The Use of Internet-Based Technologies in Elections Management Processes in South Africa towards the design of a framework: A Case Example of the Gauteng Province

By

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Dedication

This thesis is dedicated to my lovely wife, Lisbeth Maqenase Maphephe, daughter, Ntshepeng Joyce Maphephe, my parents, Mr Clement Mohau Maphephe and Mrs Rosalia Lisebo Mamojela Mmaphephe Maphephe, all my younger brothers, Daemane, Qobose, Monkoe, Retselisitsoe, Poloko, my Senior Sister Mme Mannete Ntsane (Ntsoaki Maphephe), and the entire Maphephe family. For their endless love, support and encouragement.

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No study is feasible without the use of the library, the centre of learning resources. I would like to express my gratitude to all the library staff at the Durban University of Technology for their services; Sara Mitha was very helpful. To the postgraduate staff members and all staff members within the Department of Management Sciences, I just wanted to say thank you for your help and guidance over the past five years. You have been patient and willing to assist me within the timeline of my studies.

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Glory to Almighty God.

Plagiarism Declaration

I, John Maphephe, Student Number 21351730, know and understand that plagiarism is using another person's work and pretending it is one's own, which is wrong. I declare that this thesis is my own work. I have appropriately referenced the work of other people which I have used. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his/her own work. Furthermore, I cede the right of publication of this thesis to the Durban University of Technology.

05 May 2019

Student Signature (John Maphephe) Date

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05 May 2019

Promoter (Professor Rishi Balkaran) Date

05 May 2019

Joint Promoter (Dr. Surendra Thakur) Date

Abstract

Over the past two decades, new technologies have played an increasingly integral role in the organization of elections around the world. A number of countries have turned to a variety of technological solutions in a bid to make elections more efficient and more cost-effective, and to strengthen stakeholder trust at each stage of the election cycle. On the other hand, the evolution of disparate modern technologies has proven that the introduction of technology comes with some risks, such as the malfunctioning of equipment, the contested integrity of machines, or exposure to hacking and lack of trust from stakeholders. In the context of elections, technology is used to achieve three objectives: (1) to ensure that all information produced during the elections process, particularly the election results and the elections roll, is correct, trustworthy and secure; (2) to generate a broad acceptance that the elections outcome is a true and fair representation of the citizens' will; and (3) increased administrative efficiency, reduced costs and strengthened trust among electioneering stakeholders.

Hence, the aim of this study was to develop a generic framework to guide the effectiveness of Internet-based technologies in safeguarding elections management processes in Gauteng, South Africa. To achieve this, the study adopted an artefact model to improve integrated human and technology performance, exploring the existing literature in order to develop a framework comprising views and opinions of elections stakeholders. It employed a detailed Design science approach which makes use of a case-example strategy to collect data through a literature review, recorded observations, questionnaires, focus groups and expert reviews. The study, by design, is a mixed-method exploring both qualitative and quantitative approaches in the investigations. Consequently, the study adopted the multivariate regressive predictive modelling method and descriptive statistics for analysis. The study population consisted of 500 participants, comprising the Electoral

Commission of South Africa[1] (IEC), political parties, NGOs, media houses, government institutions, election observers and elections experts located in Gauteng. The study made use of the stratified purposive sampling of 385 voters as the representation of four geo-political areas of Gauteng.

The main findings of the study pointed to a significant correlation between the use of Internet-based technologies and election integrity in Gauteng. An increase in usage of internet-based technologies results in greater election integrity and legitimacy, which also covers trust in the accuracy, completeness and reliability of information. Based on the results, the study developed four predictive models to estimate the integrity of elections outcomes with technology integration in elections. These models were validated and found to be relevant to the context of South African elections. Based on the descriptive statistics results obtained, this study recommends that an effective and efficient automated elections process, systematizing and standardizing observational methodologies, should be put in place to help improve the integrity of e-enabled elections.

The most important currency is public trust, and manual ballot papers will remain the golden standard for any election in South Africa. The thesis submits that the foreseeable Internet-based technology future may well support automated, digitised elections procedures and processes in four key areas of elections processes, namely voter registration, voter identification, voting procedures and real-time results. Furthermore, the research concludes with specific implementation guidelines as well as areas for future research.

[1] The Electoral Commission of South Africa is officially known as "Electoral Commission of South Africa"; the study has adopted the 'IEC' instead of 'EC', as the current Commission operations retained 'IEC' for marketing purposes, without spelling it out in full.

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List of Abbreviations and Acronyms

AADHAAR	India Biometric ID system
ACE	Elections Knowledge Network Project
ACT	FEDERAL Register of Legislation in Australian Government
AFIS	Automatic Fingerprint Identification System
ANC	African National Congress
API	Application Program Interface
BVR	Biometric Voters' Registration
CCC	Constituency Collation Centre
CEO	Chief Elections Officer
CEO	Chief Executive Officer
CODE	CODE Inc-Canadian Elections Supplier
CPE	Customer Premise Equipment
CRDF	Carbonated Results Declaration Form
DA	Democratic Alliance
DOI	Diffusion of Innovations Theory
EFF	Economic Freedom Fighters
DRES	Direct-Recording Electronic System
EISA	Electoral Institute for Sustainable Democracy in Africa
EMB	Elections Management Body
EMP	Elections Management Process
ERP	Enterprise Resource Systems
ESS	Electoral Staff System
EVM	Electronic Voting Machine
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GMS	Google Mobile Services
GSM	Global System for Mobile
HCI	Human Computer Interactions
HOG	Histogram of Oriented Gradients
IBT	Internet-Based Technology
ICR	Intelligent Character Recognition
ICT	Information Communication Technology
IDEA	International Institute for Democracy and Elections Assistance
IEBC	Independent Elections and Boundaries Commission
IEC-SA	The Electoral Commission of South Africa (Also EC, IEC)
IFES	The International Foundation for Electoral Systems
IRI	International Republican Institute
ISO	The International Organization for Standardization
KIEMS	Kenya Integrated Elections Management System
LAM	Lever-Arch Machines
LAN	Local Area Network
LPCC	Linear Prediction Cepstral Coefficients
MEO	Municipal Electoral Officer
MPCU	Model of Pc Utilization
MPLS	Multiprotocol Label Switching

MPs	Members of Parliament
MTR	Maximum Transmission Unity
NASA	National Super Alliance
NDP	National Development Plan
NFC	Near-Field Communication
NIST	National Institute of Standards and Technology
NPE	National Provisional Elections Results system
OBB	Opaque Ballot Box
OCR	Optical Character Recognition
OECD	Organization for Economic Cooperation and Development
OMR	Optical Mark Readers
OSISA	Open Society Initiative for Southern Africa
OSS	Optical Scan System
OTP	One Time Password
PBSU	Programmable Barcode Scanning Unit
PCM	Punch-Card Machine
PCOS	Precinct Count Optical Scan
PIN	Personal Identification Number
PVC	Permanent Voter Cards
REAM	Regional Elections Assessment Missions in Southern Africa
RMS	Results Management System
SA	South Africa
SABC	South African Broadcasting Corporation
SADC	Southern African Development Community
SADC-PF	Southern African Development Community Parliamentary Forum
SAID	United States Agency for International Development
SAP	Systems Application and Products(Enterprise Resource Planning)
SCR	Smart Card Reader
SCT	Social Cognitive Theory
SIM	Subscriber Identification Module
SMIV	Secure Mobile Internet Voting
SMS	Short Message Services
Stats	Statistics South Africa
SWOT	Strengths, Weaknesses, Opportunities and Threats
TAM	Technology Acceptance Model
TBB	The Transparent Ballot Box
TCP	Transport-Communication Protocol
UNDP	United Nation Development Programme
USA	United States of America
VAP	Voting Age Population
VMS	Voter Management System
VPN	Virtual Private Network
VS	Voting Station
V-SAT	Very-Small-Aperture Terminal
WAN	Wide Area Network
WAP	Wireless Application Protocol
WML	Wireless Mark-up Language

Peer Reviewed Articles

Maphephe, J. 2011. Government of Lesotho Diagnostic review on the status of ICT systems. *African Journal of Computing and ICT*, 4(2)46-78. Available: http://www.ajocict.net (Accessed 16 March 2016).

Maphephe, J. 2011. Is it time for E-voting in Africa? Pushing buttons for electoral change. In: *6th annual EISA Symposium*. Nairobi, Kenya, 23-24 November 2011.

Maphephe, J. 2013. Information communications technology lessons from Lesotho 2007-2013, bench-marking and evaluating towards full implementation of ICT policies and strategies. *Computing, Information Systems, Development and Allied Research Journal*, ISBN 978-2257-44-7 5(1). Available: https: www.cisdijournal.net (Accessed 19 May 2019).

Maphephe, J., Balkaran, R. and Thakur, C. S. 2016. The importance of the use of Internet-based technology in securing inclusive and legitimate elections. A review of the South African elections technology practice between 2014 and 2016. *African Journal of Democracy and Governance*, 3(3-4): 186-216.

Maphephe, J., Balkaran, R. and Thakur, S. 2014. Digital and interactive content production as part of Lesotho Strategic Development: A brief study on Lesotho working towards national collaboration for updated civil register and voter register in the spirit of improved service delivery. *African Journal of Computing and ICT*, 7(4): 89-90.

Maphephe, J., Balkaran, R. and Thakur, S. 2014. Impact of information and communication technology presence on direct parliament debates and security of the future laws of Mountain Kingdom of Lesotho. Computing, *Information Systems, Development Informatics and Allied Research Journal,* 5(3). Available: http://www.cisdijournal.net. (Accessed 14 May 2019).

Maphephe, J., Balkaran, R. and Thakur, S. 2016. How The Use of Social Media Networks Can Influence The Growth of Lesotho Political Economy Beyond the Jubilee Celebration of Independence. *Advances in Multidisciplinary and Scientific Research Journal*, 2(4):76-68.

Maphephe, J., Balkaran, R., Fagbola, M. and Thakur, S. 2019. Review of Internet-Based Technologies for electioneering in South Africa. Twinomurinzi, H. *Digital innovation and transformation conference*. Birchwood Hotel, Gauteng, South Africa, 28-29 August 2019, Pretoria, UNISA. Available: http://www.nemisa.co.za/wp-content/uploads/2017/07/DigitalSkills2019_Programme_20190822.pdf (Accessed 1 January 2019).

Maphephe, J., Balkaran, R., Thakur, S. and Temitayo, M.F. 2019. Southern African Region Leading the Way in Election Technology: 2009-2019 Review of Global Standards and Unanswered Questions. *Journal of Law, Society and Development*, 1(4) Available: https://www.upjournals.co.za/index.php/JLSD/issue/current (Accessed 19 May 2019).

Maphephe, M. J. 2012. *The role of elections stakeholders in Eastern African communities:* A comparative analysis of selected states. Available: http://aceproject.org/ero-en/misc/the-role-of-elections-stakeholders-in-eastern/view (Accessed 1 March 2018).

Maphephe, M. J. 2013. E-Government for Effective Service Delivery, Challenges and Prospects for the Lesotho Government 2009-2013. *African Journal of Computing and ICT*, 6(4): 64-75.

Published Report for International Elections Engagement

Appointed by the former Minister of Finance and Development Planning 2003-2007 as an Interim Senior ICT Adviser for the Crime Intelligence Unit for the Lesotho Government, IFMIS Project, Lesotho Mounted Police Service

(LMPS), ECOL Lesotho, Ministry of Finance, Ministry of Communications Science and Technology, Central Bank of Lesotho and other key stakeholders.

Appointed by the Open Society Initiative for Southern Africa and ECF-SADC to be the Lesotho and Zimbabwe Regional Elections Researcher in Lusaka 2015, and also participated in a workshop for a Methodology approach for gathering EMBs practice within the SADC region.

Development and implementation of online elections Assessment Scorecard for the Electoral Institute for Sustainable Democracy in Africa (EISA) 2019 Project.

ICT Adviser for the Somaliland 2010 presidential elections – introduction and implementation of new elections ICT reforms – Interpeace and European Union.

ICT Adviser for the United Nations Mission in Sudan (UNMIS) 2009-2010 – Sudanese presidential elections – implemented a new electronic voter register, under the assistance of the United Nations Mission in Sudan and UNDP.

ICT Project Adviser 2015 – Republic of Tanzania NEC and ZEC-UNDP-DEP Project.

ICT Voter Audit Adviser – Afghanistan 2014 presidential elections, and delivered an accepted report which led to the formation of the current government.

Participated in certification of international observer training offered by the African Union Commission and European Union in 2015 in Addis, Ethiopia.

Recent Elections Missions and Technology Projects

Senior Team Leader for Long-Term Observer for the African Union Commission in 2018 Cameroon presidential elections, under revised constitution and electoral laws and regulations.

Senior ICT Elections Analyst and Team leader for long-term observers for the Nigerian 2015 and 2019 Presidential elections.

Senior ICT Elections Analyst for the Kenya 2017 Presidential elections June-Nov 2017 African Union Commission.

Senior ICT Adviser for Liberian Administrative System and Strengthening (LASS) Project 2015 under USAID-Liberia

Short-Term Observer for the African Union Commission for the first electronic elections for 2014 Namibian presidential elections, first Electronic Voting system in Africa.

Senior Interim-ICT Adviser 2011-2012 for the Government of Lesotho Ministry of Finance and Development Planning, Ministry of Communications, Central Bank of Lesotho – implementation of the new Lesotho Government Accounting System under the supervision of the EU and UNDP Lesotho (2011 IFMIS).

Short-Term Observer, African Union Commission – Egyptian 2014 presidential elections.

United Nation Development Programme (UNDP). 2016. Democracy Empowerment Project Terminal Evaluation. Available: https://erc.undp.org/evaluation/documents/download/10024 (Accessed 18 March 2017).

Worked for the Independent Electoral Commission of Lesotho from 1999-2008, with the last position acting as Systems Administrator.

List of Terms

Term used	Description and characters
A transposition error	A transposition error is a simple error of data entry which occurs when two digits which are either individual or part of a large sequence of numbers are accidentally reversed(transposed when posting a transaction).
Acceptable Votes or Ballots	The criteria and election law will normally provide guidance, for example, clearly marked votes, not showing voter identify, no scarred marks, voter intention is clearly reflected, and only a single choice is made.
Advance voting	Elections officials and other essential staff from government and key institutions are allowed to vote a few days ahead of election day, such that if they are working on election day, their votes will be counted on the same day.
CEF	Registration form: The Commission on Elections Philippines
Collation Centre	A designated place for elections results to be announced (Constituency level or national)
COMELEC	The Commission on Elections Philippines
Credible elections	Main characteristics will be inclusiveness, transparency and equal opportunity for all eligible voters and parties to contest the elections.
DRC Congo	Democratic Republic of the Congo
E-Government	Electronic government (or e-government) essentially refers to the utilisation of Information and Communication Technologies (ICTs), and other web-based technologies to improve or enhance the efficiency and effectiveness of public service delivery.
E-enabled elections	Any type of elections using technology to safe-guide the elections management processes without the use of paper manuals
E-minded	Supporting the use of smart technologies for public services and election processes
E-voting/systems	Any electronic system which is designed to take care of casting and counting the votes
Election	The formal process of selecting a person for public office or of accepting or rejecting a political proposition by voting
Electoral System	Methods and rules of counting votes to determine the outcome of elections
Election Cycle	Three stages of elections: pre-elections phase, during the elections phase, and post-elections phase
Elections stakeholders	Stakeholders are those individuals, groups and organisations which have an interest in any election; the primary stakeholders will include EMB staff, political parties and candidates, government officials, legislatures, civil police, members of the judiciary, local and international observers, monitors, members of the media, civil societies, non-government organisations, donor communities, technical advisers and marginalised groups.
Elections timetable	Refers to the national elections calendar, as regulated by each country’s electoral law
Electoral integrity/ Integrity of elections	Refers to the international standards and global norms guiding and governing the appropriate conduct of elections
Focus Groups	Focus groups are panels, facilitated by a moderator, who meet for a specified time period to exchange perspectives, knowledge, and/or opinions on a particular topic.

Term used	**Description and characters**
Free and fair elections	*Free* means that all those entitled to vote have the right to be registered and to vote, and they must be free to make their own choice; *fair* means that all registered parties have an equal right to contest the elections.
Gerrymandering	Manipulation of election boundaries or constituencies to favour one party or group or class such that the results of the elections will favour someone
Internet-based technology for elections systems	Combination of hardware and software technologies to secure Internet connection, web applications, and web services, in order to maintain elections products and services
Internet voting, I-voting, M-voting	Casting the ballots through Internet platforms; the mobility offers the voters convenient voting at any place and any time
Issue logging module	Platform designed to capture elections complaints and hot issues, to be resolved by elections stakeholders
M-Services or M-readiness	The extent to which M-services can be deployed
Presiding Officers	An elections official in charge of a Voting Station or Polling station during the time of elections
Rejectable Ballots	Every country or EMB has approved principles which stipulate the conditions for invalid ballots, which will ideally include votes which are blank, those which identify the votes, those where more than one choice is selected, and votes where a voter does not clearly reflect the intention of the voter.
Returning Officer	An elections official designated to be in charge of the results of constituency elections
Secure Socket layer	A standard protocol used to secure transmission of documents over networks
Spoiled Ballots	Any ballot declared by law to have been spoiled, void, null, invalid and stay; the EMBS and other elections stakeholders will normally have criteria from elections regulations to ensure that the votes are not counted. Ballots can be spoiled accidentally or deliberately, may contain unacceptable marks, parts torn off, or anything which may change the lawful and acceptable ballot
Technological intervention in elections	The use of technology to improve the quality of election voter rolls, the cleaning of de-duplication for Voter IDs, geo-location systems, video conferencing to monitor critical and hot spot areas, polling station finders, voter participation registers, elections results systems, online political parties registers, and online candidates validation tools for nomination
Transparent elections	Each step is open to scrutiny and all the stakeholders can independently verify whether the process is conducted honestly
Trust in electoral process	Public trust and ownership of electoral processes, procedures and outcomes
Voter register/roll/elections roll	Active list of voters who are eligible to vote in elections
Voting Station Finder	A software designed to help a voter locate the nearest voting station on his/her smart phone or any Internet-connected device during the election period

Chapter 1 INTRODUCTION

1.1 **Background to the Study**

The introduction of Information and Communications Technologies (ICTs) into the election process is generating both interest and concern amongst voters and stakeholders across the globe. In general terms, an election enables certain formal decisions to be made through the participation of a given population responsible for choosing individuals to hold public offices (Heinz *et al.* 2018; Rexha *et al.* 2011). Evidently, ICT integration into election administration has made the processes and procedures more accurate, efficient and effective (Osei 2010; Rabindra 2012). In developing countries with poor communication infrastructure, the growing trend of Internet penetration is enabling Elections Management Bodies (EMBs) to perform their major responsibilities more effectively (Watson *et al.* 2015). It has also opened new ways of registering for elections, identification of voters, observing elections, casting votes and declaring election results. This in turn has enhanced the transparency and integrity of election processes, increased administrative efficiency, reduced costs and strengthened trust among electioneering stakeholders (Therese 2001: 2-8).

Some fierce agitations for free, open, fair and peaceful contest in elections and associated management processes have led EMBs to employ ICT as a tool to meet these constitutional and political demands to harness its transformational impact in strengthening the credibility and integrity of election outcomes (Maphunye 2010). For example, the use of biometric technology in voter registration has enabled EMBs to improve the accuracy of voters rolls and enhanced trust in the election process by providing an effective mechanism to identify duplicate entries into the voter registry (Avgerou *et al.* 2019; Tran 2019: 127-149).

It has also allowed EMBs and non-partisan organisations to collect and share election data in real-time with large groups of people (Diamond 2010). Similarly, ICT has provided EMBs with ways to count, tabulate and transmit election results more rapidly through measures such as electronic voting or transferring election data through mobile technology (Watson *et al.* 2015). This enables election results to be announced sooner, potentially diffusing tension in closely-contested elections and mitigating against severe post-election violence (Young *et al.* 2010).

Elections in Africa and its management processes remain very controversial and continue to dominate the discussion across the continent due to certain associated imminent challenges. However, ICT has been perceived as a solution to these electoral challenges, including the creation of accurate voter registers, simplified voting and result tallying, and faster transmission of election results (Callen, Michael and Long 2016). As technology matures, some expect that eventually fully-automated elections will become unavoidable as well as a requirement for a credible and transparent electoral process (Schulz-Herzenberg 2014: 189-209). On the other hand, the use of ICT services, equipment and facilities evidently comes with some risks, malfunctioning of equipment, the contested integrity of machines, or exposure to hacking and lack of trust by the elections stakeholders (De Kadt 2017; Schulz-Herzenberg 2014: 189-209). There are instances where electoral events have triggered deep technological crises. An example is the Kenya Integrated Electoral Management System (KIEMS) which did not achieve the main objectives for the 2017 Kenya presidential elections (Micheni and Murumba 2018; Cheeseman *et al.* 2018; O'Brien 2018). The initial objectives of KIEMS were to identify the voters, tally the results and transmit the results to the National Tally Centre (Kenya Supreme Court Order 2017). The process was very simple in theory but the practical implementation of electoral information production and dissemination within a state of enhanced transparency and full legitimacy was compromised (Kalinin and Hicken 2017: 1-7). Citizens were denied receiving electoral results which were supposed to be true and represent voters' desires (Krimmer *et al.* 2015, 2012c; Kenya Supreme Court Order 2017)

The majority of EMBs across the globe have adopted a number of modern electoral technologies in a bid to deliver elections more efficiently and in a cost-effective manner. With some past elections conducted in South Africa by the Electoral Commission (IEC) (Struwig *et al.* 2011: 1122-1138), a number of associated challenges were evident (Mpekoa 2017a; Achieng 2014; Achieng and Ruhode 2013; Swanepoel 2012; Swanepoel *et al.* 2010: 70-77). These included the disconnection between the zip-zip device and the central commanding centre, leading to manual verification of voters' registration using the green Identity Document (ID) book and smart card; long queues at polling units; a high percentage of missing votes; stolen or miscounted ballots; an increasing number of unclear ballots; invalid votes; rejected votes; spoiled ballots at times; poor arrangements for people with disabilities and marginalised societies; vote compulsion, where voters were being influenced regarding for whom to vote; transparency issues; allegations of election fraud, as previously-marked ballot papers and ballot boxes went missing; electoral violence; and the ineffective use of technology in the elections (Mashile 2014; Mpekoa 2017a; Thakur 2015a; Achieng 2014; Achieng and Ruhode 2013; Swanepoel 2012; Swanepoel *et al.* 2010: 70-77). Consequentially, these problems negatively affected the turnout of voters, and the integrity, fairness, credibility and public confidence in the outcome of the elections (De Kadt 2017; Korstad *et al.* 2017; Norris 2016; Enikolopov *et al.* 2013; Achieng and Ruhode 2013).

However, it becomes highly significant to evaluate the appreciable level of ICT impact on elections administration around the world. The use of ICT in election processes must be grounded in well-designed policies, surrounded by adequate safeguards and supported by legislation which is adequate in dealing with the issues which it raises (Thakur 2015). Otherwise, technological applications may lead to the erosion of public confidence in election processes. In other contexts, technology has been introduced with inadequate research, planning, testing, and training and voter education, resulting in decreased trust in the process and/or increased costs to the elections budget (Sheriff *et al.* 2014). Many EMBs are also faced with the challenge of maintaining and replacing software and hardware, which is raising concerns about the sustainability of certain election technologies (Watson *et al.* 2015a). Pastor (1999b), as well as Altman and Klass (2005), among others, have indicated that there is no readily-available research on the application of technology in the election arena in developing countries (Obaidat *et al.* 2019; Callen *et al.* 2016).

Furthermore, information sharing between election management bodies and aid agencies is poor, and at the same time, vendors tend to promote solutions which maximise their return rather than address long-term needs (Evrensel 2010). This is clearly illustrated by the number of voter registration solutions implemented in Africa and which have no sustainability (Pallister 2017). As a result, master planning for technology application in elections tends to focus on the immediate needs of an Election Commission, as well as the election process as applicable at that time. Therefore, there is a need to develop a generic framework to guide the effective and efficient use of Internet-based technologies (Makulilo 2017: 198-2012).

In the South African context, Mpekoa (2017), Thakur(2015a), IEC(2013), Swanepoel (2012) and Achieng(2014) have suggested that South Africa (SA)should amend its laws to allow experimentation with the use of Internet-Based Technologies (IBTs) for Election Management Processes (EMPs), adding to the voters' choice some form of E-voting, but not migrating away from paper ballots, as paper ballots remain the gold standard of elections projects (Gibson and Mcgaley 2008; Thakur 2015a; Sheriff *et al.* 2014). Despite the transformational benefits evident in the integration of ICT in election processes globally, the following countries have adopted and tested E-voting to a satisfactory level: Namibia, Estonia, India, Brazil, the United States, Canada, the UK, and Geneva. Atypically, limited research has been conducted to investigate the reasons for the failure of E-voting projects (Gibson and Mcgaley 2008; Thakur 2015; Sheriff *et al.* 2014), factors which may be unique given the local context in which ICT is implemented (Krimmer 2014).

Hence, the intent of this research study is to propose a conceptual framework which can be used to guide the effective and efficient use of Internet-based technologies for elections management processes in South Africa, so as to enhance and improve election operations in SA, Botswana, Lesotho, Eswatini, Zimbabwe, Democratic Republic of Congo (DRC), Tanzania, Zambia, Namibia and Malawi. The study looked at the following areas of election processes: election administration activities, election operations, boundary delimitation, voter registration (including capturing of voter biometrics), candidate registration, ballot casting (voting), counting, result reporting, and dispute resolution, as stated by Golden *et al.* (2015).

It is notable to mention that the current IEC technology is playing a role in enhancing the integrity of electoral processes by employing technology to boost stakeholders' electoral confidence and trust (EISA 2009). An example is the use of biometric technology to verify voters' identities on the election day, contributing to enhanced trust in the electoral process (Golden *et al.* 2015). Technology has also been adopted to count, tabulate and transmit elections more rapidly using scanning, faxing and Internet services (Mpekoa 2017; Thakur 2015a; Achieng 2014; Achieng and Ruhode 2013; Swanepoel 2012; Swanepoel *et al.* 2010: 70-77). With this growing trend, it is very pertinent to assess emerging trends and impacts of ICT integration into electoral management processes over time.

1.2 **Statement of the Problem**

The digital age presents South Africa with new opportunities while exposing the nation to new threats to democratic elections in terms of the holding of free and fair elections which are accepted as legitimate by both voters and outsiders. ICT has been already been perceived as a solution to certain election challenges, such as the creation of accurate voter registers, possible result tallying or auditing, and faster transmission of election results. On the other hand, as mentioned earlier, the use of ICT services, equipment and facilities does come with risks such as the malfunctioning of equipment, the contested integrity of machines, or exposure to hacking and lack of trust by the elections stakeholders. South African Development Communities (SADC) and over 23 countries have already held elections employing a biometric voter register. For example, in 2016, the Electoral Commission of Uganda used biometrics to verify voters. Biometric scanners were deployed in all polling stations clearing voters in 30 seconds – a record time in voting.

The first main advantage is the speeding up of vote counts, reducing the time between voting and the announcement of results. A long delay between voting and the results is widely seen as a signal that the count is being rigged or negotiated by elites. If India, a country with 540 million participating voters, is able to count and release results within 24 hours of polling, there is little reason why this should take longer in southern African countries with notably fewer voters. To this end, the method of voting used in SA and many other SADC countries today is derived from the Australian paper-based ballot system.SA has an estimated population of over 58,558,270 million people (Statistics SA2019). The country is divided into nine provinces and has 11 official languages, as recognised by the Constitution of SA. To date, all democratic elections have employed a traditional paper-based voting system. There were several controversies around the 2009, 2014 and 2019 national elections, which were spread virally on social media, but finally, all of the 2009,2014 and 2019 election results were adjudged to have been free and fair by the Electoral Commission of South Africa (IEC). However, the current traditional manual paper practice used by the IEC has setbacks, as mentioned earlier in Section 1.1. Further setbacks include: inaccuracies due to human error and inefficiency; certain voting stations opening late; a shortage of voting material, not allowing voting to take place in a timely and efficient manner; and voters walking long distances only to be turned away due to being in the incorrect voting district/station, or voters not being registered as legitimate voters. Nowadays, the waiting period between voting and obtaining the results provides fertile ground for the planting of seeds of discontent, sadly often justified, which threaten the credibility of polls.

South Africa needs to focus on an identity program which provides each citizen with a secure and trusted digital identity token, which forms the basis of a next-generation voting system. Instead of looking to Southern African digital electoral systems leaders such as Namibia and Ghana in the region, SA should be benchmarking itself against world innovators such as Estonia, which some years ago built on digital identities to enable a fully electronic voting system which allows voters to cast their ballots over the Internet. With these factors addressed, South Africa would be well-placed to implement a fully digital, automated voting system ahead of the next elections – moving from procurement to phase-by-phase deployment in a few short years.

The research gap from the existing body of knowledge suggests limitations in terms of the use of technology, specifically ICTs, in elections. A synthesis of previous related studies shows that African EMBs are slowly utilising technologies. This motivated the objectives of the present study, but with specific focus on the EMB officials who have first-hand experience in the running of elections in their countries. To this end, there is a growing demand for an elections management conceptual framework which will guide the effectiveness of Internet-based technologies in safeguarding elections management processes in South Africa.

***The problem statement for this study can be stated as follows*:**

There is currently no framework guiding the effectiveness of Internet-based technologies in safeguarding elections management processes in the South African context.

1.3 **Aim and Objectives**

1.3.1 **Aim**

The aim of the study is to develop a generic framework to guide the effectiveness of Internet-based technologies in safeguarding elections management processes in South Africa.

1.3.2 **Objectives**

The specific objectives are to:

i. Design a framework which could help to improve the South African elections, through an understanding of the dynamics of the province of Gauteng
ii. Identify all EMPs and which IBTs are used for each process
iii. Examine the best global practices and identify gaps within the current South African EMPs in relation to the effective implementation of IBTs
iv. Examine the factors which have influenced the adoption of IBTs for all stages of election cycle processes
v. Identify the current challenges associated with the use of IBTs for EMPs in South Africa's Gauteng province

1.4 **Research Questions**

The main research question is stated as:

What are the components of an effective and efficient framework for EMPs for the implementation of an IBT system within the South African elections context?

The research sub-questions include:

i. Which factors should be considered when designing a framework model for the implementation of IBTs in South African election processes?
ii. How can the IBTs improve the current South African EMPs?
iii. What are the best global practices for using IBTs in elections?

iv. What is the role of IBT in the South African EMPs, what are election stakeholders' views on the use of IBTs for elections, and what are their perceptions and misconceptions?

v. What are the current election challenges associated with the use of IBTs in South Africa's Gauteng province?

1.5 **Research Design and Techniques**

A good research design is one which is based on a well-designed study involving research questions with objectives (Mackey and Gass 2015; Mpekoa 2017: 10). Consequently, the study was implemented in three phases, as shown in Table 1.1, which articulates the research questions, objectives and techniques for this research study.

Table 1.1 Research Phases (Mackey and Gass 2015: 1-25; Mpekoa 2017: 10).

Research Problem	There is currently no working framework guiding the effectiveness of Internet-based technologies in safeguarding elections management processes within the South African context.	
Primary Research Question	The primary research question for this study is: 'What are the components of an effective and efficient elections management processes framework for the implementation of an IBT system within the South African elections context?'	
Phase 1: Secondary Data Collection		
Research sub-questions	**Research Methods**	**Research Objectives**
1. How can the IBTs improve the current South African EMPs	• Literature review • Questionnaires	1. Identify all EMPs and which IBTs are used for each process
Phase 2: Primary Data Collection		
2. What are the best global practices for the use of IBTs in elections	• Literature review • Questionnaires	2. Examine the best global practices and identify gaps within the current South African EMPs in relation to the effective implementation of IBTs
3. What is the role of IBT in the South African EMPs, and what are election stakeholders' views on the use of IBTs for elections	• Focus groups • Questionnaires • Literature review	3. Examine the factors which have influenced the adoption of IBTs for all stages of election cycle processes

4. What are the current election challenges associated with the use of IBTs in South Africa's Gauteng province	• Focus groups • Questionnaires • Literature review	4. Identify the current challenges associated with the use of IBTs for EMPs in South Africa's Gauteng province
Phase 3: Framework Design and Evaluation		
5. Which factors should be considered when designing a framework for the implementation of IBTs for South African elections	• Literature review • Expert reviews • Questionnaires	5. Design a framework which could help to improve the South African elections, specifically in Gauteng

As indicated in Table 1.1, the study made use of both primary and secondary data. The overview of the research design and how each research question and objective was treated in the study is presented in Figure 1.1.

