructure hindered the effective use of biometric systems. Even Senegal, which has successfully integrated BT since 2016, continues to grapple with operational difficulties, reflecting the complexities of technological transitions. Additionally, financial constraints present a formidable barrier. Dziva et al. (2020) argue that while BT improved Zimbabwe's voter roll accuracy, its high costs and financial limitations underscored the need for broader reforms. Similarly, Haley and Zubrinich (2015) found that the Solomon Islands' fingerprint and facial recognition technology enhanced confidence in the process but remained burdened by data security concerns and substantial financial demands.

These cases reveal that BT's effectiveness hinges not merely on its adoption but on the presence of strong infrastructure, thorough planning, and adequate financial investment. Without these, the technology risks exacerbating electoral disputes rather than resolving them, serving as a stark reminder that technological tools cannot substitute for sound electoral governance.

2.3.4. The Role of International Donors and Power Dynamics

The role of international donors in the implementation of BT in African elections introduces challenges related to external influence, financial dependence and mismatched priorities. Jacobsen (2019) argues that while BVR was locally promoted as a "solution" to electoral challenges in Kenya's elections from 2009 to 2017, it neglects significant obstacles to democratic elections in the country. Globally, he posits that the use of BVR perpetuates imbalanced power dynamics. For example, many Western countries, including the United States, endorse these technologies for African countries but have rolled back their use in their

electoral systems due to hacking concerns. This positions Africa as a testing ground for these technologies in elections. Supporting this view, Loeber (2020) highlights the irony that poorer countries in Africa and Asia, often dependent on international funding, have adopted BT in their elections more rapidly than Western nations. This trend underscores unequal power dynamics, where the global North advocates technological solutions for the South while hesitating to implement similar measures domestically due to concerns over cybersecurity vulnerabilities. Beyond financial dependence, international donor involvement can distort electoral priorities. Pommerolle (2016) illustrates this in Cameroon, where donor-driven reforms prioritised meeting target voter registration numbers over ensuring genuine electoral integrity. As a result, this narrow focus inadvertently legitimised fraudulent practices, causing widespread scepticism regarding data integrity and suspicions of political control.

These cases reflect a broader challenge. While international support can provide essential funding and technical expertise, it can also impose external agendas that may not align with local electoral needs or realities. Without local ownership and institutional safeguards, the introduction of BT risks perpetuating dependency and reinforcing existing inequalities, rather than fostering meaningful electoral reform.

2.4. Gap

Existing literature on BT in African elections predominantly focuses on single-country case studies, often presenting a narrow view of its successes and failures. This overlooks the comparative dimension needed to understand how similar technologies may yield different outcomes across diverse political and institutional landscapes. While both Ghana and Nigeria have adopted BT to enhance their electoral systems, the comparative aspects of their experiences remain underexplored. This study addresses that gap by examining how different political, institutional, and socio-economic conditions shape the effectiveness of BT in these two contexts. Moreover, existing literature emphasises technical and logistical challenges, such as device failures and inadequate infrastructure, without considering how these challenges evolve across different phases of implementation, from pre-implementation to post-implementation evaluations. By analysing multiple electoral cycles in both countries, this study offers insights into the longitudinal effects of BT, contributing to the limited body of work on its sustained impact over time. Additionally, while previous literature has also focused on either the technological aspects of BT or broader political dynamics, there is a lack of studies that

systematically explore the interplay between BT and electoral governance. By applying Mozaffar and Schedler's (2002) framework of electoral governance—rule making, rule application, and rule adjudication—this research investigates how institutional structures mediate the outcomes of BT, addressing a crucial gap in understanding the governance mechanisms necessary to ensure its effectiveness.

2.5. Conclusion

The literature on BT in African elections reveals a multifaceted landscape of opportunities and challenges. On one hand, BT is praised for enhancing electoral integrity by reducing fraudulent practices, improving the accuracy of voter rolls, streamlining electoral processes, and fostering public trust. On the other hand, its implementation has been hindered by socio-political dynamics, inadequate legal frameworks, technical and logistical limitations, privacy concerns, and power imbalances in donor-driven initiatives. A recurring theme across studies is that BT's effectiveness is not solely determined by the technology itself but is deeply shaped by the political and institutional environment in which it is adopted. Cases from countries such as Uganda, Zimbabwe, and Kenya reveal that the integration of BT has often proceeded without the necessary institutional oversight and safeguards to ensure its effectiveness, which can inadvertently reinforce existing inequalities and manipulation tactics.

Furthermore, while BT has the potential to improve transparency, its integration into electoral processes has often outpaced the development of legal safeguards, raising concerns about data security and the protection of personal information. Overall, the literature underscores the need for a holistic approach to electoral reforms that combines technological advancements with strengthened legal frameworks, institutional independence, and broader political will. Understanding the interplay between these factors is crucial for ensuring that BT contributes to genuine electoral integrity rather than serving as a superficial solution to deeper governance challenges.

Chapter 3: Conceptualising Electoral Governance, Electoral Integrity and Biometric Technology (BT)

3.1. Introduction

This chapter conceptualises *electoral governance*, *electoral integrity* and *BT*. Electoral governance and BT are intrinsically linked, as the successful implementation of BT in electoral processes to improve integrity can be influenced by the legal frameworks, institutional capacities, and public perceptions that shape the overall electoral governance landscape (Donno et al., 2022; Haque & Carroll, 2020; Makulilo & Henry, 2017; Norris, 2017). This conceptual framework explores the various facets of this relationship. First, electoral governance and the importance of its components will be explained and linked to BT. Second, electoral integrity will be defined and connected to BT. Finally, the use of BT in elections will be explored.

3.2. Electoral Governance

The study of electoral governance is a relatively new and complex field. The concept is often overlooked and not fully understood by many (Rahman, 2023). Electoral governance is defined as the broader range of activities that establish and maintain the multifaceted institutional framework in which electoral competition and voting occur (Matlosa, 2015). It encompasses various activities such as electoral legislation, election protocols, defining district lines, voter registration, the process of registering candidates and parties, media reporting, campaign funding, election day procedures, processes following the closing of polls, result declarations, and the conduct of election officials. All these factors are managed by institutions responsible for electoral governance, such as EMBs, legislatures, constitutional bodies, and the judiciary (Rahman, 2023).

For this chapter, Mozaffar and Schedler's (2002) electoral governance framework is employed. The framework is divided into three broad categories containing multiple subfields. To conceptualise and understand the research problem of this study, certain fields are singled out as they pertain to BT. As shown in **Figure 1**, the three levels of electoral governance— rule making, rule application and rule adjudication— are closely tied to some aspects of electoral integrity (Mozaffar & Schedler, 2002; Norris, 2013). These levels shape how BT is adopted and implemented in elections. A well-defined legal framework (rule making) establishes the foundation for BT by outlining clear procedures, standards, and accountability measures that

guide its use. An effective and impartial EMB (rule application) is crucial for applying these rules, ensuring the proper deployment, management, and oversight of BT throughout the electoral process. Additionally, a proactive and neutral judiciary (rule adjudication) plays a vital role in maintaining electoral integrity by resolving disputes related to BT and addressing legal challenges arising from technical failures, manipulation or access disparities (Orji, 2016).

Figure 1: Levels of Electoral Governance

TABLE 1. *The Three Levels of Electoral Governance.*

Levels	Elements
1. Rule Making Choosing and defining the basic rules of the electoral game.	
(a) <i>Rules of Electoral Competition:</i>	– Formula – District magnitude – District boundaries – Assembly size – Electoral time table – Franchise
(b) <i>Rules of Electoral Governance:</i>	– Voter registration – Party and candidate registration – Campaign financing and regulation – Election observation – Ballot design – Polling stations – Voting, counting, and tabulating – Election management bodies – Dispute settlement authorities
2. Rule Application Organizing the electoral game.	– Registration of voters, candidates, parties – Registration of election observers – Voter education – Electoral organization – Voting, counting, and reporting
3. Rule Adjudication Certifying election results and resolving disputes.	– Admission of complaints – Processing of cases – Publication and implementation of rulings

Source: Mozaffar and Schedler (2002)

The first level refers to selecting and defining the fundamental rules of the electoral game. Essentially, it is the establishment of regulatory bodies and norms. It involves defining the rules of electoral competition regarding elements such as district magnitude, district boundaries, assembly size and assembly timetable. It also involves rules of electoral governance regarding elements such as voter registration, election management bodies, party and candidate registration, polling stations, voting, counting, and tabulating (Mozaffar & Schedler, 2002;

Torres & Díaz, 2015). This paper posits that the first level (rule making) applies to the formation of laws and policies governing the adoption and use of BT in elections, particularly regarding voter registration, identity verification, and data protection.

The second level refers to the application of established rules that were established, or what the authors refer to as the organisation of the electoral game. This involves the implementation of norms related to voter, party, and candidate registration, as well as voter education, electoral organisation, voting, counting, and reporting (Mozaffar & Schedler, 2002; Torres & Díaz, 2015). The second level (rule application) applies to the practical implementation of the rules that were established. In this context, it would thus refer to the implementation of BT in elections and the logistical or technical planning by EMBs that goes into processes such as voter registration and identity verification on polling day.

The third and final level pertains to verifying election results and settling disputes. This involves the processing of cases, admission of complaints, and the publishing and implementing of rulings. Failure at this stage can undermine progress made at previous stages. Impartial adjudication can serve as a safeguard when election management fails. Judicial intervention can rectify administrative shortcomings by resolving disputes fairly. Political parties participate under agreed-upon rules. However, their acceptance of election results often depends on the perceived ability of conflict resolution mechanisms to address irregularities (Mozaffar & Schedler, 2002; Torres & Díaz, 2015). Therefore, upon analysing the third level (rule adjudication), it would refer to the disputes that may arise over BVR, BVV or BT system failures, and ensuring that they are resolved fairly and appropriately.

Suppose political actors are confident that the rules governing the elections and how they are applied will not influence the results, they will tolerate the uncertainty surrounding the results of the elections. This procedural assurance is provided by electoral governance (Matlosa, 2015). However, when electoral governance is compromised, it undermines the voices of other communities and results in electoral fraud, biased election financing laws, and unfair constituency delimitations. This is usually manifested through the intimidation of voters, inefficient voter registration and voting procedures, which all tend to discourage rather than increase voter participation (Bwanyire, 2018). Therefore, electoral governance is an important factor in the implementation of BT. The following section will thus explore the importance of

a legal framework and regulatory environment (rule making), EMBs (rule application) and public or stakeholder perceptions (rule adjudication) in implementing BT.

3.2.1. Rule Making: Legal framework and regulatory environment

A legal framework can either facilitate or hinder the adoption of biometric systems. Consequently, a robust legal structure is vital for the successful implementation of BT in elections. It is essential to have laws and regulations governing biometric data, data protection, and privacy safeguards in place to uphold the integrity of the voter registration process (Gelb & Diofasi, 2019; Makulilo & Henry, 2017). Moreover, these laws and regulations help electoral bodies secure the necessary resources for supporting the technology through multiple election cycles (Garland & Iverson, 2019). Evrensel (2010) asserts that guiding principles for processes such as voter registration should be enshrined in the electoral legal framework, and EMBs, as key practitioners, must work alongside governments and civil society organisations (CSOs), including academia, to align these frameworks with universally accepted principles. These rules and procedures should be fully implemented within the boundaries of the legal framework and tailored to the administrative, political and knowledge contexts of each nation, ensuring that technology enhances the integrity and inclusivity of elections (Evrensel, 2010).

Many African nations have adopted various technologies in their electoral processes, yet there is a lack of clear legal frameworks to govern their use. Without specific regulations, the discretion granted to election officials can result in arbitrary deployment of these technologies, potentially undermining transparency and accountability (Kaaba & Fagbayibo, 2021; Obiefuna-Oguejiofor, 2018). For example, a petition was filed in Uganda's 2016 elections citing concerns regarding the use of BT, which was not explicitly outlined in the legal framework. Petitioners argued that faulty biometric verification machines prevented the Commission from identifying voters using their voter cards, as legally mandated. This shortcoming, they argued, led to legitimate voters being excluded from voting due to failed identification and unregistered individuals were permitted to vote if they were biometrically verified (Kaaba & Fagbayibo, 2021). Such unchecked power given to ECs in deploying technology signifies the need for stricter legal oversight to ensure both the appropriateness of the technology and its effective implementation. Moreover, Makulilo (2017) contends that in countries where there is a regulatory vacuum regarding privacy in BVR, there are significant risks of data misuse, unauthorised access, and weak safeguards. Personal voter data is often

shared with third parties or misused for corruption. Therefore, legislative reforms to strengthen privacy and data protection in voter registration must be implemented.

3.2.2. Rule Application: BT Implementation by Electoral Management Bodies (EMBs)

EMBs operate at the intersection of legal frameworks and the practical systems that ensure efficient electoral governance. They play a crucial role in organising legitimate electoral processes by facilitating structured conversations between citizens and governments regarding policy, authority, and accountability (Ekundayo, 2015; Hartlyn et al., 2007; Mozaffar, 2002). Voter registration is one of the most significant yet time and resource-intensive tasks EMBs undertake (Wolf et al., 2017). Beyond this, EMBs are responsible for implementing electoral rules, educating voters, and ensuring elections are conducted fairly and equitably. Their independence is crucial to maintaining electoral integrity, as factors such as the composition and expertise of EMB members directly influence the fairness and effectiveness of electoral governance (Onishi, 2012).

The introduction of BT has reshaped the role of EMBs, particularly in voter registration and identification. By producing digital records, BT streamlines electoral processes, reducing the physical and logistical burdens on EMBs and enhancing technical efficiency (Haque and Carroll, 2020). However, the successful implementation of BT depends on efficient logistical planning, training of electoral staff, and adequate infrastructure. Poor implementation can undermine public and stakeholder trust, whereas effective use can enhance the credibility of elections by reducing fraud and increasing voter confidence (Darnolf, 2017; Eilu, 2017; Haque & Carroll, 2020). Stakeholder perceptions play a crucial role in shaping the success and acceptance of BT implementation. Public trust in the electoral process is closely tied to how voters, political parties, and CSOs view the integrity of the technology and the transparency of EMBs' management. Positive perceptions can enhance voter confidence and participation, while scepticism or negative experiences risk undermining trust and amplifying concerns over electoral manipulation (Darnolf, 2017; Eilu, 2017).

Therefore, in this study, the implementation of BT by Ghana and Nigeria's EMBs— the Electoral Commission of Ghana (ECG) and the Independent National Electoral Commission (INEC) of Nigeria— is assessed. This study also examines perceptions of their effectiveness

and impartiality in deploying and managing BT, with a focus on voter registration, the issuance of biometric voter cards, and the use of biometric devices at polling stations.