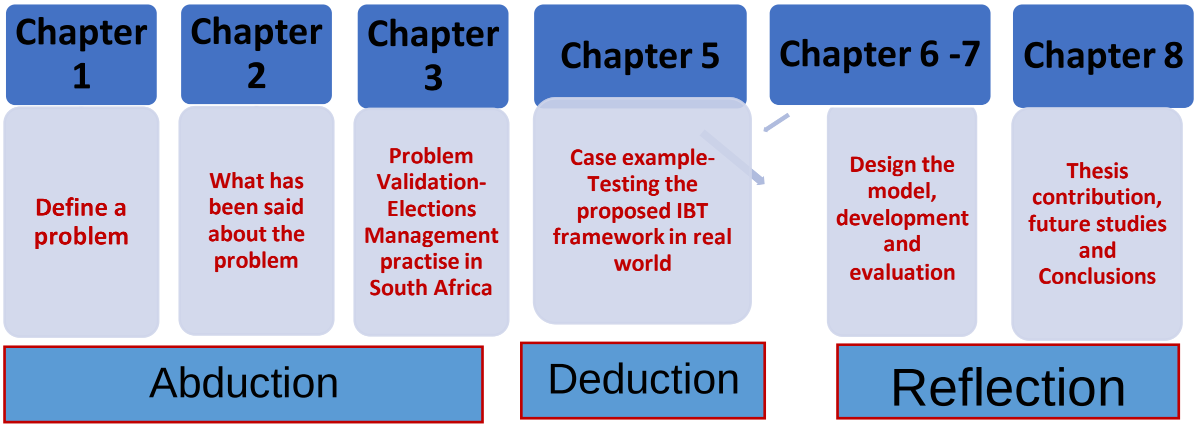


Figure 1.1 Research Design Process(Peffers et al. 2006: 83-106)

The research design commenced with the literature review. The literature review helped the study to investigate and understand the challenges and the weaknesses of the current manual paper work and technologies and identify the gap. The literature review was conducted via the collection and review of the relevant documentation on the study in Gauteng. The focus group and a survey also assisted in discovering detailed impressions, ideas and concepts about factors which might influence the successful adoption of IBTs in South Africa. Three focus groups, with a maximum of eight people in each group, were utilised. Once all the data had been triangulated, the framework was refined, where necessary, and the findings were finally documented. The details are documented in Chapter 4.

1.6 **Scope of the Study**

This study primarily investigates the use of IBTs in the elections management processes in the Gauteng province of South Africa only. Only IBTs being used in this study area were investigated and evaluated. The other eight provincial offices, namely Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, North West, Northern Cape and Western Cape, were not included in the study. Election stakeholders' views, perceptions and misconceptions, as well as the major challenges associated with the adoption and use of IBTs for EMPs in Gauteng are the core focus areas of this study. The study period ran between 2009 and 2014. The study reviews elections policy and elections management. It is also important to note that this research did not consider some IBTs used in EMPs, but rather all IBTs used for EMPs in Gauteng.

1.7 **Ethical Considerations**

In this research, ethical guidelines and principles were applied while interacting with human participants to ensure that no indignity and no mental or physical harm was inflicted on the participants in the research process. The rights and views of the participants were respected during the study. This means that the decision to take part in the study remained the choice of the participants. The participants were allowed to withdraw from the study at any time, and the participants were not coerced into providing information. The participants were considered as partners, and they were assured that the information which they provided would remain confidential. Their identities and personal details were not disclosed, and will remain unknown, except for research purposes. No data used in the report was linked to any of the respondents. Furthermore, the required ethical clearance was obtained from the Durban University of Technology (DUT), IEC and the Elections Institute for Sustainable Democracy in Africa (EISA), in order to conduct the research. The participants were told that should they need to access the results of the study, necessary procedures would be followed.

1.8 **Delimitation and Limitations**

This study is a cross-sectional study since the researcher had limited time and budget to conduct the study, for period of 2009 to 2014 National elections in South Africa. The preparations for any elections in the world are ranked amongst the highest logistical nightmare projects conducted in the lifetime of any developing society (Shamos 2004; Albright 1942; Mpekoa 2017; Thakur 2015a). There is no single solution for all election problems and in practice, there are neither perfect nor imperfect elections. Every phase of an election brings unique problems (Mpekoa 2017; Thakur 2015a). EMBs may consider using the lessons learnt from past elections, and they may adopt a new system or improve the existing system to ensure that the election management practices are more effective and acceptable to all stakeholders. It is within this context that this study accepts that ICT is a tool, not a panacea. Like any tool, ICT can be misused.

1.9 **Study Outline**

The study is organised into eight chapters starting with *Chapter 1*, which presents the introduction and background, research problem, research objectives, significance of the study, contributions and delimitations.

Chapter 2 discusses technology definitions, election concepts, perspectives on ICT, ICT and elections administration, assessment of ICT policies within elections missions, descriptions of types and forms of IBT for election processes, a global description overview, comparisons of a variety of forms of IBT, the level of technology maturity required for elections, an assessment of IBTs which form the best practices globally, the security of Internet-based technologies, the analysis of the social political context, country-specific case studies, identified gaps relevant to the South African context, a SWOT analysis in the South African context, and the use of IBTs in relation to election challenges/issues. The chapter presents international and regional experiences of technology used by different countries and identifies both good and bad practices.

Chapter 3 presents elections management processes and technology interventions in Gauteng. It also covers the use of IBTs at each stage of the elections management process and identifies each stage of the EMP successively, indicating which IBTs are used and for which purpose. Election data and figures show the increase in the numbers of voters, which justifies the need for the IEC to look for an improved way of handling elections information services for all stakeholders. The chapter also highlights the factors which have influenced the adoption of IBTs for all stages of election cycle processes and the IEC's policy with regards to the proliferation of E-voting systems.

Chapter 4 presents the research design and methodology, which were critical in answering the primary research question and sub-questions. This chapter describes the research methodology and design used in this study and its justification. The chapter also presents the research approach, strategies, targeted study population, data collection procedures and analysis.

Chapter 5 presents the background information of the Gauteng case example. The findings from the first observation are presented in this chapter, as well as the findings from the focus groups and the survey.

Chapter 6 presents the IBT-use and election integrity models obtained from the multi-linear regression analyses of the elections management processes adopting Internet-based technologies for the South African elections based on the views of the voters, political parties, Electoral Commission of South Africa (IEC), and EISA.

Chapter 7 reports on the design and development of the IBT conceptual framework which has the potential to successfully implement IBTs for the South African election. This framework is based on the information collected in Chapters 2, 3, 4,5 and 6. The chapter further evaluates the proposed framework for IBTs and interprets the research findings in relation to the formulated research questions and objectives.

Chapter 8, the final chapter, communicates the overall results of this study drawn from data collection procedures involving surveys, a literature review and focus groups. It also covers the evaluation of the conceptual framework of IBTs by interpreting the research results of the formulated research questions and objectives of the study. The chapter covers the final discussions, contributions to knowledge, future work and the overall study conclusions.

1.10 **Summary**

This chapter *introduces* the main objective of this study, clearly describing the research problem and giving a brief guide on how the main objective was accomplished. The aims of the research and the research question which guided the examination were expressed. The significance of the study is discussed, and the ethical considerations are articulated. The next chapter presents the literature review for the study.

Chapter 2 LITERATURE REVIEW

2. Introduction

Chapter 1 presented an overview of this study; it introduced the research problem, and also briefly described how the study was undertaken. Chapter 2 outlines and explains the information technology for elections. It also presented the traditional toolkit of election managers, the electoral cycle. Different types of information technologies are also presented and discussed, some of them do not apply to South Africa or Gauteng Province but their significance are explained as they link to the study arguments. The concluding remarks and the summary are presented in section 2.10.

2.1 Information and Communication Technologies

Information and Communication Technology (ICT) can be defined as computer-based tools used by people to work with the information communication processing needs of an organisation. It includes the computer hardware and software, the network, and several other devices (video, audio, photograph cameras, computer sets, laptops etc.)which convert information (texts, images, sounds, motions etc.) into a common digital form (Oyier et al. 2015; Zuppo 2012; Van Wart et al. 2017). It integrates both Information Technology (IT) and telecommunications to include telephone lines and digital signals, computer applications with web services (Mishra et al. 2016), middleware, storage, and audio-visual systems, which enable users to access, store, transmit and manipulate information (Sallai 2012: 10; Jagun and Heeks 2007; Heeks 2002; Heeks 2001).

The term ICT is also being used to refer to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system (Zhang, Cheng and Boutaba 2010; McFarlane et al. 1994). However, Reddick (2009)has stressed that the concepts, methods and applications involved in ICT are constantly evolving on an almost daily basis. Technology inventions have drastically altered the traditional ways of interaction and communication with information, and now a global system of interconnected computer networks (the Internet) has approximately more than one and a half billion users worldwide (Harveston 2016: 15-16). The Internet has restructured most traditional ways of communication; nowadays, instant messaging, social networking, online shopping and e-banking have become new methods of communication (Stair and Reynolds 2013). In general, ICT is no longer regarded as an inhibitor or perceived as a supplementary tool; it has become a crucial asset (Nduati et al. 2015).

The above definitions and ICT background is very relevant and practical in Gauteng (Swanepoel et al. 2010; Achieng 2014). The study concurs with the theory of Sallai(2012), Harveston(2016), and McFarlane et al. (1994), amongst others. The South African broadband policy and current South African infrastructure is discussed in later sections.

2.2 **Assessment of IBT Integration at each Stage of the Election Cycle**

The concept of an election cycle was introduced from the field experience of the European Commission (EC) and the International Institute for Democracy and Elections Assistance (IDEA) (UNDP 2009, 2007; IDEA 2014a, 2014b). It has been noted as a new way of looking at election programmes. Sierra Leone and Nigeria became the first two African countries to benefit from the approach, and other countries such as Brazil, India, South Africa, Zambia, Mozambique and the Democratic Republic of Congo later adopted it (Graham 2014; UNDP 2009). The election cycle runs ahead of Election Day. Figure 2.1(IDEA 2014a: 1-30; Graham 2014: 25; UNDP 2009: 10) depicts a prototype election cycle, which is composed of the entire elections activities and processes leading up to an election day.

This indicates the scope of the elections' coordination and the associated management activities, the fieldwork and the required real-time information for decision-making. All election information set up by the Election Management System (EMS) can be used prior to elections, during elections and post-elections(INEC 2015; UNDP 2009; IDEA 2014a, 2014b). From an

ICT point of view, particularly with the use of IBTs, the election cycle may be divided into different stages, each with its own technologies and its own set of technical pre-requisites, opportunities and problems.

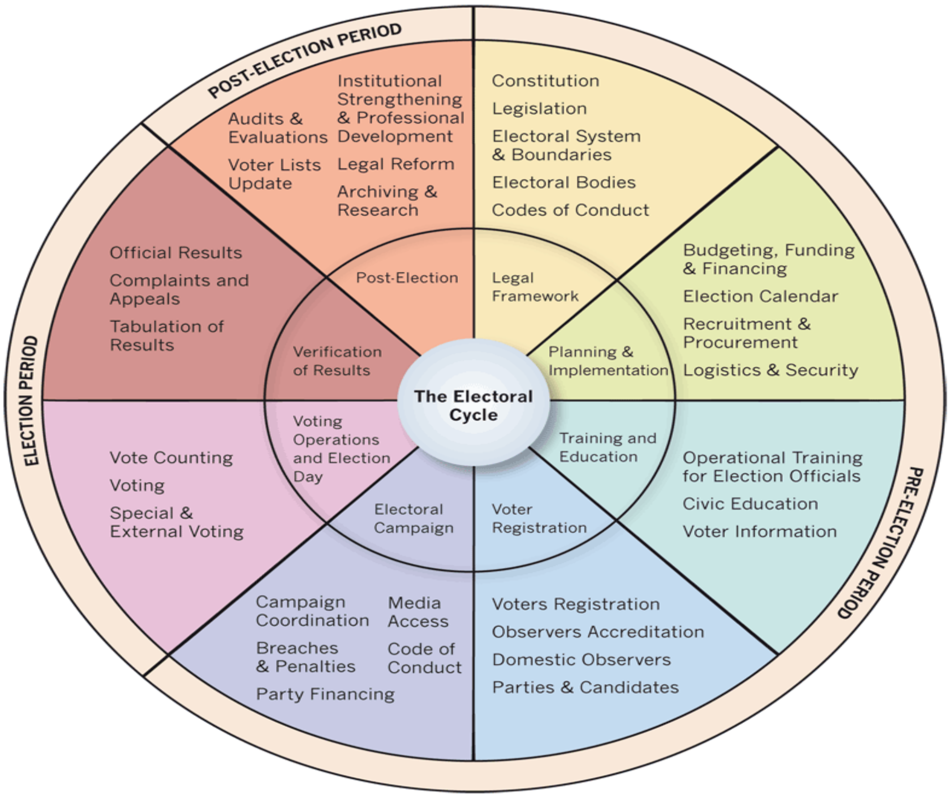


Figure 2.1 Election Cycle (IDEA 2014a; Graham 2014; UNDP 2009).

The election cycle strengthens the activities of elections on a continuous basis rather than individually as once-off events. Regarding technology, some authors highlight that database solutions for voters' registration, delimitation, Geographic Information Systems (GIS) and logistics planning have been successfully used by numerous elections management bodies in the past 20 years. They have emphasised that electronic voting is not only a new application of technology but also an unproven one. They have acknowledged that although there are a number of perceived benefits to electronic voting, these benefits have yet to be empirically proven. They have further proposed that a decision to use electronic voting should be one taken carefully which looks at the full impact on all stakeholders involved as well as the associated costs (Thakur 2015a: 32).

The Internet-based technology framework follows the election cycle from the pre-election phase to voter registration activities during elections(voter identification at voting stations) to the post-elections phase (counting, tabulation and declaration of election results) (EML7.0 2011). Gauteng province had experienced different stages of election cycle (IEC 2017, 2013, 2010; Thakur 2015). It would appear that there is a general feeling that Gauteng youth have an appetite for Internet-based technologies (Cupido and Van Belle 2012).

2.3 **Automations for Elections Management Processes**

In this section, the trends in the evolution of automation in elections management processes are discussed, from the traditional mechanical era to the electronic age. Mechanical voting machines were widely used in the United States, and to a lesser extent in a small number of other countries around the world, but recently they are being replaced by electronic voting machines (Gupta *et al.* 2013: 5). Since the emergence of information and communication technology, the mode of conducting elections has changed and improved drastically. Modern technological tools, systems and applications are now replacing manual and mechanical means of conducting elections of past times by digitising election administration within real time. By definition, E-voting is the use of information technologies to cast votes in an election (Gupta *et al.* 2013; Hapsara 2013). According to Ayo and Ekong (2011: 1-5), it is an election or referendum which involves the use of electronic means in the casting of the vote. Idrisa and Yusofb (2015: 1-8) also claim that voting could be termed as an act of establishing a relationship between citizens, governments and democracy (Ekong and Ekong 2010). There are different types of electronic and mechanical voting systems. However, different electronic voting devices are already in use in several countries and their usage is expected to increase (Avgerou *et al.* 2019: 9).

The main trends in the evolution of automation which has been incorporated into elections management processes are discussed below.

2.3.1 **Lever-Arch Machine (LAM)**

These are also known as direct-recording voting systems (LAM). They were the first major alteration in voting technology after the Australian paper-based voting system (Mpekoa and Van Greunen 2017, 2016a). In 1892, the very first lever-voting machine was introduced. It was known as the Myers Automatic Booth in New York. To cast a vote, the voter enters the voting booth and pulls a lever to close the curtain. This then unlocks the voting levers. A ballot – with a small lever near the name of each candidate – is positioned, and the voter makes a choice by flipping the small levers next to the names of the preferred candidates. After completing all the choices, the voter pulls a large lever to cast the ballot. When the voter has finished, a lever is pulled which opens the curtain and increments the appropriate counters for each candidate (Patel 2012; Jacobs and Pieters 2009). The mechanical interlocks prevent over-votes, under-votes and ambiguous choices or spoiled ballots. This machine also eliminates the need to count ballots manually. Although it has great potential, the lever-voting machine is subject to tampering and to malfunctions, which could invalidate hundreds of votes (Johnson *et al.* 2017; Matney 2017).

2.3.2 **Punch-Card Machine (PCM)**

The punch-card tabulation machine (PCM) was introduced in 1864 by Herman Hollerith for statistical computation (Altun and Bilgin 2011: 2494-2500). It was initially developed to process large amounts of information from a census, but it was later improved for commercial and scientific purposes, and it was then used for voting. Punch-card systems make use of a card and a small clipboard-sized device for recording the votes (Cortada 1993; Brooks *et al.* 1963). The machines have pre-scored perforations or “chad” (Olusola and Adesina 2015: 1; Patel 2012: 5; Mpekoa 2017: 92), and small numbers imprinted on the card, which is linked with each chad. For voting, the voter properly places the punch card in a slot at the top of the punching device. These are printed on pages attached to the device. The voter punches through the perforations in the card which correspond to their choice, and once this is completed, the card is placed in a box. The cards are then counted using a tabulation machine which reads the ballot based on the passage of light through the spaces (Olusola and Adesina 2015: 12-16; Patel 2012: 1).

There are two common types of punch cards, the Votomatic card and the DataVote card (Pallav *et al.* 2012; Jacobs and Pieters 2009). These systems have several drawbacks, the most critical being the way the votes are punched. Unfortunately, the system does not always guarantee a clean-cut punch and there is no intuitive basis on how to judge the voter's intention when in doubt. Consequently, there is a large number of invalid votes and the system cannot prevent under- and over-voting. Furthermore, if the chad is not fully removed or is punched in the wrong place, errors can occur due to misalignments. It is also very difficult for the voters to verify their votes because the candidates' names and ballot choices do not appear on the punch card itself (Masuku 2006; Patel and White 2005). In 1937, IBM introduced the Type 805 Test-Scoring Machine. It was capable of sensing graphite pencil marks on paper by their electrical conductivity.

The optical-scan voting system appeared again in the 1980s (Enguehard 2008). This made use of computers for the counting process. Since then, numerous types of electronic optical-mark-sensing scanners have been tailored to count votes (Prosser 2004: 21-28). These systems have a pre-printed computer-readable paper ballot and the voters cast their votes by marking the empty box (rectangle, circle or arrow) next to the candidate's name using a marking device. The voter feeds the ballot into the computerised tabulation device (optical-mark-recognition equipment) which reads and selects all the marks darker than a fixed threshold as being votes and it then records them. The machine displays the choice and the voter verifies the choice by pushing the 'OK' button and the vote is then stored (Adjei 2018: 1-25; Stenbro 2010: 1-62).

2.3.3 **Direct-Recording Electronic System**

The Direct-Recording Electronic System (DRES) is the electronic implementation of the old mechanical lever systems invented in 1978 (Dunn and Merkle 2018: 182).With this system, the voter enters his/her choices into the electronic storage device with the use of a touch-screen, push buttons or similar device, and the choice is then stored in memory and added to the final tally (Altun and Bilgin 2011; Gentles and Sankaranarayanan 2012, 2011). In some instances, an alphabetic keyboard is provided to allow voters to cast write-in votes. However, governments' ambitions in using ICT is to overcome economic, social and environmental challenges and to create a more open, flexible and collaborative government (Cloete 2012; Sepeame and Ajala 2013; Maumbe and Owei 2006; ACE Elections Knowledge Network 2014: 1, 2013: 2-5; Adeshina and Ojo 2014; Abdulhamid *et al.* 2013; Buckland and Wen 2012).

The Electoral Commission of South Africa(IEC 2013: 12) acknowledges the mechanical lever, the punch card system, and the direct recording electronic (DRE) and touch screen for their roles in elections, however IEC South Africa does not make use of these machines and therefore noted some challenges, which are discussed further in Section 2.8 of this chapter.

2.3.4 **The Transparent Ballot Box (TBB)**

The first technological innovation was the introduction of the Transparent Ballot Box (TBB) in 1996 for Ghana's general elections. The Opaque Ballot Box (OBB) was used earlier in the 1992 Presidential and Parliamentary Election and resulted in alleged "ballot stuffing" by the opposition political parties (Commission of Ghana 2000: 1-35). The Elections Commission considered this complaint as a serious matter since the ballot box is an essential material for elections (Botchway and Kwarteng 2018; Van Gyampo 2017). It is critical because it is one of the tools for establishing the secrecy of the ballot (Elections Commission of Ghana 2000: 1-35). The design of the slot of the TBB ensures that only one ballot paper is put in at any one time (Wakefield Metropolitan District Council 2007). This reinforces the principle of fairness, since each voter is entitled to cast only one vote. A close examination of the nature of the complaint shows its linkage with transparency and fairness as values of the Elections Commission. Consequently, the introduction of the transparent ballot box innovation in the 1996 Presidential and Parliamentary Elections was facilitated by donor support and resulted in a rise in voter turnout, rising markedly from 56.2% in 1992 to a record of 78.2% in 1996, showing the heightened level of confidence which stakeholders had in the elections process (EC 2000).

2.3.5 **Double Box Marking and Digital Photographs on Ballot Papers**

Paper-based ballot elections have posed certain logistical and administrative challenges, such as the difficulty to implement on a large-scale and the increasing costs of production (Commission of Ghana 2000: 1-35). Paper ballots and other physical records are perhaps the oldest and most protracted vote-casting technologies known (Commission of Ghana 2000: 1-35).

According to Jones(2003:3-16) cited in Ekong and Ayo (2007: 172-179), the first paper ballot replaced the oral voting system in Rome in 139 BC. The first modern paper ballot, called the "Australian ballot", was used in the Australian public elections in 1856 and it was considered a great improvement. Paper is susceptible to ballot miscount, coercion and vote-buying. Every form of paper ballot which has been devised has been manipulated with considerable ease (Thakur *et al.* 2015; Shamos and Yasinsac 2012: 16-17; Shamos 2004; Albright 1942). Hence, improved technological innovations, such as the use of digital cameras and high-quality stencils for printing ballot papers, have been implemented over time in elections management processes.

The practice of using paper ballots or mark-sense ballots has proved reasonable for emerging democracies. Appropriate computer programmes, such as Corel Draw and Publisher, have been employed to redesign the ballot paper (Luhusena 2018: 1-55). With the aid of this technological innovation, a double box was introduced for the thumbprint area, which facilitated a redefinition of what should constitute a valid marking on the ballot paper. Black-and-white photographs of candidates were also introduced in the ballot paper but have since been changed to coloured photographs. This reform of the ballot paper reduces controversies surrounding ballot counting during elections. Stakeholders also agreed that it had created a level playing field for all contestants in elections, which is a core value of credible elections around the world (ACE Elections Knowledge Network 2014: 2-10, 2013: 1).

2.3.6 **Scanning-Optical Mark Readers and Polaroid Cameras**

Electronic scanning systems are used to convert data marked manually on paper into electronic form (Enguehard 2008a: 1, 2008b: 1). While scanning is often used to capture voting data written into machine-readable ballots, it can also be used to capture other data, such as lists of electors who have voted or information shown on forms (Enguehard 2008a: 22-24). There are five main types of optical scanning technologies:

i. Optical Mark Reading (OMR) is the process of capturing human-marked data from election document forms used for activities such as surveys and tests. They are used to read questionnaires and multiple-choice sections on documents regarding elections management processes in the form of lines or shaded areas (Enguehard 2008a). The introduction of the optical mark reading scanners in the voter registration system was the first type of technological innovation introduced by elections management bodies. However, before its adoption, the West African Examination Council (WAEC), institutes of higher learning and the Lesotho Examination Council were already using it for the grading of students' tests. The relevance of this machine to elections is the ability to gather bulk information prescribed in manual forms with minimal error.

ii. A number of EMBs around the world were assisted by the United States Agency for International Development (USAID) and International Foundation for Elections Systems (IFES) to apply this technology for data-capturing during voters' registration exercises, which significantly improved the acceptability of the registration exercise. According to Kangah and Sarfo-Kantanka (1998: 1-8), immediate benefits which were accrued included the timely completion of the exercise, a high level of accuracy of the captured data as compared to previous years, and a significant lowering of the cost to the EMBs, among other benefits (Debrah 2015: 1-5, 2011: 25). The technology enhanced the identification process with two significant innovations, by making it possible for Voter ID Cards to be issued to voters with unique identification numbers drawn from the OMR forms, and photographs to be issued to qualified voters in urban areas.

iii. Optical Character Recognition (OCR) is the mechanical or electronic conversion of images of typed, hand-written or printed text into machine-encoded text, whether from a scanned document, a photo of a document, a scene photo (for example, the text on signs and billboards in a landscape photo), or from subtitle text superimposed on an image (for example, from a television broadcast),in all elections management processes (Olusola and Adesina 2015: 10; Sheriff *et al.* 2014: 1-5; Ekong, Ikhu-Omoregbe and Ayo 2007: 12-16). The optical recognition technology was used to scan the forms compiled during the voter registration process in order to computerise the data. Photographs of voters were first taken with Polaroid cameras and later with digital cameras, and printers were used to print voters' ID cards with unique numbers and thumbprints (Chapman 2017: 37-91; Riggs and Earls 2017: 23-56; Odhiambo 2016: 5).

iv. Intelligent Character Recognition (ICR) is an advanced OCR or rather a more specific handwriting recognition system which allows fonts and different styles of handwriting to be learned by a computer during processing to improve accuracy and recognition levels (Olusola and

Adesina 2015; Sheriff *et al.* 2014; Ekong, Ikhu-Omoregbe and Ayo 2007: 12-16).

v. Imaging technology is the application of materials and methods to create, preserve, or duplicate images regarding elections management processes (Olusola and Adesina 2015; Sheriff *et al.* 2014; Ekong, Ikhu-Omoregbe and Ayo 2007: 12-16).

2.3.7 **Carbonated Results Declaration Forms (CRDFs)**

Coming on the heels of troubled elections on the African continent, particularly the Nigerian 2007 and 2011 elections, the Kenyan 2007 and 2017 elections, and the Zimbabwean 2008 elections, Ghana's 2008 general elections were of much interest to both international and local observers (Luhusena 2018: 14-74). Carbonated Results Declaration Forms (CRDFs) were introduced as a new technological innovation by the elections commissions to solve the difficulties which most presiding officers experienced, especially the repetition of results on different results declaration forms, while recording results at the polling stations and constituency centres. This was done to eliminate the transpositional errors which usually characterise such activities. A transposition error is a simple error of data entry which occurs when two digits which are either individual or part of a large sequence of numbers are accidentally reversed/transposed when posting a transaction (Doyle 1985: 43-47).

The use of carbonated results declaration forms normally ensures that election results are recorded only once and copies of results are instantly issued to party/candidate agents. It also allows for the pre-printing of presidential candidates' names on the presidential results declaration and constituency results declaration for the position of president to prevent any mistake in the spelling of names on the polling day (Luhusena 2018: 14-74; EC-Ghana 2000: 1-10). Some EMBs also introduced the Very-Small Aperture Terminal (V-SAT) technology during both presidential and parliamentary elections to improve on the receipt of results from the constituency centres. This technological innovation facilitated the transmission of election results in an efficient and cost-effective manner to the head office of the elections commission from the constituencies (Luhusena 2018: 14-74; EC-Ghana 2000: 1-10).

2.3.8 **Geographical Information System for mapping Polling Stations**

In other to obtain a clearer picture of the location of polling stations for the purposes of effective and efficient logistic planning and management during elections and to eliminate the bottlenecks which usually characterise the deployment of both election materials and officials, the Elections Commission of Ghana, during the 2008 general elections, employed the Geographic Information System (GIS) technology. With GIS, polling stations were dotted across the length and breadth of the country and were captured with the aid of the geographic positioning system device, while digital cameras were used to capture the latitudinal and longitudinal positions as well as the pictures of polling stations, which enabled the Elections Commission to place them on Google maps(Luhusena 2018: 14-74).

This technological innovation enabled the EMBs to identify riverine areas and other inaccessible polling stations, which enabled the Elections Commission to allocate resources and the type of transportation facility which best suited such terrains (for example, the use of commandeered helicopters to airlift election materials and personnel to such commonly-inaccessible areas). This resulted in the elimination of delays which usually characterised the opening of polls in such areas, and the supply of sufficient materials to such difficult-to-reach areas on election day (Luhusena 2018: 14-74; EC-Ghana 2000: 2)

2.3.9 **Photo and Thumbprint Identification Systems for Voter Identification**

An effective system of voter identification is very crucial in every election. Several stages in the election process need to reliably identify a person: when a person votes, when a person registers to vote or when an employee needs access to a restricted place (Karlan 2017; Olusola and Adesina 2015; Sheriff Folarin *et al.* 2014; Ekong and Ayo 2007).

The need to ensure that only persons qualified by law are identified and given the opportunity to cast their votes cannot be underscored in any democratic election, since this constitutes an important determinant of the credibility of the election (Karlan 2017). However, the major complaint from stakeholders concerning the manner in which voters were identified concerns the use of slips by voters bearing only their names instead of the use of identification cards.

Certain countries rely on the voter's self-identification, without the need of an elections identification document (Chandramouli and Lee 2007: 92-96), while other countries may require a specific elections identification system. As electronic voting becomes more widespread and more automated, particularly where voting is introduced on the Internet or by telephone, these identification systems become crucial in ensuring that only eligible voters are able to vote. Ayee (2001: 15) argues that "There is no doubt that a credible elections register is key to the administration of free and fair elections".

Various types of identification systems are used during elections management processes (Enguehard 2008a: 22-24; Evrensel 2010: 57-305; Effah and Debrah 2018: 104-113; Makulilo 2017: 198-2012; Chike 2017: 136). Table 2.1 presents different types of identification systems and cited sources.

Table 2.1 Different Types of Identification Systems (Enguehard 2008a: 22-24).

<table>
<tr><th>Type of IDs</th><th>Sources</th></tr>
<tr><td>Identity Cards</td><td rowspan="6">Enguehard 2008;
Evrensel 2010;
Effah and Debrah 2018;
Akpan and Adagba 2018;
Makulilo 2017;
Chike 2017;
Piccolino 2016;
Nwangwu 2015a,2015b;
ACE Elections Network Knowledge 2014, 2013</td></tr>
<tr><td>Personal Identity Numbers (PINs)</td></tr>
<tr><td>Bio-identification Systems including Voice</td></tr>
<tr><td>Hand/Finger/Thumb</td></tr>
<tr><td>Retinal Identification Systems</td></tr>
<tr><td>Digitised Photography Bar-coding Public Key Infrastructure/
Electronic Signatures Passwords</td></tr>
</table>

2.3.10 **Biometric System for Voters Registration and Vote Capturing**

The Biometric System is composed of multiple systems to store and process data critical to voting processes (Luhusena 2018; Golden *et al.* 2015). The systems mainly include: the Automatic Fingerprint Identification System (AFIS) software, including adjudication functions and servers; voter database management software; database servers; data collection software; data storage software; as well as digital mobile registration kits. Prior to the 2012 Ghana elections, stakeholders' agitation for a credible register for the elections was heightened, leading to the adoption of the biometric system. However, it has become the trend in many African countries undertaking election reforms (Debrah 2015: 104-113). According to Debrah (2015: 104-113), Somalia, Nigeria and South Africa have incorporated the use of biometric registration and voting into their elections processes in the last presidential elections.

Towards the time of Ghana's 2012 general elections, the political stakeholders of the elections process pushed for a full-proof elections process to block election-voting loopholes. As a result, biometric registration and verification systems were integrated into all aspects of the elections process, indicating a radical departure from election norms and practices. Its implementation started with the registration of voters. The system provided an opportunity to accurately capture the biometric data (unique physical features) of applicants in addition to their demographic data. The aim of the biometric system in the voter registration process is to prevent multiple voter registration and voting, as well as mitigating the incidence of fraud during registration and elections. The system uses the V-SAT technology, which is installed in all districts and regional offices to facilitate the export of daily registration data from district offices to the national data centre. This has resulted in the shortening of the timespan for generating the voters register. It has also eliminated human errors often associated with the packaging and transporting of large volumes of registration forms (Luhusena 2018: 14-74).