3.2.3. Rule Adjudication: Dispute Resolution

Rule adjudication is the final stage of electoral governance, focused on verifying election results, resolving electoral disputes, and ensuring the consistent application and interpretation of electoral laws (Mozaffar & Schedler, 2002; Torres & Díaz, 2015). It addresses ambiguities in election rules and operational challenges, as seen in Ghana's 2000 elections, where the Supreme Court ruled that both old and new voter identification cards were valid after unclear electoral guidelines created confusion. Fair and timely adjudication of electoral disputes is crucial for maintaining procedural legitimacy and ensuring peaceful conflict resolution in democratic elections (Mozaffar & Schedler, 2002). The introduction of BT in elections has created new legal challenges, such as disputes over biometric voter registration and verification failures, and allegations of biometric data manipulation (Odote & Kanyinga, 2020; Maina, 2015; McGrath, 2016; Munoriyarwa & Mare, 2022). Effective adjudication of these disputes is critical to ensuring that biometric systems strengthen, rather than undermine, electoral integrity. Judicial bodies, electoral tribunals, and other adjudicating institutions thus play a key role in resolving disputes related to BT system failures, thereby upholding electoral credibility, fairness, and public trust in the democratic process.

Public and stakeholder trust is not only essential to electoral integrity but also to electoral governance. This underscores the need for strong institutions that operate inclusively, transparently, and accountably. Kofi Annan emphasised electoral integrity as a critical element of credible and legitimate democratic governance, advocating adherence to international standards and fostering public confidence in electoral outcomes (Hussein, 2018). Poorly managed elections can lead to disputes, societal unrest, and weakened democratic credibility. Conversely, well-administered elections reinforce democracy, protect rights, and yield representatives more attuned to public interests (Jacobsen, 2019; The Global Commission on Elections, Democracy and Security, 2012). According to Bowler et al. (2015), people in states with higher administrative quality scores expressed greater confidence in the impartiality of election officials and the fairness of counting ballots. Since fair elections are a fundamental component of democratic processes, this suggests that improvements in election governance may also advance the democratic legitimacy of states. Egobueze and Ojirika (2017) similarly

posit that elections are now widely acknowledged as a means of legitimising the governments of states. Therefore, when the public perceives elections as flawed, it could potentially lead to violence within the state, which could escalate into political instability. For example, electoral manipulation and elite power struggles led to election-related violence in Nigeria's elections from 1999 to 2015.

3.3. Electoral Integrity

Electoral integrity lacks a universally agreed-upon definition, but it generally refers to the adherence to ethical standards and democratic principles throughout the electoral process. It is described as embodying incorruptibility and a commitment to moral values that extend across the entire electoral cycle. It includes professionalism, impartiality, and transparency in election administration, grounded in principles such as universal suffrage (the right for all citizens to vote regardless of gender, race, social status or wealth) and political equality (Hussein, 2018; The Global Commission on Elections, Democracy and Security, 2012). Electoral integrity is important because it affects perceptions about the legitimacy of political outcomes and the extent to which political actors can be trusted to maintain promises and follow the rules. Other scholars define electoral integrity as the degree to which elections are free, fair, and procedurally sound (Donno et al., 2022). With high electoral integrity, citizens are less likely to believe that the electoral process is flawed (Mauk, 2020).

Elections with integrity matter as they can produce tangible benefits. Research indicates they empower marginalised groups, combat corruption, enhance governance, and improve service delivery to disadvantaged populations. For instance, in Brazil, greater electoral accountability reduced corruption and redirected public resources toward health care, resulting in improved health outcomes for poorer citizens (The Global Commission on Elections, Democracy and Security, 2012). However, when elections lack integrity, they often fail to deliver these benefits and can instead incite societal unrest and instability, underscoring the vital role of electoral integrity (Linebarger & Salehyan, 2020). While elections alone cannot transform economies or governance, they serve as a foundational step toward achieving these broader goals (The Global Commission on Elections, Democracy and Security, 2012).

Electoral integrity is a multifaceted concept. Therefore, election-related irregularities can occur at various points during the election cycle, such as the pre-election phase, the campaigning phase, election day, and the post-election phase. Certain electoral malpractices relating to

widespread vote buying, manipulated laws, partisanship in the electoral commission, and opposition boycotts may be serious enough to cast doubt on the integrity and legitimacy of the election outcomes, sparking demonstrations and even deadly violence (Frank & Martínez i Coma, 2017). Other problems that might emerge during elections and indicate compromised electoral integrity include irregularities such as ballot stuffing and the use of double identification, government intimidation and vote buying (Birch & van Ham, 2017). Van Ham (2014) argues that since electoral integrity is a multi-faceted phenomenon, a multi-indicator measurement approach is essential. The author posits that elections are intricate, logistical procedures, and electoral malpractice occurs in varied forms. Therefore, relying on various indicators allows for more precise and valid electoral integrity assessments. Additionally, collecting data from many sources reduces bias, increasing the reliability and validity of election integrity data. Therefore, this study measures electoral integrity using indicators such as voter roll accuracy, public trust and overall election credibility, and reduction of electoral fraud, including voter impersonation, and multiple registration and multiple voting.

Electoral integrity and voter registration are also linked to each other. According to Evrensel (2010), the legitimacy of an election relies heavily on the integrity of the voter roll. A fair and transparent voter registration process is crucial as it ensures that all eligible individuals can register without interference or manipulation while preventing ineligible registrations. Similarly, Idowu (2021) posits that a reliable and updated voter register enhances electoral integrity, contributing to the development of sustainable democracy. The inclusiveness, accuracy, and up-to-date nature of credible voter rolls are crucial for ensuring electoral credibility as they legitimise the electoral process by preventing fraud, and ensuring that all eligible voters can cast their vote—and only once—in an election. Therefore, for this study, electoral integrity is particularly relevant to BT's ability to enhance voter registration accuracy, prevent multiple voting, and increase public confidence in elections.

3.4. Biometric Technology (BT)

Biometric Technology (BT) is primarily used for voter registration and voter verification purposes. A thorough voter register, including eligible voters in their voting district, is imperative for conducting a credible election (Ifedi & Ezenwanko, 2023). Biometric systems, which are primarily based on fingerprints but can also include facial recognition, are used during voter registration to ensure a clean voter roll. On election day, these systems validate a

voter's identification. They have become a reliable method for ensuring integrity, confidentiality, and the accessibility of a person's information and data (Boateng & Akaba, 2015; Gelb & Diofasi, 2019). Biometric data is initially captured as an image using a camera or sensor, then transformed into a biometric template and saved in a database. Combined with personal details such as name and birthdate, this data forms a voter profile, contributing to the creation of a biometric voter register. Once registered, a voter's biometric template can be stored in various formats, such as printed or digital voter identification (ID) cards. The biometric register can also cross-check templates to identify and remove duplicate entries efficiently (Garland & Iverson, 2019).

Biometric voter verification (BVV), on the other hand, refers to the verification of voter identities at polling stations by comparing biometric templates to confirm a person's identity. This process uses electronic devices, such as e-poll books, which scan fingerprints and match them against stored records. If a match is found, the voter's identity is confirmed (Garland & Iverson, 2019; Gold, 2012). Whereas, biometric voter identification is used when a person is unknown or there is doubt about who they are. It includes performing an excessive number of searches against an image and fingerprint database to identify who a person is (Gold, 2012). BT can thus be used to reduce duplicate registrations and prevent citizens from voting more than once or outside of their designated constituency. However, BVV at polling stations is still relatively uncommon. In most cases, election day checks compare the voter's picture to the one on their voter identification card. Only a few African countries have employed or attempted to employ biometric voter verification in elections, some of which include Ghana in 2012 and Nigeria in 2015 (Gelb & Diofasi, 2019).

Before introducing BVR and BVV technologies, Ghana relied on the Optical Mark Recognition (OMR) method for voter registration, which involved completing scanned forms with personal data at polling stations. However, this system lacked biometric data collection, enabling double or multiple registrations and multiple voting due to the inability to share registration information between stations. This process was widely criticised as bloated, with allegations of irregularities surfacing before the December 2012 general elections (Makulilo, 2017; Thiel, 2020). Whereas, in Nigeria, the previous voter registration process in 2007 was criticised by the INEC for being prone to manipulation. It included false names such as "Nelson Mandela" and "Mike Tyson". Additionally, it enabled multiple registrations and impersonations (Fatai &

Adisa, 2017). Permanent Voter Cards (PVCs), with biometric and demographic data of voters, were introduced in Nigeria's 2011 elections and used for identification, improving the integrity of the electoral process. Later in 2015, a Smart Card Reader (SCR) was employed to authenticate PVCs and fingerprints (Nwangwu et al., 2018).

3.4.1. Technological Preparedness and Security Considerations

The successful implementation of BT is heavily dependent on the technological preparedness of EMBs, particularly in the context of rule application. Managing BT systems requires not only technical infrastructure but also skilled personnel to operate the technology effectively and troubleshoot potential issues. Inadequate training or rushed deployments lead to system failures that undermine credibility (Odote & Kanyinga, 2020). Technological preparedness also plays a crucial role in rule adjudication. It may reduce election disputes by ensuring voter rolls compiled from BVR are accurate and that electoral fraud, such as multiple voting or impersonation, is mitigated through BVV (Jacobsen, 2019). When disputes arise, particularly over biometric registration or verification failures, adjudicating bodies rely on the proper documentation and management of BT systems, which can provide biometric records to assess these claims effectively. However, Iwuoha and Doeverspeck (2023) posit that BT also introduces new cybersecurity concerns, as biometric databases are attractive targets for hacking and data breaches, posing risks to voter privacy and election integrity. Without proper safeguards, such vulnerabilities can be exploited, weakening trust in electoral processes. Therefore, technological preparedness extends beyond infrastructure. It requires robust security measures, comprehensive training, and contingency plans to ensure BT functions as intended throughout the electoral cycle.

3.5. Conclusion

This conceptual framework illustrates the dynamic interplay between rulemaking, rule application, and rule adjudication in electoral governance. It emphasises how each stage informs and influences the others while incorporating stakeholder participation, technology risks, and the vital role of public trust in ensuring the legitimacy and credibility of BT systems throughout the electoral process. Findings from rule adjudication (such as technical failures or system vulnerabilities) might prompt revisions in rulemaking (such as stricter legal standards for biometric systems), which in turn influence future application strategies. Furthermore, the relationship between electoral integrity, technology adoption, and public trust can be shown as

an intertwined set of feedback mechanisms. For instance, rule-making might be driven by a desire to increase public trust in biometric systems. However, if the technology is poorly implemented (rule application), the public trust could diminish, leading to legal challenges and disputes that require resolution (rule adjudication). This creates a cyclical dynamic between these elements.

Chapter 4: Ghana Case Study Findings: Pre- to Post-Biometric Technology Implementation

4.1. Introduction

This chapter presents the results of Ghana's electoral processes across three phases: pre-implementation (2008), the year of implementation (2012), and post-implementation (2020) of BT. Using election observation reports and academic literature, this chapter provides data related to the research question and sub-questions on BT's effectiveness in enhancing electoral integrity, alongside its strengths and weaknesses in curbing fraudulent registration, multiple voting, and impersonation. It focuses on Ghana's 2008, 2012, and 2020 general elections, with electoral governance principles introduced after each phase to frame the results. The results will later be interpreted in the discussion in Chapter 6.

4.2. Pre-Implementation: 2008 Elections

4.2.1. Electoral Integrity Challenges

Assessing the effectiveness of BT requires first examining the electoral challenges that shaped Ghana's voter registration and verification processes before its adoption. In 2008, Ghana transitioned from manual voter registration methods to the use of Optical Mark Recognition (OMR) forms. The forms captured personal details and were later digitised alongside photographic identification to produce a computerised voter register. However, it faced credibility issues. The Electoral Commission of Ghana (ECG) recorded 1.8 million new voters, far exceeding its anticipated target of 600,000 to 800,000. This raised concerns about fraudulent registrations, including underage and foreign voters (Omotola, 2013; The Carter Center, 2012). Political parties accused each other of inflating voter rolls, fuelling tensions, particularly in the Ashanti and Volta regions, where anomalies and violence occurred (Jockers et al., 2010). In response, the ECG removed 349,496 ineligible entries but provided revised registers to parties only weeks before the election, limiting verification time (European Union Election Observation Mission [EU EOM], 2009). Despite public appeals and penalties for double registrations, inconsistencies persisted, such as unverified transfer lists and allegations of organised activities to manipulate voter identification cards (EU EOM, 2009; The Carter Center, 2012). The ECG's logistical and administrative challenges, compounded by frequent changes to the electoral schedule, resulted in eroded public trust. Criticism of the voter registration process added to this decline in confidence (CODEO, 2008; The Carter Center,

2012). Ultimately, these challenges exposed the limitations of Ghana's voter registration system and highlighted the need for stricter safeguards to ensure the integrity of future elections

4.2.2. Public Perceptions

Several factors undermined stakeholder confidence in the ECG during the 2008 elections. The Commonwealth Observer Group (COG) highlighted that a delayed voter registration process, discrepancies in the voter roll, and modifications to the electoral timetable significantly weakened public trust in the ECG's ability to deliver credible elections (COG, 2008). Reflecting these challenges, public opinion surveys conducted by Afrobarometer revealed mixed perceptions of the electoral process as the percentage of Ghanaians who regarded the elections as "completely free and fair" fell from 61% in 2004 to just 39% in 2008. However, the percentage of Ghanaians who found the elections free and fair, but with minor problems, rose from 22% in 2004 to 40% in 2008. Political affiliations also influenced perceptions, with only 30% of supporters of the NPP, which lost the 2008 election, rating it as "completely free and fair," compared to 54% of supporters of the NDC, which won that year (Parku, 2014). These findings indicate that while many Ghanaians continued to believe in the democratic process, concerns over election management and partisan biases eroded confidence in electoral integrity during this period.

4.2.3. The Role of Electoral Governance

Rule Making: Regulatory and Legal Framework for Voter Registration

Ghana's 2008 elections were governed by a comprehensive legal and regulatory framework designed to ensure free, fair and transparent electoral processes. At the heart of this framework were the 1992 Constitution and the Electoral Commission Act of 1993, which grant the ECG several core responsibilities. These include maintaining and revising the voter register, educating citizens about electoral processes, and conducting voter registration exercises. Additionally, the commission is tasked with issuing voter identity cards to eligible participants (Debrah, 2011; Nkansah & Gawu, 2020).

Ahead of the elections, a limited registration exercise from July 31 to August 11 aimed to enrol newly eligible voters, particularly those who turned 18 after the 2006 update. However, the process was also open to all eligible voters who had not previously registered, ensuring broader

inclusivity (COG, 2008). The voter registration process was structured and guided by the Public Elections (Registration of Voters) Regulations, 1995 (C.I. 12), which provided detailed procedures for voter registration, including eligibility criteria, the registration process, and mechanisms for addressing objections and challenges. By aligning with international standards, this framework offered a solid foundation for democratic elections (The Carter Center, 2012). However, although these frameworks and initiatives demonstrated the ECG's efforts to ensure comprehensive voter registration, challenges with resources and execution highlighted areas needing improvement.

Rule Application: Quality and Impartiality of the ECG

The 2008 elections highlighted both strengths and weaknesses in the performance of the ECG. Challenges, including inadequate preparation, limited voter education, and a lack of resources, such as registration forms and photographic equipment, exacerbated the tight timelines for voter registration (EU EOM, 2009). Due to the compressed electoral timetable that the ECG presented to the nation, there was limited time to address irregularities such as the bloated voter register (Gyimah-Boadi, 2009). Observers also noted that political candidates and parties played an overly influential role in the registration process, and the ECG failed to implement adequate safeguards to prevent this from compromising the accuracy of the voter register. For example, the candidates and political parties transported their supporters to registration centres without sufficient control measures to verify their eligibility (EU EOM, 2009). Despite these challenges, the ECG was observed to have managed the elections with a high degree of transparency, competence, and professionalism. Its staff across the country were viewed as mostly impartial and demonstrated strong dedication to their roles (Debrah, 2011; EU EOM, 2009; Omotola, 2010). The Carter Center (2008) further emphasised the ECG's reputation for independence, noting that it enjoyed substantial public trust.

Rule Adjudication: Electoral Dispute Resolution

Ghana took significant steps to improve electoral dispute resolution by streamlining judicial processes. Historically, the adjudication of electoral disputes was a lengthy process. To address this, the Chief Justice introduced a Fast Track mechanism to expedite rulings and assigned High Court judges across all regions to handle disputes efficiently (COG, 2008; EU EOM, 2008; The Carter Center, 2012). Furthermore, the Supreme Court released a manual outlining how individuals can access the courts and promoted alternative dispute methods, such as

mediation by court-appointed mediators, to accelerate the resolution of electoral disputes (Crook, 2012; The Carter Center, 2012). As a result, the judiciary was widely recognised for its professionalism and neutrality in adjudicating election disputes, contributing to the overall credibility of the electoral process (Gyimah-Boadi, 2009). These reforms have strengthened the efficiency of Ghana's electoral dispute resolution system and ultimately increased public confidence in Ghana's legal system.

4.3. Implementation: 2012 Elections

4.3.1. Introduction and Key Features of the BT System

Ghana introduced BVR and BVV in 2012 to address longstanding electoral issues, particularly duplicate registrations and the inclusion of deceased individuals on the voters' roll. These concerns were especially pressing after the challenges experienced during the 2008 elections (COG, 2013). These reforms were also driven by factors such as potential conflict risks, threats of boycotts by key stakeholders due to anomalies, judicial interventions, and recommendations from local and international entities (Arah, 2023). The BVR and BVV systems introduced a more secure system to prevent fraud and strengthen credibility. The selection of vendors followed public procurement guidelines through a transparent bidding process (Aiyede et al., 2013; Boateng & Akaba, 2015; Kaaba & Fagbayibo, 2021). BT was legally reinforced through the Public Election Regulations, 2012 (C.I. 75), which required voters to be both biometrically registered and verified to participate in the elections (Effah & Debrah, 2018). Political parties in Ghana widely supported the introduction of BT as a means of mitigating electoral malpractices. The slogan "No Verification, No Vote" was strongly emphasised by political leaders, symbolising the consensus among parties and highlighting the importance of verification in preventing fraud such as double voting and impersonation (Van Gyampo et al., 2022). Ultimately, the introduction of BT was primarily intended to enhance electoral integrity and mitigate fraud, reflecting broader efforts to modernise Ghana's electoral system.

Understanding the key features of the BT system provides insight into its role in enhancing electoral integrity and preventing electoral fraud. The system's technological infrastructure included a central data centre at the ECG headquarters in Accra, satellite data communication stations in each district capital, and data capture kits at each registration centre. These kits comprised fingerprint scanners, laptops, digital cameras, identity card printers, lamination devices, and USB drives (Effah & Debrah, 2018). BVR replaced the previous OMR system,

which was criticised for enabling double or multiple registrations (Makulilo, 2017). Under the new biometric system, voters provided personal identification documents to confirm eligibility, while their demographic data, photographs, and fingerprints were digitally captured. Additionally, its de-duplication feature allowed the ECG to detect and eliminate duplicate registrations (Effah & Debrah, 2018; Yeboah, 2013).

On election day, biometric verification devices (BVDs) were deployed across over 26,000 polling stations, with 7,500 spares available to mitigate technical failures. These machines were also battery-operated, and each was supplied with spare batteries to ensure uninterrupted operation. Verification through fingerprint and photographic data ensured that voters were accurately identified, reinforcing the credibility of the electoral process (Aiyede et al., 2013; COG, 2013; Krawczyk, 2019). Initially, voters presented photo identity cards to electoral officers for a manual cross-check against the printed voters' register. If details matched, they proceeded to biometric verification, where a barcode linked to the voter's data was scanned, displaying their photo on the biometric device screen. Electoral officers then verified if the image matched the voter's identity card and facial appearance (Effah & Debrah, 2018; Effah & Owusu-Oware, 2020). For biometric confirmation, voters placed their finger on the scanner. If the device failed to verify any of the ten fingers, the individual was not allowed to vote. However, those classified as "face-only" voters underwent manual verification alone. Once verified, indelible ink was applied to the voter's thumb to prevent double voting (Effah & Debrah, 2018). These systems implemented advanced security measures designed to improve the accuracy of voter registration and verification, thus minimising the risk of electoral fraud.

4.3.2. Strengths of BT in the 2012 Elections

The introduction of BT in Ghana's 2012 elections significantly improved the integrity of the voter register, addressing longstanding issues such as duplicate registrations and outdated voter lists. ECG officials confirmed that the voter roll produced from the biometric database was more accurate than previous versions, with approximately 130,000 duplicate entries identified and removed from the voter register, demonstrating the system's ability to enhance electoral credibility (Debrah et al., 2018; Idowu, 2021). Additionally, BVR ensured the inclusion of those inadvertently omitted and facilitated the removal of deceased individuals from the roll, thereby minimising inaccuracies (Debrah et al., 2018). The integration of multiple identification methods, such as fingerprints, photos, serial numbers, and secure barcodes,

further reduced opportunities for fraudulent entries (Aiyede et al., 2013). Furthermore, BVV acted as a deterrent against multiple voting and impersonation, two historical challenges in Ghana's elections. Interviews conducted with voters in March 2016 indicated that biometric verification limited voters' ability to impersonate others and reduced polling officials' ability to falsify voter turnout figures (Debrah et al., 2018; Golden et al., 2014). These measures collectively contributed to a more transparent and credible electoral process, reinforcing public trust in the system.

The system also facilitated the registration of over 14 million voters in just 40 days, demonstrating its efficiency and strengthening electoral administration (Boateng & Akaba, 2015; Idowu, 2021). Moreover, the BVR system instilled a greater sense of trust and transparency in Ghana's electoral process. Interviews conducted by Debrah et al. (2018) after the elections revealed that more than half of the respondents (54.7%) believed the system significantly improved the election process. Additionally, 92.4% felt it ensured a free and fair election outcome, highlighting widespread confidence in the biometric system (Debrah et al., 2018). CODEO's findings further reinforced this trust, as 78% of sampled citizens agreed that BT improved electoral processes, and 87% regarded it as instrumental in promoting peaceful and credible elections (Idowu, 2021). These results illustrate how BT played a pivotal role in strengthening electoral governance and public confidence in electoral outcomes.

4.3.3. Weaknesses of BT in the 2012 Elections

The biometric registration process was, however, not without challenges. Despite the system's efficacy in reducing duplicate registrations and removing deceased individuals from the voter list, the presence of underage individuals was reported. However, this did not appear to be a significant issue on election day as only a small number of underage voters were observed, primarily in the Tamale area of the Northern region. Additionally, there were errors in recording some voters' ages and genders (COG, 2013).

Equipment failures were widespread, with biometric devices breaking down at various centres. This led to some eligible citizens being unable to register, as their fingerprints could not be captured despite multiple attempts (Alidu, 2014; Effah & Debrah, 2018). The ECG also had to extend voting into a second day in affected areas, with some centres allowing voters to bypass BVV altogether. However, this introduced inconsistencies, with different polling stations applying the rules unevenly (Aiyede et al., 2013; Effah & Debrah, 2018). Some devices also

froze due to high temperatures or improper battery handling, resulting in significant delays. Untrained electoral officials compounded the issue, as they often mishandled machines or failed to follow protocol. Moreover, the reliance on fingerprint verification alone excluded voters whose prints could not be captured, such as manual labourers and elderly people with worn fingerprints (COG, 2013; Dorpenyo, 2020; Effah & Debrah, 2018). As a result, these individuals were ultimately denied the right to vote, creating an accessibility challenge (COG, 2013). Researchers also found that polling stations with election observers were fifty per cent less likely to experience equipment failures, indicating possible human manipulation of machines to facilitate fraud. In contrast, stations without observers were more prone to experience over-voting and machine breakdowns (Cheeseman et al., 2018; Kaaba & Fagbayibo, 2021).

4.3.4. Public Perceptions

Public trust in the ECG has exhibited a downward trend between 2005 and 2014, with the proportion of respondents expressing little or no trust in the ECG rising from 25% to 59%, while those with significant trust declined from 75% to 37% during the same period. This erosion of confidence coincided with controversies surrounding the 2012 elections, such as allegations of people voting without BVV, disputes over the accuracy of results and alleged partiality toward the ruling NDC. These challenges culminated in a Supreme Court case, further undermining public trust in the ECG (Adams & Asante, 2019; Golden et al., 2014). In contrast, attitudes toward BVR and BVV systems appeared more favourable. Despite some challenges, the biometric system received widespread approval from the Ghanaian public. A CODEO survey found that 78% of registered voters believed that BVR was an improvement over previous methods, while 87% viewed it as a valuable tool for ensuring credible and peaceful elections (Krawczyk, 2019; Piccolino, 2015).

BVR and BVV technology in Ghana's 2012 elections also significantly influenced voter behaviour. Adams and Asante (2019) note that many well-educated and technologically inclined individuals expressed a sense of curiosity about the new system, motivating them to participate in the election. However, those with limited education, particularly older voters, encountered challenges that deterred their participation. Institutions such as the ECG and the National Commission for Civic Education failed to address the informational gap effectively, disadvantaging uneducated and elderly voters (Adams & Asante, 2019). This underscores how

the lack of education and familiarity with technology left some voters feeling excluded. With better public education, broader segments of the population could have benefitted from the technology. The ECG's inability to integrate all voter demographics equitably represents a missed opportunity to enhance turnout comprehensively. Overall, integrating BT in Ghana's 2012 elections was a significant step towards improving electoral credibility, reducing fraud, and fostering public trust.

4.3.5. The Role of Electoral Governance

Rule Making: Regulatory and Legal Framework for Voter Registration and Verification

Ghana's electoral system is grounded in a strong legal foundation provided by the Constitution, supplemented by various laws and regulations. The Public Elections Regulation Law (2012) and the Public Elections (Registration of Voters) Regulation 2012 (CI. 72) were introduced to validate BVR and BVV legally, thus ensuring the integrity of the BVR and BVV. These laws outline BVR and BVV processes, requiring that voter registration use biometric data to ensure each voter is uniquely identified and thus reduce the chances of voter fraud (Adams & Asante, 2019; Aiyede et al., 2013). Moreover, the legal framework stipulates that the biometric data of a registered voter may only be disclosed to other individuals or authorities if directed by an order from the High Court, thereby emphasising data protection (Public Elections (Registration of Voters) Regulations 2012 C.I. 72, 2012). These legal and institutional measures underscore Ghana's commitment to credible voter registration and identification, which are vital for maintaining the integrity of its electoral processes.

Rule Application: Quality and Impartiality of the ECG

The Electoral Commission of Ghana (ECG) has made significant efforts to maintain its independence and impartiality, crucial for electoral credibility. A survey by Adu-Gyamfi (2014) found 100% of respondents trusted the ECG's autonomy, noting its independence from government interference and control over its budget. Constitutional provisions also strengthen this trust. Furthermore, the constitutional provisions governing the appointment and conditions of service for the ECG's chairman and deputies have reinforced public trust. Omotola (2013) notes that although the ECG is constituted under the presidency, it has consistently aimed to maintain independence, professionalism, and legitimacy in its operations. This achievement is largely attributed to the robust institutional structure of the commission and the political

frameworks that support it. Among these frameworks, the Inter-Party Advisory Committee (IPAC), established in 1994, is key as it promotes collaboration between political parties, CSOs, the media, and the donor community. These factors collectively bolster the ECG's institutional credibility. However, the appointment process for ECG officials, as outlined in Ghana's 1992 Constitution (Articles 43, 44, and 70[2]), often sparks debates regarding its inclusivity. Some stakeholders advocate for opposition parties' involvement in the selection process to enhance credibility (Botchway, 2018; Botchway & Kwarteng, 2018).

The application of BT by the ECG in Ghana's 2012 elections revealed both its transformative potential and its limitations. On one hand, the system successfully addressed key issues such as voter roll accuracy, reduced fraud, and improved public trust (Debrah et al., 2018; Idowu, 2021). However, the challenges associated with equipment failures, accessibility issues, and untrained officials (Alidu, 2014; Effah & Debrah, 2018) highlight the importance of adequate planning, training, and inclusivity when implementing new technologies. Additionally, while the biometric system itself garnered positive feedback from the public (Debrah et al., 2018; Idowu, 2021), the persistent lack of trust in the ECG due to broader electoral controversies (Adams & Asante, 2019) suggests that technology alone cannot fully restore confidence in the electoral process unless accompanied by institutional reforms and greater transparency. Ultimately, the application of BT in Ghana's 2012 elections was a significant advancement in electoral integrity, but its success was tempered by operational challenges and public scepticism towards the Electoral Commission. Addressing these weaknesses could lead to more effective use of BT in future elections.

Rule Adjudication: Election Dispute Resolution

The ECG played a crucial role in resolving election disputes during the 2012 presidential election, which involved the application of BT. The ECG demonstrated its neutrality and transparency by cooperating fully with litigants and providing necessary electoral materials for the court's deliberations, which helped ensure public trust in the dispute resolution process (Omotola, 2013). The NPP contested the election results, alleging irregularities such as over-voting, failure of biometric verification, and missing presiding officer signatures. They also criticised the ECG for its contract with Superlock Technologies Limited, claiming a lack of transparency (Omotola, 2013; Asante & Asare, 2017). Key allegations focused on the failure of biometric verification, which the NPP argued allowed unqualified individuals to vote,

contributing to over-voting (Kaaba & Fagbayibo, 2021). The Supreme Court ruled that while irregularities were present, they did not substantively affect the results. Allegations of duplicate serial numbers and over-voting were dismissed, and the Court confirmed that the electoral process was not fundamentally undermined (Nkansah, 2016; Benson, 2022).