The Automatic Fingerprint Identification System (AFIS), with its adjudication functions embedded in the biometric system, is able to undertake the procedure referred to as “matching”(Luhusena 2018: 24-74), which compares both the demographic and biometric data of every registrant on the database(Luhusena 2018: 24-74). This process facilitates the identification of persons who have indulged in multiple registrations. Another component of the biometric system is the Voter Management System (VMS) (Luhusena 2018: 24-74). The VMS allows all corrections and modifications involving voters’ registration and other elections management processes to be carried out in the district offices and posted to the National Data Centre in Accra with the aid of the V-SAT system. This, in effect, ensures accuracy in data-capturing and also reduces the time and cost in processing data in Accra. Additionally, the system was also accompanied by the application of other technological innovations such as the use of the mobile telephone. The study share a view that the mobile telephone is unquestionably currently the most versatile and most commonly-used tool for participation in Ghanaian politics. During the exhibition of the biometric voters register, the Elections Commission initiated a working contract agreement with a telecommunications company which created a mobile telephone platform where voters, from the comfort of their offices, homes or cars, could simply check their registration details in the voters register by simply sending their voter identification numbers to a short code which was provided (Luhusena 2018). According to a CODE INC (2012a: 1-5) survey of Ghanaian registered voters, 78% of the respondents surveyed agreed that biometric registration represented a remarkable improvement as compared to the old system, while 87% considered it as a useful tool for promoting credible and peaceful elections(*ibid*).

2.3.11 **Election Results Management System**

The Elections Results Management System (ERMS) has already been adopted in the 2012 Ghanaian presidential elections, the Tanzanian 2015 presidential elections, and the Lesotho 2000 and 2007 national assembly elections, among others(ACE Elections Network Knowledge 2014, 2013). The ERMS is a robust application which has been used to capture, validate, collate and transmit election results from the constituency collation centre to the national collation centre. The application facilitates the operations at the Constituency Collation Centre (CCC) through intuitive and easy-to-use interfaces which are segmented in line with the manual procedures of collation at the CCC(ACE Elections Network Knowledge 2014, 2013). The CCC application runs on a laptop computer and uses a webcam, memory stick with a token, a printer and connectivity to Customer Premise Equipment (CPE) for the Virtual Private Network (VPN). The CCC application utilises the VPN, which allows results to be automatically transmitted during the capturing process to the national collation centre in Accra. It has also served as a back-up to manual collation as well as for comparing the accuracy of the manually-collated results before declaration. The public projection of the results at the Constituency Collation Centre has also given an opportunity to the public, who could not have access to the room, to see the results from polling stations as they are captured. This has enhanced the transparency of the results collation process and has taken away the mystery which has hitherto surrounded the so-called strong room (Luhusena 2018; EC Ghana 2000).

This section of the study has presented a literature review and analysis of the different types of election automation processes available within the electoral community. Some have not been put into use in Gauteng (Kogeda and Mpekoa 2013: 1-10; Mursi *et al.* 2013: 1-11), however the evidence shows that most of the technological innovations have improved some of the core election services (*ibid*). The study has noted that, guided by the use of technology in elections from the early days of organising elections using punch-card machines, lever-arch machines, the direct-recording electronic system, the transparent ballot box and scanning-optical mark readers and polaroid cameras, progress has been made and IBTs remain and continue to be relevant to the task of conducting free and fair elections (Thakur 2015: 2).

This has eased the burden from using manual methods of undertaking certain core election activities, and has made the processes faster and friendlier (Luhusena 2018: 28-72). IDEA (2014: 5) asserts that electronic systems serve voters by making polling processes easier and more transparent because they have a number of user-friendly features. The application of technological innovations is thus central to the effective and efficient implementation of election reforms on a global scale.

For example, Table 2.2 provides a summary of the different technologies introduced as part of the election reform efforts in Ghana over a period of 20 years(Luhusena 2018). Table 2.2 Summary of Major Technological Innovations in Election Reforms in Ghana *(Luhusena 2018: 28-65; Author's Construct 2016: 1-3)*.

S/No	Item Description	Year introduced
1	Design of transparent ballot paper	1996 General Elections
2	Re-design of ballot paper	1996 General Elections
3	Introduction of photo and thumbprint ID card	1996 General Elections
4	Optical Mark Readers and Polaroid Cameras	1996 General Elections
5	Networking Systems	2000 General Elections
6	Carbonated Results Collation Forms	2008 General Elections
7	Geographical Information Systems	2008 General Elections
8	Very-Small Aperture Terminal (V-SAT)	2008 General Elections
9	Biometric System of Registration and Voting	2012 General Elections
10	Election Results Management System	2016 General Elections

2.3.12 **Office Automation**

The personal computer-based office automation software has become an indispensable part of election management in many countries (ACE Elections Network Knowledge 2014, 2013). Word processing programs have replaced typewriters; spreadsheet programs have replaced ledger books; database programs have replaced paper-based election rolls, inventories and staff lists; and personal organiser programs have replaced paper diaries. Word processing and spreadsheet programs developed in the 1970s are cumbersome in comparison to the sophisticated office automation programs currently available (Laanela 2017: 327-340; Therese 2001). These programs have empowered ordinary office workers by enabling them to complete tasks in-house which were once completed off-site. For example, desktop publishing programs allow relatively novice users to produce professional-quality publications, instead of using professional typesetters and printers. Database and spreadsheet programs running on high-powered personal computers allow ordinary users to input, store and use data in ways which once would only have been possible on large mainframe computers operated by programmers (Sahana *et al.* 2017: 1619-1622).

2.3.13 **Specialised Electronic/Mechanical Devices**

In addition to standard computers and electronic voting devices, there are a wide range of specialised electronic/mechanical devices which are used for election purposes. Table 2.3 tabulates the specialised mechanical devices used in elections.

Table 2.3 Specialist Devices Used in Elections

Type of Machine/Device	**Sources**
Counting Machines	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)
Letter Openers	(Altun and Bilgin 2011: 2494-2500)
Mail Inserting Machines	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)
Label Printers	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)
Overhead Projectors	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)
Televisions/Videos	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)
Electronic Whiteboards	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)
Date Stampers	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)
Automatic Numbering Machines	(Patel 2012: 1-5; Jacobs and Pieters 2009: 121-144)

2.3.14 **Web-Based Technologies for Elections Procedures and Processes**

The Global System for Mobile communication (GSM) allows for biometric authentication during the use of IBT systems by making use of a fingerprint-supported biometric-control information and encryption system, as well as the Secure Socket Layer. This system is web-based and utilises the GSM mobile system consisting of a GSM SIM card and the application, which is developed to operate only on the Android 3.0 operating system. The voter must possess a smart phone to be able to use this system. It also requires a highly technological camera and scanning capabilities to capture the ridges of fingerprints and biometric information for authentication. In this system, the mobile company registers and links the SIM card and phone identity to the individual. Voters then proceed to their constituency office where their fingerprints are scanned, and where the verification of their residential addresses and other personal information is also carried out (Gentles and Sankaranarayanan 2012: 57-58, 2011: 1-10).#

Voters register for voting by connecting to the server, using a Transport-Communication Protocol (TCP) connection; subsequently, a screen to capture personal information will appear and Google maps are used to capture the physical address. After the user has submitted the correct fingerprint from the correct phone and provided the correct voter's ID, the server will authenticate the voter, after which the voter is permitted to vote.

Thakur (2015a: 3) discusses that within the particular context of South Africa, which is a young stable democracy with little evidence of electoral fraud and violence, mobile Internet voting would enhance efficiency, effectiveness, stability, and foster voting convenience at reduced costs.

2.4 **Internet-Based Technology for Elections Management Processes**

Internet-based technologies are essentially technologies driven by the Internet to allow computers to communicate with each other using mark-up languages and multimedia packages (Cant, Wiid and Hung 2019). It enables a medium to interact with hosted information such as websites (Freire 2007; Nijland *et al.* 2008; Sin *et al.* 2009). The IBTs are comprised of simple Microsoft Office applications and detailed technical databases. The technology platform ranges from the use of basic back office automation tools such as word processing and spreadsheets to more sophisticated data-processing tools such as database management systems (Cant, Wiid and Hung 2019),optical scanning and geographic information systems (Castells 2013, 2009; Krimmer, Triessnig and Volkamer 2007).

The advent of IBTs has changed the elections process in several different ways including political campaigning, citizen participation, debates, newsroom discussions, conducting opinion polls, and the enhancement of election administration (Gibson *et al.* 2016: 4-17). The impact has reduced disputes in results declarations since political parties can check the machine and be assured of its performance or output (Prosser and Krimmer 2004: 21-28). Therefore, IBTs could be a vital tool for an efficient elections administration, and could serve as an instrument to engage citizens, support the democratic decision-making processes and strengthen representative democracy (Davis and Chelsea 2012; Davis and Chelsea 2010). However, technology is a rapidly-changing field, and now is an opportune time to assess emerging trends and speculate on how they may affect elections processes over the next decade (Kayisire and Wei 2016: 630-653).Vasquez (2016),ACE Elections Network Knowledge (2014: 1-5) and Owusu-Oware *et al.* (2017: 1-10) add that the use of technology in elections is designed to improve the effectiveness and efficiency of the elections management processes.

Several E-voting systems have been developed and invented throughout the years with some inherent advantages and disadvantages (Adeshina and Ojo 2014; Abdulhamid *et al.* 2013; Buckland and Wen 2012).

There is a genuine call from South Africa and the SADC region election observers to make electronic technologies more integrated into the elections process (Davis and Chelsea 2012, 2010). The study has accepted that the current South African elections procedures and processes were suitable for South Africa in 1910 (Mpekoa 2017: 84), as the population was manageable, and only three languages constituted the official languages in the country. Now, the current population is over 58 million people, and 11 official languages are recognised by the Constitution of the country and competing priorities of daily public service delivery protests.

Figure 2.2 presents an abridged IBT conceptual framework(IDEA 2014: 24-33) which provides a comprehensive overview of the important and critical steps which may be performed when considering the type and character of the election technology components for any electoral process to be deployed.

The elections processes consist of several steps, as discussed in Section 2.2, using the election cycle to explain the different phases including voter registration, party registration, election logistics, vote counting and tools to provide the initial results to the media. All such activities – organisational or real elections, with and without ICT support – should align with functional requirements for elections management processes for any South African elections. Therefore, Figure 2.2 describes the different phases and their deliverables.

The literature review has aided the thesis to develop an IBT framework for elections management bodies, which can be used for planning and guiding the adoption of IBTs in order to become more effective and safeguard the South African democracy beyond Gauteng. To this end, an overview of a framework for Internet-based technologies will be further explained in Chapters 7 and 8 of the study. Most recently, the currency of trust in and effectiveness of technology towards free and fair elections is emerging as an important topic in the discussion on how to prevent interference or fraud in elections (Young and Asgarkhani 2010: 1-5).

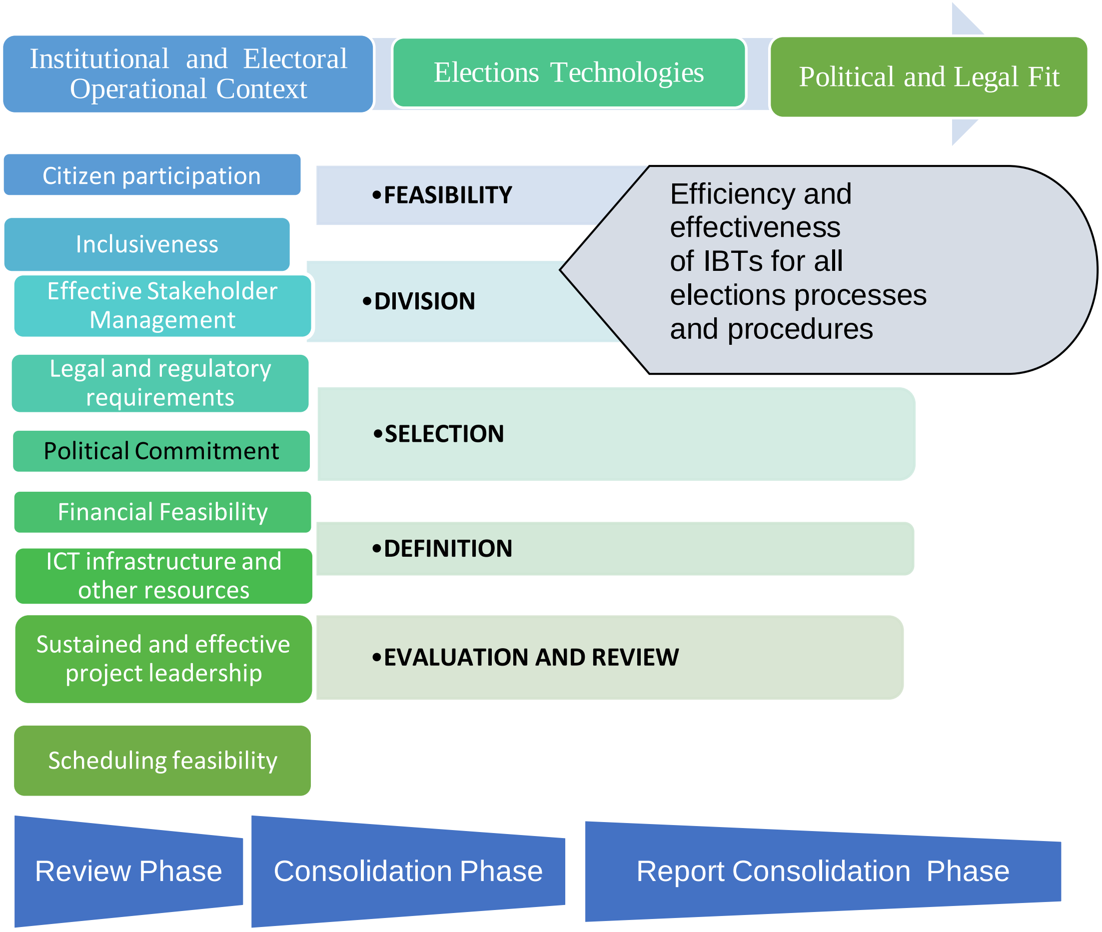


Figure 2.2 Overview of an Abridged IBT Framework (IDEA 2014: 24-33)

The discussion with regards to Figure 2.2 which follows refers to the part of the election process involving building functional requirements as the *election technologies*. It is assumed that precise requirements and system design documents can be made available before the system is actually adopted. The proposed conceptual framework is a methodology designed to preserve an election technology system in a sequence of phases: (1) Feasibility, (2) Division, (3) Selection, (4)Definition, (5) Evaluation, and (6) Review and Consolidation. These phases are described in more detail below.

(1) Feasibility Phase (Hapsara 2013: 81-86; Mpekoa 2017: 182-185) within the elections management body, legal requirements, political fit and supporting institutional operations:

- ***Legal and country political feasibility***: The conduct of elections is generally regulated by laws and acts, which might influence the election outcome. For example, legal regulations might determine the procurement of evaluation. The feasibility study should verify that there is no conflict of interest(Hapsara 2013: 81-86; Mpekoa 2017: 182-185).
- ***Financial feasibility***: EMBs' financial resources are limited. In many cases, aspects of the election technology might become cost-intensive – cost-benefit analysis should be an integral part of this phase(Hapsara 2013: 81-86; Mpekoa 2017: 182-185).
- ***Scheduling feasibility***: The development and process for elections may be time-consuming. The feasibility study should take into consideration legally-prescribed timeframes, the time needed for decision-making, the time until the next election, and how the certification process should be regularly conducted to ensure timely completion(Hapsara 2013: 81-86; Mpekoa 2017: 182-185).
- ***Technical (operational, infrastructure) feasibility***: The EMB evaluates whether its operational and infrastructure capabilities satisfy the minimum requirements for the quality assurance process (Hapsara 2013: 81-86; Mpekoa 2017: 182-185).

(2) Division Phase: Election technology systems are usually complex and need to be evaluated from different perspectives(Hapsara 2013: 81-86; Mpekoa 2017: 182-185):

- An Internet voting system, for example, contains communication mechanisms which should be analysed in terms of their security, and a user interface which should be analysed with regards to usability.
- Some voting systems provide mechanisms for individual and universal verifiability, and their reliability depends on voters checking their cryptographic receipts.
- Another example is a digital voter registration system which is used to remove voters' names from the electoral roll after voting. Voter

registration systems must be easy to use, and should be designed to easily recover from unforeseen problems such as system failures (Hapsara 2013: 81-86; Mpekoa 2017: 182-185).

- *Division* should consider the views of election stakeholders who include voters, political parties, EMBs, civil society organisations, non-governmental organisations, the current government, parliament, the media, election observers and members of donor communities (Hapsara 2013: 81-86; Mpekoa 2017: 182-185).

(3) Selection Phase, selecting technology components: Taking into account the results of the feasibility study, EMBs should prioritise the system elements to be evaluated. It is in an EMB's interest to allocate resources in a way which maximises quality assurance. For example, the EMB could prioritise components which are mission-critical and/or have specific legal requirements (Hapsara 2013: 81-86; Mpekoa 2017: 182-185).

(4) Definition Phase: Based on the results of the previous phase, the definition phase identifies the component requirements, defines the operational context and identifies the evaluation method, level of detail and time frame for the evaluation. The activities include:

- ***Define component requirements***: The EMB derives requirements based on the results of the feasibility study and according to the best practices and expert advice. It should also consider (and be aligned with) requirements for interdependent components***.***
- ***Define operational context***: The EMB identifies the assumptions and unique circumstances of the election settings. For instance, evaluating an election communication infrastructure which utilises multiple relay steps, such as from the central headquarters to regional offices, an area office, the electoral district and the local voting station. This evaluation process requires more resources than a flat communication infrastructure which allows direct information flow and

control from the central EMB to local electoral offices, because it has more failure points.

- ***Evaluation and method***: The EMB reviews suitable evaluation methods, and defines new ones if necessary. These might include well-established methods, for example as outlined by the Common Criteria Protection Profiles, ISO 9001 or country-specific standards.
- ***Define level of detail and time frame*****:** The EMB defines the scope of the evaluation, indicating the level of detail at which it is to be conducted. During this phase, it should also specify the deadline for completion.

(5) Evaluation And Review Phase: This phase systematically determines the degree of compliance with the defined standards and scope. If the evaluation identifies any problems, this phase may be used to conduct corrective actions. The activities include:

- ***Prepare evaluation*****:** The EMB initiates operational meetings, introduces key personnel and coordinates task assignment.
- ***Define communication plan***: The EMB and the evaluator agree on a communication plan which includes the establishment of a communication structure, alternative means of communication and escalation procedures.
- ***Evaluation execution*****:** The evaluator produces the designated output as stated in the scope of work.
- ***Resolve problems*****:** If the evaluator finds issues or irregularities during the evaluation, it is the EMB's responsibility to fix these problems, which may entail making changes to the component under evaluation.

(6) Review and Consolidation (Hapsara 2013: 81-86; Mpekoa 2017: 182-185). This step is used to revisit the findings documented in the reports produced during the evaluation phase. The activities include:

- ***Conduct quality control*****:** The EMB creates a quality control team responsible for reviewing the reports from the previous phase. The team must submit a report confirming that all evaluation activities were adequately completed.

- ***Consolidation phase:*** *Th*e consolidation phase combines the findings of the individual evaluation reports to create a single quality assurance document.
- ***Report consolidation***: All output reports from the previous evaluation phase are merged into one unified document which communicates the result of the overall quality assurance process.

There are different types of Internet-based applications being adopted for elections missions, as presented in Tables 2.4,2.5 and 2.6 (Alveraaz and Hall 2010; Pammet and Goodman 2013).

Table 2.4 Types of Internet-based Applications Adopted for Elections Management Processes.

Technology Type and Character	**Core Elections Functions**	**International Standards and Best Practice**	**Sources**
Biometric Voter Registration Systems Electronic Voter Identification Permanent Voter Card and Fingerprint Scanner Integrated Elections Management Systems Elections Management Systems	Identification of voters' details at polling stations Demarcation of political constituencies Election dispute resolutions Observer management systems	Voter registration which follows legal framework and stakeholders' concerns Elections observation and elections disputes Independence and impartiality Diffusing potential tension	Loeber 2016: 139-160
Combination of Technology Systems including GIS, Biometric Data, Office Systems and Specialised Technology Integrated Elections Management Systems Commission Issue Tracking System, Conflict Mapping System, Observer Accreditation System	Nomination and Pre-Election (including procurement, recruitment, secure ballot paper printing, logistics, security)	Registration, funding of political parties and candidates nomination and audits Safeguarding the integrity and transparency of elections Promoting the openness of and contributing to the acceptance of election results Enhancing public confidence	Loeber 2016: 139-160 Norris 2017, 2015, 2012 Norris *et al.* 2014 IDEA 2014 Norris and Grömping 2017 Kenya Supreme Court Order 2017 Windt 2014 Tsunga 2005 Waltz 2001 AUC 2007, 2002
Office Systems HR Systems Finance and Accounting Systems Warehouse Systems Communication, logistics Campaign Finance Monitoring and Reporting Results Management System and Transmission Technology	EMB administration and field operational support services system Corporate Management	Participation of media, women, minorities, marginalised groups, youth, civil societies and internal displaced people Efficiency, Professionalism Enhancing public confidence	Loeber 2016: 139-160 Thakur 2015a Thakur *et al.* 2014 Norris and Grömping 2017 López-Pintor 2000
Electronic Whiteboards and Website	Constituency Demarcation Voter Education Security Management Services	Constituency Demarcation Service-Minded-ness Validation of Election Result selection Campaigns	Elklit and Reynolds 2001 Goodwin-Gill 2016, 2014 Maphunye 2010 Mozaffar 2002 Goldsmith and Ruthrauff 2013 Harel 2008

There are differences amongst the forms of Internet-based technologies, with each type offering a different functionality to address voter identification, registration, counting and results tabulation (Mossberger, Tolbert and McNeal 2008).The study focuses on the IBTs for safeguarding election management processes, with specific focus on elections policy and elections management.

IBT's networking facilities provide for Local Area Network (LAN) and wide area network (WAN) services, ensuring communication between clients, servers and ultimately between people. All the district offices of the election management body are now networked with the aim of increasing communication, and improving efficiency and data transmission. Depending on the country, all or some of these telecommunications technologies are used by the elections administration to transmit information: via voice through telephones and radio, documents in faxes or data including text, sounds and images, and in computer networks. Telecommunications technologies continue to evolve rapidly and are becoming increasingly affordable and reliable to communicate voice data and even images between distant and isolated places around the world. This facilitates the organisation of elections by enabling communication between elections officers stationed at remote locations and their respective regional and national offices. Tables 2.5 and 2.6 illustrate adopted IBTs and their associated election challenges.

Table 2.5 Internet Voting System (Alvarez and Hall 2012a, 2012b, 2010, 2009, 2004).

Types	Description	Merit	Demerits
Polling Place Internet	Voting from an area under the direct control of an authority	Infrastructure under the direct control and supervision of the EMB	Requires infrastructure to be replicated across the entire country without exception
Precinct Internet Voting	Voting from a particular voting district, ward or precinct – for example, where the voter resides – through the Internet	Geofencing of the voter promotes local social cohesion; mediates denial of service attacks; assists in post-election audits.	Geofencing requires mobile devices or an Internet-enabled device. Authentication and coercion become a challenge.
Kiosk Internet Voting	Voting from a dedicated terminal not under the direct control of the authority This may be at an office or shopping mall but also through the Internet.	The public nature may take democracy to the people in familiar settings. It is connected to a closed, controlled network.	The absence of the authority may encourage some voters to try to hack the system. Authentication and coercion become a challenge. The placement of the kiosk may distract and divert the voter to other activities.
Remote Internet	Casting the ballots through Internet	The mobility offers the voters anyplace anytime	Exposes the process to the entire Internet, where hackers

Voting	platforms	convenient voting.	may attack a system because it is there Authentication and coercion become a challenge

Table 2.6 List of Forms of IBTs and Election Challenges/Issues.

IBT Types and Forms	Elections Problems and Issues	Appropriate IBT Solution	Sources
Biometric Voter Register	Voter registration duplication, inclusiveness and identification for casting votes at voting stations	Biometric voter register database connect to the cloud and run decentralised system, databases, digitised photographs for facial recognition, barcodes or data chips, electronic signatures, encryption systems, electronic storage applications and auditing tools for data analysis	Olusola and Adesina 2015; Jaleel 2013; Maphephe *et al.* 2016
Political Party Registration Nomination System and Biometric Voter Register Political Campaign	Eligibility for candidates nomination and party registration Presentation of political manifesto and political fact-checking	Nomination system and Biometric Voter Identity database connected to the Cloud technology plus digital footprints (Website, Email account, Facebook, Twitter, YouTube and Google, Smart campaigns, devices for authenticating and validating IDs, databases connected to the cloud, mobile applications such as Tell-Town Hall call centre	Cutler 2015; Mitrovic and Klass 2013, 2012
Website, Email, Tweeter accounts	Online voter education and information dissemination to all elections stakeholders, but subjected to security and cyber-attacks by criminals	Real-time and secured sites connected to the cloud run decentralised system databases	IEC SA 2014; Cutler 2015; Mitrovic and Klass 2013, 2012
Specialised Mapping Tools (such as MapInfo, ArcView, Arc-GIS) Constituency Demarcation	Mapping allows for visualisation of the boundaries of various election units (sections, districts, municipalities, states), as well as the location of the voting centres Monitoring of political parties' campaigns, statements and ethical behaviour	GIS Arc View, Editor, Real-time, IP-based Video Recording connected to the cloud run decentralised system Databases, Interactive Voice Response, call centres, text messages, cloud-based technologies	IEC-SA 2017, 2014; Cutler 2015; Thakur 2012;
Voter Education	Information dissemination and other elections services	Communications systems, ITV, website, connected to the Cloud technology plus digital footprints (Website, Email account, Facebook, Twitter, YouTube and Google, Smart campaigns, databases connected to the cloud, mobile applications such as Tell-Town Hall call centre, cloud-based technologies)	Cutler 2015; Mitrovic and Klass 2013

IBT Types and Forms	Elections Problems and Issues	Appropriate IBT Solution	Sources
Results Management System	Final election results validation, sorting, counting, transmission and declarations	Smarter PDF forms connected to the cloud run decentralised system	Sarkar and Islam 2013; Mitrovic and Klass 2013; Islam *et al.* 2011
Conflict and Elections Mapping	Hot spots for elections challenges or new political issues with potential of linking to elections services dissatisfaction such as voter register, voting station and results validation	Geographical Codes or References. Geographic Information Systems (GIS) Global Positioning Systems (GPS)	IEC-SA 2017, 2014
Observing automated election	How to observe highly-automated process	Online database for observation Questionnaire for a highly-automated process, connected to cloud-based technologies	Cutler 2015; Laanela 2017; Therese 2001

According to Mpekoa(2017), these technologies (e.g. Back-end computer systems, optical readers) have been introduced for voter registration, voter-list generation, voter authentication, the counting of votes, and the tabulation of results, as well as their electronic transmission. This recent development indicates that E-voting is probably insuppressible in today's technically-oriented society, where an increasing number of processes are mapped into the electronic world (Krimmer 2014: 1381-1389; IEC 2010: 1).

The discussion above allows the study to appreciate and classify IBT systems through the analysis of incremental improvements. This study investigates the IBTs, which comprises a comprehensive list of different technologies at their best performance, but within an umbrella of ICT systems and covering the core elections processes and procedures.

2.5 **Role of Stakeholders in Elections Management Processes**

Stakeholders in elections management processes are those individuals, groups and even organisations which have diverse interests in the elections process. Bryson (2004: 1-10) identifies stakeholders as individuals or groups who are directly affected, whether positively or negatively, by either a decision or consequence of a decision (Ninsin 2006: 10). Angeles (2013: 1599-1608) claims that the Technology Organisation Environment framework posits three elements which influence technological adoption: the environmental context, the organisational context, and the technological context (Angeles 2013: 1599-1608).

Table 2.7 presents descriptions of the various roles of stakeholders in elections management processes (African Union 2007a:1-2: 2007b: 1; Glen 2012).

Table 2.7 Description of Roles of Stakeholders in Elections Management Processes (Ninsin 2006: 10).

Description of stakeholder	**Role**	**Source**
Election Management Body (EMB) or IEC, and staff members	Coordinating and managing all elections	Atkeson and Saunders 2007; Clark 2014; Montjoy 2008; Mozaffar 2002; IDEA 2014A; ACE Elections Knowledge Network Project 2014; AU 2007, 2002; Makulilo and Henry 2018
Legislature	Developing elections legal frameworks	IDEA 2014a; Clark 2014; AU 2007, 2002
Voters	Casting Votes	Franck 1992; Elklit and Reynolds 2002
Political parties and candidates	Key stakeholders who seek to receive voters and encourage participation Contest Power Lobby	Atkeson and Saunders 2007; Clark 2014; Montjoy 2008; Mozaffar 2002; IDEA 2014; ACE Elections Knowledge Network Project 2014, 2013; AU 2007, 2002
Marginalised groups	Casting ballots Protest/contest exclusion from mainstream society	Habib and Naidu, 2006; IDEA 2014a; Clark 2014
Traditional leader and religious leaders	Key stakeholders who encourage participation Represented community interest	INEC 2015
Judiciary and security	Provide some degree of platform conflict and dispute resolution and adjudication	IDEA 2014a; Clark 2014
CSO and Media	Inform voters and protect Human Rights	Anglin 1998; IEC 2015; Nohlen *et al.* 1999
Donor community and international partners for elections missions	Provide funding and technical resources	*Ibid*
Elections observers and monitors	Observe and report Monitors may question dubious results	Laanela 2017; Therese 2001; IDEA 2014a, 2014b

Suppliers and vendors	Provide services and products	Laanela 2017; Therese 2001; IDEA 2014a, 2014b

The study appreciates the definition provided by Bryson (2004: 1) to guide its analysis on IBTs used in elections management processes for Gauteng. The progress in South African elections has been recorded as the most successful project; however, there are myriad challenges often resulting in stakeholders' agitation after the election results. The study admits that stakeholders are different, as indicated in Table 2.7. The selection of stakeholders is based on the contribution which each stakeholder makes in the elections process. The aim of the study is to develop a generic framework to guide the effectiveness of Internet-based technologies in safeguarding elections management processes in South Africa, therefore it is important to be aware of the views and opinions of the stakeholders.

2.6 **Case Studies of IBT Adoption in Elections in Selected Countries**

The ICT technology developed during the 21st century has dramatically altered election administration and the way in which elections are conducted (McCormack 2016: 1; Thakur 2015: 28; Callen *et al.* 2016; Goldsmith *et al.* 2013a, 2013b).The basic election tasks of voter registration, voting and vote counting have conceptually remained the same since the beginning of the modern democratic process. However, the organisation of modern elections nowadays depends very much on technology(McCormack 2016: 1; Thakur 2015: 28).The study noted a remarkable progress in E-voting systems, as alluded to by academic and elections practitioners who point out that there is a growing trend across the world to use IBT systems to solve election challenges. It is important to note that for the ASDC region, the evolution of E-voting is still at the early stages of development and infrastructure, marginalised groups, and unethical practices beyond the scope the study may still need to be revisited before full automation can be implemented (McCormack 2016: 1; Thakur 2015: 28).

2.6.1 **Zambia**

The Zambian E-voting initiative was powered by Smartmatic to improve its voter registration process. Smartmatic is a multinational company which specialises in technology solutions for electronic voting systems (Evrensel 2010; Thakur 2010: 5). Smartmatic normally supplies Zambia with 1,000 mobile electronic biometric registry units, known as PAR-kits (Evrensel 2010; Thakur 2010: 5). These include all hardware and software components, with their respective protective cases, training services, technical assistance and a one-year warranty (Thakur n.d.).

2.6.2 **South Africa**

South Africa is a developing country with a population of 57 million. It requires about 21,000 poll sites to run elections. South Africa has a mixed economy like India and Brazil with well-developed connected urban areas. It has a high level of illiteracy amongst the elderly with 42% of the registered voters between the ages of 18 and 35(IEC report 2009). According to a survey conducted by IDASA (2008: 1-2), there is concern about the confidence in the current ballot form, expressed by South African citizens, indicating a decrease in the faith which voters have in their elections system (Mattes 2002: 22-36; Andersson and Lindvall 2018: 33; Bogaards 2018: 181-198; Gerring *et al.* 2018: 57). Table 2.8 indicates the current threads to the IEC system.

Table 2.8 Current Threads to the IEC System.

Thread description	**Sources**	**IBT intervention**
Equal rights for all South African citizens	Athiemoolam 2003; Habermas *et al.* 2018; Bam 2015, 2009, 2008	IBT for youth E-voting and customised technology for specific groups
Suspicion about elections fraud occurred through previously-marked ballot papers and ballot boxes going missing	Southall 2014; Daniel *et al.* 2010; Kersting 2007; Sapa 2009a, 2009b; Mafirakurewa 2009	IBT systems for ballot paper generation and logistic system

Thread description	Sources	IBT intervention
Cost of voting and registration challenges for expatriate voters	LeRoux 2009; Qantas 2012; Travelmath 2010; Braconnier *et al.* 2017; López-Pintor 2000; Swanepoel *et al.* 2009; Golden *et al.* 2015	E-voting linked with biometric voter register
Lack of confidence and trust in the South African elections process. Voter participation decreasing.	IDASA 2008; Mattes 2002; Kersting 2007	Promote IBT to stakeholders, and use manual where society factors do not allow IBTs to build trust
Logistical challenges which included ballot paper shortages, long queues and barcoded identification document shortages were experienced in various elections	Achieng 2014; Achieng and Ruhode 2013; Sapa 2009b; Khosa and Muthien 2000; Thakur 2015a, 2012, 2010	IBT systems for ballot paper generation and logistic system
The current South African elections process is challenging for the high number of illiterate adult citizens	Botes 2010; World Bank 2014	Manual voting complemented by the use of semi- technological tools
Voter coercion where voters are influenced to vote for certain individuals	Sapa 2009a; Bam 2015, 2009, 2008	E-voting
Spoiled ballots, unclear marks by voters to indicate party choice. Time-consuming for stakeholders to agree on which ballot is spoiled.	IEC South Africa 2009; Mtyala 2011	E-Voting
South Africans are not able to commute to polling stations as a result of poverty, *inter alia*	February and Misra-Dexter 2010: 178; Swanepoel, Thomson and van Niekerk 2010, 2009; Thakur and Murphy 2010; Swanepoel 2012; Thakur 2015a, 2015b	M-Voting and E-Voting
Disabled voters face various challenges when participating in an election	Mpumlwana 2011; SAHRC 2002; Xingwana 2011; Van Zyl 2009	E-voting with customised software and hardware to accommodate marginalised people, Universal Ballot Template (UBT) Voting aid for voters with disabilities
Recording voter who actually cast ballots for South African elections	SAHRC 2019; IEC-SA 2019	Voter Participation Survey – VPS
Reporting the performance of the IEC	SAHRC 2019; IEC-SA 2019	Elections Satisfaction Survey – ESS
Helping voters to fast-track their eligibility online in terms of being registered voters	SAHRC 2019; IEC-SA 2019	Special Vote Application Status

The system allows a voter to check his/her registration details online on the IEC's official website. A voter could also check his/her status online and he/she could send a text message using a mobile phone to receive relevant information with regards to his/her registration status(Mattes 2002: 22-36; Andersson and Lindvall 2018: 33; Bogaards 2018: 181-198; Gerring *et al.* 2018: 57).

The aim of the study is to investigate the use of Internet-based practices within the elections management process of South Africa. To achieve this, the study needs to identify all elections management processes and which IBTs are used for each process. The factors which have influenced the adoption of IBTs for all stages of election cycle processes also need to be examined, and the current challenges associated with the use of IBTs for EMPs in Gauteng need to be identified. In response, this thesis will evaluate and present the use of Internet-based technologies in elections management processes in Gauteng.

Gauteng is considered the economic hub of South Africa and contributes heavily in the financial, manufacturing, transport, technology, and telecommunications sectors, among others. It also plays host to a large number of overseas companies requiring a commercial base in and gateway to Africa (Kogeda and Mpekoa 2013: 1-10; Mursi et al. 2013: 1-11). Gauteng is home to the Johannesburg Stock Exchange, the largest stock exchange in Africa. According to the latest Statistics South Africa population estimates, Gauteng is home to 14.2 million people (Statistics South Africa 2017: 1-20).

The study accepts that the IEC South Africa seems to have made a significant development in so far as the use of ICT systems in management is concerned. This has resulted in the South African academic community having in-depth discussions with IEC South Africa to rapidly deploy and legitimise potential technology such as E-voting systems (Thakur 2015a; Mpekoa 2017a, 2017b; Mpekoa and van Greunen 2016; Mpekoa and Bere 2013).

2.6.3 **The Gambia**

The Gambia has an innovative, though non-technical, unique voting system which is notably simple in catering for its high-level illiteracy. A voter is given a clear glass marble which they must drop into a steel drum marked with party symbols and photos of the candidates. The marble hits a bell to indicate that they have voted (preventing vote stuffing), and the next voter is given another marble. This makes a non-vote or spoiled ballot difficult to envisage. This only becomes difficult if there are many candidates or if a voter does not drop a marble (Lin et al. 2011).

The study concerns the use of technology in safeguarding democratic elections; Gambia has the simplest method of voting in West Africa which has always worked, therefore if it is possible to carry out the elections process correctly and bring opposition into government without IBTs, possibilities are high that South Africa can learn and improve its manual procedures into a fully-automated system.

2.6.4 **Kenya’s Elections 2013-2017**

By the end of the 2013 election cycle, there were unanswered questions relating to the formulation and finalisation of the voters register, the planned counting and tallying processes, and the legitimacy of the final election results. Consequently, it emerged that the results of the presidential race were announced without the receipt of all the data processed from all the voting stations (Trujillo *et al.* 2014: 111-128; Boast 2014; Cheeseman *et al.* 2014: 670-687). The monitoring groups and domestic and international observers praised the election as the analysis placed greater emphasis on the relative lack of violence – as opposed to 2008 when 1,200 citizens died – than on the administrative and technical integrity of the process (Mutung’u 2017: 1; Okong’o and Matatu 2017: 3).

While there have been significant changes – including a new set of Independent Elections and Boundaries Commission (IEBC) commissioners and the introduction of complementary mechanisms (an addition to technological tools) for the voter registration, identification and results transmission – much has remained the same (Okong’o and Matatu 2017: 4; EISA 2014: 1). The current election cycle has already been characterised by problems such as election technology procurement delays, discussions and debates over the use of technology versus the use of a manual system, pre-election violence, shifting timelines, voter registration irregularities, chaotic party primaries, back-tracking on campaign finance regulations and slow progress related to the implementation of the gender parity law (Sagoe-

Moses 2017: 1-5). The rhetoric around elections sets peace against credible polls, portraying these issues falsely to the public as a winner-takes-all choice between the two (Micheni and Murumba 2018: 1; Kenya Supreme Court Order 2017: 13).

The general elections in Kenya consequently became a protracted process where the Supreme Court of Kenya, following a successful election petition filed by opposition leader Raila Odinga and the National Super Alliance (NASA) (Sagoe-Moses 2017: 1-5), rescheduled a fresh presidential poll for 26 October 2017 because of the unprecedented nullification of the presidential election result. The NASA presidential election petition claimed that there had been deliberate manipulation of the electronic results transmission system and associated documentation. The Supreme Court, in its judgement, ruled that the IEBC failed to conduct the elections in a manner consistent with the law and that the process did not meet the threshold of a transparent, credible and verifiable poll (Sagoe-Moses 2017: 1-5; The Guardian 2017: 1). In the summarised findings, the judges held that major “irregularities and illegalities” in the elections process centred on results transmission (Micheni and Murumba 2018: 1; Kenya Supreme Court Order 2017: 13).

2.6.5 **Somaliland Elections 2012-2017**

Somaliland accepted and embraced the use of Iris biometric technology for the 2017 presidential elections. The country dropped the finger and facial recognition system which had been used for past voter registration processes(Bowyer 2016: 4; Bowyer *et al.* 2015a: 5, 2015b, 2016: 1; Juma 2016: 10; Araida *et al*. 2016: 1). The first approach was to compare fingerprint matching with facial recognition. The use of Iris technology was not yet frequently applied(Bowyer 2016: 4; Juma 2016: 10; Araida *et al*. 2016: 1). In the second approach, Somaliland has held voter registration processes using a high degree of technology twice and changed the type of biometric technologies without gaining any positive results. Nevertheless, it is encouraging to note that which they learned from previous experience and how it will affect the next registration phase(Bowyer 2016: 4; Juma 2016: 10; Araida *et al*. 2016: 1). The third approach involved the voter registration process for the 2017 presidential elections being completed to take the National Election Commission to the March 2017 presidential elections (Kuehlkamp *et al.* 2016: 1-8; Daugman 2014: 1; Jacobsen 2012: 2-3).

Somaliland's shift to such advanced voting technology emerged as a result of a lack of trust due to problems with the 2008-2010 elections. For instance, names were duplicated in the voters register because of pressure from local elders. These fraudulent activities and other logistical issues threatened to undermine Somaliland's good standing in the international community(Juma 2016: 1-10). Somaliland is notably not the only country in Africa to experience problems with its election processes. Other countries such as Kenya, Liberia, Zimbabwe and the Democratic Republic of Congo have also turned to technology to try to deal with their challenges (Schueller and Walls 2017: 1-2; Eilu 2017; Alebiosu 2016; Muse n.d.; Okoro 2017: 332-349; Bereketeab 2017: 1; Price and Stremlau 2017: 1-5). Somaliland wanted to reduce voter duplication (Bowyer and Burge 2016; Bowyer *et al.* 2015a) by comparing the efficacy of different face, finger and iris recognition technologies, and this assessment showed that iris recognition was superior (*ibid*). Pilot efforts then allowed for lessons in the design of the system, which helped to reduce anxiety over the consequences of possible failure during elections. It also made the process transparent where interested users could access the available datasets, thereby enhancing public trust (Mpekoa 2017: 122-189a; Mpekoa and Bere 2015: 1; Pallav *et al.* 2012: 5; Ekong and Ayo 2007: 13).

2.6.6 **The Philippines Elections 2010-2017**

A general election in the Philippines took place on 9 May 2016 for the executive and legislative branches at all levels of government – national, provincial and local – except for the Barangay officials (COMELEC 2016: 1; Mayen 2016: 1-3, 2011: 1-2). To become a registered voter, voters had to personally submit all their required documents. Voters had to supply their election officer with a fully-completed registration form (CEF-1A) which voters could either obtain from the Office of Election (OE) officer or download from the Commission website. Along with the voter form, voters also had to present a photocopy of any valid ID, inclusive of a voter photograph, signature and home address. None of the three qualifications could be neglected (Mayen 2016: 1-3, 2011: 1-2).Voters had to wait until all the documents were verified by the assigned election officer. Only once the documents had been authenticated could the voters proceed to the next step involving the downloading of biometric data including voters' signatures, thumbprints and photographs(COMELEC 2016: 1).

The Philippines began using technology to streamline vote counting in 2010 when it automated its general elections. During the 2013 mid-term elections, it used the same technology, processing approximately 760 million votes cast by approximately 50 million voters (Thakur 2015a: 15-66; CELIS and Watch 2014: 2-17; Karan *et al.* 2009; Kimura 2009; Borra 1995: 4). The 2016 general elections represented the largest electronic ballot vote counting exercise in the history of the election community, as 92,509 vote counting machines were used to digitise voter-marked ballots and transmit the results to the Municipal Board of Canvassers (COMELEC 2016: 1; Smartmatic 2016: 9; Mayen 2016: 1). According to Cruz *et al.* (2017: 3006-3037), the 2016 Philippines elections were characterised by choices, changes, and other challenges. This included counting machines which were leased from the London-based firm, Smartmatic, after the Supreme Court of the Philippines invalidated the P300 million contract between the Commission and the Smartmatic-TIM consortium for diagnostics and the repair of 80,000 Precinct Count Optical Scan (PCOS) machines in April 2015 (Go 2017: 4; Salvador *et al.* 2017: 1; Azurin 2016; Greenleaf 2016; Hicken *et al.* 2017: 1-2). Smartmatic won the contract worth P500 million for the electronic results transmission services of the voting machines. The Commission unanimously voted to disallow the issuing of voting receipts to voters, although on-screen verification was allowed, which would take an additional 15 seconds per voter (Azurin 2016: 22; Greenleaf 2016: 6; Kimura 2009: 7). The Commission eventually aborted mall voting and allowed the use of replacement ballots. Smartmatic created a Virtual Private Network (VPN) for the secure and reliable transmission of elections data. This VPN was used to transmit the votes of over 44 million citizens from 36,805 polling centres. On election night, four hours after the polls had closed, 80% of the vote counting machines had transmitted the election data, setting a new record for the Philippines. Speed was one of the main reasons why Philippines authorities decided to automate elections (Azurin 2016: 22; Greenleaf 2016: 6; Kimura 2009: 7).

2.6.7 **Nigeria's 2015 Permanent Voter Identification Card**

In preparation for the 2015 presidential elections, the Independent National Elections Commission (INEC) trained over 150,000 election officers and introduced a number of technological innovations aimed at curbing elections fraud in a bid to increase voters' confidence in the elections process (Osho *et al.* 2015: 202-211; Olanipekun 2015: 1; Fagunwa 2015: 1-2; Norris 2017: 2-7, 2016: 10). Voters were issued permanent voters cards which stored biometric information on the voters, including their fingerprints and facial images (INEC 2015: 1; Beetseh and Akpoo 2015: 470-477). The smart card reader is an electronic device which was used to detect the authenticity of one's permanent voter's card (Ayinde and Idowu 2016: 13; Nwangwu 2015a: 1, 2015b; Enwere and Ladan-Baki 2015: 1; Osho *et al.* 2015: 202-211; Olanipekun 2015; Fagunwa 2015: 1).

According to INEC (2015: 1-15), it takes about 10 to 20 seconds to validate a votecard reader, also helping to maintain a credible elections system (Beetseh and Akpoo 2015: 470-477).The evolution of smart card reader technology gives this thesis a basis to continue exploring IBT's ability to significantly improve the elections systems in many countries which have challenges similar to those experienced by Nigerian voters (Beetseh and Akpoo 2015: 470-477*).*In light of the above, this study acknowledges that the use of smart card readers(PVCs and SCR) brought about a credible election in the 2015 presidential elections in Nigeria and reduced the high level of elections malpractices (Beetseh and Akpoo 2015: 470-477).

General elections conducted in political environments which have accepted technology as a tool are seen by the elections stakeholders as the most credible elections since the inception of democratic governance in developing democracy. The technological smart card and Internet tools are critical components in modern elections processes and remain some of the greatest technological innovations which are yet to advance public discourse in exercising democratic rights. There are certain controversies in South Africa where the elections management body has recently endorsed that technology brings both solutions and challenges (IEC 2014: 1-7). The challenges to be addressed are how to maintain public trust, the accuracy of the voters roll and safeguarding against potential voter fraud (HSRC 2016: 1; Mpekoa 2017: 57; IEC 2014: 1-7).

2.6.8 **Estonia's Smart Card Technologies**

Estonia developed a plan to have electronic voting in approximately 2001. The intention was to have an electronic-minded coalition government. Estonia was the first nation to hold legally-binding general elections over the use of the Internet (Shakiba, Doostari and Mohammadpourfard 2017: 463-494; Kuzmina 2017: 141). The project was piloted for the local municipal elections in 2005. The EVM withstood the test of reality and was declared as successful by Estonian election officials. The Estonian parliamentary elections in 2007 were also conducted through Internet voting for the first time in the world (Shakiba, Doostari and Mohammadpourfard 2017: 463-494; Kuzmina 2017: 141).The Estonian Internet voting system is built on the Estonian identity card (Shakiba, Doostari and Mohammadpourfard 2017: 463-494; Kuzmina 2017: 141).The identification card is a regular and mandatory national identity document as well as a smart card allowing for both secure remote authentication and legally-binding digital signatures by using the Estonian state-supported public key infrastructure (Strielkowski, Gryshova and Kalyugina 2017: 174; Morgan and Parsovs 2017: 175-191).

The principle of "one person, one vote" is sustained as the voter can potentially cast more than one ballot but still only a single vote (Karlan 2017: 1; Chapman 2017; Riggs and Earls 2017: 23-56; Germann *et al.* 2017: 1; Estonia Authority 2014: 1-5; Levinson 2001: 1269).

2.6.9 **The Use of Social Media by Kenya and Zambia**

The advent of social networks such as Twitter, WhatsApp and Facebook, used to mobilise citizens to call for the downfall of repressive regimes in Tunisia and Egypt, the so-called Arab Spring, are clear cases of the successful promotion of democracy using technology. Beyond the use of technology in transitional processes, citizens have also employed it in their demands for good governance and respect for the rule of law (Meier 2012; Diamond 2010; Carter Center 2015, 2007; COMNET-IT 2002; EISA2011). Another practical example from Zambia is the monitoring of the 20 September 2010 elections with the inauguration of Bantu Watch. The joint platform of Civil Society and (social) media representatives in Zambia use a short message service as a tool for monitoring and reporting election malpractices (Zulu 2011). Their alertness and pledge to shield their vote by verifying SMSes and Twitter reports on Bantu Watch has been noteworthy (Zulu 2011: 2-10).To this end, the influence and performance of the Ushahidi project from Kenya continues to open more opportunities for other African countries such as Tanzania and Zambia (Zulu 2011: 2-10). BantuWatch is an Ushahidi-based technology platform which allows citizens and civil society to monitor and report incidents around the elections process (Zulu 2011: 2-10).

2.6.10 **India's Biometric Plan (Aadhaar)**

At the time of writing this thesis, India was building a biometric database for 1.3 billion people in which enrolment was mandatory. *Aadhaar*, which means 'foundation', is a 12-digit unique identity number issued to all Indian residents based on their biometric and demographic data (Nilekani and Shah 2016: 1-10; Government of India 2017: 1; Falk *et al.* 2017: 3-23; Abraham *et al.* 2017: 3). The data is collected by the Unique Identification Authority of

India (UIDAI), a statutory authority established in January 2009 by the Government of India, under the Ministry of Electronics and Information Technology, under the provisions of the *Aadhaar* (Targeted Delivery of Financial and other Subsidies, benefits and services) Act 2016 (Saralaya *et al.* 2017: 1810-1814; Rajendiran *et al.* 2017: 1711-1718; Mahajan *et al.* 2017; Karthikeyan and Nithya 2017a: 1, 2017b: 1-2). *Aadhaar* is the world's largest biometric ID system, with over 1.171 billion enrolled members as of 15 August 2017 (Rao 2019: 231-235). As of this date, over 99% of Indians aged 18 and above were enrolled in *Aadhaar*. World chief economist, Paul Romer, has described *Aadhaar* as "the most sophisticated ID programme in the world" (Gupta *et al.* 2017: 1-2; Sarkar 2014: 516-533; Khera 2011: 28-43).

2.6.11 **Geneva's (Switzerland) Experience**

This began in 1982, when the parliament passed a new law on the exercise of political rights, which allowed the testing of new voting methods in cantonal or communal matters. Since then, Geneva, Switzerland, has introduced I-voting in a controlled environment. Starting in 2001, the system passed through several trials, and between 2003 and 2005, through eight official votes. The implementation of Internet voting was supported by almost two-thirds of the Geneva population. The application was tested on a representative sample of Geneva citizens, and they discovered that giving people time to learn how to use the Internet voting application increased public support. Internet voting has been offered and used in two official elections. In the first election in 2003, 43.6% of the votes were cast on the Internet, and it has been growing from there (Jaleel 2013: 8-14; Gibson and Mcgaley 2008: 283-290; Enguehard 2008a: 22-24).

It was also noted (Mpekoa 2017: 96) that a very large number of voters over the age of 60 had used Internet voting, rather than the anticipated youth. This is a clear indication that the choice of voting methods is not linked to age (Chevallier 2009: 29-44; Gerlach and Gasser 2011: 101-146, 2009; Chevallier *et al.* 2006: 55-64).

2.6.12 **The Bangladeshi Experience**

The Bangladesh Voter Registration Project registered more than 80 million voters, using biometric face and fingerprint technology. After evaluating a number of biometric systems, Bangladesh was completely sure that Mega Matcher identified more duplicate registrations with a higher degree of accuracy than any other tested system. Mega Matcher from Neuro-technology developed the E-voting system, and the voter information collected consisted of face and forefinger print images, along with the personal demographic information of each person registered. The biometric registration of voters began in early 2007 and resulted in a database which includes photographic and fingerprint records of 80 million voters (Sarker and Islam 2013: 15-21).

The Bangladesh system runs on Microsoft Windows XP and the Microsoft Windows Server, and by using a combination of the Mega Matcher Server and Mega Matcher Cluster Server to conduct the duplicate search matching operations. A standalone server is used, when necessary, for biometric matching at the lowest level of administrative jurisdiction. It has the capacity to match up to 500,000 records. The cluster server provides a higher capacity, depending on the number of cluster nodes used. The cluster server in Bangladesh is configured to match up to five million records at data centre (Sarker and Islam 2013: 15-21; Islam *et al.* 2011: 80; Hossain *et al.* 2015: 79-80).

2.6.13 **The Namibian Experience**

Africa saw its first nationwide use of E-voting in Namibia for the 2014 presidential elections. The Elections Commission of Namibia (ECN), organising and conducting elections in Namibia (EISA 2014b: 1-20), purchased 3,400 Electronic Voting Machines (EVMs) from India. These machines were developed and designed specifically for the elections process in Namibia. The EVMs were introduced by the ECN in order to address some of the shortcomings (low turnover from young voters, cumbersome results verification process and inaccuracy of final elections results) of the previous elections system. Each EVM records a maximum of 3,840 votes.

The EVMs have two components: the Control Unit (CU) and the Ballot Unit (BU). The EVMs have a controller which has its operating programme engraved permanently in a silicon chip at the time of manufacture (EISA 2014b: 1-20). No person, including the manufacturer, can change the programme once the controller has been manufactured. For voting purposes, the presiding officer, or a polling officer, retains the CU during elections, while the BU is placed inside the voting compartment for the voters. Rather than issuing a ballot paper, the presiding officer in charge of the CU pushes the ballot button to enable the voter to cast his/her vote. The voter, in turn, pushes a button on the BU against the candidate and symbol of his/her choice. After the last voter has voted, the presiding officer pushes the 'Close' button. Afterwards, the EVM will not acknowledge any further votes. The BU is then disconnected from the CU and kept separately. The EVMs do not provide a paper trail of the votes cast(Mensah 2016: 780-786; Idrisa and Yusofb 2015: 1; Thakur 2015a: 14-84; Chirambo and Motsamai 2015: 1).

Although some E-voting systems in developed countries have failed, raising much suspicion, from these global E-voting experiences (Mensah 2016: 780-786; Idrisa and Yusofb 2015: 1), the study concurs with common views which have concluded that if properly planned and executed, E-voting solutions have a great potential (Mpekoa 2017a: 180-190, 2017b: 1-25; Thakur 2015a: 10-78). Even with the largest population as in India, E-voting was applauded and no security threats were detected (Das 2015: 633-642; Gupta *et al.* 2013:29-32).

This collection of technological characters from some of the world's most prominent growing democracies adds value to the inquisitiveness of the study. The technological trend offers the thesis an opportunity to monitor the most interesting and unique behind-the-scenes perspective on what it takes to enfranchise the disenfranchised and which countries are leading the curve on digital democracy. They offer lessons for the future and food for thought for governments, elections management bodies and many others who work on the frontline of elections.

Comparisons of various IBTs by country and technology type are presented in Table 2.9.

Table 2.9 Comparison of a Variety of Forms of IBT by Country and Technology Type (Jaleel 2013: 8-14; Gibson and Mcgaley 2008: 283-290).

Name of Country	**Type of IBT**	**Type of Elections**	**Period Introduced**	**Estimated Population**	**Problems**	**Source**
Namibia	E-voting	All elections	2014	1.2m	None	Mpekoa 2017
South Africa	Zip-zip	All elections	1998	54m	None	Evrensel 2010
Nigeria	Biometric card reader	All elections	2015	170m	Failed	Olusola and Adesina 2015; Jaleel 2013; Ozuru *et al.* 2012
Brazil	E-voting	All elections	1996	140m	None	Thakur 2015; Jaleel 2013; Gibson and Mcgaley 2008; Enguehard 2008
Spain	E-voting	Municipal	2002	300,000	None	Thakur 2015a; Jaleel 2013; Gibson and Mcgaley 2008; Enguehard 2008
Australia	E-voting	Act Federal (Australian Act of law)	2001	218,000	None	Thakur 2015a; Jaleel 2013; Gibson and Mcgaley 2008; Enguehard 2008
Belgium	E-voting	General and municipal	1994	3.2m	Failed	Thakur 2015a; Jaleel 2013; Gibson and Mcgaley 2008; Enguehard 2008
Canada	E-voting	Municipal	2002	98,000	None	Thakur 2015; Jaleel 2013; Gibson and Mcgaley 2008; Enguehard 2008
Ireland	E-voting	State	2002	4.5m	Failed	Thakur 2015; Jaleel 2013; Gibson and Mcgaley 2008; Enguehard 2008

Name of Country	Type of IBT	Type of Elections	Period Introduced	Estimated Population	Problems	Source
Lesotho	Results reporting system	All elections	2007	1.2m	None	Allison 2015
Zambia	Biometric Voter register	All elections	2010	17.86m	Failed	Commonwealth Observer Group 2011
Kenya	KIEMS	All elections	2017	49.7m	Failed	Kenya Supreme Court Order 2017

Table 2.9 further shows that several countries such as Brazil, the United States, Canada, the UK, India, Geneva, Namibia and Estonia experienced and benefited from the E-voting system at different stages of the elections processes. Moreover, it illustrates the level of maturity at which each of these countries have since introduced E-voting solutions, either as a pilot system or in its entirety. Countries which have tested and found E-voting satisfactory in Africa include only Namibia – South Africa has not started.

2.7 **Factors Influencing Successful Adoption of IBT Projects in Developing Countries**

There are a very limited number of works which have focused on factors influencing the successful implementation of IBT in elections and associated processes, especially in the context of voting in developing countries. Some studies only examine factors influencing e-government and e-participation adoption (Carter and Bélanger 2005; Lee and Kim 2014).

2.7.1 **Efficiency of ICT Policies within EMBs**

ICT policy-making is becoming a priority for elections management bodies and other private organisations (Msuya *et al.* 2018: 23-34; Feng *et al.* 2018: 3). It is often technically complicated yet very important and cannot be ignored (Gillwald *et al.* 2012: 1-20). While the EMBs' management recognise this fact, they are faced with the challenges of ICT infrastructure and the establishment of policy acceptable for use as well as maintenance compliance (Thakur and Singh 2013: 41-54, 2012: 1-11).

In 2000, the Election Commission in Ghana, through their consultants, included a policy for ICT in its nine-year strategic and modernisation plan of 2000-2009. The policy was revised in 2005. Therefore in 2005, a working group of commissioners and headquarters directors of the EC provided an updated programme emanating from the modernisation policy, reflecting the implementation of ICT programmes which have taken place over the years (Thakur and Singh 2013: 41-54, 2012: 1-11).The policy document set out the objectives for ICT policy for the elections commission and listed the policy options: software, training, hardware, and schedule for each rationale, which were further broken down into short-term and long-term components. It also provides for the training and recruitment of technicians as well as ensuring the acceptable use of information communication technology by the staff of the Commission. Current studies have cited that EMBs, as established entities, should consider developing separate ICT policy as a pre-requisite of the organisation-wide implementation of ICT systems (Odukoya *et al.* 2018: 6; Smith 2018: 1-5; Bailey *et al.* 2017: 201-227). The policy should then be communicated amongst all election stakeholders to ensure that every stakeholder can access and use the technology with ease and with efficiency.

2.7.2 **ICT Infrastructure and Other Resources**

It is no surprise that studies such as those conducted by Mpekoa (2017: 75), Mphindi (2008: 10) and Habib and Naidu (2006: 81-92) list insufficient ICT infrastructure as a major obstacle to e-government and e-participation in developing countries. Conversely, literature also highlights ICT infrastructure as a success factor (Mphindi 2008: 10; Habib and Naidu 2006: 81-92). ICT infrastructures include, but are not limited to, telephone networks, cellular phone infrastructure, broadband Internet networks and electricity (Heeks and Jagun 2007: 1; Link *et al.* 2017: 1-2). Bollou and Ngwenyama (2008) analysed the productivity growth of the ICT sector in six West African countries. They found that the Total Factor Productivity (TFP) growth in the ICT sector was declining in these countries despite the significant expansion of ICT infrastructures. Hence they concluded that investment in ICT infrastructure should be balanced with investments in other infrastructures such as health, education and civil infrastructure.

Cloete (2012: 128-142) argues that while the largest challenges to South African e-government are a lack of leadership and inconsistent policy, a strong focus on Information Technology (IT) infrastructure is also necessary such that e-government initiatives can be widely utilised. Mutula and Mostert (2010: 28-53) found that while South Africa has the necessary e-government policy in place and ICT infrastructure in urban areas is adequate, approximately 45% of the population live in rural areas where ICT infrastructure is often inadequate or non-existent. This inhibits the success of e-government initiatives.

It is important for the study to note that the South African Government has shown appreciation of ICT by directing and prorating tax payers' monies into ICT development projects, especially for Gauteng (Mzekandaba 2015: 1). The recent SA's e-government strategy has piloted early project enrolments in Gauteng. Realising the key role of ICT in enabling modernised government services and benefits for service delivery, the government has developed its own e-government policy framework (Mzekandaba 2015: 1).

2.7.3 **Legal Influence and Regulatory Status**

A legal framework is the most fundamental component of any elections system. The legal framework is a collection of rules under which the elections are conducted, and it determines how the regulation of an elections system works (Thomas and Gibson 2014). A legal framework may be seen as the entirety of a group of constitutional, legislative, regulatory, jurisprudential and managerial rules which, together, establish the voting rights used by citizens to elect their representative officials (Schwartz and Grice 2012; (Wiebusch et al, 2019a:1-10: 2019b:1-3)

2.7.4 **Political Commitment on the Use of IBTs**

According to Bennett (2015: 24), a number of studies argue that political consensus regarding the importance of e-government and e-participation influences the success of these projects. Bhuiyan (2011: 1-2) argues that political consensus on the issue of e-government is needed in order for the government to support e-government initiatives. Qureshi *et al.* (2017: 327-362) explained that e-government in Bangladesh has become politicised, and argues that the ensuing non-consensus between the ruling party and the opposition was a major inhibitor of e-government in Bangladesh. Cloete (2012: 128-142) likewise identified a lack of political support for e-government in South Africa, as well as a continued political internal crisis, which are causing e-government initiatives to fail (Sepeame and Ajala 2013: 1-12; Maumbe and Owei 2006: 160-170). Heeks and Jagun (2007: 1) builds on the theory of public value, and more specifically the strategic triangle which shows that legitimacy and support for an organisation affects the value created by the organisation, and vice versa. Heeks proposes that for e-government to create public value, it needs political legitimacy and support (Heeks 2010, 2009, 2003, 2001).

2.7.5 **Inclusiveness of IBT Programme for all Election Stakeholders**

According to Bennett (2015: 24), several studies have discovered that one of the main challenges for e-government and e-participation in Africa and the developing world is bridging the so-called digital divide and ensuring that all citizens have access to these services. Bhuiyan (2011: 1-2) explains that in Bangladesh, a substantial gap exists between access to technology in rural and urban households, and argues that this digital divide is a critical challenge for e-government in Bangladesh. Geness (2004 cited in Mutula and Mostert 2010: 45) found that e-government initiatives in South Africa were hampered by a “lack of equal access to all citizens especially with regard to the rural-urban divide in the distribution of national resources”.