Post-election interviews showed that, despite the flaws, BVR contributed to reducing tensions and fostering collaboration among stakeholders (Debrah et al., 2018). The Supreme Court's acknowledgement of irregularities led to reforms, strengthening Ghana's electoral integrity in future elections (Lawal, 2023; Nkansah, 2016). Ultimately, Ghana's 2012 election dispute highlights both the strengths and limitations of BT in improving electoral integrity. While BT helped reduce fraud, legal and procedural flaws showed that BT alone cannot guarantee election legitimacy. The ECG's cooperation with the judiciary and the Court's reforms underscored the importance of legal frameworks and institutional independence in ensuring BT's effectiveness in safeguarding elections.

4.4. Post-Implementation: 2020 Election

4.4.1. Strengths of BT in the 2020 Elections

The ECG introduced notable technological upgrades to BT in the 2020 elections by deploying 74,800 new Biometric Verification Devices (BVDs). These devices were equipped with both fingerprint scanners and facial recognition capabilities, allowing voters to be authenticated even if their fingerprints failed to register, possibly due to worn-out or damaged fingerprints. The devices operated independently without network connections, eliminating the risk of cyber manipulation, and voter data was securely stored on the devices until election day (COG, 2021). This marked a significant improvement over the technology used in 2016.

Despite some logistical challenges, this massive operation successfully registered a significant number of voters. The process, monitored by party representatives and domestic observers, was inclusive, with no major disputes regarding the voter count across regions. Notably, the system effectively removed deceased individuals from the voter list. Moreover, 18,619 voter entries were flagged as multiple registrations and removed from the provisional voter register (EU EOM, 2020). By the end of the process, just over 17 million voters were registered, representing a 7.4% increase over the previous register, an increment supported by demographic trends. To ensure inclusivity for those lacking formal identification, the guarantor

system was implemented, allowing registered voters to vouch for others (COG, 2021; EU EOM, 2020). Furthermore, the biometric system generally functioned well, and in cases where fingerprint recognition failed, facial recognition served as a reliable alternative. Additionally, the biometric registration process ensured that voters' data, including photographs and fingerprints, were instantly captured and integrated into voter identification cards issued on-site, ensuring inclusivity (COG, 2021; EU EOM, 2020).

4.4.2. Weaknesses of BT in the 2020 Elections

Despite its advantages, concerns about the high costs and lack of transparency in the procurement process persisted. The ECG justified the new register as a measure to address issues of credibility, such as allegations of non-Ghanaians being included in the old register. However, the decision remained contentious (EU EOM, 2020). The NDC opposed the new register, arguing that the 2016 version should remain valid. Whereas the NPP had long advocated for a replacement, citing allegations of underage voters and non-Ghanaian nationals in the database (Lawal, 2023). However, the Supreme Court ultimately upheld the ECG's decision, allowing the registration to proceed under amended regulations (COG, 2021; Lawal, 2023). Technical challenges also emerged during both registration and voting. BVDs failed to verify some voters in approximately 9% of cases, requiring backup devices or technical assistance (EU EOM, 2020). Additionally, some voters faced difficulties such as registration machine malfunctions, incorrect polling station assignments, and long queues under the sun, leading to health concerns and delays (Agbevade, 2024; COG, 2021).

4.4.3. Public Perceptions

The elections occurred in a polarised environment dominated by the two main political parties, the NDC and NPP, which contributed to tensions and mistrust among key stakeholders, including the ECG and political parties (EU EOM, 2020). The opposition NDC rejected President Akufo-Addo's victory, prompting nationwide protests by its supporters. These demonstrations resulted in casualties and injuries, with police reporting over 60 incidents. However, while the ECG admitted potential errors, it maintained that any discrepancies did not significantly impact the final results (Asekere, 2021). The EU EOM (2020) also concluded that despite these challenges, the overall conduct of the elections reinforced Ghana's reputation for stability and peaceful electoral transfers of power in West Africa (EU EOM, 2020). Reflecting these sentiments, a survey conducted in 2022 found that 63.5% of Ghanaian respondents found

the elections mostly or completely free and fair (Afrobarometer, 2022). However, 67% of respondents in an Afrobarometer survey expressed little to no trust in the ECG, while only 9.8% trusted the Commission and 22.7% “somewhat” trusted it (Afrobarometer, 2022).

4.4.4. The Role Of Electoral Governance

Rule-Making: Regulatory and Legal Framework for Voter Registration and Verification

The legal framework for voter registration and elections in Ghana is primarily governed by the Public Elections (Registration of Voters) Regulations, specifically the 2016 Constitutional Instrument (C.I. 91), which was later amended by C.I. 126 in 2020, along with the Public Elections Regulations 2020 (C.I. 127). The procedures for elections were defined under these regulations, covering everything from voter registration to the announcement and official recording of results (COG, 2021; EU EOM, 2020). The previously issued voter ID cards and driving licenses were removed from the list of acceptable documents for voter registration under C.I. 126. However, it expanded the guarantor system, allowing one person to vouch for up to 10 applicants, an increase from the previous limit of five in 2016. The ECG’s decision to exclude existing voter ID cards was, however, legally contested by the NDC and a private citizen. Additionally, another legal challenge was raised against C.I. 126 for not recognising birth certificates as valid identification for registration. The Supreme Court, however, ruled in favour of the ECG in June 2020 (EU EOM, 2020).

Rule Application: Quality and Impartiality of the ECG

The 2020 Ghanaian elections raised concerns about the impartiality and credibility of the ECG. As previously mentioned, the ECG’s leadership structure, where all seven members, including the chairperson and deputies, are appointed solely by the President without opposition consultation, fuelled accusations of bias. This appointment process has been criticised for lacking inclusivity and undermining confidence in the ECG, with the NDC frequently accusing the Commission of incompetence and favouritism toward the ruling party (Asekere, 2021; EU EOM, 2020). However, despite these trust issues, a survey conducted across 116 constituencies found that 76% of respondents were satisfied with the registration process, while only 11% expressed dissatisfaction. Moreover, although the NDC challenged the election results, alleging voter suppression and questioning the Commission’s credibility, the Supreme Court upheld the ECG’s declaration of the results, deeming the elections credible (Owusu-Mensah &

Akeliwira, 2022). Nonetheless, persistent tensions between political parties and the ECG, particularly between the NDC and the Commission, underscored the need for enhanced transparency and inclusivity. Strengthening relationships with CSOs and opposition parties remains crucial for improving the ECG's credibility and mitigating political polarisation in future elections (Asekere, 2021).

Rule Adjudication: Electoral Dispute Resolution

As mentioned before, the ECG's decision to compile a new biometric voters' register shortly before the elections sparked controversy. Concerns were raised about the exclusion of some eligible voters from the final register and inadequate communication regarding the criteria for inclusion or exclusion. These legal and procedural issues highlighted gaps in ensuring transparency and inclusivity in the voter registration process (CODEO, 2020; Effah & Debrah, 2018). Despite some stakeholders, including opposition parties, contesting the new register's legality, the ECG defended its actions under its constitutional mandate to compile and revise electoral rolls. The controversy was addressed through legal challenges in Ghanaian courts, where the ECG's authority to manage the voter registration process was upheld. This resolution allowed the elections to proceed with the new register, although concerns about inclusivity persisted (CODEO, 2020; Lawal, 2023).

4.5. Conclusion

This chapter presented the findings on Ghana's notable transformations with the adoption of BT to address long-standing challenges. Before BT implementation, the 2008 elections highlighted serious issues with voter registration, including allegations of fraudulent entries and a bloated voter roll. Although the ECG maintained a reputation for independence, logistical hurdles and insufficient safeguards revealed gaps in electoral governance. The 2012 elections marked a pivotal moment with the introduction of BVR and BVV, which significantly improved voter roll accuracy and reduced impersonation. However, technical failures, delays, and the exclusion of some voters due to fingerprint recognition issues underscored the complexities of implementing BT. While public trust in the electoral process improved, political tensions and logistical challenges declined trust in the ECG, revealing the need for further refinement. By 2020, Ghana had made considerable strides in enhancing BT, introducing facial recognition and improving registration processes. These upgrades bolstered electoral integrity and reduced fraud, yet issues persisted. Concerns over transparency, high

costs, and exclusionary practices fuelled political tensions and post-election disputes. Despite these challenges, the 2020 elections reinforced Ghana's reputation for electoral stability, though ongoing trust deficits signal the continued need for stronger electoral governance and transparency.

Chapter 5: Nigeria Case Study Findings: Pre- to Post-Biometric Technology Implementation

5.1. Introduction

This chapter presents the results of Nigeria's electoral processes across three phases: pre-implementation (2003), the year of implementation (2011), and post-implementation of biometric technology (2019). Drawing from election observation reports and academic literature, the findings are structured to provide data concerning the research question and sub-questions in this paper. Moreover, the role of electoral governance will be highlighted after each phase to contextualise the results. These results will later be interpreted in the discussion chapter.

5.2. Pre-Implementation: 2003 Elections

5.2.1. Electoral Integrity Challenges

Before adopting BT, Nigeria's voter registration faced inaccuracies, duplicates, and underage registrations (Wolf et al., 2017). In 2002, the INEC introduced OMR technology to improve the process, starting with the 2003 elections, while keeping manual methods as a backup (Afolabi, 2020; Layiwola, 2023; Wolf et al., 2017). Applicants completed forms with personal details, which were then scanned and processed to create a computerised database, cross-check duplicates, and publish provisional lists (COG, 2003; EU EOM, 2003; Unufe & Justin-Ugo, 2019). However, OMR faced significant challenges in 2003, undermining electoral integrity. The registration process suffered from inadequate materials, insufficient training, and political interference, leading to issues such as underage registrations, multiple registrations, and non-citizens on the list. Registration materials were hoarded and sold by party agents, further disenfranchising voters (The Carter Center, 2002).

Additionally, delays, logistical issues, and non-compliance with posting lists at the ward level raised concerns (COG, 2003). The absence of a central database prevented cross-checking across states, allowing errors such as multiple registrations to persist. Furthermore, systemic flaws, such as inadequate oversight of registration centres and poor implementation of safeguards such as ink finger checks, contributed to underage voting and voter impersonation (EU EOM, 2003). These irregularities not only compromised the accuracy of the voters' register

but also eroded trust in the electoral process, revealing significant weaknesses in the OMR system's implementation.

Technical challenges also worsened the process. Limited resources caused voter cards to lack photographs, and rushed production led to errors (COG, 2003). Transparency was further compromised when 7 million applicants were removed from the final register without explanation, fuelling suspicions of bias. The absence of a civil registry, unreliable census data, and poor implementation of procedures weakened the system's credibility (EU EOM, 2003). Ultimately, the system's technical and procedural failures, including improperly completed forms, led to the register being discarded (Wolf et al., 2017), undermining confidence in Nigeria's 2003 elections and exposing critical flaws in the INEC's voter registration process.

5.2.2. Public Perceptions

In Nigeria's 2003 elections, public trust in the electoral process was severely undermined. The widespread reliance on manual voter registers on election day diminished the credibility of the entire registration process, reflecting the INEC's lack of confidence in the accuracy of the electronic register (EU EOM, 2003). Observers documented significant irregularities and fraud across several states, further eroding voter confidence, which remained unrecovered after the elections (EU EOM, 2003). Survey data reflected this distrust, with 65% of Nigerians perceiving their country as either not democratic or as a democracy with major issues shortly after the elections (Afrobarometer, 2009). Additionally, Nigeria recorded the lowest levels of trust in political institutions compared to several other African nations, with 67% of respondents expressing no trust in these institutions (Lavallée et al., 2008). These indicators underscore the deep public disillusionment with the integrity of Nigeria's 2003 elections.

5.2.3. The Role of Electoral Governance

Rule Making: Legal and Regulatory Framework Governing the 2003 Elections

The legal and regulatory framework governing Nigeria's 2003 elections was clearly defined. However, there were significant challenges which led to electoral irregularities and undermined public trust. The Electoral Act of 2002 established key eligibility criteria, requiring voters to be Nigerian citizens, at least 18 years old, and residents of the local area where they registered (COG, 2003). However, there were cases of underage registrations and voting (EU EOM, 2003). Additionally, the Act mandated the public display of voter registers for at least five

days, 30 days before elections, to allow for claims and objections. However, the INEC did not display the voters' register for the legally required period, depriving citizens of the opportunity to review and challenge inaccuracies (COG, 2003). Moreover, the introduction of a permanent electronic voter register using OMR under the 2002 Act aimed to address previous electoral shortcomings, but poor implementation undermined its effectiveness. The INEC faced significant logistical and training challenges, resulting in an unreliable system (EU EOM, 2003). Notably, there was controversy over whether the Act had been duly adopted by the National Assembly, with some legal opinions asserting that the 2003 elections conducted under this contentious Act should be rendered null and void (COG, 2003; EU EOM, 2003). These failures underscored the necessity for comprehensive institutional reform as they revealed critical gaps in Nigeria's electoral governance, which eroded public confidence in the overall integrity of the electoral process.

Rule Application: Quality and Impartiality of the INEC

The INEC's management of Nigeria's 2003 elections raised concerns about its quality and impartiality, as logistical failures and poor planning undermined the credibility of the process. Voter registration, initially set for May 2002, was delayed until September due to funding and equipment shortages, leaving the INEC struggling to handle the high volume of applicants across 120,000 centres (COG, 2003). The voter register, required by law to be displayed for public scrutiny, was only posted in December 2002 and failed to reach ward levels as mandated (COG, 2003). The INEC's lack of demographic preparedness further complicated the process. Relying on outdated population estimates, the commission underestimated logistical challenges, resulting in registration officials struggling with OMR forms. This led to errors such as misspelt names, incorrect polling assignments, and omissions (EU EOM, 2003). The absence of proper public awareness campaigns also limited citizens' understanding of the registration process, excluding many eligible voters. A second registration phase in January 2003 aimed to address earlier complaints, but the INEC failed to display the updated register for verification, violating the Electoral Act. Moreover, 6.9 million applications were disqualified without adequate transparency, fuelling suspicions of manipulation (COG, 2003). These failures exposed the INEC's poor planning and lack of impartiality, eroding public trust in the electoral process.