2.7.6 **Management of ICT Projects to Support Elections Processes**

Cloete (2012: 128-142) expresses a lack of strong and consistent leadership as a constraint to South Africa's e-government development. He argues that management failures in the State Information and Technology Agency (SITA) and the e-government ministerial portfolio are causing the failure of e-government in South Africa (Cloete 2012: 128-142). Similarly, Matavire *et al.* (2010: 153-164) and Maumbe and Owei (2006: 160-170) indicate that some aspects of leadership are posing a challenge for the implementation of e-government in South Africa. Notably, they conclude that leaders exhibit a lack of sustained interest in e-government, and though they may start out being energetic and enthusiastic, they find it difficult to sustain the process in the long-term .The effect of leadership on firm performance in the private sector has been the subject of some debate. Lieberson and O'Connor (1972: 117-130) conducted a well-known study of 167 corporations over 20 years, and concluded that the effects of CEOs and their leadership on company performance were marginal. Hall (1977 cited in Becker and El-Said 2013; Weiner and Mahoney 2013) argues that leadership is important during periods of organisational growth or crisis, but that in general, leaders do little to affect performance outcomes of organisations.

The study notes the existence of an increased body of literature regarding leadership in the public sector (Cheeseman 2018: 1-15), but Nutt and Backoff (1993: 209-231) maintain that leadership does affect the performance of public organisations, as in the private sector, and that strategic leadership must be tailored to fit the public sector (Kroukamp and Cloete 2018: 61-80).

2.7.7 **Elections Stakeholder Management**

Stakeholder management refers to the process of identifying stakeholders and considering these stakeholders' interests when making policies or decisions (Donaldson and Preston 1995). Dada (2006) established that implementers of e-government should be aware of the vested interests of stakeholders. For example, some stakeholders may be averse to sharing certain knowledge and information, as this may lead to altered power structures and diminish their authority. Cecchini and Raina (2004: 65-75), while studying a consumer-to-consumer e-government project in rural India, concluded that it was vital to involve various stakeholders in the implementation of the project, instead of simply taking a top-down approach to the project. They argue that engaging with stakeholders can foster participation and local ownership of a project, thereby increasing the long-term resilience of the project. Scholl (2001) found that stakeholder workshops yield relevant and useful information and that stakeholder support furthers the project process and aids the discontinuation of redundant efforts. Thapa and Sæbø (2014: 1-15), in agreement with Thapa (2011), state the stakeholder's theory which provides a deeper analysis to identify stakeholders and their needs, i.e. that they are useful in e-government initiatives, as stakeholders' analyses can reveal the agendas of citizens, government entities, administrators and politicians.

2.7.8 **Citizens Trust in IBT for Elections Processes**

Carter and Bélanger (2005: 5-25) studied users' acceptance of e-government and found that greater levels of perceived trustworthiness are positively related to citizens' intentions to use e-government services. Their results show that citizens must have confidence in both the government and the enabling technology before they start using e-government services. Carter and Weerakkody (2008: 473-482) build on this, showing that the adoption of e-government in the United Kingdom is affected by both trust and relative advantage, and that trust is thus an integral part of e-government adoption. By contrast, unkept promises and deceitful behaviour by government employees will negatively influence e-government adoption. Bennett (2015: 24) concludes that "the importance of trust can be explained by principal-agent theory (PAT)". This economic theory was developed to understand the difficulties which occur when a principal, who is unable to perform certain tasks, hires an agent to do the work. The government and the citizen can be seen as an example of such a principal-agent relationship.

Fiduciary trust is the trust which the principal puts in an agent, believing that the agent will act in the principal's best interest, despite the fact that the principal has minimal control over the agent's actions (Checkland and Holwell 2005; Thomas 2016, 2015). For the government-citizen relationship to work, particularly in the domain of e-government and e-participation, a trust relationship must exist.

2.7.9 **Security of Internet-Based Technologies Audit Trail**

Goldsmith and Ruthrauff (2013a, 2013b: 64) state that security is a major concern for both Internet users and system administrators. Whether to protect confidential data and information in individual files, lock a computer system to unauthorised users, control access to an intranet or an extranet or conduct business on the Internet, one needs to determine an appropriate level of security as well as effective means to achieve the objectives. The information age is revolutionising the way in which transactions are conducted. However, some studies argue that they are decertifying EMBs' paperless voting machines to secure elections (Thakur and Singh 2012: 1-11). In this case, ballot computers do not print a ballot, thus only one person presses a button to cast a ballot (Thakur 2015a: 3). Everyday actions are increasingly being handled electronically instead of with pencil and paper or in a face-to-face manner. This growth in electronic transactions has resulted in a greater demand for fast and accurate user identification and authentication. According to Abraham and Chengalur-Smith (2010), one needs to identify and classify threats concerning information systems. The identification and classification can be seen as one of the cornerstones to safeguarding information systems (Abraham and Chengalur-Smith 2010). However, utilising a fast-growing medium such as the mobile phone to cast a vote poses various new security threats and challenges such as hacking, ID theft, national security, national interest and sometimes Acts of God (Moloja 2018; Mpekoa and van Greunen 2016b).

2.8 The IBT Adoption Status by the Current South African Elections System

The current South African elections process makes use of paper ballots and a manual counting process. There have been discussions in the IEC about the implementation of E-voting in the South African elections process (Mawson and McConnachie 2011: 1-3). For more than 10 years, running an election has been a manual and work-intensive operation. Gradually, ICTs are being introduced into various aspects of the election process. These technologies have been discussed in Section 2.4 of this chapter, where it was noted that E-voting is probably inevitable in today's technically-oriented society. The current South African paper-based voting process has numerous technological aspects associated with it. Table 2.10 (Mpekoa 2017: 69-87) in Section 2.8.1 presents a summarised state of ICT adoption in the current South African elections system**.** Within the heart of the IE, ICT capability is part of non-stop support services which secure and guarantee the availability, accessibility and functionality of entire ICT products and services (Mpekoa 2017: 80-83). These services include:

1. stable applications which support and enable all business processes;
2. closely-integrated systems which ensure a seamless flow of information across the different systems (Mpekoa 2017: 80-83);
3. a reliable and highly-secured technology, a reliable network which covers both Wide Area Networks, Local Area Networks levels and the data centre (Mpekoa 2017: 80-83);
4. accessible networks and strong server support with adequate capacity and with the highest capabilities of supporting improvement of election activities and network signals (*ibid*);
5. establishing clear business continuity and management of risks, business recovery and sustained continuity (Mpekoa 2017: 80-83);
6. online collaboration of self-service features for stakeholders' engagement through the use of Internet-based technologies(SMS, smart phones and undefined additional service data and the social networks)(Mpekoa 2017: 80-83); and

vii. reliable and working open digital portals which provide collaborated technology for all stakeholders through the use of the Application Programming Interface (API) (Mpekoa 2017: 80-83).

During the announcement of the 2009 national and provincial elections at the Electoral Commission Headquarters, President Kgalema Motlanthe indicated that serious consideration should to be given to e-enabled future elections for South Africa (IEC 2009: 1-35).

2.8.1 **Voter Registration**

The Elections Amendment Act No. 34 of 2003 Section (8) (1),(2),(3) enunciated that any South African citizen who has an Identity Document (ID) and is 16 years old, can apply to register as a voter. Eligible voters are normally required to register to vote a few months before the election day. The voter registers by producing his/her ID and proof of residence, either at the local or national elections offices. Voters are registered to a particular voting district, and in local elections, they may only vote at voting stations in that district. During national and provincial elections, if the voter has proof that he/she is registered, he/she is allowed to vote outside the voting district. Throughout active registration periods, the voter fills in a voter registration form and his/her identity is captured (Mpekoa 2017: 69-87).

Table 2.10 The Status of IBTs in Current South African Election Procedures (Mpekoa 2017: 69-87).

Internet-Based Technologies	**Description and Functions**
Voter Registration Scanners: programmable barcode scanner unit (also known as zip-zips)	To support and enhance authentic voter register. The main objective of these units is to allow voter registration details into the national voters roll system. The PBSUs can be used to identify voters before they cast their ballots at the polling station and enhance the procedures and processes to record voter participation information
Ballot Paper production System(BPS)	Generates and produces the images of single ballot papers and election results reports(slips) for every ward/constituency election and are produced in precise and controlled quantities
Logistics Information System (LIS)	Enhance planning, tracking, monitoring and supervising of the deployment of elections material at every polling station

Internet-Based Technologies	Description and Functions
Integrated and Online Candidate and Nomination System (IOCNS)	Technology innovation which allows candidate nomination processes to be self-service for political parties and individual candidates to capture details through an online system
Elections Staff Deployment System(ESDS)	Supervise the deployment of elections staff including contracting and engagement, controlling daily work schedule and payment of temporary staff members
Online Candidate Nomination System (OCNS)	Used for submitting applications for special votes online through the Internet and by SMS
National and Provincial Election Results System (NPERS)	Captures the results, has a result scanning module, results slip generation, and issue-logging module
Local Government Election (LGE) Results System	Capturing of local government elections results, auditing and validating of captured results, provides reporting, seat allocation and regulates any legal objections
Elections Stakeholder Engagement Committee-Party Delegates and Records Management System	Capture all delegates minutes and provide dashboard reports through online platforms, based on national and provincial levels
Data Centre Facility	Provides storage and backup infrastructure
Network Infrastructure	Provides network signals, data collaboration, system application under secured environment
Network Security	Symantec Security Information Manager (SSIM) Symantec Control Compliance Suite (CCS) Cisco ASA firewalls Checkpoint management servers, firewalls and appliances for monitoring
Office automation and Administration	Emails, Internet, application suites, support office and printing facilities

Table 2.10 summarises the most popular ICT tools used for South African elections. The current technologies have been subjected to controversies around the 2014 and 2019 national elections. There were two key questions for the study to note: (1) could these ICT-based elections be trusted for future elections, and (2) double voting possibilities.

With the advent of today's technology and the use of smart phones, people started 'shopping around' for shorter voting queues, and what was meant to be a special facility became a convenience facility (Mpekoa 2017: 85). This led to certain shortages in some voting stations. To this end, the current adoption of technology does not accommodate a convenience facility as the study would suggest that it is the right path to follow for South African elections. The accuracy of the voters roll and safeguarding against potential voter fraud and ICT systems can help with voter training and registration, and offer election agencies the opportunity to communicate directly with voters in an unprecedented fashion, improving the voter turnout. South Africans should not only be able to vote, but should also have a system which can be trusted (Mpekoa 2017: 85).

2.8.2 **Counting**

In South Africa, the counting process normally unfolds in the presence of observers and party agents and/or independent candidate agents, who confirm that the counting is being done correctly and fairly. The IEC official who is counting advises all those present on the counting procedures and validates the rules about the valid and invalid ballots (Krimmer 2019: 421-426; Zukerman 1925: 45). A first reconciliation of the ballots is done before opening the ballot box (Mpekoa 2017: 139). Spoiled ballots are counted and put aside. Once the ballot box is emptied of its contents, the validity of each ballot is verified; they are unfolded and sorted into different piles (Mpekoa 2017: 139). The votes are counted into valid ballots (by candidate/political party/option) and rejected ballots (a ballot found in the ballot box is rejected if it was improperly marked, or if it is not marked at all, when a mark is required) (Madise and Priit 2011; Van Zyl Slabbert 2003). The recorded votes are entered on both results slips (with several copies) by the IEC official (counting officer) and signed off by his/her deputy in the presence of more than three party delegates. These party delegates must attach their signatures to the elections results slips. The ballots are now deposited and inserted into the ballot containers, which are resealed for storage for a period of six months after the elections. The rationale is to help the IEC officials to cater for registered queries and challenges pertaining to the election which may arise in the future (Madise and Priit 2011). One copy of the results slips is sealed in a tamper-proof bag and then sent to the Municipal Election Office(MEO)where the results are validated, scanned, captured and transmitted to the Elections Commission’s central results system. The other copy of the results slip is displayed outside the door of the voting station on the results wall and notice board (Krimmer 2019: 421-426; Mpekoa 2017: 139; Zukerman 1925: 45).

2.8.3 **Provisional Election Results**

Interim results for every polling station are presented outside the polling station when the counting process has been completed. These results are transmitted to municipal elections officers where they are validated and re-scanned, captured and transmitted to the central results system. The double-scan feature of the system creates an image of the original results slip, combined together with the captured result. The process of capturing elections results requires a double-blind process and validation and it is only reviewed by the appointed auditors (Mpekoa 2017: 115-139).

2.8.4 **The South African Elections Law**

The overarching law of the country is driven by the Constitution of the Republic of South Africa of 1996. Based on current South African law, regulations and the IEC institutional policy, there will be a need to re-align the several laws and introduce IEC institutional IBT framework policy in order to make use of modern technology innovations in elections. The following present some legal acts which may be affected:

i. Electoral Commission Act No. 51 of 1996 to make provision for the conduct of free and fair elections for the National Assembly and Provincial Legislature as contemplated in the Constitution of the Republic of South Africa, to make provision for the conduct of certain Referendums by the IEC and provide matters that connected therewith (IEC 2009).

ii. Referendums Act No. 108 of 1983 to provide for the holding of Referendums in order to ascertain the views of voters in the Republic, or any part thereof in any matter (IEC 2009: 1).

iii. Promotion of Access of Information Act No. 2 of 2000, (PAIA) – this act has established voluntary and mandatory procedures to enable persons to obtain access to the records of public and private bodies as swiftly, inexpensively and effortlessly as reasonably possible. This act should be balanced with the IBT conceptual framework for South Africa and availability with an almost instant immediacy of information. This is a very crucial and necessary intervention if the IEC decides to provide the necessary resources, legal framework, and management settings to test and operate the modern IBT. This is not exhaustive; there are other expert areas such as legal, elections analyst, financial, procurement, voter education, media practitioners, ICT security, management experts and change experts, all of whom will need to be consulted regarding the matter (IEC 2009: 1).

iv. Other election laws

South African elections have to conform to several specific laws and regulations (IEC 2009: 1). The highest law, superior to any other law, is the Constitution of South Africa. The Constitution is the main legal standard of any State; it is not only mandatory, but must be enforced and honoured as well. Election rules set down by the Constitution are legal standards which must be upheld by constitutional and democratic regimes. Subsequent regulations are then legislated in order to develop the content and application of these Constitutional rules to the actual conduct during the elections process (IEC 2009: 1). The current elections legislation in South Africa, according to the Constitution of the Republic of SA of 1996 (IEC 2009: 1), include:

- Elections Act 73 of 1998 (Elections amendment Act 18 of 2013)
- Elections Commission Act No. 51 of 1996
- Municipal Structures Act No. 117 of 1998
- Municipal Demarcation Act of 1998
- Municipal Elections Act No. 27 of 2000 and Elections Regulations
- Regulations on the Accreditation of Observers 1999, Schedule B

All the above-mentioned regulations and Acts form part of the election laws which regulate elections on the national, provincial and municipal levels in SA. Therefore, all the elections must conform to these laws. Currently, none of these election laws accommodates the implementation for an IBT conceptual framework for South African elections. Careful planning and active consultation with election stakeholders will be required such that certain steps can be initiated to modify and change the current election laws, and to enable the introduction of IBT voting technologies into the voting process.

The reform of election laws is a complex task. Parts of the legislation requiring amendment would need to be identified, and suitable amendments would need to be passed before the introduction of an IBT conceptual framework for South African elections. The process of developing amendments should involve input from all the election stakeholders, including the various political parties and civil society.

2.8.5 **IEC-ICT Policy Framework**

The advent of ICT has provided a means for faster and better communication, efficient storage, the retrieval and processing of data, and the exchange and utilisation of information to users. The ICT policy is an integrated set of decisions, guidelines, laws, regulations, and other mechanisms geared to directing and shaping the production, acquisition and use of ICTs (DTPS 2015: 1). Policy is the key determinant of legislation and regulation. It sets out the vision for ICT development, together with its links to the national development goals. The three main areas covered by an ICT policy include telecommunications (telephone communications), broadcasting (radio and TV), and the Internet (Gillwald *et al.* 2012: 1-20). South Africa Connect, adopted by Cabinet in 2013, is the central policy for broadband infrastructure, and it adopts an integrated cross-cutting attitude, as well as a citizen-centric approach to broadband technology (DTPS 2015: 1).

South Africa Connect provides a strategy to close the gaps between the current poor status of broadband penetration in the country, and the vision of a seamless pervasive network (*ibid*), which by 2030 will be universally accessible at a cost and quality which meets the needs of citizens and the business and public sectors. Mpekoa (2017: 183a) argues that the mission of this policy should be to improve the quality of life of South African citizens, including those in the rural areas, to the highest attainable levels, by ensuring the availability of accessible, universal, affordable, modern and high-quality ICT facilities and services.

2.8.6 **ICT and Elections Management**

Elections in South Africa are spearheaded by the IEC which manages the elections at all levels of government, to ensure that all such elections are free and fair as stipulated by the Constitution of South Africa and the Electoral Commission Act 51 of 1996. The IEC is an independent, impartial institution established by Chapter 9 of the Constitution of South Africa to strengthen constitutional democracy. In 2016, South Africa marked 22 years of democracy, and the IEC was running its fourth local government elections; two years prior in 2014, it had its fifth national elections (IEC 2009: 1). These elections were the ninth democratic elections conducted for public representation in the country since 1994. Therefore, citizens are no longer simply satisfied just to be voting. There has been a constant drive to push for automation which could increase the security and accessibility of elections (Masuku 2006: 1-18). There is also a significant need to accommodate senior citizens and voters with disabilities, and to give them the same opportunity to vote privately and securely (Swanepoel *et al.* 2010: 70-77), without having to bring them to a physical voting station which can sometimes be a problem due to their conditions.

The IEC is currently using IT in order to efficiently and effectively prepare and conduct elections. Some of these IT systems are utilised in various sections of the election process, from communication to registration and online-election applications (Swanepoel *et al.* 2010: 70-77).

Some of the well-known technologies include the zip-zip scanner, used during registration to collect and update voters' information. From this information, a database is used to create a voters roll, which is stored back onto the zip-zip scanner to be used on election day for the authentication of voters. Computer networks are also used for communication and to send the regional and provincial results to the counting station (IEC 2004). However, there has not been any implementation of technology in the vote-casting process (Swanepoel *et al.* 2010: 70-77). Instead, for the national elections in 2014, the IEC developed a mobile application which voters could use to obtain the election results, check their registration details, find their voting station, obtain answers to common questions, and keep up to date via the social media (IEC 2017: 1). This application does not allow the voter to register, cast his/her vote, nor to update his/her personal details. The Elections Commission has a duty to ensure that there is adequate planning, human resources, technology innovation and financial capital to deliver acceptable election services and products (IEC 2017: 1).

In an attempt to fulfil this mandate, the IEC organised a stakeholder workshop on E-Voting Technologies in Cape Town, South Africa, in 2013. The main objective of the seminar was to assess the feasibility of E-voting in SA, by drawing on the lessons learned from comparable experiences. The recommendations from the seminar were that South Africa should embark on E-voting and that the process should be guided by the country's unique socio-political and economic realities. It was also recommended that a prolonged and focused research study of the technology should be piloted (Thakur 2015a; IEC 2014: 1-5). The success of an IBT conceptual framework is highly dependent on the support and motivation from the election management body.

2.9 **A SWOT Analysis for South African Election Processes**

2.9.1 **Strengths**

Ndletyana (2015: 2-32) states that South Africa has been a democratic republic for more than 20 years. Among the major markers of the country's democratic status have been five successful elections (Ndletyana 2015: 2-32). The success of the elections have, in turn, yielded stable institutions of governance. Since they have been elected through a credible electoral process, various spheres of government enjoy popular legitimacy (Ndletyana 2015: 32). Ndletyana (2015: 2-32) and Mangcu (2011: 1153-1168) concur that there are also various improvements which have brought local government into the democratic age(Mangcu 2011: 1153-1168).To this end, the Electoral Commission was able to affirm its independent and moral character (Ndletyana 2015: 2-32).

2.9.2 **Weaknesses**

A limited record of complaints from the public about the current voting systems and procedures suggests that voters are satisfied. Any unsatisfied outcomes would have invoked an automatic reaction from voters. The voter will question the value added and how this new form of voting will improve democracy. There have also been reported cases where the IEC was facing accusation of using teachers during election time, who were seen to be in alliance with the Teachers Trade Union with the ruling party (Moepya 2010: 1-5; Sowetan 2010: 2).

2.9.3 **Opportunities**

(a) The Political Stability

It is also necessary to consider the effect which the introduction of an IBT framework could have on political processes. Political pressure, for or against a voting system, is a major driver for adopting a particular pattern of voting policy and practice (Moynihan and Lavertu 2012: 592-602; Heeks and Jagun 2007: 69). According to Mpekoa(2017:880-98) the political consensus and support are important issues. A factor identified in literature as influencing E-enabled elections in a developing country is political consensus (Thakur and Singh 2013: 1-11; Cloete 2012: 128-148). Political consensus can be defined as the consensus, or agreement, of politicians and government officials on the importance of e-participation. The need for political consensus for a government to support e-government initiatives, and the failure of e-government initiatives in Bangladesh and South Africa, have been covered in Section 2.7.4 of this chapter.

(b) IBT Project Leadership

The strategic leadership theory indicates that leaders' decisions directly affect a firm's performance (Maumbe and Owei 2006: 160-170).

(c) Information Communication Technology Infrastructure

ICT infrastructure is defined as the combination of telephone networks, cellular networks, broadband-Internet networks and electricity present in an area (Heeks and Jagun 2007; Heeks 2002). One of the most important factors identified from literature as influencing the implementation of IBTs in a developing country is the quality and coverage of the ICT infrastructure (Thakur 2015a: 60-78; Achieng and Ruhode 2013: 1-12). *Quality* refers to reliability and speed, while *coverage* refers to the percentage of the surface area of the country which has access to the ICT infrastructure. The state of ICT infrastructure in urban and rural areas of South Africa has been mentioned in Section 2.7.2 of this chapter. The SA Connect broadband policy calls for reaching a universal average download speed of 100 Mbps by 2030 (DTPS 2015: 1; Mpekoa 2017: 194). The South African government is taking steps to ensure that mobile broadband penetration reaches optimum levels in the country.

2.9.4 **Threats / Drawbacks of Paper-Based Elections Procedures**

The relationship between leadership and the implementation of e-government in South Africa has been discussed in Section 2.7.6 of this chapter. There are numerous challenges with which the current South African elections process is faced. Traditional paper-based elections procedures can be overwhelming, time-consuming, inconvenient, costly and prone to human errors (Ekong and Ayo 2009, 2007; Masuku 2006). The challenges are divided and described according to the following themes: election fraud, low levels of voter literacy, voter disenfranchisement, voters with disabilities, South Africans living abroad, the running costs of elections, the competence of election officials, logistical issues, intimidation of and impediments to voters, and lastly, human error(Mpekoa 2017a: 215).

The use of IBTs, especially the social media, can spread fake news which undermines the credibility of elections processes and procedures. The study share a view that the most important currency for South African elections is trust, security, authenticity and accuracy.

(a) Election Fraud

Literature suggests that failed security controls have led to modified, spoiled, and stolen ballots, as well as stuffed ballot boxes. Election fraud ensues through previously-marked ballot papers, and in some instances, ballot boxes going missing (Ayo *et al.* 2012, 2010, 2008, 2007). On a number of occasions, there have been reports of ballots found inadvertently discarded in bin bags by election officials (Rexha *et al.* 2012: 84-92, 2011: 1-3). Moreover, communicating election results through traditional means of transportation exposes the results to numerous risks such as attack by political thugs, aggrieved party members, or manipulation (Rexha *et al.* 2012: 84-92; Ayo *et al.* 2007: 172-179). The use of cardboard ballot boxes also raises concerns, because these ballot boxes invite fraud, as one can easily put a paper into it (Rexha *et al.* 2012: 84-94).

The study period involved the 2009 and 2014 elections, but it is noteworthy that in the recent 2019 elections in Gauteng, some voting stations were in the spotlight and faced significant allegations of election results discrepancy, where the Democratic Alliance raised alarm over possible fraud (Business live 2019: 1).

(b) Low Literacy

Tibane and Vermeulen (2014) reported that there were nearly five million South Africans who were illiterate in 2009. This presents challenges when casting votes using the traditional paper-voting system. Although it sounds simple to an educated person, for an illiterate person this can be a challenging task. The incorrect marking of a ballot box results in spoiled ballots, and in the 2009 election, there were 239,237 spoiled ballots during the national elections and 223,462 in the provincial elections (EISA 2009: 9). It was also reported that during the 2014 national elections, voters were given the ballot papers and directed to the booths, without receiving any explanation regarding how to mark the paper and how to fold it (EISA 2009; Beck and Weber 2014: 4-18).This also implies that there was little voter education.

(c) Voter Disenfranchisement

According to the World Bank (2014: 1-9), the high levels of poverty in SA constitute the largest challenge, where 50% of the population live in under-privileged conditions. In most instances, voters living in rural areas might not have the necessary funds to travel to a voting station (Coghlan 2019; Thomson 2016). Immobility of voters can result in decreased voting registration and participation. According to the research conducted by the HRSC (2016), 64% of voters stated that it took them 10-15 minutes or less to walk to their polling station, 23% took between 16-30 minutes, 8% took between 31-60 minutes, and 3% took longer than an hour (Mpekoa 2017: 189a; Schulz-Herzenberg 2014: 189-209). Secondly, the survey conducted by the HRSC (2016) revealed that 56% of those who left without voting did so because of the long queues. Voters in queues by 9am are allowed to cast their votes, which in some instances led to the close of polls (and the count) taking place several hours afterwards; in some instances, polls closed only in the early hours of the next morning.

(d) People with Disabilities

People with disabilities face certain challenges when it comes to casting their votes. During the 2009 and 2014 elections, no wheelchair facilities were provided in the majority of Gauteng voting stations, and limited or no accommodation for people with disabilities was arranged (Maseko 2009: 623-639). In most instances, people with disabilities rely on the presiding officer to assist them when casting their vote, where the integrity of the vote might be influenced. For this reason, voters are unable to cast their vote in secret (IEC 2009: 1-5). During the 2009 elections, the IEC introduced a new braille template which allowed visually-impaired voters to cast their votes without any assistance from an election official. There were various issues associated with this new template; for example, the ballot had numbers instead of the names of political parties. This compelled a visually-impaired voter to ask for the name of the party of their choice against the numbers provided on the ballot paper (Maseko 2009: 623–639; Maphunye 2017: 55-75, 2010: 56-78).

(e) South Africans living abroad

A large number of South Africans are living abroad, and as from 2009, they have been eligible to take part in South African elections. In 2009, the Constitutional Court made a ruling that all South Africans living abroad are eligible to take part in elections. However, these voters are expected to go to a South African embassy, a High Commission or a General Consulate in the respective visiting country to cast their vote. Some of the challenges which they encounter include difficult and costly access to an embassy to register and cast their votes, and this might hinder election participation by expatriates (Mpekoa 2017a: 71; IEC 2009: 1-15).

(f) Running Cost of Elections

According to the Elections Institute of South Africa (EISA 2009: 1-10), report No. 12, the cost of the physical ballot paper is also identified as a major drawback of the current paper-based voting system. According to the above-mentioned report No. 12, the total cost of the 2004 elections was R790 million, and 56 million ballot papers were printed in colour in 11 official languages. The total cost for the 1999 elections was R713.5 million, and that for the 1994 elections was R960 million. The IEC budgeted R2 million to cover the cost of couriering the ballot papers from overseas (Mpekoa 2017a: 71-89; EISA 2009: 1; IEC 2009: 1-15).

(g) Logistical Problems

The difficult geographical landscape of some communities is among the main challenges of the existing traditional voting system, such that the effective distribution of electoral materials is not only arduous but also challenging (Mpekoa 2017: 72; SADC 2014: 1-4). The SADC Electoral Observation Mission (Mpekoa 2017: 72; SADC 2014) observed that the voting process was delayed in many cases due to administrative delays, such as the shortage of materials or electoral staff not reporting for duty on time. At some voting stations, ballot papers ran out and the voters had to wait for long periods of time before ballot papers were replenished. Several rural voting stations did not have access to electricity, forcing them to rely on candles and gas lamps (Mpekoa 2017: 72; OSISA 2016: 2-25). The SADC (2014: 1-9) mission also noted that with the increase in the number of registered voters, the number of voting stations is becoming insufficient to cater for the number of voters (Mpekoa 2017: 72).

(h) Intimidation and Impediment of Voters

A number of cases have been reported where party supporters have transported elderly voters to the voting station, with party members wearing party regalia assisting them to vote inside the polling booths. This situation might compromise the secrecy of the assisted voter's vote, their right to a free choice, and may even lead to intimidation (OSISA 2016; SADC 2014). It was also reported that some farmers did not allow their employees to register and vote. According to an election monitor, farmers generally did not allow workers to leave their places of work on election day (OSISA 2016; SADC-PF 2014).

(i) Human Error

Human error can occur both on the voters' side and on the election officials' side, and these errors cannot be confirmed by the current system (Ayo *et al.* 2007: 172-179; Thakur *et al.* 2014: 1-7). The SADC-PF (2014) mission noted that most election officials worked day and night without a break. In other cases, the election officers were exhausted, even before election day, as they had been involved in special voting for the previous three days, and immediately thereafter on election day, this led to tiredness and debilitation, which slowed down the voting and counting process. At a significant number of voting stations, the presiding officers literally fell asleep, and they did not count the votes until the following day or two (OSISA 2016: 15-20; SADC-PF 2014: 5). The above-mentioned challenges, among others, could contribute to a decrease in trust and a lack of confidence in the South African elections system. The thesis accept that South Africans should not only be able to vote, but they should also have a system which can be trusted. This would assist in achieving a free and fair election, where the voters have confidence in their country's elections system.

2.10 **Summary**

The majority of countries which have adopted IBTs with E-voting technologies are largely classified from developed countries (Thakur 2015: 13-78). On the other hand, the majority of African, Asian, South American and Middle Eastern countries are now adopting the use of technology, where most of them are still at the entrance level with a high expectation to develop more technologies which are sophisticated. It is important to note that as a nation adopts ICT, it receives extensive regional media coverage, as can be seen from the Kenyan (2017), Nigerian (2015), Australian as well as Brazilian, Indian and Filipino experiences (Thakur 2015: 13-78).

Relevant to the study, the information collected from Tables 2.1 to 2.10 will support the notion that the use of Internet-based technologies plays a significant role in supporting the election management bodies. EMBs are said to play the most important role in the institutionalisation of democracy (Mangcu 2015: 159), with reference to South Africa's Electoral Commission. Therefore, they play a critical role in the election management process.

Available data from African countries (Achieng and Ruhode 2013: 1-11) suggests that African countries still have a considerable way to go before they can address election-related technological challenges. In terms of mobile phones in particular, the benefits obtained by the continent on economic development have largely benefited elections as well because the mobile phone is increasingly cited by the respondents in this study as being extremely useful in their communication with their offices and stakeholders or the "political marketplace" (Ormrod and Henneberg 2010: 115; Vankov 2013: 74-80). According to Aker and Mbiti (2010: 207), "while sub-Saharan Africa has some of the lowest levels of infrastructure investment in the world … access to and use of mobile telephony in sub-Saharan Africa has increased dramatically over the past decade". Understandably, the original idea of introducing such technology was to enable "banking [for] the unbanked" through what is termed "mobile money", as in the Kenyan mobile money service (M-Pesa) (Aker and Mbiti 2010: 220-221), but it has also extended the use of mobile phones in many of Africa's rural areas, ensuring that they are reached even during elections.

The study can argue that this view suggests that the use of information and communications technologies will continue to enhance election management, and thus address the following challenges: voter registration enrolment, voter identification, real-time elections results, prevention of election fraud and effective election monitoring.

Chapter 3 presents the elections management processes and Internet-based technologies intervention in Gauteng, South Africa.

Chapter 3 ELECTIONS MANAGEMENT PROCESSES AND TECHNOLOGY INTERVENTIONS IN GAUTENG, SOUTH AFRICA

3.1 Introduction

Chapter two presented and meticulously described literature review of this study. This chapter presents the various election management processes and associated technologies being used in Gauteng Province, and the purposes for which they are used. This chapter gives a broad view of the challenges and drawbacks of the South African election system. This chapter reviews and presents the existing literature on elections technology tools and its parent research field E-voting, with a particular focus on the literature relevant to IBTs for EMP. The concluding remarks and the summary are presented in Section 3.10.