Rule Adjudication: Electoral Dispute Resolution

Nigeria's 2003 elections revealed significant shortcomings in electoral dispute resolution, casting doubt on the effectiveness of the rule adjudication. Numerous petitions were filed, contesting results across various election levels, reflecting widespread dissatisfaction. For instance, the Court of Appeal received a petition from Mr. Yusuf, the Movement for Democracy and Justice's presidential candidate, challenging the presidential election results. Gubernatorial election outcomes were contested in states such as Adamawa, Enugu, Imo, Anambra, and Plateau. Additionally, disputes over National Assembly results emerged in states such as Lagos, Benue, and Sokoto, involving multiple parties (EU EOM, 2003). The petitions were primarily driven by allegations of widespread electoral fraud, political interference, and procedural irregularities. Key concerns included vote-buying, ballot-box stuffing, manipulation of results, a flawed voter register, and the INEC's failure to properly display the register at the local level as legally required (Azeez, 2016; Enweremadu, 2011). The handling of these disputes was marked by delays and procedural challenges. At the time of reporting, few judgments had been delivered, with delays caused by tribunal orders focused on requesting documentation from the INEC. Some petitions were dismissed due to technicalities, such as a case in Zamfara, where a petition was struck out for failing to meet the Electoral Act's requirements (Enweremadu, 2011; EU EOM, 2003). These delays and procedural barriers highlighted the inefficiencies in Nigeria's electoral adjudication process, raising concerns about the accessibility and impartiality of electoral justice.

5.3. Implementation: 2011 Elections

5.3.1. Introduction and Key Features of the BT System

The previous 2007 elections marked Nigeria's preliminary attempt at BVR, but severe equipment shortages and technical failures hampered the process. Of the 33,000 Direct Data Capture (DDC) machines procured, only 1,000 were functional by November 2006, and just 5,000 were genuine biometric machines (COG, 2007; EU EOM, 2007). The INEC resorted to using 30,000 off-the-shelf laptops, which could only produce temporary ID cards without fingerprints (COG, 2007). Amid concerns over voter disenfranchisement, the Electoral Act was amended to give the INEC more time and instruct it to adopt manual registration (NDI, 2008). The 2007 elections were thus a preliminary attempt at BT integration, rather than a full implementation.

The 2011 elections aimed to address the flaws of the 2007 elections, which had suffered from multiple registrations, underage voting, impersonation, and ballot stuffing (Adebayo & Omotola, 2009; EU EOM, 2007). This prompted the creation of a new voter register and the establishment of the Election Reform Committee (ERC) by President Yar'Adua (NDI, 2011). Moreover, amendments to the Electoral Act in 2010 enabled the INEC to enhance the biometric system, including a Data Consolidation Exercise and an upgraded Automated Fingerprint Identification System (AFIS) to remove duplicates (Afolabi, 2020). These reforms aimed to strengthen the integrity of the electoral process.

For the 2011 voter registration, the INEC acquired over 132,000 DDC machines, one for each of the 119,973 polling centres and 8,809 registration areas, with additional units for contingencies. These machines, which included laptops, high-resolution cameras, fingerprint scanners, integrated printers, and backup power units, captured facial images, fingerprints, and assigned unique voter IDs (INEC, 2012; INEC, 2015). The data was uploaded to a central server, where it was processed through the Automated Fingerprint Identification System (AFIS) to identify and flag duplicate registrations (Afolabi, 2020; INEC, 2015). This de-duplication process aimed to ensure only eligible voters could vote, thereby enhancing electoral integrity and transparency (Afolabi, 2020; NDI, 2011; Onapajo, 2015). The implementation of biometric measures represented a significant step toward addressing fraud and manipulation in Nigeria's elections.

5.3.2. Strengths of BT in the 2011 Elections

The introduction of BT in Nigeria's 2011 elections marked a significant improvement over previous electoral processes, particularly in enhancing the credibility of the voter register. By using DDC machines, the INEC was able to detect 870,612 duplicate registrations through cross-checking photos and fingerprints, though it remained unclear whether these resulted from genuine errors or intentional fraudulent attempts (EU EOM, 2011; INEC, 2012; NDI, 2011). Moreover, the INEC's success in creating a new biometric voter register in a relatively short time reflected notable improvements in both logistical efficiency and credibility (COG, 2011). By the end of the exercise, 73,528,040 Nigerians were successfully registered. This process facilitated the creation of a reliable voter register and the issuance of high-quality temporary voter cards, which were used during the April 2011 General Elections and in subsequent electoral processes (INEC, 2012). As a result, the 2011 biometric voter register was seen as a

significant step forward, boosting public and political confidence compared to the deeply flawed 2007 register (EU EOM, 2011). The register thus served as the foundation for three general elections, as well as all by-elections held in 2015 and 2019 (INEC, 2022). These advancements laid the groundwork for a more reliable electoral system, setting a precedent for future elections and reinforcing the role of BT in strengthening electoral integrity.

5.3.3. Weaknesses of BT in the 2011 Elections

Despite the strengths, the implementation of BT in the 2011 elections faced operational and technical shortcomings. The software and scanners used for registration malfunctioned, leading to prolonged registration times. To speed up the process, some registration officials resorted to registering voters without capturing all ten fingerprints. In response, the INEC issued software updates to address the scanner issues and instructed those who had been inadequately registered to return for re-registration (NDI, 2011). Additionally, observers reported several logistical failures, such as insufficient printer ink, malfunctioning cameras and printers, lack of essential materials, and no supply for backup power (NDI, 2011). Further issues included reports of underage registrations, particularly in northern Nigeria, where some communities were found to have included non-eligible voters in the list (Abodunrin et al., 2018; EU EOM, 2011). Another concern was the financial burden associated with the technology's adoption, with the cost increasing to about US\$9 per person (Cheeseman et al., 2018; Okwueze, 2022). Although the INEC overcame some of the aforementioned issues, these weaknesses highlighted the gap between adopting new technology and ensuring its effective implementation. Without adequate training and planning, the potential of BT to enhance electoral integrity can be undermined.

5.3.4. Public Perceptions

While public confidence in the voters' register was not fully restored, it was seen as an improvement over previous registers. The INEC Chairman, Professor Jega, was praised for his transparency and inclusiveness, though election delays due to logistical and technical issues caused some loss of confidence. Nevertheless, many trusted Jega's integrity (COG, 2011). An Afrobarometer survey revealed that 71% of respondents viewed the elections as mostly or completely free and fair. Additionally, 49% rated them as better than the 2007 elections, while 16% described them as "much better" than the 2007 elections (Afrobarometer, 2013). Stakeholders acknowledged improvements but called for further reforms, such as replacing temporary voter cards with permanent ones that could be verified on voting day. In response,

the INEC introduced PVCs with biometric and demographic data by the 2015 elections (Olurode, 2017). This shift underscored the role of BT in enhancing electoral credibility and preventing fraud, paving the way for future reforms.

5.3.5. The Role of Electoral Governance

Rule Making: Regulatory and Legal Framework for Voter Registration

The 2011 Nigerian elections were marked by significant reforms to the regulatory and legal framework governing voter registration, reflecting a renewed commitment to enhancing electoral integrity. The amendment of the Electoral Act led to the introduction of stricter safeguards. These included prohibiting registration on behalf of another person. Each person was now required to appear in person to have their biometric data captured. Additionally, more formal identification was required for registration. This further strengthened the integrity of the process by making it harder for ineligible voters to register, thereby reducing opportunities for fraud and inaccuracies in the voter register (COG, 2011; EU EOM, 2011). The INEC strengthened these efforts by carrying out a fresh registration exercise for a new voter list, using DDC machines and AFIS (COG, 2011; EU EOM, 2011; INEC, 2012). However, logistical delays and inefficiencies led to constitutional and electoral act amendments granting the INEC an extension, which in turn delayed the display of preliminary voter lists and reduced public participation in the review process of the lists (NDI, 2011). While reforms marked a crucial step toward improving electoral transparency, challenges persisted, such as inadequate training of registration officials and reports of underage registration, indicating that robust legal frameworks alone are insufficient without proper enforcement and oversight (EU EOM, 2011). Nevertheless, these regulatory changes laid the groundwork for a more credible electoral process, reflecting Nigeria's ongoing efforts to strengthen democratic governance through technological innovation and institutional reform.

Rule Application: Quality and Impartiality of the INEC

The INEC's efforts to improve its independence and capacity were seen as key reforms in the 2011 electoral process. Notably, the separation of INEC membership from political party affiliation and the enhancement of INEC's financial independence were significant steps forward. The constitutional amendments that placed the INEC's funding and administrative decisions beyond executive control were aimed at fostering greater impartiality and efficiency in the electoral process (Onapajo, 2015). However, despite these reforms, some issues

regarding the INEC's performance persisted. Observers pointed out that the quality of training for election staff varied across regions, with insufficient time allocated for practical sessions on machine use and no focus on troubleshooting or support procedures. Allegations of partisan manipulation and nepotism in the INEC's hiring practices also arose, particularly at the local level (NDI, 2011). Additionally, the INEC faced criticism for its lack of transparency, notably failing to provide clarity on the 870,000 detected cases of duplicate registrations, which fuelled suspicions among political parties (NDI, 2011). The INEC's self-assessment acknowledged a widespread negative perception of the body, with many Nigerians viewing its actions as influenced by political partisanship and manipulation, especially in the context of the President's appointments of commissioners. This continued to fuel doubts about the INEC's impartiality, as its reliance on presidential appointments led to concerns that it was too closely aligned with the incumbent government (Mgba, 2017). These persistent challenges underscored the need for further reforms to enhance public trust in the electoral process.

Rule Adjudication: Electoral Dispute Resolution

The adjudication of election disputes in Nigeria during the 2011 elections was governed by the Electoral Act 2010 (as amended), which set strict time limits to ensure a swift resolution of petitions. To expedite proceedings and maintain electoral legitimacy, the law emphasised front-loading during litigation. This refers to the early submission of all necessary documents, evidence, and arguments, rather than introducing them gradually (EU EOM, 2011). A total of 53 petitions were filed regarding state governor elections across 26 states. However, none succeeded due to the 180-day time limit imposed by Section 134(2) of the Electoral Act, which restricted tribunals from overturning results after this period (Omenma et al., 2017). Similarly, out of approximately 140 petitions contesting National Assembly election results, 128 cases were reviewed by the EU EOM across 18 states. The common grounds for these disputes included allegations of electoral fraud and candidates not being duly elected by the majority of lawful votes. Two separate petitions sought the nullification of the presidential election results, filed by the CPC and the Hope Democratic Party (EU EOM, 2011). Notably, this was a decrease in the number of cases brought before the tribunals compared to the 2007 elections (Obiefuna-Oguejiofor, 2018). While international observers praised the 2011 elections for being more credible than past ones, concerns remained regarding the transparency of the complaints system. The EU EOM recommended that the INEC and judiciary publish consolidated records of complaints, responses, and rulings to enhance public accountability.

(Yagboyaju, 2011; EU EOM, 2011). These legal frameworks aimed to improve the efficiency of electoral dispute resolution, but the lack of transparency highlighted the need for clearer processes to enhance public trust and accountability.

5.4. Post-Implementation: 2019 Elections

5.4.1. Strengths of BT in the 2019 Elections

Building on the technological advancements of previous years, the 2019 elections marked a significant improvement in Nigeria's voter registration process. During the continuous voter registration exercise, there was a significant increase in voter registration, reaching a total of 84,004,084 registered voters, including 14.3 million new registrants. This represented a 22% rise from 2015 (COG, 2019; EU EOM, 2019). Deduplication through BT removed one million records, thereby enhancing the accuracy of the voter register (EU EOM, 2019; Omondi et al., 2024). Moreover, significant advancements were made in voter verification processes, such as the introduction of the smart card reader (SCR) in 2015. The SCR was initially designed to ensure the authenticity of permanent voter cards (PVCs), confirm the legitimacy of the voter, and ensure that only accredited individuals were allowed to vote (Yakubu, 2023). However, early challenges, such as the SCR's failure to authenticate fingerprints, led to delays and frustration during the 2015 elections (Idowu, 2021). However, these issues were mitigated in the 2019 elections, resulting in a more reliable system (Chukwuma, 2022). The process of biometric data capture during voter registration for the 2019 elections included fingerprint scans, with automated systems used to detect duplicate entries. Voters were required to revisit INEC offices to collect their PVCs, which contained personal biometric data stored on a chip. These steps were aimed at enhancing the integrity of the electoral process and reducing the risk of impersonation and other fraudulent activities. Voter authentication accuracy and reliability were thus improved (EU EOM, 2019; Wasiu & Chukwudi, 2023).

Ultimately, the integration of the Electronic Voters Register (EVR), AFIS, and SCR played a key role in limiting instances of electoral fraud, particularly voter impersonation, multiple registrations and multiple voting. Research also revealed a notable reduction in court-ordered re-run elections in constituencies due to electoral irregularities and fraud, decreasing from 5.37% in 2015 to just 1.92% in 2019, a clear indication of the positive impact of technology (Chukwuma, 2022). Furthermore, Registration Area Technical Support (RATech) personnel were employed to manage the use of SCRs and other technological devices. This further

minimised manipulation and bolstered the integrity of the elections (Sule et al., 2020). These advancements reduced strain on both voters and polling officials. Additionally, SCRs experienced fewer technical issues in 2019, and any malfunctions were promptly resolved (International Republican Institute & National Democratic Institute, 2019).

5.4.2. Weaknesses of BT in the 2019 Elections

Despite the benefits, there were deceased voters on the voter register. In addition, there was a possibility of duplicate registrations in the voter register across states because the de-duplication process only occurred at the state level. Eight instances of apparent underage voting were also recorded (EU EOM, 2019). Furthermore, there were some cases where card readers failed to verify fingerprints and manual accreditation processes were not consistently adhered to (EU EOM, 2019; Sule et al., 2020). The adoption of BT could not fully prevent electoral violence, which remained a significant challenge to the integrity of the elections. Violence often results from human factors such as political manipulation, where political actors work to undermine technological advancements in the electoral process (Duruji et al., 2021).

Despite these issues, observers noted the robustness of the voter register (COG, 2019). Moreover, BT played a crucial role in mitigating electoral malpractices, including ballot stuffing and over-voting. The use of card readers was a transformative measure, making it more difficult for political actors to interfere with election outcomes. The director of the Centre for Democracy and Development, Idayat Hassan, emphasised that this technological shift revolutionised Nigeria's electoral process, enhancing its credibility (Onyekwelu, 2023).

5.4.3. Public Perceptions

Despite the increase in voter registration from 2015, voter turnout suffered in the 2019 elections, with 28,614,190 voters participating in the elections— a 8.90% decline from 2015. This decline was partly attributed to the cumbersome and stressful registration and voting processes (Franklin, 2023). Additionally, the failure of SCRs sparked anxiety and fuelled concerns among the electorate (Edet et al., 2021). However, several studies highlighted the positive effect of BT, such as PVCs, SCRs, and the EVR, in strengthening public trust in the electoral process. A survey by Layiwola (2023) found that many interviewees viewed these technologies as enhancing public trust, with one noting the decline in election petition tribunal cases from 2011 to 2023 as evidence of growing confidence in election outcomes. This shift

was largely attributed to BT's role in improving voter registration and accreditation, which allowed greater access to and easier verification of the voters' register, thereby improving the perceived legitimacy of the process. Similarly, an Afrobarometer (2021) survey reported that 66.9% of the respondents perceived the 2019 elections as completely or mostly free and fair. Furthermore, when asked about the prevalence of multiple voting, 53.9% of the respondents stated it "never" occurred, 15.7% said "a few times", and only 11.3% reported it happening "often. However, trust in the INEC remained low, with 65.7% expressing little to no trust in the institution, while only 8.5% trusted the INEC "a lot" and 21.9% "somewhat" trusted it (Afrobarometer, 2021).

5.4.4. The Role of Electoral Governance

Rule Making: Regulatory and Legal Framework for Voter Registration and Verification

The 2019 Nigerian elections highlighted ongoing challenges in the regulatory and legal framework governing voter registration and verification. The electoral regulation issued by the INEC in the elections provided clarity on procedures but conflicted with the Electoral Act, creating potential for legal disputes. For instance, the INEC guidelines required voters to use PVCs verified by SCRs. However, the Electoral Act notes that people are qualified to vote if their name is on the register, making no reference to the SCR technology (Alao & Lanre, 2022). The Court of Appeal ruled that although the technology lacked legal backing, it did not invalidate the physical voter verification. The case was dismissed due to insufficient evidence (Kaaba & Fagbayibo, 2021). Another issue that arose was the fact that the INEC managed biometric data for 84 million registered voters in 2019, thus exposing it to risks of breaches and compliance issues. To address this, the Nigerian Data Protection Regulation (NDPR) was introduced that year, mandating lawful and transparent data handling with consent. The NDPR recommended that the INEC conduct Data Impact Assessments before engaging in any data-centric activities and adhere to NDPR guidelines to safeguard voter information, avoid breaches, and maintain public trust (Sibe, 2022). These regulatory gaps underscored inconsistencies between the legal framework and the technological processes introduced during the 2019 elections.

Rule Application: Quality and Impartiality of the Independent National Electoral Commission (INEC)

The effectiveness of Nigeria's electoral governance has been questioned due to issues related to the impartiality and transparency of the INEC. Observers highlighted concerns over the lack of sufficient safeguards to prevent the manipulation of card readers. The absence of a paper trail supporting data from biometric systems limited accountability, particularly in cases of over-voting. Although the INEC gathered electronic data from the SCRs, it did not make this information publicly accessible (COG, 2019; EU EOM, 2019). Additionally, challenges such as poor logistics and delays in the printing of cards hindered the process, causing voter disenfranchisement. Consequently, collection rates varied significantly across states, with 49% in Sokoto compared to 96% in Osun. By election day, nearly 3.5 million remained uncollected (Alao & Lanre, 2022; EU EOM, 2019). The cumbersome nature of the continuous voter registration process also disproportionately affected rural voters, who faced long travel distances and high costs, further exposing the systemic inequities in electoral governance (Alao & Lanre, 2022). Moreover, electoral institutions were also seen as susceptible to manipulation, particularly in cases where political vigilantes interfered with the process through malpractice, violence, rigging, and inflation of votes, thus undermining the credibility of the elections (Edet et al., 2021).

However, the International Republican Institute and National Democratic Institute (2019) highlighted an innovative approach by the INEC during the Ekiti and Osun off-cycle elections, where SCRs were used to recapture fingerprints on-site if a voter's PVC was verified but their fingerprints were not recognised. Citizen observer groups reported that these technological improvements led to a reduction in the number of voters being turned away compared to previous general and off-cycle elections.

Rule Adjudication: Election Dispute Resolution

Election dispute resolution in Nigeria has faced challenges due to legal ambiguities and procedural inefficiencies. The Court of Appeal ruled that although smart card readers lacked explicit legal backing, their use for voter verification did not invalidate the process. Therefore, the court dismissed the appeal (Kaaba & Fagbayiyo, 2019). However, overlapping jurisdictions, lengthy timelines, and complex evidence requirements have hindered effective resolution, creating uncertainty in the electoral process. Additionally, the INEC's delayed release of electoral documents needed for the petition procedure fuelled tensions, raising concerns about adherence to the rule of law in post-election adjudication (EU EOM, 2019).

5.5. Conclusion

This chapter traced Nigeria's journey towards enhancing electoral integrity through BT implementation. Before BT, the 2003 elections revealed severe flaws in voter registration, political interference, and weak legal frameworks, undermining public trust. The introduction of OMR technology aimed to address registration issues but faced logistical failures and inaccuracies. The 2011 elections marked a shift with BVR, using DDC machines and AFIS to detect duplicates and improve voter roll accuracy. While these measures bolstered credibility, issues such as equipment failures and underage registration persisted. Legal reforms contributed to fewer election petitions than in 2007, though transparency and dispute resolution remained areas of concern. Subsequent elections saw further adoption of BT, including EVR and SCRs, which strengthened voter verification and reduced fraud. However, logistical inefficiencies, SCR malfunctions, and inconsistent communication continued to challenge electoral processes. Public confidence remained mixed, reflecting ongoing concerns about the INEC's impartiality and procedural gaps.

Chapter 6: Analysis of Biometric Technology Implementation in Ghana and Nigeria

6.1. Introduction

This chapter critically analyses the effectiveness of BT in improving the integrity of electoral systems in Ghana and Nigeria, addressing the overarching research question: “*How effective is biometric technology in improving the integrity of electoral systems in Ghana and Nigeria?*” The chapter also explores the sub-questions: “What are the strengths and weaknesses of biometric technology in addressing electoral challenges such as multiple registrations, multiple voting, and impersonation in Ghana and Nigeria?”, “How have the different phases of biometric technology adoption (pre-, during, and post-implementation) influenced electoral transparency, electoral outcome credibility, and public trust in Ghana and Nigeria?”, and “What lessons can be learned from Ghana and Nigeria’s experiences with biometric technology to inform future applications in electoral processes of other African countries (i.e. strengths, weaknesses, opportunities and threats of BT in electoral systems of other African countries)?” Moreover, this discussion interprets the findings in relation to three hypotheses. The main hypothesis (H1) is “Biometric technology improves the integrity of electoral systems in Ghana and Nigeria by reducing fraudulent practices such as multiple registrations, multiple voting, and voter impersonation.” The second hypothesis (H2) is “Biometric technology enhances the efficiency and accuracy of voter registration and verification, and strengthens public trust in the electoral process in Ghana and Nigeria.” The third hypothesis (H3) is “Despite its benefits, biometric technology faces challenges such as technical issues, vulnerabilities to manipulation, and accessibility barriers for marginalised populations.” Ultimately, this discussion will systematically assess whether BT has improved electoral integrity, the strengths it has introduced, and the challenges it presents. A comparative approach is taken to highlight key similarities and differences in implementation outcomes across the two countries.

6.2. Hypothesis 1 (H1)

Ghana and Nigeria Before BT

The findings in chapters 4 and 5 indicate that both Ghana and Nigeria’s electoral systems faced significant challenges undermining election credibility and public trust before the implementation of BT. In Ghana, the 2008 elections revealed challenges such as bloated voter registers, underage registrations, and allegations of political parties inflating voter rolls in their strongholds, contributing to heightened tensions (Omotola, 2013; The Carter Center, 2012). In

Nigeria, the 2003 elections faced widespread irregularities, including multiple registrations, underage voting, and the absence of a central database for cross-checking voter records (EU EOM, 2003; The Carter Center, 2002). These findings suggest that the absence of technological safeguards in both countries increased their vulnerability to fraud and manipulation, while administrative inefficiencies further eroded confidence in electoral governance. In Ghana, for instance, logistical constraints and political interference hampered efforts to address irregularities (EU EOM, 2009; Gyimah-Boadi, 2009). Similarly, Nigeria's INEC faced logistical failures, delayed registration exercises, and inadequate oversight, resulting in the exclusion of eligible voters and suspicions of manipulation (COG, 2003; The Carter Center, 2002). These shared challenges underscored the urgent need for electoral reforms to enhance transparency, accuracy, and public trust, ultimately strengthening electoral integrity. The adoption of BT in subsequent elections was, therefore, driven by a desire to address these systemic weaknesses to improve voter registration, identification, and verification processes and thereby mitigate the risks of electoral fraud.

The Ghana Experience

The findings in Chapter 4 suggest that BT significantly improved electoral integrity in Ghana's 2012 and 2020 elections by reducing fraud and enhancing election credibility. In 2012, biometric voter registration (BVR) led to the removal of approximately 130,000 duplicate entries, curbing multiple registrations and minimising opportunities for multiple voting (Idowu, 2021). Additionally, biometric voter verification (BVV) curbed impersonation and ballot stuffing, contributing to a more transparent process (Debrah et al., 2018; Golden et al., 2014). In 2020, BT further strengthened the system, removing 18,619 cases of multiple registrations and introducing facial recognition to enhance voter verification (EU EOM, 2020; COG, 2021). Despite these advancements, technical failures with biometric verification devices (BVDs) in about 9% of cases led to delays and some disenfranchisement (EU EOM, 2022). While this highlights ongoing challenges, the cases were too minimal to disrupt the overall process. Overall, Ghana's experience with BT demonstrates notable progress in reducing electoral fraud, though gaps remain in ensuring smooth implementation and accessibility.

The Nigerian Experience

The findings in Chapter 5 suggest that BT significantly enhanced electoral integrity in Nigeria's 2011 and 2019 elections by tackling fraud such as multiple voting, impersonation, and ballot

stuffing, while also influencing public trust and election credibility. In 2011, the introduction of Direct Data Capture (DDC) machines and Automated Fingerprint Identification Systems (AFIS) detected 870,612 duplicate registrations, curbing multiple voting and improving transparency (EU EOM, 2011; INEC, 2012; NDI, 2011). However, technical failures, inadequate training, and logistical challenges undermined BT's effectiveness (NDI, 2011; Cheeseman et al., 2018). By 2019, advancements such as smart card readers (SCRs) further strengthened voter verification and reduced impersonation (EU EOM, 2019; Yakubu, 2023). The removal of over one million invalid records significantly reduced opportunities for fraud, reinforcing election credibility (EU EOM, 2019; Omondi et al., 2024). Additionally, fewer court-ordered re-run elections due to irregularities suggested a decline in ballot stuffing and other malpractices (Chukwuma, 2022). Nonetheless, occasional SCR failures, inconsistent backup manual accreditation, and logistical shortcomings undermined public confidence in the INEC (Sule et al., 2020; Alao & Lanre, 2022; Edet et al., 2021). These findings highlight that while BT reduced fraud and strengthened electoral credibility in Nigeria, its full effectiveness was undermined by persistent governance challenges.

Comparative Analysis

A comparison of Ghana and Nigeria's experiences reveals both similarities and significant differences in the impact on electoral integrity. Both countries faced severe challenges in terms of multiple registrations, impersonation, and multiple voting prior to BT adoption. However, after implementing biometric systems, both saw notable reductions in multiple registrations, multiple voting and impersonation. Ghana, particularly, experienced a more seamless implementation of BT, particularly after introducing facial recognition in 2020, which addressed the fingerprint failures encountered in 2012. This advancement provided a more robust verification process compared to Nigeria, where persistent technical failures and logistical shortcomings continued to affect public trust and election credibility, especially in 2019. Ghana's relatively smoother adoption can be attributed to better institutional capacity and public trust in the electoral commission. Whereas, Nigeria's progress was hindered by ongoing political manipulation, procedural inefficiencies, and insufficient political will to address operational challenges. The challenges contributed to voter disenfranchisement and sustained scepticism toward the INEC's capacity to conduct credible elections.

While both countries used BT to improve transparency and reduce fraud, Ghana's implementation was marked by higher levels of public trust in BT's capabilities and more effective technical solutions, such as the introduction of facial recognition. In contrast, Nigeria's ongoing issues with the INEC's capacity to manage biometric systems and logistical hurdles undermined the full potential of BT. This contrast highlights that the success of BT in enhancing electoral integrity depends not only on the technology itself but also on the institutional and political environment in which it is implemented. The findings suggest that Ghana's relative success with BT can be attributed to stronger electoral management and less political interference, whereas Nigeria's challenges were rooted in deeper governance issues, such as corruption, political manipulation, and operational inefficiencies. Moreover, applying process tracing revealed the causal mechanisms linking BT to improved electoral integrity. By mandating biometric registration and verification, BT addressed vulnerabilities such as duplicate registrations, multiple voting, impersonation, and ballot stuffing, ensuring that only authenticated voters could cast ballots.

These findings align with broader literature suggesting that BT holds promise for improving electoral integrity in developing democracies by tackling longstanding vulnerabilities (Cheeseman et al., 2018). However, the experiences of Ghana and Nigeria also echo concerns raised by Aiyede et al. (2013) and Makulilo (2017) regarding technological failures and uneven implementation. This reinforces that while BT can curb fraud and impersonation, its effectiveness relies heavily on institutional capacity and logistical preparedness. Overall, the evidence supports H1, demonstrating that BT significantly reduced electoral fraud and irregularities in Ghana and Nigeria, thereby enhancing election credibility. Nonetheless, persistent technical failures, electoral governance gaps, and logistical challenges highlight the need for further institutional reforms to address these shortcomings and ensure the sustained integrity of the electoral process. Strengthening electoral management institutions, improving technological infrastructure, and fostering political commitment will be essential for maximising the benefits of BT in future elections.

6.3. Hypothesis 2 (H2)

Increased Accuracy and Efficiency of Voter Registration and Verification

BT significantly enhanced voter roll accuracy and voter verification processes in Ghana and Nigeria, addressing longstanding challenges in electoral administration. In Ghana's 2012

elections, BVR detected and eliminated 130,000 duplicate entries, ensuring a cleaner and more reliable register (Idowu, 2021; Debrah et al., 2018). Additionally, the removal of deceased individuals minimised inaccuracies (Debrah et al., 2018). The system streamlined voter registration, with over 14 million voters being registered in just 40 days, demonstrating efficiency and strengthening electoral administration (Boateng & Akaba, 2015; Idowu, 2021). Similarly, in Ghana's 2020 elections, the BVR exercise was inclusive and successfully registered over 17 million voters efficiently (COG, 2021; EU EOM, 2020). Likewise, in Nigeria's 2011 elections, BT assisted in identifying 870,612 duplicate registrations, significantly improving the integrity of the voter roll (EU EOM, 2011; INEC, 2012). Additionally, Nigeria's 2007 voter register was abandoned and not used in subsequent elections, necessitating a fresh voter register in 2011 using BT. Over 73 million voters were registered in a relatively short time, demonstrating the logistical efficiency of BVR (COG, 2011). These findings align with Cheeseman et al. (2018), who argue that BVR can substantially reduce fraudulent entries by enhancing the accuracy of electoral databases. As a result, the enhanced reliability of voter rolls not only curbs multiple registrations but also strengthens electoral management in both countries. This reflects broader trends in emerging democracies aiming to modernise electoral processes through technology.