Technology is a tool and not an end in itself (Harsh *et al.* 2017: 597-607; Bosch 2017: 221-232; Colomer 2016: 3). The degree to which technology is deployed in an elections process of a given country at a given time is directly associated with the perceived level of trust and independence enjoyed by the elections management body (European Union 2018; Harsh *et al.* 2017: 597-607; Bosch 2017: 221-232; Colomer 2016). It is this level of trust and independence which finally determines the acceptance of election outcomes by the various stakeholders and the general public (Harsh *et al.* 2017: 597-607; Bosch 2017: 221-232; Colomer 2016: 3).The study noted that use of internet based technology had brought good results with regards to proficiency and effectiveness to the elections process, as these early technological adoptions were drawn from other different fields, where technology had been used and rigorously developed and validated before operational use (Tlakula 2007: 1-20; Cheeseman *et al.* 2018: 1397-1418).

Taking a holistic view of technology use in every election, it is important to share a view which considers the involvement of Internet-based technologies within the elections context in which technology is used. To this end, almost 20 years has passed since the Electoral Commission South Africa (IEC) readily adopting different types of technologies into the EMPs. These include database systems and applications such as Geographical Information Systems (GIS) for re-districting and logistics planning. The proliferation of Internet-based technologies within the IEC has also increased functionality and the reduced costs of delivering election services to South African citizens (Tlakula 2007: 1-20; Clottey 2014: 1). Innovative use of IBT in support of business processes has been acknowledged by the IEC as a key component in endorsing the Elections Commission to deliver a proficient service within all categories. To attain this, a variety of IBT programmes are initiated and adopted by the Information Technology Department (ITD). The design of the infrastructure of the Elections Commission's department of technology is intended and structured to permit flexibility and quantifiability in the least levels, and to be absolutely aligned with the seasonal nature of the elections business (Achieng and Ruhode 2013: 1312-2406).

3.2 The IEC's Information Technology Department (ITD)

The ITD integrates information provision, technology acquisition and supports election operations of the IEC (Singh *et al. 2*019: 103-123; Marx 2019: 1-5). The department plays a key role in planning, implementation, support of the data centre infrastructure, maintenance of administrative office automations, systems development and GIS in the IEC. The ITD, within the elections management body, provides an internal ICT support service throughout the entire election cycle – pre-elections phase, during the elections and postelections (Marx 2019: 1; Friedman 2009: 108-122).

Preparations for the election's delivery are reinforced by a pledge to ensure that all registered voters and concerned citizens receive equal treatment from the Elections Commission. The advanced data communication technology should be used to support the business processes which enable the elections' management to deliver proficient services at all levels (IEC SA 2014a: 3; Ferree 2010: 1). Under current IEC technology, the systems combine the use of labour-intensive processes and digital technologies (crossbreed systems) which offer a good variety of solutions, many of which are utilised in certain other countries (Singh *et al.* 2019: 103-123). The mix of those manual and electronic processes into an appropriate hybrid system is influenced by a large variety of aspects, and will arguably be thought of as distinctive in any given country. The IEC has in place a fully-electronic voter registration system, and is still working at an acceptable level of system automation from the physical voting station to the national level of election administration. Hence, it can be stated that the ITD is the key to the successful delivery of elections by the IEC (Achieng and Ruhode 2013: 1312-2406).

3.3 **The Design and Management of ICT Facility**

The design of the IEC SA-ITD facility is based on a net-centric architecture. This symbolises an elegant system of systems composed of subsystems and services which are a unit of an endlessly-evolving advanced community of individuals, devices, data and services interconnected by a network which enhances data-sharing and collaboration (Faik, Thompson and Walsham 2019: 1-22). These subsystems and services were not all developed or closely-held by the same entity, and in general they do not frequently offer a complete lifecycle of the system of systems. Samples of this design embrace service-oriented architectures and cloud-computing architectures (Faik, Thompson and Walsham 2019: 1-22).

3.4 **ITD Structure**

The department currently has a staff of 184 employees. The Chief Information Officer reports directly to the Chief Elections Officer. The 184 regular workers are directly answerable for performance delivery at the national level (IEC 2014a: 1-9; Thompson and Walsham 2019: 1-22). The need for ICT systems which can facilitate transparency in EMPs will impact on the effectiveness and efficiencies of activities and the judicious management of resources around elections. Figure 3.1 in Section 3.5 depicts the entire IEC organisational structure and presents the Gauteng region and ITD department (IEC 2014a: 1-9; Thompson and Walsham 2019: 1-22).

3.5 **Gauteng Provincial Structure**

The Chief Elections Officer (CEO) supervises the implementation of the Commission and compliance to the Commission's strategic priorities and structure policies (Nohlen *et al.* 1999). Moreover, the CEO ensures the accomplishment of goals and objectives to enhance the effective and cost-effective functioning of the Elections Commission. There are four permanent personnel within the unit who give support in achieving the strategic goal and objectives of this programme (IEC 2014a:1-6). The elections provincial offices are accountable for activities in all the nine provinces (Rooyen and Rena 2019: 2-3). Every elections provincial office is comprised of a Provincial Electoral Officer (PEO) and support employees. The provincial office supervises the municipal elections officers in their own provinces and conjointly manages elections missions (Mashile 2014: 1; IEC 2014: 1-20; Thakur 2015a: 32).

The Gauteng Provincial Officer is responsible for election activities for the entire province. The Gauteng PEO has both permanent staff members, who are employed under pensionable conditions, and temporary employees, who work during the election period. The provincial electoral officer oversees the municipal electoral officers in their respective municipalities and also manages electoral projects, including any technological development to support election activities in the province (IEC 2014: 1-20; Thakur 2015a: 32).

The study has the potential to enable the successful adoption of IBTs in Gauteng and other South African provinces. The provincial electoral office in Gauteng is composed of technological and human elements, which are part of the proposed framework, and IT artefacts which endeavour to improve people's experience and use of technology for elections. The entire organisational structure for the Electoral Commission South Africa is depicted in Figure 3.1.

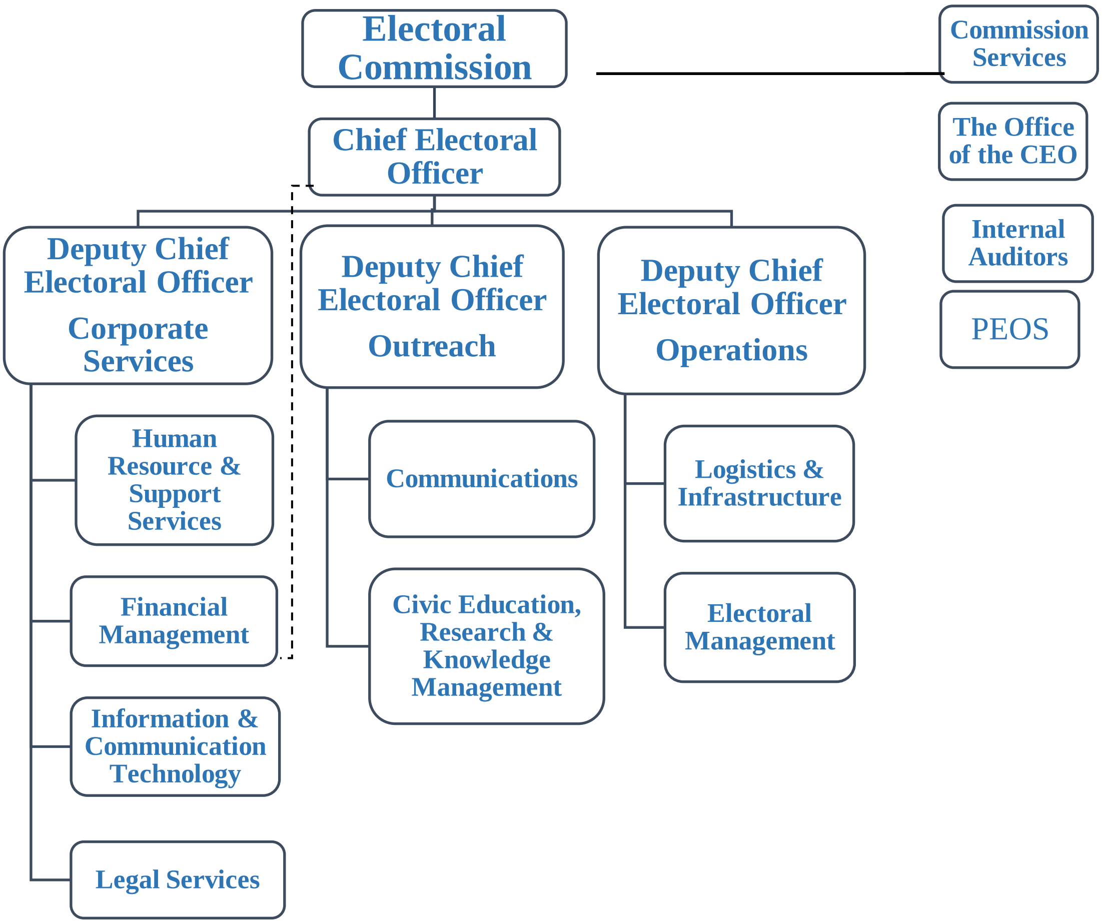


Figure 3.1 Organisational Structure for the Electoral Commission in South Africa (IEC 2014a: 1-20).

As shown in Figure 3.1, elections in SA are administered by the Electoral Commission South Africa, which manages every part of the elections to ensure that they are credible, free and fair (Swanepoel *et al.* 2010: 70-77; IEC 2014a: 1-20). As stipulated by the Constitution of SA and the Electoral Commission Act 51 of 1996, Figure 3.1 exhibits the organisational structure, demonstrating the hierarchy of IEC senior officers and the level of reporting structure from the Chief Electoral Officer to the members of the Commission. The CEO delegates constitutional powers to various heads of departments to fulfil the constitutional mandate(Ndletyana 2015: 2-32). The Gauteng PEO constitutes part of the entire IEC structure, and therefore all election activities in the province are managed and supervised by the Gauteng PEO, who reports directly to the CEO (IEC 2014a: 1-20).

3.6 **IBT Operations Management**

Planning for the 2009 and 2014 elections was reinforced by a pledge to ensure that data communication technology would transcend providing support solely to business processes, by providing environments and technologies which enabled the Commission to deliver election services in all election stages (Babich and Hilary 2019: 1-8; Southall and Daniel 2010: 3). Information technology thus became a core driver of performance for the elections, and in line with this variety of programmes, was developed to supply the subsequent capabilities (Babich and Hilary 2019: 1-8; Feltus 2012: 27-28).

3.6.1 **Additional Resources Used to Achieve IBT Goals**

The success of IT services within the elections centred on stability, security, flexibility and dependability. In line with these key drivers, the subsequent results were achieved. Extended services to mobile technologies (SMS) and processed Integrated Voice Responses (IVR) created potential for the Commission to produce public information services at all times and at any place. Some samples of this information commonly include queries, election registration details and election results (Sheldon 2019). Upgraded WAN networks and increased network bandwidth capability can produce improved response times irrespective of web traffic congestions and centres (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

As part of a risk management process, varied business continuity plans and disaster recovery processes were put in place. Service-level agreements with all affected service suppliers were upgraded to ensure a shorter unit of time to repair (MTR) as well as the continuous convenience of support services at the least vital moments. Alternative external service suppliers were also brought in to supply autonomous requests. Besides providing assurance for readiness, this initiative can also be interpreted to provide external transparency of the underlying business processes. In line with enhanced capability needs, the Wide Space Network was extended to the results operations centre and also the provincial results centres (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

3.6.2 **IBT Infrastructure**

The data communication technology plans of the Commission is created to guide and support flexibility and quantifiability within all levels, rigidly aligned with the seasonal nature of the elections business centres (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).The specification, besides guaranteeing stability, consistency and dependability, forms a key part of election readiness (Sheldon 2019). Pre-planning and lessons learned from previous elections enabled the IBT operations team to address past inadequacies and place the most stable, secure and reliable infrastructure created thus far for an election. Strict management and cooperation with Telkom and the dedication of its technical groups simplified the process centres (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

With relevancy infrastructure, successes which were achieved involved ensuring a decent network and background server capability, with the specified capability of supporting huge election activity and network traffic. This ensures hosting the general public website by Internet service providers and providing ample server capability to handle thousands of requests from approximately 3,000 desktop computers deployed within two to three months to cover over 300 sites across the country, to replace the out-dated computer centres (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

There were more than 90 new servers commissioned into the network to boost the capturing and reporting of election results into the National Elections Results system. The process of capturing and reporting was also supported by an additional 460 working desktop computers for all sites within the country to scan the results slips. All sites were running under a secured environment using Virtual Private Network and Multi-Protocol Label Switching (VPN-MPLS). The configuration and installation guaranteed an increased availability of systems and reduced bottlenecks while enabling the required speed at all times (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

The number of workstations was increased and metro stations were combined for data-capturing. The network was attained and was kept 100% stable throughout the election period. The rationale was to enable the results to be captured in record time. Extra capturing sites were made available in areas where technology equipment shortages had been identified, especially in the Eastern Cape and Mpumalanga. Equally, there were supplementary sub-stations within municipal elections offices where the established networked-workstation connectivity was enabled (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

The greatest IBT network had to be strictly watched to ensure that the production and operations continued without any disruption. The Commission deployed various surveillance technologies such as Simple Network Management Protocol (SNNP) and Microsoft Operations Management (MOM) to actively watch over server and network activities. The process permitted the prompt detection of problems and the resolution of any identified challenge. The management team of the Commission also watched its network activities several times in order that trends could be studied and future development could be accommodated before internal capacity matters could arise (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

The next section presents the technology performance and the election outcomes. Typically, sample data between 1994-2009 and 2014-2016 are deployed to demonstrate and envisage final elections results. This approach employs numerous collections of static information and data sources, such as voter registers and dynamic information sources, to develop personal voter scores for every member of the population. These voter scores are used to estimate expected vote counts under different turnout scenarios (Mpekoa 2017: 25-77; Thakur 2015a: 32; Swanepoel *et al.* 2010: 70-77).

3.6.3 **Results Operations Centres**

There were a number of Results Operations Centres (ROCs) created beyond the Commission's premises, and fully-connected to the Commission's network to ensure redundancy and signal duplication (IEC 2014a; Samaranayaka and Premaratne 2019: 385-395). Below is a list of the ROCs which were set up across the country:

- Eastern Cape – Regent Hotel in East London (IEC 2014a: 1-20)
- Gauteng – Renaissance Hall at the SABC in Auckland Park
- KwaZulu-Natal – International Convention (IEC 2014a: 1-20)
- Centre in Durban, Mpumalanga, Free State, Northern Cape (IEC 2014a: 1-20)
- Limpopo – Showgrounds in Polokwane(Samaranayaka and Premaratne 2019: 385-395)
- North West – SABC offices in Mahikeng (Samaranayaka and Premaratne 2019: 385-395)
- Western Cape – International Convention Centre in Cape Town, National Office – Tshwane Events Centre in Pretoria (IEC 2014a: 1-20)
- Disaster Recovery Site outside Pretoria (IEC 2014a: 1-20)
- Results centres were established in all premises of regional offices and at extra office spaces in such a way that the expansion of the network was a Local Area Network within the regional office (IEC 2014a: 1-20; Samaranayaka and Premaratne 2019: 385-395).

3.6.4 **Network Capacity**

Over the past two decades, the number of workstations using VSAT technology has dropped from 426 to 25. As for the remaining workstation, Wide Area Network makes use of high-traffic terrestrial links to bond with VPN-MPLS, enabling the communication signal between 2,000 computers and more than 75-85 servers within more than 250-300 individual sites. The magnitude of the increased volume of transactions required a very large amount of communication capacity across the WAN, particularly for the period of national elections, as a new development to the results system (Gibbon *et al.* 2019: 747-752; Isoe *et al.* 2019:1-12). The scanning of results papers at the scanning points of entrance was the key to embracing the implementation of audited results (IEC 2014a: 1-20).

To guarantee that the key workstations were adequately equipped to communicate with each other when the WAN was under the pressure of load balancing, an additional isolated VPN was used within the MPLS to avoid interference from other non-key stations. The key stations enjoyed an improved redundancy in the form of back-up power from the Uninterrupted Power Suppliers (UPS) and generators, as well as several duplicated telecommunications links which made use of alternative routes to reach the service providers. This made the key stations highly resistant to failure and sustained their continuity in functioning, even if the national grid was down or any of the communication devices and links were damaged (Gibbon *et al.* 2019: 747-752; Isoe *et al.* 2019:1-12).The deployment of VSAT technology for the connectivity of the MEO office was reduced from 68.9% in the 2004 elections to approximately 9.9% during the 2009 elections. In 2007, there was a contract negotiation between the Commission and Telkom to increase the network infrastructure for urban and rural areas (IEC 2014a: 1-20).

3.7 **IBT Systems and Core Elections Management Processes**

Elections technologies are comprised of a number of business applications which seek to support a variety of elections procedures and processes such as polling stations' operations, as indicated and summarised in Section 3.8.1, table 3.1, mainly for managing voters' registration, party and candidate nomination, voting, counting and results capturing (Odeyemi and Abioro 2019: 217-232). Some of the major projects completed in preparation for the 2019 elections are included in the following sections (IEC 2014a: 1-20; Makoza 2019: 950-970).

3.7.1 **Voting Station Operations (VSOs)**

VSOs are some of the systems which have been introduced to enhance previous technologies (Odeyemi and Abioro 2019: 217-232). These systems were built to incorporate GIS maps such that end-users could simply view the exact position of a voting station within the boundaries of a voting district. Such functionality allowed municipal staff to immediately identify voting stations which were located outside the boundaries of a specific voting district (IEC 2014a; Makoza 2019:950-970). Early identification location of such voting stations saved time in the approval process, as people did not waste time proposing venues which were not within the boundaries of a voting district (Odeyemi and Abioro 2019: 217-232).

3.7.2 **Voter Registration (VR)**

The Electoral Commission (IEC) has been carrying out a commendable job in ensuring free and fair elections, however certain stakeholders are complaining about voter registration details (Russon 2017: 150-165). In its recent judgment in Kham and Others versus the Electoral Commission and Another, the Constitutional Court declared that, in future, when registering a voter to vote in a particular voting district, the Electoral Commission is obliged to obtain sufficient particularity of the voter’s address to enable it to ensure that the voter is, at the time of registration, ordinarily resident in that voting district(Russon 2017: 150-165).The IEC must also, in all future municipal elections or by-elections, provide all candidates in municipal elections, on the date on which they are certified, a copy of the segment of the national voters roll to be used in that ward in that election, including the addresses of all voters where the addresses are available(Russon 2017: 150-165).This ruling was made because the voters roll did not contain the addresses of voters as required by electoral legislation and it has cast a shadow on the credibility of elections in South Africa (Russon 2017: 150-165).

Adding addresses to the voter register is not only a laborious exercise but also very costly (Russon 2017: 150-165). For developing countries with limited resources, this is a major challenge (Maundeni 2017: 21-28). From the above discussions it is clear that the solution to the problem of the voters roll lies in amending the legislation to remove the requirement of addresses in the voters roll (Russon 2017: 150-165). This would be the quickest and most cost-effective manner in which to correct the voters roll and improve its technical accuracy. Other options include using modern technology, such as geographic positioning systems (GPS),to accurately locate addresses. This would require a very large outlay of resources, because it would require door-to-door visits to capture addresses. In many places such as informal settlements and rural areas, officials would have to create the addresses on the GPS platforms in order to capture the exact address name on the voters roll. This is indeed a mammoth task (Russon 2017: 150-165).

It may be the time to review the traditional paper voters roll used during elections; perhaps it will be replaced by an electronic voter register which functions like a speed paypoint located at the voting station (Russon 2017: 150-165; IEC 2013:1-22). The voter's identity card or book is scanned and a slip is printed and issued to the voter, who then presents it to an official who files it away before issuing a ballot paper. This would provide the paper trail regarding which political parties have been concerned. Should the electronic register be used at the voting station, this would allow the ballot paper to be replaced with an electronic voting machine, as is the current international trend (Russon 2017: 150-165; IEC 2013: 1-22).

(a) Organisation of Voting Station for Election Day

Voting consists of many activities from the delivery of ballots, ballot boxes and other equipment to putting the seal on all paper ballots allocated to a polling station. Moreover, the organisation of voting places for special votes requires additional equipment and particular skills from the staff. For electronic voting, setting up the voting place is no less complicated. For an E-voter, the voting place is the voting application through which a voter casts a vote. However, the supporting infrastructure, without which E-votes could not be cast, includes: an electronic ballot box (which is a vote storage server), a vote forwarding server and the log server (Russon 2017: 150-165; IEC2013: 1-22).

(b) Process of Voter Identification

The process of voter identification differs significantly for the different voting procedures. During election day, voter identification occurs based only on the printed voters list. During advance voting, those polling places allowing voters from outside their place of residence (county centres) conduct voter identification with the help of the electronic voter registers which are updated daily (Colomer 2016: 1-3). Therefore, such voting locations must have computers with access to an updated electronic voter register. For voter identification in I-voting, the voter identifies himself/herself with an ID card used via a card reader in the voter application. Based on the information retrieved from an ID card, the voter application gives a voter an appropriate list of candidates. To cast a vote, a voter places a digital signature onto the ballot. Alternatively, identification may be completed with the help of digi-ID or mobile-ID (IEC 2014a: 1-20).

In South African elections, the voters queue outside the voting station entrance on voting day, and their names are checked against the voters roll as they enter the station using an ID card. Voters can vote only in the area in which they are registered to vote. A voter's thumb is examined under an ultra-violet scanner for traces of the indelible ink which is applied to everyone who has voted, to prevent voters from voting more than once. The voter then receives the ballot paper with a list of all the registered political parties contesting the elections. Alongside each party name is the photograph of its leader, the party's logo, and a block in which the voters can make their mark – this is depicted in Figure 3.2, which presents a sample of a ballot paper used in past South African elections (IEC 2014a).

Each voter enters a private cubicle to cast a vote. A voter is allowed to make only one mark on the ballot paper for the party of his/her choice. Any visible mark inside the box on the ballot paper is acceptable as long as it shows the voter's intent and does not transcend the box. Some Muslim voters in the

Western Cape have also objected to the use of a ‘Christian’ cross as the preferred mark on the ballot paper. A mark anywhere else spoils the ballot paper and nullifies the vote. After making a choice, voters deposit their ballot papers in a sealed ballot box and leave the station. Once the voting stations have closed, the process of counting the votes begins.

(c) Processing Votes

Processing the votes is the least complicated activity for election day voting, as all votes are stored in ballot boxes, and no additional steps are required before the count. In contrast, processing votes cast during advance voting requires transportation of the votes from outside the Voting District (VD) to the appropriate VD/County/National Elections Commission. For this purpose, votes should first be sorted according to their VD. This process also requires delivering votes belonging to this VD. Processing E-votes takes place with the help of an electronic ballot box. All other activities associated with it, such as removing the information on a voter from a vote, take place during the counting process (IEC 2014a: 1-20; Mpekoa 2017: 66-68).Figure 3.3 illustrates the voting process during elections in South Africa.

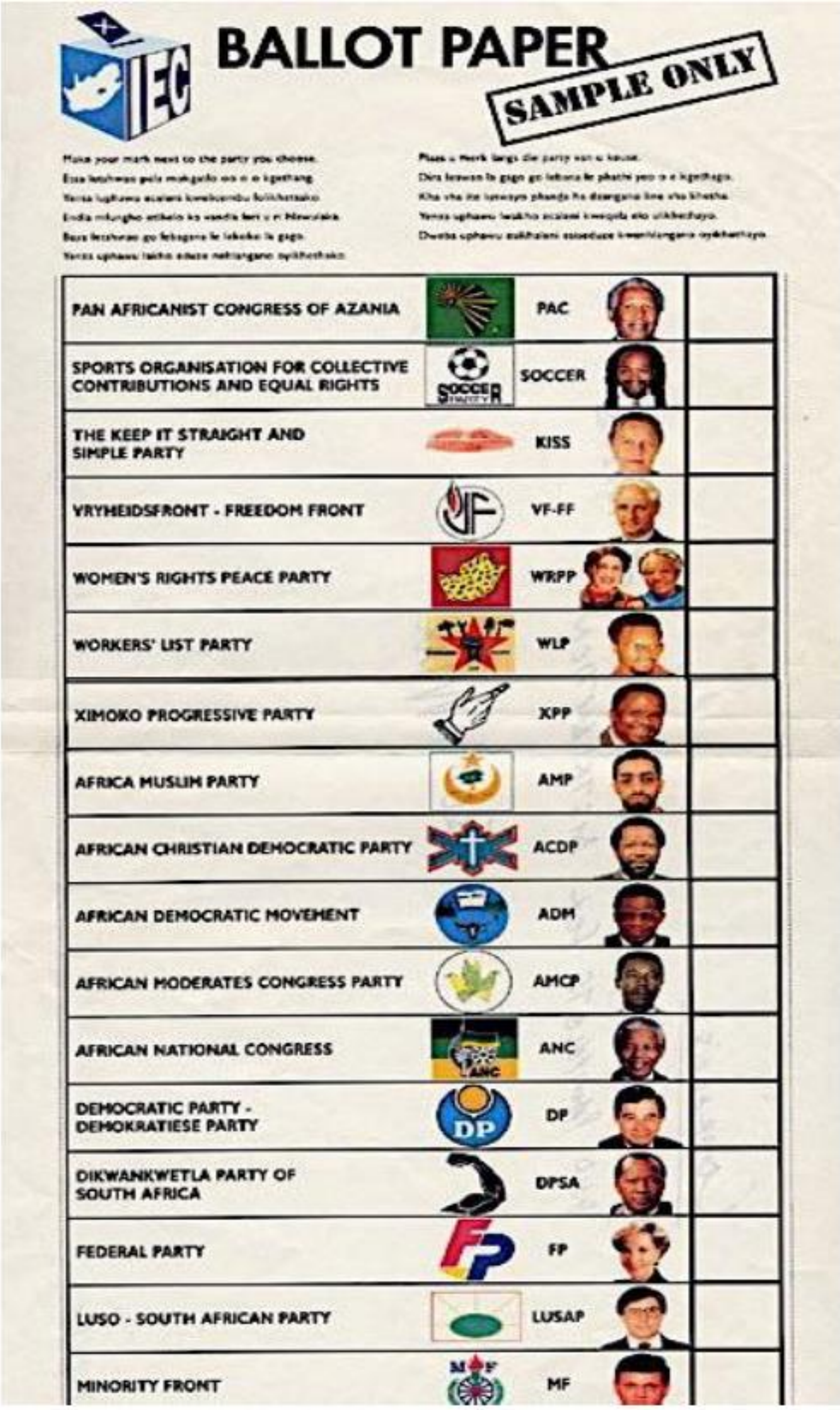


Figure 3.2 Sample Ballot Paper in the South African Voting Process (IEC 2009: 1-3).

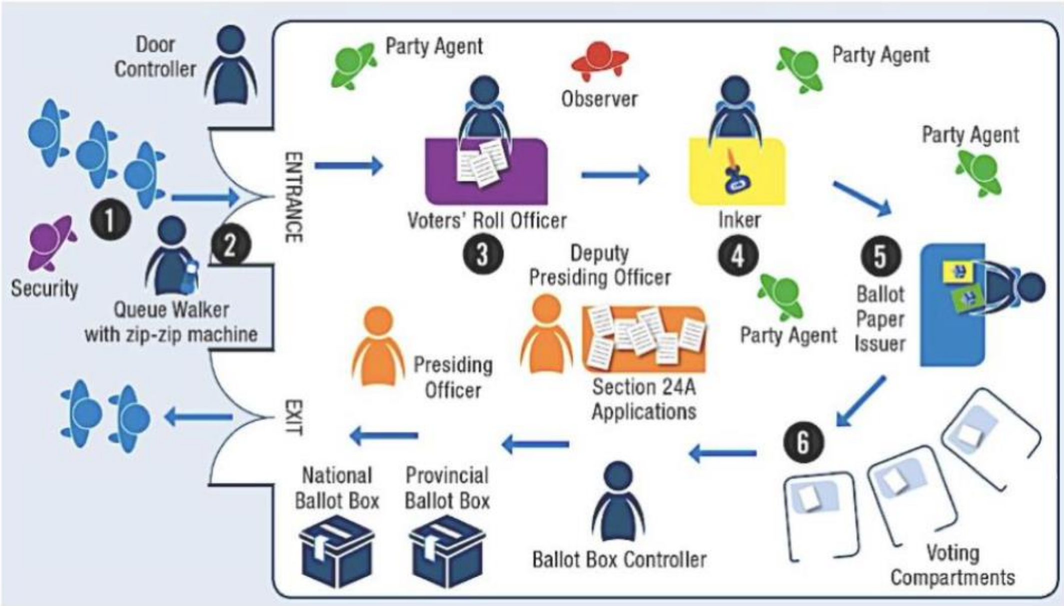


Figure 3.3 South African Voting Process (IEC 2009: 1-3).

3.7.3 **Supply Chain Management**

The procurement of election materials such as ballot papers, ballot boxes and stationery is an immense logistical challenge for the Commission and can have a very large impact on the successful delivery of elections. The Commission must ensure that every voting station has been supplied with the necessary material required for the voting process. To support the procurement of the material needed, the Logistics Information System (LIS) has served as a materials requirements planning tool (Struwig, Roberts and Vivier 2011: 1122-1138; IEC 2014a: 1-20).

3.7.4 **Elections Staff Recruitment**

As part of the preparations for the elections, the Commission appointed more than 220,000 election staff who worked in each of the 19,726 voting stations (Struwig, Roberts and Vivier 2011: 1122-1138; IEC 2014a: 1-20). The ESS was used to manage the recruitment process by providing election staff appointment functionality and related reporting. To facilitate the payment process, the ESS was enhanced to integrate with SAP. Through the use of flat files, the ESS was able to integrate with SAP, thus ensuring that the details of all the people captured on the ESS and who had signed attendance registers were transferred to SAP for payment. The payment functionality was also used for the registration staff and field workers who worked on the elections democracy education projects (IEC 2014a; Struwig, Roberts and Vivier 2011: 1122-1138).

3.7.5 **Candidate Nomination**

As part of the election timetable, political parties had to submit lists of candidates for the elections in which they wanted to contest. To support the nomination process, a newly-revamped Candidate Nomination System (CNS) was used (Jewitt 2019: 129-149). The system allowed the management to track all exceptions linked to the nomination of candidates. These exceptions included missing documentation, candidates on multiple party lists and outstanding payments (Yang and Gelb 2019: 2-29). The capturing of party lists on the CNS culminated in the publication of all party lists in the major newspapers throughout the country. The publications allowed ordinary members of the public to raise objections against candidates who appeared on the respective party lists (IEC 2014a).

3.7.6 **Special Votes**

In 2013, the Constitutional Court ruled that all South Africans living abroad who were registered voters had the right to vote (Russon 2017: 150-165; Tran 2019: 127-149). In a very short space of time, the Commission had to respond by establishing a process to capture requests from overseas voters who wanted to vote on election day. To support this process, a Special Votes Application Request (SVAR) system was developed in less than a week (Tran 2019: 127-149). The system allowed data-capturers to capture the details of all overseas voting applications which were sent to the Commission. Upon capturing of the ID number, the system was able to automatically verify whether the applicant was on the voters roll. Using the data captured on the system, the Commission was able to generate voter lists which were sent to the different missions throughout the world (Tran 2019: 127-149). The Commission website was also modified to allow voters abroad to track the status of their applications (IEC 2014a: 1-20).

3.7.7 **Voter Participation Systems**

In addition to the voter registration application, the IT team was also involved in the design and testing of the voter participation application loaded on the zip-zip scanners. On election day, all voter IDs were scanned using the voter participation application loaded on the scanners. Each scanner was loaded with the entire voters roll (Jefferson 2017: 1; Mattes and Richmond 2014: 1-3). Election staff could therefore easily identify people who were registered at other voting stations and they could easily be directed to their correct voting stations. For voters who arrived at their registered voting stations, the application played a critical role in the management of queues. Once their IDs had been scanned, the voters were given a sequence number which they handed to the voters roll officer (Pazhyanur 2015: 1-8). The sequence number made it easy for the officer to find the voter on the voters roll. Capturing the ID numbers of people who had voted on election day also helped the Commission to understand the demographics of the people who had voted. Demographics such as age and gender will allow the Commission to design more targeted campaigns in the area of voter education and communications (Jefferson 2017: 1; Pazhyanur 2015: 1-8). In addition to this, the Commission will now better understand patterns in the voting times and when the peak numbers of voters arrive to cast their votes (Struwig *et al.* 2015: 1-15; Schulz-Herzenberg 2014: 1-5).

3.7.8 **Elections Results Capturing System**

The NPE results system was enhanced to incorporate lessons learned from the 2006 municipal elections, including the verification of data accuracy. To better handle exceptions such as high voter turnouts and party votes' variance, voting districts were categorised in the NPE results system according to the registered voter population. Categorising voting districts ensured that unnecessary exceptions were avoided by setting different thresholds for the different voting district categories (Krimmer 2019; Zukerman 1925: 45). The exceptions played a major role in detecting errors and ensuring that corrections were applied before the publication of results.

In addition to this, the system was also modified to streamline the edit window process. Instead of capturing edit windows using paper forms and faxing these forms for approval, the system was changed to accommodate online edit window requests and approval of edit windows (Krimmer 2019: 45). Approvers at the provincial and national levels received SMS notifications every time a request was captured on the system. The reporting module was also modified to provide multiple reports which played a critical role in the management of elections (Zukerman 1925: 45). Political parties and the media were also able to use these reports to track election results (United States Election Assistance Commission 2017: 2-15; Jefferson 2017: 1). All the reports were developed using the latest reporting technology which integrates with the data warehouse (United States Election Assistance Commission 2017: 2-14; Jefferson 2017: 1).

The counting process for election votes has been described in Section 2.8.2 of Chapter 2 and is depicted in Figure 3.3 in Section 3.7.2(c) of this chapter.

3.7.9 **Interconnection with the Elections Register**

The current IEC-SA setup has no electronic collaboration between the voters roll and the manual voting process, which means that the verification of a voter's identity is a core concern in assessing the suitability of an IBT solution which addresses these processes. As noted below, most E-voting systems are a hybrid combination of manual and automatic processes (Krimmer 2019: 421-426; Zukerman 1925: 45). In many cases, the process of voter identification continues to be a manual activity. To integrate the two systems normally requires technological upgrades to be made to the voter registration system, such that it 'interlocks' with the E-voting system (Song and Tang 2010: 8-10). Furthermore, a major factor in the integration of these processes is considering whether to allocate a voter to a specific polling place to cast a vote (Krimmer 2019: 421-426; Zukerman 1925: 45).

3.7.10 **Transparency and Elections Observation**

Observers play a critical role in ensuring the credibility, freeness and fairness of an election (Cheeseman and Klaas 2018: 3-241). In South Africa, observers, both domestic and international (African Union Commission, EISA, Carter Centre, European Union, The International Foundation for Electoral Systems (IFES)), are accredited in terms of Section 84 of the Elections Act of 1998, as amended in 2003 and 2013. Observers are required to abide by and observe the Code of Conduct for Accredited Observers (Iwuoha 2019: 89-113). All accredited observers, both domestic and international, are issued with certificates of accreditation and identity cards to ease access at the voting stations. One impact of adopting any IBT solution is the lack of transparency associated with the polling exercise for elections observers (Nganje and Nganje 2019: 1-22). Without invasive techniques, the process can become opaque for elections observer groups, which may cause criticisms of the process. The IEC is allowing elections observer groups and other interested groups to conduct independent audits of the elections results systems prior to polling and after polling. Moreover, most elections observer groups usually bring their own independent ICT auditors. In some countries, this transparency concern has been a principal argument for retaining manual systems (Nganje and Nganje 2019: 1-22).

3.7.11 **Results Slip Scanning System**

Transparency plays a major role in ensuring the integrity of election results. To ensure transparency, a results slip scanning module was introduced on the NPE results system for both the 2009 and 2014 elections (IEC 2013: 1-11). All the original results slips were scanned using a packaged solution which was customised to meet the business requirements of the Commission (Tran 2019: 2). Political party representatives and the media were able to view the scanned image of each result slip and compare it with the data captured on the NPE results system. Both the 2009 and 2014 election results of each voting district were not made available on the system until the corresponding result slip image was available for viewing (IEC 2011a: 1-20). As part of the solution, more than 300 desktop image scanners were procured and distributed to the respective capturing sites (Venkataraman *et al.* 2019: 101-248). The scanning software was also rolled out to more than

300 capturing sites, ensuring that each site had at least two desktops loaded with the scanning software (Krimmer 2019: 421-426).

3.7.12 **Results Slip Generation**

To enable the scanning of results slips, a barcode solution was introduced. Each result slip was generated with a barcode which could be easily read by the scanning software (Krimmer 2019: 421-426). The barcodes ensured that human errors were limited, as users were only expected to type the voting district number in exceptional cases where the barcode could not be read by the scanner. Automatic reading of the barcode also eliminated the possible bottleneck which could have been caused by manual capturing of the voting district number. To ensure that all barcodes could be read by the scanning software, the team liaised with Lithotech (one of the printing companies) which produced the results slips (Contorer *et al.* 2019: 102). A scanner and desktop loaded with the scanning software was deployed at the printing site (Krimmer 2019: 421-426). The printing company was expected to scan a sample of each batch which they had printed to ensure that the barcode was readable.

3.7.13 **Issue Logging**

As part of the Commission's objective to ensure free and fair elections, political parties and the media were allowed to raise any issues relating to the elections (Krimmer 2019: 421-426; Gopee *et al.* 2019: 449-460; Hara 2019: 203). To support this process, the Issue Tracker allows all stakeholders to raise any election-related issues such as irregular procedures and unfair treatment by the IEC officials. The system was modified to allow political parties to log in. All parties were provided with a username and password to log into the system. Using the login credentials, political parties could keep track of all the calls which they had logged (Gopee *et al.* 2019: 449-460; Hara 2019: 203). The system also made provision for political parties to reopen closed calls should they not be happy with the resolution of the respective call (Oke *et al.* 2019: 88-105).

3.7.14 **Geographic Information Systems (GIS)**

The Constitution of South Africa (Seventeenth Amendment Act 2012) stipulates that all elections in the country (i.e. national, provincial and municipal) must be based on a national common voters roll (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370). In order to achieve this, citizens who are aged 16 and above should apply for registration as voters at a place where they are ordinarily resident such that their names are geographically linked to the appropriate segment of the voters roll. The Elections Act (No. 83 of 2013) therefore provides for the creation of voting districts, where one voting district has one voting station and represents one segment of the national common voters roll. Voting districts are also designed to be administrative and not political groupings (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370). GIS technology has been used since 1997 as an effective tool for the delimitation of voting districts (VD) and the plotting of voting station (VS) locations (Amillo *et al.* 2018), as depicted in Figures 3.4 and 3.5.

The Municipal Demarcation Board (MDB) reviews and prepares the municipal boundaries before elections commence (Municipal Demarcation Board 2016: 1-2). The MDB plays a key role in the process. The elections system provides for the election of ward councillors, and it is the responsibility of the MDB to delimit within which wards councillors can be elected. There are different stakeholders involved, for example, the IEC will divide the national voters roll into municipal segments. The number of registered voters is then used by the national minister responsible for local government, to determine the formula for the number of councillors for each municipality. This is carried out in terms of Section 20(3) of the Structure Act, 2013

Figure 3.4 Satellite Image showing Voting District Boundaries (IEC 2014a: 1-20; Amillo et al. 2018: 63-76).

The Electoral Commission's GIS section is primarily responsible for spatially maintaining, enhancing and ensuring the integrity of the voting districts and associated voting stations, and producing thousands of maps in support of the delimitation and voter registration processes. As a secondary responsibility, the GIS section provides spatial management reporting maps and customised GIS software solutions to assist the other units in the Commission with election planning, logistics planning and progress monitoring, registration reporting and results presentation. Many additional supporting datasets are maintained, which include aerial and satellite images, cadastral information, topographic information, GPS information and geo-referenced physical address data. With respect to images, the country had some coverage in 2007 but at the moment it is 100%. With the increasing availability of images at higher resolutions, delimitation revisions for the 2009 elections included the realignment of voting district boundaries where identified (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370).

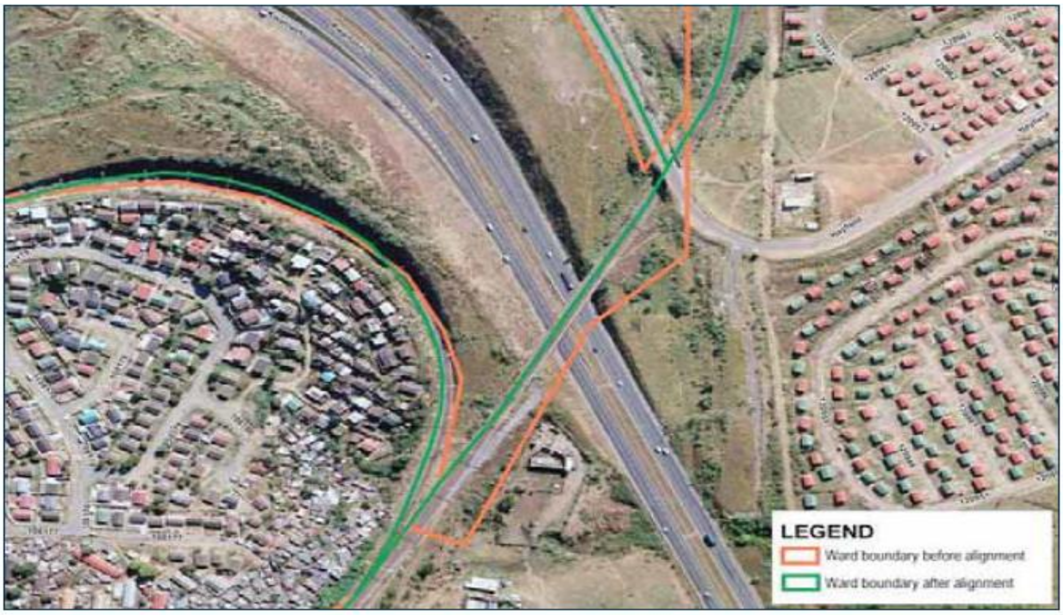


Figure 3.5 Satellite Image showing Ward Boundaries (IEC 2014a: 1-20; Amillo et al. 2018: 63-76).

Newly-acquired image datasets played a vital role in revealing discrepancies in both the IEC business layers (VD and VS) and layers from the MDB ward and municipal areas (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370). Each dataset was subjected to extensive checks, comparisons and impact analyses before voting districts were amended and incorporated into the corporate geographic database. Municipal orientation maps were produced and not only used at municipal offices, but published in local newspapers to help voters to locate the nearest voting station and the correct one based on their registration details for the 2009 elections (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370).

Spatial management reporting maps were once again widely used to track projects, analyse processes and display information in a vivid visual format (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370). For example, maps were used to depict voter registration patterns after general registration events, track staff appointments, determine distribution strategies for zip-zips and notify users of voting station locations. Spatial information was also made available through GIS software over the internal IEC intranet – a local restricted communication network within a secured private network using

World Wide Web software (GIS-on-Desktop) and the Internet (web VS Finder) – as depicted in Figure 3.6 (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370).

The mapping facility was also used extensively to display results and progress maps at the national Results Operations Centre and the nine Provincial Results Centres. The Commission further provided a number of spatial datasets to News24 and SABC for implementation of their GIS-based results reporting systems (Mazeka *et al.* 2019: 57-88; Opiyo 2019: 347-370). The services offered included:

- Dissemination of results reports, delimitation information and distance calculations to the IEC-SA's various offices
- Interactive electronic maps to facilities for checking whether voting station coordinates were inside or outside the intended voting district
- Helping citizens to view their correct voting stations via the "*Where do I register/vote*" facility on the Internet (web VS Finder), as depicted in Figure 3.6.

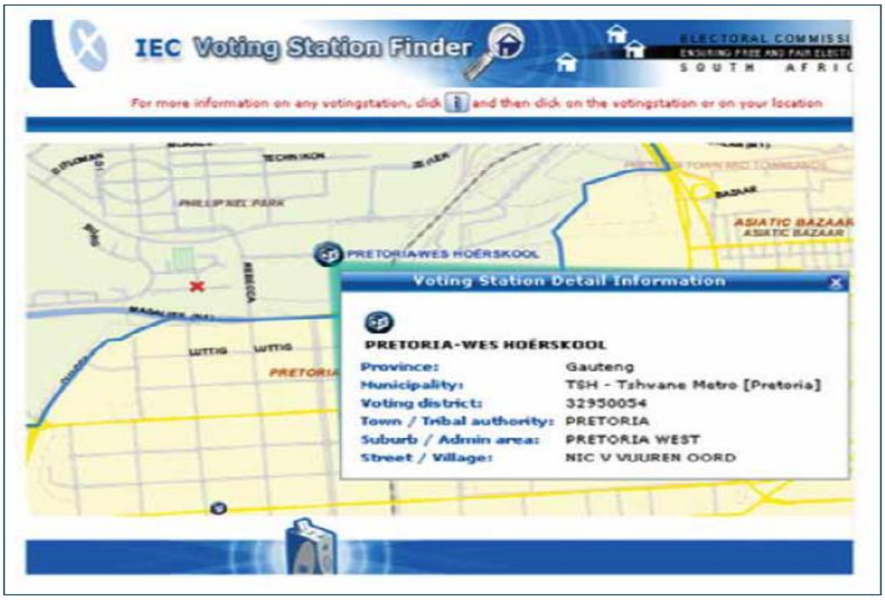


*Figure 3.6 Locating a Voting Station by using GIS Software and the Internal IEC Intranet (IEC 2014a: 1-20; Amillo et al. 2018: 63-76).*Public IEC Website

Mangcu (2015: 159), with reference to the 2019 elections, states that it is known locally and globally that the IEC relies on the media and the Internet to disseminate information to the voters. Likewise, research evidence suggests that the media (both traditional and the Internet) can help to increase voter participation by not only providing citizens with information to make informed decisions, but by stimulating interest in elections (Tolbert and Mcneal 2003: 176).

Applications on the website were increased to provide additional services to the public in preparation for the elections. There were several controversies surrounding the 2019 national elections, which spread like wildfire on social media, but in the end, the 2019 elections were judged to be free and fair by the Electoral Commission South Africa (IEC 2019: 1). The chairperson of the IEC endorses this position while agreeing that technology brings with it both solutions and challenges. The IEC seems to be endorsing the view that the voter experience is important, as election management bodies around the world seek to incorporate ever-more technology into the electoral process (IEC 2019: 1).

During the 2019 elections, two main factors had an impact on the IEC controls, namely Section 24 of the Electoral Act, and the replacement of the green bar-coded ID documents with smart ID cards. Section 24A of the Act allows one to vote at a place which is not one's registered voting station, for example, if one is sick and in hospital, or for emergency and other personnel who are working on voting day. Section 24A exists because it is supremely important to allow all citizens to exercise their right to vote (IEC 2019: 1).Another factor at play has been the growing use of smart ID cards to replace the green bar-coded ID book. On the latter, IEC officials could place stickers to show that a person had voted, but this is not so with the smart card version.

The IEC website was effectively used as a communication and marketing channel. Over and above general elections processes and procedures, services included (Shi and Yuan 2019: 91-96):

- Frequently-asked questions

- Voter registration information (where one can go to be registered, where one is registered to vote)
- Voting Stations Finder
- Publication of results
- Downloadable Commission forms and reports

3.7.15 **Disaster Recovery and Business Continuity**

The Commission's Disaster Recovery (DR) site was relocated due to continuous power outages at the previous site (McMurray, Cross and Caponecchia 2019: 486-499). The new site was designed for DR hosting and had sufficient redundancy in place to deal adequately with any unforeseen eventualities. All critical systems were identified and replicated onto the DR site and secure servers (McMurray, Cross and Caponecchia 2019: 486-499). These systems were kept up to date through replication via high bandwidth data lines between the national offices and the DR, as well as through frequent restores(McMurray, Cross and Caponecchia 2019: 486-499; Miller and Engemann 2019: 25-72). This provided the Commission with a system which could be brought online within an hour or two of a disaster during the election period, thus making sure that the election results could be announced within the specified period (McMurray, Cross and Caponecchia 2019: 486-499; Miller and Engemann 2019: 25-72).

3.8 **Election Cycle Components and Technology Application**

Well-run and credible elections which reflect the will of the people are critical events, but they fit into a larger election cycle which needs to be kept in mind. Ideally, an election cycle starts at the end of one election and runs through the beginning of the next election. It consists of three basic phases: pre-elections preparations, elections operations and post-elections strategies, as presented in Figure 3.7 in Section 3.8.1. This shows how each phase can link to potential IBT activities via the election cycle (Presser *et al.* 2019: 27-57; Thakur and Millham 2018: 1-16). Using an election cycle perspective may allow better identification of needs, including urgent short-term requests, and facilitate advance planning. ICT systems evolve very rapidly as compared to the duration of an election cycle. Most ICT equipment, both hardware and software, has a useful life of about three to five years. After this period, equipment needs to be either replaced or significantly refurbished and upgraded. For election ICT applications, this can pose a significant challenge. With many election cycles lasting for approximately four years, an ICT system which has been successfully deployed for one election can be expected to require major upgrades or even a complete replacement for the next election.

The significance and justification of enhancing elections in Gauteng using the latest technologies have not been questioned. However, gaps have arisen in terms of the legislation, including the constitution; the efficiency of EMBs; the procurement cycle; and the cost of maintaining technology within the three phases of the election cycle. The key issue here is whether any technologies are covered by relevant provisions within the South African legislation, which would ensure that any envisaged changes are legitimate and legally compliant(Maphunye 2019: 9-11).

3.8.1 **Factors influencing Adoption of IBTs for all Stages of Election-Cycle Processes**

Chapters 2 and 3 have established what elections management processes and IBTs entail, based on a survey of the existing literature. This section looks at additional factors which should be considered when making a decision on adopting the use of technology in elections within the South African context, and on a larger scale, in elections of other developing countries. Figure 3.7 provides a visual and comprehensive illustration of the core elections management processes and Internet-based technologies between pre-election, the actual elections phase and post elections phases (Presser *et al.* 2019: 27-57; Thakur and Millham 2018: 1-16; Shamos and Yasinsac 2012: 16-17).

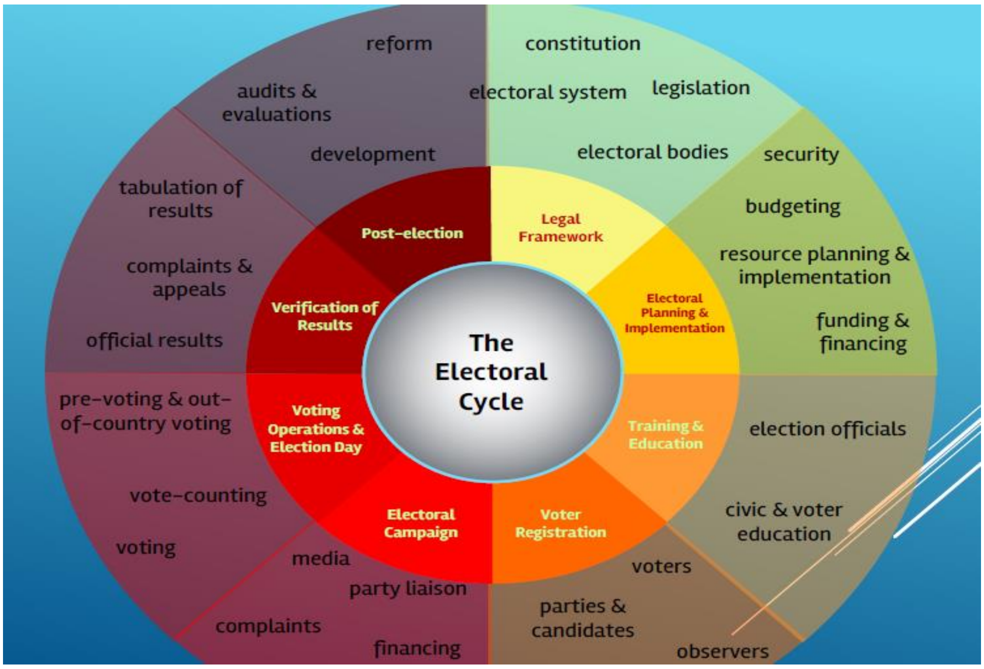


Figure 3.7 Election Cycle Components and Technology Application (IDEA 2014a: 1-30).

The first factor which must be taken into account is "how capable is the organisation in terms of technology", as this will drive the organisation's ability to utilise and support complex technologies (Nolan 1979: 2). An organisation moves through different stages as their ICT capability, utilisation and management requirements mature (Nolan 1979: 2), that is, the maturity of an organisation with respect to ICT is significant for the effective utilisation of its purpose. Determining an organisation's IT capability is referred to as capability maturity modelling (Dlamini and Mpekoa 2017: 17-19).

The second factor which must be taken into account involves the risks associated with a technology. Table 3.1 presents the core elections applications and relevant description and functions. Furthermore, Table 3.1 covers common information and communication technologies which have been increasingly used and which play a critical role in South African elections in Gauteng (Mpekoa and Kogeda 2013: 2-9).

Table 3.1 Summary of IEC-SA Elections System (IEC 2014a: 1-20).

Core Elections Applications	Description and Functions	Period used	Hardware/ Software/ Performance Improvement Tool
Online voter register verification system	Voter registration validation with GIS support	2009–2019	LAN cabling
Online candidates and nomination systems	Ballot paper generation and illegibility of candidates and self-service nomination for members of political parties	2009-2019	LAN switching equipment including wireless Apps
Elections results systems with new enhancement of exceptional management case, scan-results slip system and streaming	Results systems with double blind entry processes from voting stations	2009- 2019	Internet connections
Issue tracker	Incident reporting system	2009 - 2019	Internet subscriptions Monthly subscriptions Annual subscriptions
Voting operating systems	Profiling voting station	2009- 2019	Windows Server 2012 (application server, file server, database server, web server) Server hardware Server software licenses Annual maintenance
Voter participation	GIS linked system with smart reports to provide real-time data	2009- 2019	Helpdesk software and licenses Annual maintenance
SMS text	Smart text data collection and validation	2009- 2019	Email software/system and licenses annual maintenance, Microsoft Office software licenses Annual maintenance, Antivirus software licenses
www.elections.org.za	Featured with popular social media networks, elections reports and voter check registration status	2009- 2019	Backup devices and storage, offsite backup maintenance
Civic and education event management system	Voter and civic education programs	2009- 2019	Cyberboom unified threat management, network protection firewall and security device, annual maintenance/cooling systems
Mobile application system	Allows the voter to check registration status using the application (Figure 3.1)	2009– 2019	Desktop computers, multi-function printers
API system	Data aggregation and analysis	2009– 2019	Laptop computers, cameras and scanners

Many researchers such as Thakur and Singh (2013: 41-54) and Mpekoa (2017: 105) have identified new risks which are associated with the use of mobile devices during elections. IBT systems can be faced with several issues, which could be a contributing factor for their success or failure; some of these factors are listed below: **Lack of security:** Software attacks on the system (worms, viruses, bugs etc.), attacks on the communication infrastructure (Denial of Service, Domain Name Service attack, etc.) (Thakur and Singh 2013)

- **Lack of privacy:** Voters might not get the privacy which they need in order to cast their votes at home or outside the boundaries of election officials (Ayo *et al.* 2007)
- **Political instability:** A lack of political support and consensus might lead to unrest (Okediran *et al.* 2011)
- **Lack of transparency:** Voters are not aware of how the system essentially casts, sends and tallies the votes, and the whole process is usually not visible to the eye (Pallav *et al.* 2012)
- **Unreliable communication networks:** Mobile networks in Africa are mostly unreliable and still need development – this service is the core service for the success of an IBT system project (Ekong and Ayo 2007)
- **Trust in the system**: Due to a lack of security and transparency, this might lead to a lack of trust in the entire M-voting system (Pallav *et al.* 2012; Ekong and Ayo 2007)

3.8.2 **Acceptance and Adoption of Technology**

Desktop computers, hand-held devices, mobile phones, emails and the use of the Internet have become a central part of today's culture and society. These technologies play a vital role in people's day-to-day operations (Kogeda and Mpekoa 2013). Achieng and Ruhode (2013) conducted a study on E-voting technologies. Their study attempted to explore the challenges of the current elections process, and to determine the factors which could influence the adoption and diffusion of E-voting technologies within the South African context. The findings reveal that factors such as the availability of ICT enable the infrastructure and resources, the digital divide, and trust in technology – awareness of the technology and environment could influence the adoption of E-voting in SA (Mutula and Mostert 2010: 28-53).

The research conducted by Van Belle and Cupido (2013: 1-21) sought to investigate and determine the level of interest in South African youth for interacting with the government via their mobile phones. The study discovered that the performance expectancy construct relating to the convenience of using the mobile device and the effort construct of the user's proficiency, together with the device, were significant drivers for the intention to participate in M-government (Oyedemi and Mahlatji 2016: 311-323; Rampa 2017: 3-10; Tracey 2016: 1-56). They also discovered that there is some interest in voting by using mobile phones – although voting via the mobile phone is likely to be controversial, with concerns over secrecy, privacy and trust. According to Mpekoa(2017),a total of 16 major factors which might affect the adoption of IBTs, were identified (Mpekoa 2017: 206-241):

- Desire to reduce election costs
- Desire to make elections more efficient
- Desire to prevent election fraud
- Desire to speed up election results delivery and desire to improve audit capability
- Desire for improved transparency
- Availability of funds and technology literacy of staff
- Availability of in-country technology expertise
- Lack of supportive infrastructure and lack of technical expertise by local officials
- Perceived risks with regards to technology
- Political interference
- Flexibility and effective management of EMP's complexity
- Limited error/error-free operations

3.9 **Current Policy Direction regarding the Use of Electronic Voting for the IEC**

The Electoral Commission South Africa has several challenges and issues with electronic voting (Thakur 2015a: 32). These challenges include securing the resources necessary to effectively control and manage the evaluation and/or development process, as well as a clear mandate from political and election stakeholders for the IEC to be solely responsible for the management of the process. This latter feature has become increasingly prominent, as competition among private-sector vendors of E-voting technologies has led to aggressive methods for introducing their products into new markets (Mensah 2016: 780-786; Achieng and Ruhode 2014: 1-55, 2013: 1-12; Kogeda and Mpekoa 2013: 1-4).

The circumstances in the South African election context are not notably peculiar to those in other countries; electronic voting requires corresponding amendments in a number of areas – several of which may be outside the sole purview of the IEC-SA, as argued by Thakur (2015a: 32) and Mpekoa (2017: 235) – including the elections law; the laws governing the rules of evidence (how evidence may be presented before a judicial body); investigative capacities; regulations and procedures for dispute resolution; the structure, staffing and core competences of the elections authorities; the voter registration process; the candidate/party registration process; the training of elections officials; the regulations for elections observers; and the tabulation and announcement of results.

There are many claims associated with electronic voting, such as that it increases voter turnout or improves security (Gefen *et al.* 2005: 54-78; Zissis 2014: 1-5; Kersting 2012: 134-151; Schulz-Herzenberg 2014: 189-208). However, there are few statistical studies of the impact of these systems on the elections process and on corresponding political practices (Little and Rubin 2019). Moreover, there is little evidence at this time to support claims that a particular technology will have the same impact in one country as it does in another (Kale and Bhosale 2015). Thus, as with the process of election reform in general, the value and benefit of E-voting should be measured against the unique circumstances in which it is being proposed. There is a need for the IEC to continue making efforts to consulate election stakeholders; moreover, it necessitates dedicated programmes of consultation (with political parties and civil society) and a broad process of voter and civic education (Gefen *et al.* 2005: 54-78; Zissis 2014: 1-5; Kersting 2012: 134-151; Schulz-Herzenberg 2014: 189-208).

3.10 **Summary**

The ultimate test of any elections technology process is the confidence and acceptance of the electorate and political competitors that it will provide a fair and accurate result. Thus Chapter 3 has examined elections management processes and technology interventions in Gauteng, and lessons learned for future improvements, especially regarding the effectiveness of technology in safeguarding democratic elections.

There are three key areas where IBTs can improve elections processes and procedures, and where the voting process can harness next-generation technologies to support more secure, efficient and cost-effective voting: voter registration, supported by advanced biometric-based voter registration, accurately enrolling and geo-locating voters in real time and automatically updating the voters roll; voter identification at polling stations, using biometric-based identification to authenticate voters and automatically check them against the voters roll; and voting, using biometric identification to log on to a portal or terminal and electronically casting a vote. E-voting allows for near real-time tallies and highly-effective election monitoring.

As it is now, some of the current elections procedures and practices used were suitable for Gauteng in the 1970s, as the population was manageable, and a few languages were then the official languages in the country (Mpekoa 2017: 85).With effect from 2019, the current population is over 14 million people, and eleven official languages are recognised by the Constitution of the country. Again, the previous study conducted by the IEC (2011: 11) indicates that 59% of the people whom they interviewed showed an interest in the IEC implementing modern innovative technologies for SA. People are looking for a better way of voting , which is currently not fully available. From the same research, 56% of the people also agreed that E-voting is the right way to proceed for South Africa.

The proposed IBT conceptual framework for South African elections will allow the majority of election stakeholders to receive the greatest accuracy in the administrative costs of running elections (Mpekoa 2017: 82-85; Thakur 2015a: 32). The thesis submits that SA neither needs to be concerned nor contrite regarding not adopting IBTs (Iwuoha 2019: 89-113). Gathering information is prudent and necessary, and at best South Africa could amend its law to allow experimentation and give voters a choice to carry out E-voting, using test-run trials or partial implementation, while still holding onto manual ballot papers as the golden standard for any election in parallel, until there is sustained and complete confidence in the E-voting system.

Chapter 4 presents the research methodologies and design for the study.

Chapter 4 RESEARCH METHODOLOGY

4.1 Introduction

Subsequent to a literature review in Chapters 2 and 3, this chapter discusses the study area and the methodology employed in the study. Gauteng was selected as the case example for the study due to its uniqueness and the dynamics of the Internet-based technology used there for both private business and public institutes.

This chapter presents the research design and the methodology utilised in this study. The discussion is based on the research philosophies and paradigms, the research design, the data collection and the data analysis, in addition to the sampling as well as ethical considerations chosen for this study. A pragmatic view was taken, with inductive reasoning as the research approach. This research study employed a case example as the primary research strategy to address the research problem and the objectives. Mixed-method research, using both quantitative and qualitative research techniques and procedures, was utilised.

Sections 4.1.1 and 4.1.2 discuss background information on Gauteng and relevant issues which emerged to be significant for the study.

4.1.1 Research Study Area

The study covers the Gauteng geographic region, which is one of the smallest of South Africa's provinces, covering an area of 18,178 km² or approximately 1.5% of the total surface area of South Africa. It is bordered by the provinces of the Free State, North West, Limpopo and Mpumalanga (Spencer *et al.* 2017: 249-274; Statistics South Africa 2017: 1). Nevertheless, it is highly urbanised, containing the country's largest city, Johannesburg; its administrative capital, Pretoria; and other large industrial areas such as Midrand and Vanderbijlpark. As of 2017, Gauteng is the most populous province in South Africa with a population of approximately 14.2 million people – 24.1% of the national population– according to estimates(Spencer *et al.* 2017: 249-279; Statistics South Africa 2017: 1;

South African History Online 2013). It is the powerhouse of South Africa and the heart of its commercial business and industrial sectors. A map of the Gauteng region, with its longitude and latitude information, is presented in Figure 4.1.