In terms of voter verification accuracy, BT also introduced significant improvements. In Ghana's 2020 elections, the adoption of facial recognition technology addressed accessibility challenges by providing a backup for fingerprint verification failures, ensuring more inclusive and accurate identification (EU EOM, 2020; COG, 2021). Similarly, in Nigeria's 2019 elections, the deployment of SCRs strengthened the verification process by ensuring that only registered voters with valid credentials could cast their ballots, enhancing accuracy and preventing impersonation (Yakubu, 2023). These findings support Makulilo (2017), who highlights that effective biometric verification can significantly reduce impersonation and other forms of election-day fraud, though its success is contingent on proper device functionality and training.

While both countries improved voter verification through BT, Ghana's incorporation of facial recognition in 2020 represents an important step towards addressing potential weaknesses in the system, a feature not present in Nigeria's 2019 elections. This suggests that while both countries benefitted from BT, Ghana's adoption of more advanced technologies in 2020 provided a stronger safeguard against potential voter fraud. Overall, BT enhanced the accuracy

and efficiency of both voter rolls and voter verification, reinforcing electoral integrity and paving the way for more transparent elections.

Enhanced Public Trust in the Electoral Process

The results suggest that BT played a pivotal role in shaping public trust in both Ghana's and Nigeria's electoral processes. Results from Chapter 4 confirm that the introduction of BVR and BVV in Ghana's 2012 elections boosted confidence by addressing long-standing issues of fraud and impersonation. A survey conducted by CODEO revealed that 78% of registered voters viewed BVR as an improvement over previous methods, and 87% believed BT contributed to credible and peaceful elections (Krawczyk, 2019; Piccolino, 2015). These findings align with broader literature suggesting that BT enhances public trust in electoral processes by improving the accuracy of voter rolls and reducing electoral malpractices (Idowu, 2021; Piccolino, 2015). However, public trust in the ECG remained fragile due to political tensions. Between 2005 and 2014, the proportion of respondents expressing little or no trust in the ECG rose from 25% to 59% (Adams & Asante, 2019), reflecting broader concerns about the institution's impartiality. The 2020 elections further exposed these tensions, as the opposition NDC rejected the election results, accusing the ECG of bias toward the ruling NPP (Agbevade, 2024). Nevertheless, Mohammed (2023) found that 72% of elite respondents believed BT improved election quality by reducing fraud and enhancing verification, thereby increasing confidence and turnout. This shows that perceptions of BT and its ability to effectively achieve its intended goals were generally positive.

The findings in Chapter 5 show that in Nigeria, BT similarly influenced public trust. The findings indicate that the 2011 elections saw a notable improvement in confidence compared to previous years, with 71% of respondents believing the elections were mostly or completely free and fair (Afrobarometer, 2013). The use of BT enhanced transparency by reducing fraudulent registrations and facilitating the faster release of voter registers for public scrutiny. This increased confidence in the electoral process by enabling the timely identification and correction of errors, aligning with literature from Dziva et al. (2020). However, logistical failures and delays in voter registration eroded some of this trust (COG, 2011). By 2019, SCRs further strengthened public perceptions of electoral credibility by reducing fraudulent practices (Yakubu, 2023). Nonetheless, challenges persisted, as evidenced by low turnout and continued scepticism towards the INEC. An Afrobarometer (2021) survey revealed that 65.7% of

respondents expressed little or no trust in the INEC, reflecting ongoing doubts about its independence and effectiveness.

The findings thus demonstrate that trust in the technology and the electoral process was generally positive, as many believed BT improved transparency and reduced fraud. However, trust in the electoral institutions (ECG and INEC) declined likely due to political interference, logistical issues, and accusations of bias cited by Asekere (2021), Effah & Debrah (2018), NDI (2011), Franklin (2023) and EU EOM (2019) in chapters 4 and 5. This aligns with broader literature, which argues that political manipulation, administrative challenges and perceptions of institutional bias can erode public confidence, even when technological measures such as BT are introduced to enhance transparency (Ali- Diabacté, 2020; Cheeseman et al., 2018; Hobbis & Hobbis, 2017; Idowu, 2021; Omondi et al., 2024). Nevertheless, this decline in institutional trust in both countries does not necessarily undermine H2. The hypothesis focuses on BT's role in enhancing public trust in the electoral process by improving registration accuracy, reducing fraud, and ensuring proper voter verification. The decline in trust toward electoral institutions reflects broader political and administrative challenges, rather than a failure of BT to fulfil its intended functions.

Therefore, hypothesis 2 is supported. In both Ghana and Nigeria, BT enhanced voter registration accuracy by eliminating duplicate entries and improved voter verification through innovations such as facial recognition and SCRs. These measures strengthened the credibility of voter rolls and reduced impersonation, contributing to more transparent elections. Moreover, BT streamlined the voter registration and verification processes in both countries. Despite a decline in public trust towards the electoral institutions (ECG and INEC) due to the political and institutional contexts in both countries, BT achieved its intended goals and increased public trust in the electoral process.

6.4. Hypothesis 3 (H3)

Technical Challenges

The findings indicate that both Ghana and Nigeria faced significant technical challenges with the implementation of BT in their electoral processes, undermining its effectiveness. In Ghana, the 2012 elections saw widespread equipment failures, with biometric devices breaking down and fingerprint scanners struggling to capture worn fingerprints, particularly among manual labourers and the elderly. Untrained officials frequently mishandled devices, leading to

inconsistent verification procedures (COG, 2012; Dorpenyo, 2020). However, in 2020, the percentage of voters who faced verification failures reduced to only about 9% (EU EOM, 2022), indicating improved system reliability. In contrast, Nigeria's 2011 elections experienced malfunctioning scanners and poor infrastructure, which caused registration delays and prompted officials to bypass fingerprint capture altogether (NDI, 2011). While the introduction of SCRs improved verification, failures remained widespread, and the inconsistent backup manual accreditation processes further complicated voter authentication (Sule et al., 2020). These findings align with broader literature, which highlights that while BT holds the potential to enhance electoral processes, its success hinges on proper infrastructure, training, and technical support (Cheeseman et al., 2018; Makulilo, 2017). Both countries' experiences reveal BT's potential to enhance electoral processes, but its successful implementation requires comprehensive capacity-building, infrastructural investment, and ongoing technical support. However, while both countries encountered technical difficulties, Ghana's lower rate of device failures suggests a relatively more effective implementation of BT compared to Nigeria.

Potential Vulnerabilities to Manipulation

BT has helped reduce certain types of electoral fraud, such as multiple registrations, multiple voting and impersonation. However, both countries demonstrated vulnerabilities to manipulation, which arose from both technical and institutional factors. In this context, vulnerabilities to manipulation refer to weaknesses or loopholes that can be exploited to influence electoral outcomes or undermine the integrity of the process, stemming from both technological and institutional factors (Gelb & Diofasi, 2019; Wolf et al., 2017; Afolabi, 2020). In Ghana, the 2012 elections saw instances where biometric devices failed, prompting some polling stations to bypass verification altogether, creating opportunities for fraudulent practices (Aiyede et al., 2013; Effah & Debrah, 2018). Researchers found that polling stations without observers were 50% more likely to experience these technical failures, which raised concerns about potential human manipulation of machines to facilitate multiple voting (Cheeseman et al., 2018; Kaaba & Fagbayibo, 2021). This situation highlights how technical failures can be exploited, leading to multiple voting and identity theft, a concern also noted by Iwuoha and Doeverspeck (2023).

Similarly, in Nigeria's 2019 elections, while benefiting from SCRs, still saw vulnerabilities to political manipulation. The findings revealed that the use of BT could not fully prevent

electoral violence, which was used as a political manipulation tactic to undermine technological advancements in the electoral process (Duruji et al., 2021). Therefore, while BT reduced some fraudulent practices, these findings underscore the limitations of the technology in the face of political interference, weak oversight, and inadequate safeguards. Both countries' experiences suggest the need for stronger safeguards, robust oversight, and enforcement to prevent exploitation of both technological failures and institutional weaknesses.

Accessibility Issues

In both Ghana and Nigeria, accessibility challenges related to BT disproportionately affected marginalised groups, highlighting the need for inclusive technological design. In Ghana's 2012 elections, manual labourers and elderly voters faced exclusion due to worn fingerprints that biometric devices failed to recognise, with no alternative verification methods in place (COG, 2012; Dorpenyo, 2020). In response, Ghana introduced facial recognition technology during the 2020 elections as a backup verification method when fingerprint scans failed (COG, 2021), significantly improving accessibility. These developments reflect a growing recognition that BT must evolve to accommodate diverse voter demographics, ensuring that technological advancements do not inadvertently exclude segments of the electorate.

In contrast, Nigeria did not implement similar measures during the period under review, leaving voters with worn fingerprints vulnerable to disenfranchisement. Accessibility issues were further exacerbated by logistical failures. In Nigeria's 2019 elections, poor logistics and delays in printing PVCs, which were essential for BVV, contributed to disenfranchisement. Nearly 3.5 million cards were left uncollected by election day (Alao & Lanre, 2022; EU EOM, 2019). This disproportionately affected marginalised groups from rural communities, who faced high costs and long travel distances to collection centres (Alao & Lanre, 2022). This reflects the impact of logistical and infrastructural challenges on accessibility. These findings thus suggest that the requirement for BVR and BVV can inadvertently reinforce inequalities in contexts where institutional frameworks do not adequately account for socioeconomic disparities. Although BT aimed to enhance electoral integrity, its implementation in Ghana and Nigeria highlighted the importance of inclusive design and institutional preparedness to prevent the marginalisation of vulnerable groups.

This section thus supports H3, revealing that BT in Ghana and Nigeria faced technical challenges, vulnerabilities to manipulation, and accessibility barriers. Equipment failures, poor

infrastructure, and inconsistent verification processes undermined its effectiveness, especially in earlier elections. Vulnerabilities to manipulation emerged through technical failures and human interference. Moreover, accessibility issues disproportionately affected marginalised groups, particularly in Nigeria, where facial recognition was not adopted during the period under review. This underscores that while BT aimed to enhance electoral integrity, it can be undermined by these challenges. Addressing them requires targeted reforms, including improving technological infrastructure, enforcing stronger security protocols, and ensuring equitable access to biometric verification for all eligible voters. Overall, the experiences of Ghana and Nigeria emphasise the need for comprehensive reforms that extend beyond the technology itself.

6.5. The Role of Electoral Governance

The findings of this study illustrate the critical role of electoral governance in shaping the implementation and effectiveness of BT in Ghana and Nigeria. Applying Mozaffar and Schedler's (2002) framework, this discussion examines BT's integration into electoral processes through the three dimensions of electoral governance: rule making, rule application, and rule adjudication. The analysis highlights how the regulatory and legal environment (rule making), EMBs and logistical implementation (rule application), and dispute resolution (rule adjudication) have collectively influenced the strengths and weaknesses of BT in both countries. Therefore, without improvements in electoral governance, the full potential of BT to safeguard electoral integrity may be undermined, leaving elections vulnerable to technical, logistical, and political challenges.

Rule Making: Legal Framework and Regulatory Environment

The findings indicate that the legal frameworks for biometric voter registration and verification have evolved significantly in Ghana and Nigeria, but they face different challenges in rule-making. Ghana's legal framework is grounded in regulations such as the Public Elections (Registration of Voters) Regulation, 2012 (C.I. 72), which clearly establishes BVR and BVV processes (Adams & Asante, 2019; Aiyede et al., 2013). The legal framework also places high importance on data protection, ensuring that biometric data is disclosed only through a High Court order (Public Elections (Registration of Voters) Regulations 2012 C.I. 72, 2012). Furthermore, amendments to C.I. 91 in 2016 and C.I. 126 in 2020 further refined the

framework, expanding the guarantor system to allow more individuals to vouch for other applicants (EU EOM, 2020).

In contrast, Nigeria's 2011 Electoral Act introduced in-person biometric data capture and technologies such as DDC machines and AFIS (COG, 2011; EU EOM, 2011). However, the 2019 elections revealed legal inconsistencies, such as conflicts between the INEC guidelines and the Electoral Act, particularly regarding the legality of using SCRs for voter verification (Alao & Lanre, 2022). Furthermore, Nigeria faced issues with managing biometric data for 84 million voters, leading to concerns over data security. The introduction of the Nigerian Data Protection Regulation (NDPR) in 2019 aimed to address these concerns by enforcing strict data protection measures (Sibe, 2022). Despite these efforts, gaps remain between legal provisions and the implementation of BT, reflecting ongoing challenges (Kaaba & Fagbayibo, 2021).

Both countries have made strides in integrating BT into their electoral processes. Ghana's legal framework is more cohesive, with clear regulations that prioritise voter data protection and fraud prevention. Nigeria's framework is more fragmented, with significant gaps between the Electoral Act and INEC guidelines regarding the legal standing of SCRs. These challenges underline the need for greater alignment between legal provisions and the implementation of BT to ensure transparency and credibility in the electoral process. Ultimately, rule-making plays a critical role in shaping the effectiveness of BT in elections.

Rule Application: Implementation by Electoral Management Bodies (EMBs)

The effectiveness of BT in elections largely depends on the capacity and impartiality of EMBs in implementing voter registration and verification processes. The findings indicate that while Ghana's ECG and Nigeria's INEC faced logistical and technical challenges, their levels of efficiency and institutional credibility varied. Ghana's adoption of BT in 2012 initially faced difficulties, including device malfunctions and inconsistent verification procedures due to inadequate training of electoral officials (COG, 2012). However, subsequent improvements led to greater reliability, with verification failure rates decreasing to 9% by 2020 (EU EOM, 2022). Despite this, the ECG's decision to create a new biometric register ahead of the 2020 elections was criticised by opposition parties, raising concerns about its impartiality (EU EOM, 2020).

In contrast, Nigeria's INEC struggled with more severe technical and logistical failures, particularly in its early adoption of BT in 2011, where device malfunctions and poor

infrastructure led to widespread registration delays and the bypassing of fingerprint capture (NDI, 2011). Unlike Ghana, where institutional independence was relatively stronger, Nigeria's EMB faced greater political interference. The appointment of INEC commissioners by the president contributed to public distrust in the neutrality of electoral administration (Mgba, 2017). The 2019 elections added to these issues, as the lack of safeguards against card reader manipulation and the absence of a verifiable paper trail compromised the credibility of biometric authentication (COG, 2019; EU EOM, 2019). Additionally, logistical shortcomings, such as delays in printing voter cards and significant disparities in collection rates, disproportionately affected certain regions, exacerbating voter disenfranchisement (Alao & Lanre, 2022).

The comparison between Ghana and Nigeria underscores the significance of EMB neutrality and technical capacity in determining the effectiveness of BT implementation. While both countries experienced challenges, Ghana demonstrated a more structured approach to addressing inefficiencies over time, whereas Nigeria continued to grapple with deeper systemic issues related to political influence and inconsistent application of BT. The findings underscore the importance of EMB neutrality in fostering public confidence in election technologies, as cited by Haque & Carroll (2020) and Onishi (2012). Strengthening institutional independence and enhancing the technical preparedness of EMBs would help mitigate implementation challenges, ensure credibility, and improve the overall efficacy of BT.

Rule Adjudication: Election Dispute Resolution and Electoral Legitimacy

This study found that the electoral commissions and judicial systems in Ghana and Nigeria play critical roles in resolving disputes and ensuring electoral integrity. However, their approaches and challenges differ. The ECG has demonstrated a commitment to neutrality in Ghana, notably in the 2012 and 2020 elections. In 2012, the ECG supported legal proceedings by providing electoral materials to the court, despite allegations of irregularities, such as over-voting and voting without biometric verification (Omotola, 2013). The Supreme Court upheld the results, reinforcing the role of BVR in enhancing electoral credibility (Nkansah, 2016; Debrah et al., 2018). In 2020, the decision to compile a new biometric register led to allegations of the exclusion of some voters. However, the ECG's decision was upheld by the courts as the claims were deemed baseless (CODEO, 2020). The process of legal adjudication in Ghana

emphasises transparency and the rule of law, with the Supreme Court playing a central role in confirming the legitimacy of the election processes and results despite some challenges.

Conversely, Nigeria's electoral dispute resolution process faces significant challenges. The Electoral Act 2010 aimed to streamline dispute resolution during the 2011 elections, but the 180-day time limit on petitions led to the dismissal of several cases, including gubernatorial and National Assembly disputes (EU EOM, 2011). The absence of consolidated records of complaints and rulings further undermined transparency and public accountability (Yagboyaju, 2011). The 2019 elections saw additional complications, including legal disputes over the use of SCRs and delays in releasing electoral documents, which raised doubts about Nigeria's commitment to the rule of law in electoral disputes (Kaaba & Fagbayiyo, 2019). The overlapping jurisdictions and delayed release of electoral documents by the INEC created additional hurdles, raising doubts about the commitment of Nigeria's electoral bodies to upholding the rule of law in election disputes.

While both Ghana and Nigeria have faced disputes related to BVR and election integrity, Ghana's approach to rule adjudication has been more effective in fostering transparency and collaboration. In contrast, Nigeria's system suffers from procedural inefficiencies and a lack of public trust. The emphasis on transparency in Ghana, particularly in the 2012 and 2020 elections, has strengthened electoral credibility, whereas Nigeria's legal ambiguities and inefficiencies have undermined public confidence. Ultimately, Ghana's consistent and transparent approach to rule adjudication has bolstered public trust, while Nigeria continues to face challenges that hinder effective dispute resolution and undermine the legitimacy of election results. Effective rule adjudication is crucial for ensuring electoral integrity and maintaining democratic legitimacy in both countries.

Alternative Explanations and Unexpected Findings

1. **Manual Verification Still Used As a Backup:** In Nigeria's post-implementation phase, biometric failures still led to manual verification at times (Sule et al., 2020), reintroducing vulnerabilities that BT was designed to eliminate.
2. **Institutional Trust and the Limits of Technology:** The most notable unexpected finding was the gradual decline in public trust in the ECG and the INEC (Adams & Asante, 2019; Afrobarometer, 2021; Afrobarometer, 2022), despite improved or

maintained trust in the electoral processes, election outcomes and the effectiveness of BT (Afrobarometer, 2013; COG, 2011; Krawczyk, 2019; Layiwola, 2023; Owusu-Mensah & Akeliwira, 2022; Piccolino, 2015). This study argues that logistical and technical challenges faced by both ECs, along with political interference, likely led to voter disenfranchisement and a decline in public trust in these commissions. This highlights that while BT can improve trust in electoral processes, it cannot fully restore public confidence in the institutions. Therefore, institutional weaknesses need to be addressed.

3. **Persistence of underage registration and voting:** Although the instances of underage registrations and voting were minimal, they surfaced in Ghana's 2012 (COG, 2013) and Nigeria's 2011 (EU EOM, 2011) and 2019 (EU EOM, 2019) elections. This highlights a critical limitation of BT. BT verifies identities once they are registered, but the findings suggest it cannot independently determine a person's age if fraudulent documents are used during registration. This limitation offers an alternative explanation for why ineligible voter fraud (underage voters) persists despite technological interventions.

Chapter 7: Conclusion and Recommendations

Introduction

The integration of biometric technology (BT) in electoral systems has marked a significant shift in how elections are managed in countries such as Ghana and Nigeria. This paper aimed to assess the effectiveness of BT in improving the integrity of electoral systems in Ghana and Nigeria. This research was guided by the following questions:

Main Research Question:

“How effective is biometric technology in improving the integrity of electoral systems in Ghana and Nigeria?”

Sub-questions:

- “What are the strengths and weaknesses of biometric technology in addressing electoral challenges such as multiple registrations, multiple voting, and impersonation in Ghana and Nigeria?”
- “How have the different phases of biometric technology adoption (pre-, during, and post-implementation) influenced electoral transparency, electoral outcome credibility, and public trust in Ghana and Nigeria?”
- What lessons can be learned from Ghana and Nigeria’s experiences with biometric technology to inform future applications in electoral processes of other African countries (i.e. strengths, weaknesses, opportunities and threats of BT in electoral systems of other African countries)?

The study relied on qualitative data from sources, such as academic literature (journal articles, books and reports) and election observation reports from the European Union, The Carter Center, the African Union, and The Commonwealth Group. This approach was beneficial in capturing the overall effectiveness of BT beyond statistical trends. A before-after analysis was employed to compare electoral conditions before and after BT implementation, as well as process tracing to examine how BT was introduced and how it affected electoral integrity in Ghana and Nigeria. This chapter begins by summarising the study’s chapters, followed by the key findings and conclusions based on the three hypotheses presented in Chapter 1. It will then discuss the contributions of the study to the discipline and conclude with recommendations for

policymakers, electoral management bodies (EMBs), and future research to enhance the implementation of BT in electoral processes.

Summary of Chapters

The study explored biometric systems in Ghana and Nigeria's electoral processes, assessing their effectiveness in enhancing electoral integrity. Chapter 1 introduced the research problem, questions, and methodology, while Chapter 2 reviewed literature on the use of BT in elections, identifying gaps in African contexts. Chapter 3 outlined the conceptual framework, defining electoral governance, integrity, and BT. Chapter 4 presented Ghana's electoral processes across pre-, implementation, and post-implementation years of BT, highlighting more successful management despite initial technical glitches. Chapter 5 presented Nigeria's BT adoption across the same phases, noting its strengths, but also identifying more evident weaknesses such as technical failures, delays, and political interference that contributed to public distrust. Both chapters 4 and 5 also highlighted the role of electoral governance in both countries. Chapter 6 compared both cases, attributing Ghana's success to stronger governance and transparency, while Nigeria's struggles stemmed from instability and weak institutions.

Key Findings

The before-after and process-tracing research design proved effective in demonstrating the causal link between BT and the improvement in electoral integrity in Ghana and Nigeria, notably reducing electoral fraud, such as multiple voter registration, multiple voting, and voter impersonation. These improvements enhanced transparency, voter roll accuracy and public trust in the electoral process. However, in both countries, there was a decline in public trust in the electoral commissions due to some reports of political manipulation and logistical inefficiencies. This indicates that institutional and contextual factors, such as the quality of the EMB and political will, play a role in the effectiveness of BT. These challenges, especially in Nigeria, underscore the need for improved governance, infrastructure, and training for BT to fully realise its potential.

Summary of Key Findings:

To answer the research question and sub-questions, the discussion of this study's findings was organised around the three hypotheses:

H1 proposed that BT improves electoral integrity in Ghana and Nigeria by reducing fraud such as multiple registrations, multiple voting, and voter impersonation. The research confirms that BT significantly enhanced electoral integrity in both countries, though outcomes differed. In Ghana, BT was particularly effective, especially after the introduction of facial recognition in 2020, due to better institutional management, fewer political interferences, and higher public trust. Conversely, Nigeria's BT implementation faced persistent technical failures, logistical challenges, and governance issues that hindered its full effectiveness, despite initial progress. Ultimately, the study found that while BT reduced electoral fraud, these ongoing issues in Nigeria highlight the need for better infrastructure, improved training, and contingency planning.

H2 proposed that BT enhances the efficiency and accuracy of voter registration and verification and strengthens public trust in the electoral process in Ghana and Nigeria. The findings from both countries confirm this hypothesis. One of the most notable strengths of BVR is its ability to improve the accuracy of the voter roll by eliminating duplicate registrations and ensuring the timely removal of ineligible entries. The introduction of BVV also curtailed fraudulent practices such as multiple voting and voter impersonation, reinforcing the integrity of the verification process. In Ghana's 2020 elections, innovations such as facial recognition technology further improved accessibility and accuracy, ensuring a more inclusive process compared to Nigeria. Additionally, BT contributed to increasing public trust in the electoral process by enhancing transparency and minimising electoral malpractices. Although broader political and institutional challenges continued to affect perceptions of electoral bodies, the adoption of BT was generally viewed as a positive step toward improving electoral integrity. Overall, BT strengthened voter registration and verification processes, reduced fraud, and contributed to greater public confidence in the electoral process, even amidst persistent governance challenges.

H3 proposed that despite its benefits, BT faces challenges such as technical issues, vulnerabilities to manipulation, and accessibility barriers for marginalised populations in Ghana and Nigeria. The findings from both countries substantiate H3. Technical failures, such as malfunctioning biometric devices and inadequate infrastructure, undermined the reliability of the technology. Additionally, vulnerabilities to manipulation persisted, with evidence of political actors exploiting technical failures and bypassing verification protocols, particularly in Nigeria. Accessibility challenges were also pronounced, as elderly voters, manual labourers,

and rural populations faced obstacles such as worn fingerprints, limited access to registration centres, and prohibitive travel costs. Overall, this study illustrated that while BT has the potential to enhance electoral integrity, its effectiveness is contingent on addressing these persistent weaknesses through targeted reforms aimed at improving infrastructure, enhancing oversight, and ensuring inclusivity in electoral processes.

Collectively, the evidence from these three hypotheses comprehensively addressed the research question and sub-questions. The strengths and weaknesses of BT in addressing electoral challenges such as multiple registrations, multiple voting, and impersonation in Ghana and Nigeria were fully examined through H1 and H3, revealing how BT mitigated fraud but also exposed vulnerabilities. The different phases of BT adoption (pre-, during, and post-implementation) and their influence on electoral transparency and public trust were explored in H2. This confirmed that BT contributed to improved transparency and public confidence in the electoral process over time. Finally, the lessons learned from Ghana and Nigeria's experiences with BT, which can inform future applications in other African countries, were drawn throughout the study, especially in H3, where the challenges identified provided important insights for enhancing future BT implementations.

Broader Implications for Electoral Governance Framework

The findings of this study highlight the importance of electoral governance in ensuring the successful implementation of BT. Although the technology itself has the potential to improve electoral integrity, its effectiveness is largely dependent on the regulatory framework, institutional capacity, and adequate adjudication of electoral petitions. First, a well-defined legal framework is crucial for ensuring the proper implementation of BT. Both Ghana and Nigeria have established laws governing biometric voter registration, but enforcement remains inconsistent. Strengthening electoral laws and ensuring compliance can help address vulnerabilities in the system. Second, the efficiency of EMBs in managing BT also plays a critical role in determining its effectiveness. Ghana's ECG and Nigeria's INEC have made significant progress in adopting BT, but they continue to face logistical and technical challenges, which have undermined public trust in the institutions. Investing in better training for election officials and improving the technical infrastructure can enhance the reliability of biometric systems. Third, the overall credibility of elections can be constrained by weak legal oversight and inefficient adjudication processes. Judicial intervention, when inconsistent or

delayed, can exacerbate electoral tensions rather than resolve them. Establishing clearer legal guidelines on BT use, streamlining electoral dispute resolution mechanisms, and ensuring EMB compliance with legal requirements would strengthen public confidence in electoral processes.

Contribution to Field

This study contributes to the field by offering a conceptual framework that underscores the interplay between BT, electoral governance, and electoral integrity. The findings highlight the necessity of robust legal and regulatory frameworks to guide the implementation of BT in elections, as the absence of clear guidelines can undermine system credibility. Additionally, while BT has the potential to enhance electoral processes, its effectiveness is contingent on complementary factors such as infrastructural investment, independent and capable EMBs, voter education, and political will. Ultimately, this study demonstrates how the implementation of BT may yield varying outcomes depending on the political and institutional context in which it is deployed.

Recommendations

Based on the study's findings, several recommendations are proposed to enhance the effectiveness of BT in Ghana and Nigeria. First, there is a need to improve technical infrastructure and capacity. Upgrading biometric verification devices and ensuring regular maintenance can prevent system failures. Additionally, extensive training for election officials is necessary to enhance their ability to handle technical challenges. Second, strengthening legal and institutional frameworks is essential. Implementing stricter regulations to prevent the difficulties of biometric verification procedures and establishing independent oversight bodies to monitor the implementation of BT can ensure accountability. Third, voter education and accessibility need to be enhanced. Conducting nationwide voter education campaigns, particularly for uneducated citizens, can inform the public about the importance of biometric registration and verification. Fourth, contingency plans for election day challenges must be developed. Ghana, in particular, should deploy technical teams, similar to Nigeria's Registration Area Technical Support (RA Tech) personnel, to areas experiencing technical difficulties. This will help mitigate disruptions. Finally, although there were minimal cases of underage registrations and voting, technological advancements and better oversight are needed to completely eliminate any instances.

Implications for Policy and Future Research

This study provides a comprehensive analysis of the impact of BT on electoral integrity in Ghana and Nigeria. However, several areas warrant further research. An assessment of the long-term impact of BT on voter turnout and political participation would provide valuable insights into its broader effects. Another area for exploration is analysing the cost-effectiveness of BT compared to other electoral integrity measures. Additionally, more research on the cybersecurity risks associated with biometric data could inform strategies for safeguarding voter information.

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