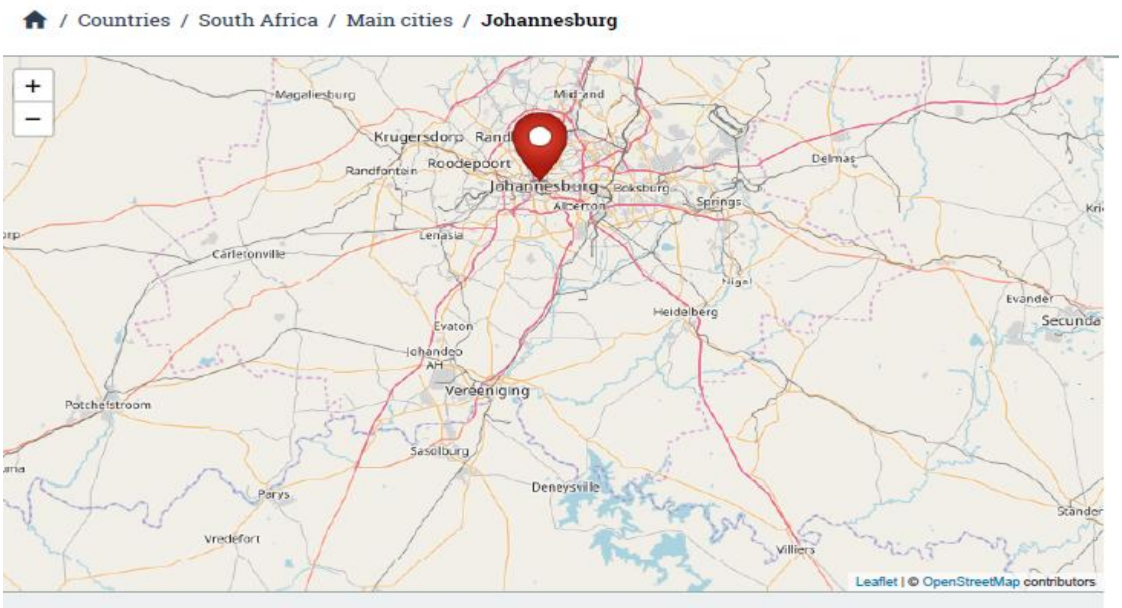


Figure 4.1 Gauteng Map (Source: https://latitude.to/map/za/south-frica/cities/johannesburg).

Gauteng is the powerhouse of South Africa and the heart of its commercial business and industrial sectors. The region has the largest electoral constituency and the Executive officials are housed in Gauteng. The majority of election stakeholders, including the headquarters of the IEC and political parties, are housed in Gauteng. To this end, certain notable e-government services which the administration has introduced include the National Treasury's e-Tender publication portal, a central supplier database, e-Home Affairs and the South African Revenue Services' eFiling system(Mzekandaba 2015: 1-3).

4.1.2 **Gauteng Voting Population**

Gauteng is the fastest growing province, experiencing a population growth of over 33% between the 1996 and 2011 censuses, thus Gauteng now has the largest population of any province in South Africa though the smallest area.

As of the census of 2011, there are 12,272,263 people and 3,909,022 households residing in Gauteng (Statistics South Africa 2017: 1). The population density is 680/km². The density of households is 155.86/km² (Statistics South Africa 2017: 1).

The next section discusses the research ideas and relevant paradigms which are cited as the most influential in the area of information systems development, with particular emphasis on human-computer interactions.

4.2 **Theoretical and Conceptual Framework**

The study is guided by cited theories in the field of Human Computer Interactions (HCI), where researchers observe the ways in which humans interact with computers, and then design technologies (services and products) which allow humans to interact with computers in novel and innovative ways – this is depicted in Figure 4.2. Hence, this study lies within the human-computer interaction domain. The study focuses on how humans interact and associate with Internet-based technologies, with the intention of improving the interactions and thereby providing a more satisfactory experience within the elections domain (Shin 2019: 302-310; Lewis 2019: 1-10). Figure 4.2 depicts that a human's orientation is shaped by the artefact ecology (Klokmose *et al.* 2019: 586-596).

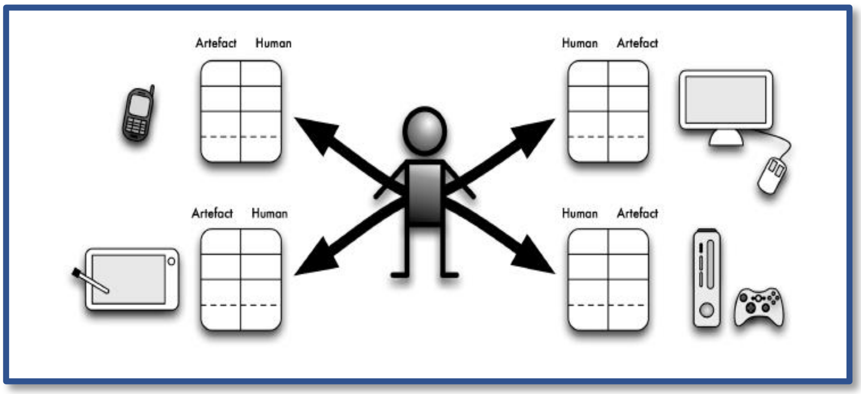


Figure 4.2 Artefact Ecology (adapted from Klokmose et al. 2019: 586-596).

There are several research approaches within the HCI field. This chapter discusses the following approaches: the design science, the traditional scientific, and the engineering approaches. Each research approach is described and explained in the following sections, with the intention of choosing the most appropriate approach for the study.

4.2.1 **Design Science Approach**

Hevner and Chatterjee (2004: 75-105) state that design science research requires the creation of an innovative, purposeful artefact for a specific problem domain. Design science research is therefore a development and performance of artefacts, with the explicit intention of improving the functional performance of the artefact(Hevner and Chatterjee 2004: 75-105; Iivari 2007: 39-64). The artefact must be executed in order to ensure its utility for the specified problem. Offermann and Platz (2009: 11) further maintain that, in order to form a novel research contribution, either the artefact must solve a problem which has not yet been solved or it must provide a more effective solution. Design science research is typically applied to categories of artefacts, including algorithms, human/computer interfaces, design methodologies and languages (Hevner and Chatterjee 2004: 75-105). These artefacts can include constructs, models, methods and instantiations (Offermann and Platz 2009: 11; Von Alan *et al.* 2004: 75-105).

4.2.2 **Orthodox/Traditional Science Approach**

Pather *et al.* (2003: 142-143) describe the traditional science approach as one which gathers quantitative data by using empirical methods for building and evaluating simulation models, based on the observable measurements. The traditional science approach employs a positivist research view. This approach aims to examine how things are, based on the observable facts which can be seen, heard and touched (Peffers *et al.* 2007: 45-47). The researcher collects the data through observations and experiments, and by formulating and testing a hypothesis prior to the empirical enquiry. The human computer interaction field produces knowledge which qualifies the researcher to arrive at deductive and inductive explanations and conclusions regarding the empirical experimental findings, thereby allowing the researcher to understand the relationship between the variables and assisting him/her to predict the outcomes (Peffers *et al.* 2006: 86-106).

4.2.3 **Engineering Approach**

Hussain and Howard (2012: 20) claim that the engineering approach is the amalgamation of concepts from both the design science and the traditional science approaches. In this approach, the researcher observes existing solutions with the purpose of refining them to better solution proposals. The researcher develops a list of possible solutions, which are measured, analysed and evaluated, based on the proposal. The process is repeated until the product is ready for use, and no further improvements are needed(Mpekoa 2017: 23). This approach puts the emphasis on what people effectively do, or what they can do in practice, rather than directing the focus to imaginations of what they are supposed to do.

The approach recommends the combination of case studies, observations and experiments in order to understand the domain of study. The engineering approach considers the social context, and it recognises that not all problems in software engineering are merely technical, but rather that they are human-oriented. Thus, it seeks to understand human-computer-related problems and bring improvements to the way in which humans interact with devices (Hussain and Howard 2012: 20).

The aim of the study, as mentioned in Section 1.3.1 of Chapter 1, is to develop a generic framework to guide the effective and efficient use of Internet-based technologies for elections management processes in South Africa. The thesis work is further influenced by an Artefact Model where technology performance and human behaviour needs to be better understood. The study has developed a comprehensive literature framework, however based on the purpose of the study, the design science paradigm is considered as the best approach to explore it. The following section motivates this decision.

4.3 **Justification for Design Science Approach**

The above theories were selected based on the research questions, as outlined in Section 1.4 of Chapter 1, with the main research question seeking to address the following issue: *What are the components of an effective and efficient framework for EMPs for the implementation of an IBT system within the South African elections context?* However, these theories were used to offer a conceptual and theoretical framework and were therefore not tested or presented for theory testing or development. The rationale for selecting these theories, given the research problem identified, was to offer a conceptual framework but not theory testing due to the sample size of the respondents and the cost of covering the entire Gauteng province.

The problem statement for this study, as mentioned in Section 1.2 of Chapter 1, is an information-system challenge, as it relates to the adoption and use of an information technology artefact by the entire election-stakeholder population within the study area of Gauteng. Offermann and Platz (2009: 11) describe the use of design science in information system research areas, particularly because of the nature of an artefact supporting the hardware, software and the human interface deliverables within information systems. Information systems can be developed by using design science, as it focuses on solving a problem. Hevner and Chatterjee (2004: 75-105) concur by saying that the problems in information systems which are addressed by design science may be those which depend on human abilities to provide effectiveness in the solution, or where the environment is not well-defined and the requirements are not specific(Mpekoa 2017: 23-25).

This research study fits into a situation where both humans and technology are involved and each of them will require a certain level of supervision and guidance; hence HCI is relevant, and in particular, a design science approach is relevant. The design science research guidelines in this study are discussed further in the next section.

4.4 **Mapping Design Science features with Study Objectives**

Design science research guidelines provide an understanding of how to conduct, evaluate, and present design science research (Hevner and Chatterjee 2010b: 1). Peffers *et al.* (2007: 11) refer to the guidelines as the practical rules for conducting design science research. Hevner *et al.* (2004) recommend seven guidelines which need to be followed in a design science research study. Table 4.1 describes these design science guidelines.

Table 4.1 Design Science Guidelines (Hevner et al. 2004: 75-105).

Guideline	Description	Significance to the Study
Design as an artefact	Design science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation	This study developed an artefact in the form of an IBT conceptual framework for the South African election management practice
Problem significance	The objective of design science research is to develop technology-based solutions to solve important and relevant elections services	The conceptual framework will safeguard democratic elections for South Africa and other similar countries within the SADC region
Design evaluation	The utility, quality, and efficacy of a design artefact must be demonstrated rigorously via well-executed evaluation methods	Elections experts and ICT reviews were used to evaluate the framework
Research contributions	Effective design science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations and/or design methodologies	No IBT framework has been developed before, thus this is the study's primary contribution
Research rigour	Design science research relies on the application of rigorous methods in both the construction and evaluation of the design artefact	Appropriate rigorous methods were followed to develop and evaluate the framework, as suggested by Peffers *et al.* (2007: 11)
Design as a search process	The search for an effective artefact requires utilising available means to reach the desired ends, while satisfying laws in the problem environment	Existing knowledge was intensively used and all laws in the subject area were observed at all times during the study
Communication of research	Design science research must be presented effectively to both technology-oriented and management-oriented audiences	The framework was communicated by means of peer-reviewed publications, as well as this thesis

As shown in Table 4.1, the design science paradigm is the most appropriate paradigm to use to answer the research question. The following section presents the various research philosophies and the paradigms.

4.5 **Research Paradigms and Theories**

Patton (1999, 1990) defines a paradigm as a worldview, a general perspective, or just a way of breaking down the intricacy of the real world. A research paradigm is an illustration of a research philosophy. This means that a research philosophy is theoretical, while a research paradigm is practical. Thomas (2010: 291-334) explains the terms ontology, epistemology and methodology as follows:

- Ontology – What is reality?
- Epistemology – How do you know something
- Methodology – How do you go about finding it out

The term worldview as meaning “a basic set of beliefs that guide action” (Guba, 1990,17). Others have called them paradigms (Lincoln & Guba, 2000; Mertens, 1998); epistemologies and ontologies (Crotty, 1998).There are at least four (4) main worldviews: Positivism, advocacy/participatory, constructivism, and pragmatism. The major elements of each position are presented and discussed in Table 4.2.

These four worldviews and their implications for the practice of social research are summarised across six core directions: ontology, epistemology, theories, methodology, tools and sources (Thomas 2010: 291-334).Figure 4.3 explains the terms and the relationships between them.

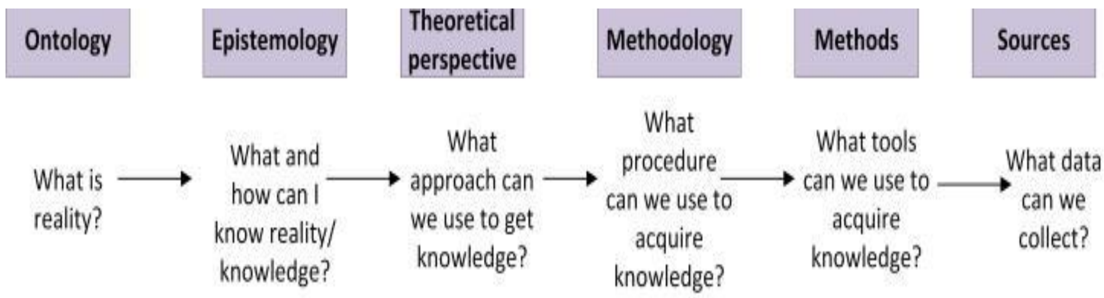


Figure 4.3 Ontology and Epistemology (adapted from Creswell et al*. 2017: 1-85; Crotty 1998: 256).*

Table 4.2 gives the common elements of the four worldviews and is consistent in explaining that a research paradigm is an illustration of a research philosophy(Thomas 2010: 291-334).

Table 4.2 Common Elements of Four Worldviews (adapted from Thomas 2010: 291-334).

Philosophical Elements	Post-Positivism	Constructivism	Advocacy and Participation	Pragmatism
Ontology	Singular reality	Multiple realities	Political reality	Singular and/or multiple realities
Epistemology	Distance and impartiality	Closeness	Collaboration	Practicability
Axiology	Unbiased	Biased	Biased and negotiated	Multiple stances
Methodology	Deductive	Inductive	Participatory	Combining
Methods	Quantitative	Qualitative	Usually qualitative	Quantitative and qualitative
Rhetoric	Formal	Informal	Advocacy and change	Formal or informal

4.6 **Paradigm Research in the Field of Information Systems**

Hevner *et al.* (2004) describe the research paradigm as a framework in which theories are created, which affects how people see the world, determines individual perspectives and forms people's personal understanding of how elements are interconnected. This means that for an individual researcher, ontology and epistemology create a holistic view of how knowledge is viewed and how people can see themselves in relation to this knowledge, as well as the methodological strategies people use to uncover/discover it (Hevner and Chatterjee 2010b: 1-12). Awareness of philosophical assumptions will increase the quality of research and can contribute to the creativity of the researcher (Orlikowski and Baroudi 1991: 1-28).

This thesis considers a research paradigm as a set of common beliefs and agreements shared between scientists on how problems should be understood and addressed. The classification of paradigms depends on how researchers identify the problem and determine the methodology. Many researchers have divided the various research paradigms into many categories. For instance, Hussey and Hussey (2007, 2003) and Creswell (2009) identify four philosophical perspectives on research methodologies: post-positivism/positivism (Creswell 2007: 1-19), interpretivism, advocacy and participatory paradigm, and the pragmatic paradigm. Social researchers have long debated on three philosophical paradigms in order to establish which approach is the most appropriate to choose in order to conduct research. These paradigms are namely positivism, interpretivism, and critical theory (Orlikowski and Baroudi 1991: 1-28; Trauth 2000: 43).

The main assumptions underlying the paradigm of any research study involve methodology, epistemology and ontology (Neuman 2003; Guba and Lincolon 1994). Methodological assumptions are concerned with the approaches used for data acquisition (Creswell 2014: 1-35). Epistemology explains how one obtains knowledge of external reality and how elements can be made known to the researcher (Alsukkar 2005). Epistemological assumptions are concerned with ways of perceiving and acquiring knowledge (Bryman 2001: 5-48).Positivist studies are based on the existence of fixed relationships within phenomena, which are typically explored with a form of structured measurement instrumentation such as surveys or experiments (Orlikowski and Baroudi 1991: 1-28). In the positivist paradigm, the researcher assumes that reality is objectively given and can be described by measurable properties, which are independent of the researcher and his/her instruments (Ravarini 2010: 1-77).

Alotaibi (2017) and Stair and Reynolds (2013) concur that Information Systems (IS) research can employ the interpretive approach, depending on the causal research epistemology (Orlikowski and Boroudi 1992; Myers 2006, 1997).The nature of the interpretive research method is to concentrate on human ideas and actions in the social and organisational situation (Myers 2006). The objective of interpretive research is to combine people's words, documents and observations into a coherent picture expressed primarily through the participants' voices (Trauth and Jessup 2000). In addition, interpretive researchers concentrate on the cultural and historical context (Darke *et al.* 1998) and try to understand phenomena by capturing the meanings which participants assign to them (Orlikowski and Baroudi 1991). The interpretive approach, instead of testing theoretically-deductive hypotheses, allows researchers to make sense of the people and the organisation under study, and to develop a theory via an inductive process which concentrates on the details of the data in order to find the important factors.

The term *triangulation* is drawn from trigonometric laws associated with triangles, where values of one angle can be known if the values of the two other angles are given (Denscombe 2007: 1-70). Triangulation allows researchers to look at research issues from different angles. This means that different methods can be used, different data sources can be utilised, or even that different researchers can join in carrying out one study. Denscombe (2014: 1-45) states that a triangulation method brings additional sources of supplementary information into the research, providing greater insight into the proposed research title. Inadequacies found in single-sourced data would be minimised when multiple sources confirm the same data. Multiple sources would be able to provide verification and validity while complementing similar data, and data which is more comprehensive will be obtained. Data and information are supported in multiple places/types of research, which makes it easier to analyse data and draw conclusions and outcomes. Finally, inconsistencies in the datasets are more easily recognised (Denscombe 2014: 1-45).

According to Alotaibi (2017), studies have shown an interest in combining the qualitative and quantitative approaches, for example, Petter and Gallivan (2004) have emphasised the importance of combining the two approaches, especially in information science research, as this provides a better understanding of the phenomena associated with the adoption and implementation of such systems in different organisational and social contexts.

This combination of positivist and interpretive approaches are appropriate for this study because they enable the researcher to check the accuracy of the findings and to provide a picture of the influencing factors, by comparing information from different sources (Creswell 2007: 1-19).

Thus, this study takes the view that a paradigm is a framework of beliefs and perceptions about the world. In information systems research, there are a number of paradigms which a research study may follow, with reference to ontological, epistemological, axiological and methodological research dimensions (Hevner *et al.* 2004; Krauss and Putra 2005: 758-770). Four of them are positivism, interpretivism, pragmatism and design science research – these are briefly explained in Table 4.3.

Table 4.3 Research Paradigms and their Definitions (Hevner *et al.* 2004; Krauss and Putra 2005: 758-770).

Research Paradigm	Definition
Positivism	According to positivists, reality is stable and can be observed and described from an objective viewpoint, without interfering with the phenomena being studied. They argue that phenomena should be isolated and that observations should be repeatable. Positivists use quantitative research methods, usually in the form of experiments or hypotheses (Hevner *et al.* 2004; Creswell 2013a; Mpekoa 2017).

Interpretivism	Interpretivists argue that only through the subjective interpretation of an intervention in reality can that reality be fully understood. Interpretivists believe that the study of phenomena must be in their natural environment, and they also acknowledge that scientists cannot avoid affecting those phenomena which they study. Interpretivists use quantitative research methods, usually in the form of observation or in-depth interviews (Thomas 2010; Orlikowski and Baroudi 1989; Mpekoa 2017).
Pragmatism	Pragmatics acknowledge that there are several ways of interpreting the world and undertaking research, that no single point of view can ever give the entire picture, and that there may be multiple realities. Pragmatics accept concepts to be relevant only if they support action. Pragmatics use both qualitative and quantitative methods in order to find answers to the research questions (Saunders *et al.* 2009; Cameron 2009; Mpekoa 2017).
Design Science	Accomplished. This involves the design of new innovative artefacts and the analysis of the use and performance of such artefacts to improve and understand the behaviour of aspects of information systems (Hevner *et al.* 2004; Livari 2007; Hevner and Chatterjee 2010).
Research Paradigm	Accomplished. This involves the design of new innovative artefacts and the analysis of the use and performance of such artefacts to improve and understand the behaviour of aspects of information systems (Hevner *et al.* 2004; Livari 2007; Hevner and Chatterjee 2010).

This study uses mixed methods for triangulation in order to secure in-depth understandings of the phenomena in question. Triangulation allows researchers to compare the findings of one method with findings of another method. One advantage of using triangulation in the social sciences is that the outcomes of one method can be corroborated or criticised through comparison with the findings of another method. Moreover, the findings of one research method can be complemented by something new and/or different, deriving from the findings of another method. The next section describes the overall research process which was adopted to address the main research objective.

4.6.1 **Research Process**

Mpekoa (2017: 28) argues that a good research design is one which is based on well-thought-out and thorough research questions and objectives, and which provides a systematic plan to answer those research questions (Mackey and Gass 2015: 48-58). It allows the researcher to answer the research questions precisely and categorically. Saunders *et al.*(2009)

recommend six layers to guide a research design process: research philosophies, approaches, strategies, choices, time horizons, and the data collection and the data analysis. As explained earlier, design science is the research paradigm which is used in this research study. The following sections explain each of the remaining layers as they relate to design science research.

4.6.2 **Design Science Process Models**

In previous sections, the study defined design science research and the goals it should pursue, as well as the practical rules (guidelines) which provide guidance for conducting and justifying it. However, principles and practice rules are only two out of the three characteristics of a methodology (Peffers *et al.* 2007). A procedure which provides a commonly-accepted process for carrying it out is omitted. Design science research process models are used to establish a research base and to contribute to the augmentation of the knowledge base through scientific investigation (Offermann and Platz 2009). Multiple design science process models have been proposed (Vaishnavi and Kuechler 2004; Peffers *et al.* 2006; Pries-Heje and Baskerville 2008). It is worth noting that these different process models vary in the number of phases, but all the approaches accomplish the same solution of designing an artefact. In general, these phases can be placed into three major categories, namely: problem identification, systems/solution design, and evaluation. Table 4.4 gives a comparative analysis of the phases among four design science process models.

Table 4.4 Comparative Analysis of Design Science Process Models (Peffers et al. 2007: 11).

Phases	Takeda *et al.* (1990)	March and Smith (1995)	Nunamaker *et al.* (1991)	Vaishnavi and Kuechler (2004)	Peffers *et al.* (2007)
Problem Identification	Enumeration of problems		Construct a conceptual framework	Awareness of the problem	Identify the problem
Systems Design	Suggestion	Build	Develop a system architecture	Suggestion	Define the objectives

	Developm ent		Analyse and design the system	Developme nt	Design and development
Build the System					
Demonstration					
Evaluation	Evaluation to confirm the solution	Evaluate	Observe and evaluate the system	Evaluation	Evaluation
	Decision on a solution to be adopted			Conclusion	Communication

On a close collaboration and comparative analysis of selected design science process models established by March and Smith (1995), Vaishnavi and Kuechler (2004) and Peffers *et al.* (2007), a common ground was established in the approaches adopted for problem identification, solution design and evaluation. It is important to note that different process models' approaches remain the same in accomplishing a solution to designing an artefact. This study would also like to be part of this important observation.

The research adopts the research process originally developed by Peffers *et al.* (2006: 83-106) and recently used by Mpekoa (2017: 30-35), as depicted in Figures 4.4(a, b & c). The most interesting features are the research objectives and the subsequent research questions which passed the iterative phases of identifying problems, motivations, defining the objectives of a solution, design and development, demonstration, evaluation and communication.

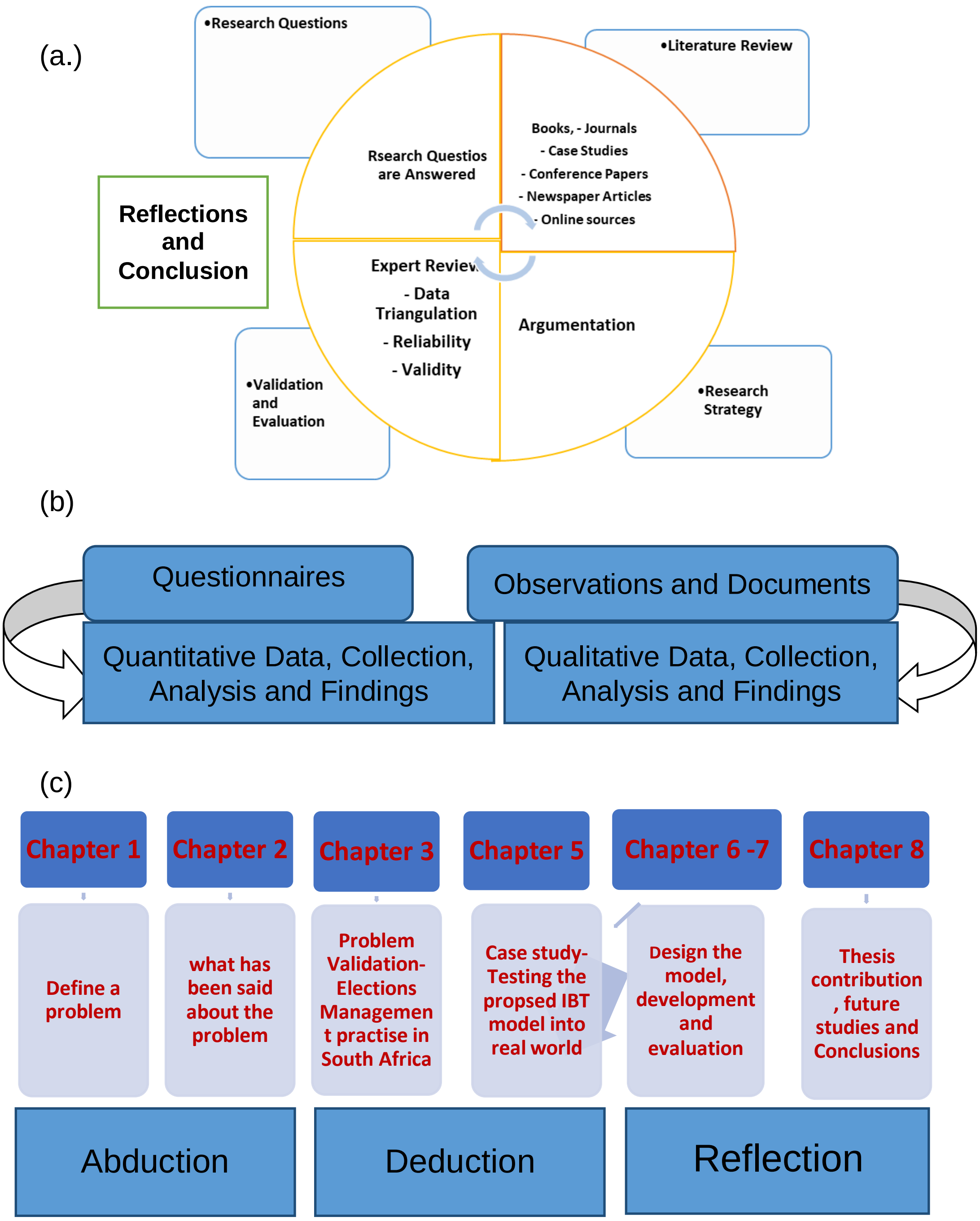


Figure 4.4 (a, b, & c) Research Design Process (Peffers et al. 2006: 83-106).

The following section presents the research approaches and the strategies which can be used to attain the research objective.

4.6.3 **Research Strategy**

A research strategy according to Saunders *et al.* (2007: 610) is "a general plan of how the researcher goes about answering the set of research questions that have been set." It gives the overall direction of the research (Babbie 2013; Creswell 2014: 1-20). Saunders (2011) suggests that the best way to select an appropriate research strategy is based on the research questions and objectives of the study, the level of existing knowledge in the subject area, the resources and the amount of time available, as well as the philosophical underpinnings of the researcher. Yin (2003, 1989a, 1989b) mentioned that researchers may adopt several strategies to approach their research.

In this study, a pragmatism paradigm is adopted, which originates from the work of Peirce*et al.*(Jonker 2009). It was recently cited and used by Mpekoa(2017: 23-28). The study further follows a pragmatic paradigm as a reliable philosophy detailed in Section 4.13.2.

4.6.4 **Research Approach**

There are two primary approaches which are associated with research (Trochim 2016: 1). These are the deductive and inductive research approaches. A research approach guides the researcher to make inferences about the findings and to draw meaning from the results (Saunders *et al.* 2009). Reasoning is the process of using one's existing knowledge to draw conclusions, make predictions or construct explanations. Figure 4.5 depicts the two research approaches as identified by the deductive and inductive logic phases (Heit and Rotell 2010: 805; Trochim 2016: 1).

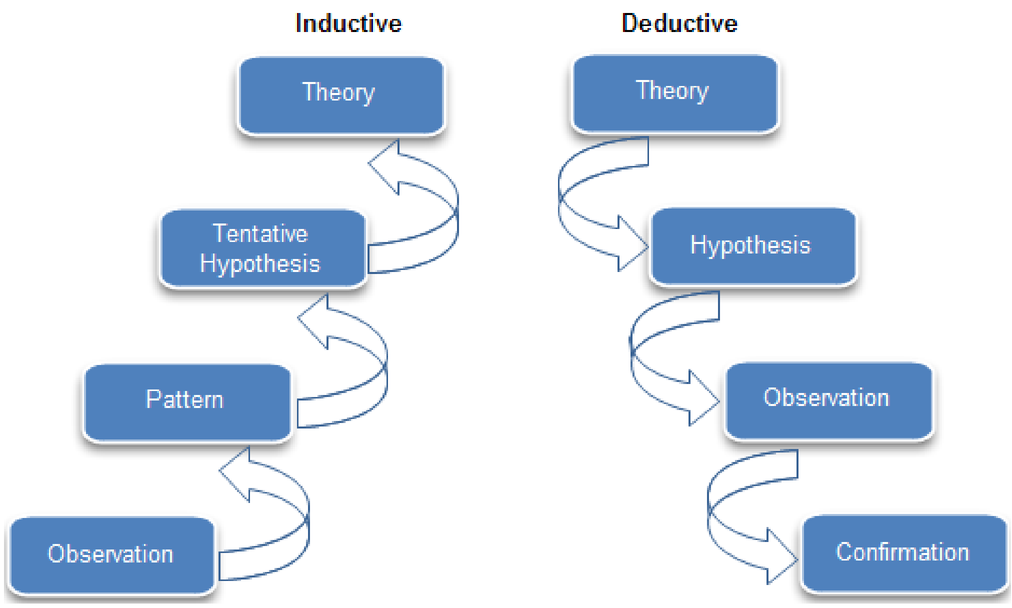


Figure 4.5 Deductive and Inductive Logic Phases (Heit and Rotell 2010: 805; Trochim 2016: 1).

According to Trochim (2016), deductive reasoning works from general to specific. The researcher develops a theory and hypothesis, which are tested by empirical observations**.** Figure 4.5 also shows that deductive reasoning creates a hypothesis to test a theory against the data, whereas inductive reasoning involves the discovery of a pattern or dataset, in order to generate a theory (Mpekoa 2017; Swanepoel 2012). This study follows a deductive reasoning approach. The thesis work begins by engaging theories where secondary data was collected. The study then identifies cited topics and analyses them in order to explain the contribution of the proposed IBT model. The validation of the proposed solution is conducted through literature, questionnaires and expert reviews.

4.7 **Stating the Research Problem**

Africa's elections require constant innovations and improvements to deliver credible results which enjoy wider acceptance and universal legitimacy, yet the introduction of new voting technologies, IBTs (including EVTs), is not widely-accepted and remains a contentious subject among EMBs, politicians, voters and citizens alike. Some of these stakeholders either publicly oppose or promote the use of IBTs or EVTs, although there are those who tend to adopt one of these two polarised positions based on the objective conditions and technology available in their countries (Maphunye 2019: 11). However, the sensitive question which is normally very difficult to answer with a definite ‘yes’ or ‘no’ by the main role players is whether such technologies can guarantee fool-proof security mechanisms which will counteract any hacking, double or multiple voting, and fraud, thereby safeguarding the secrecy of the vote (Maphunye 2019: 11).

The research gap from the existing body of knowledge suggests limitations in terms of the use of technology, specifically ICTs, in elections (Adesida 2001; Ajayi 2013; Aker and Mbiti 2010; Allers and Kooreman 2009). A synthesis of previous related studies shows that African EMBs are slowly utilising technologies. This motivated the objectives of the present study, but with specific focus on the EMB officials who have first-hand experience in the running of elections in their countries. Previous studies conducted by Mpekoa (2017), Hapsara *et al.* (2016),and Ayo and Azeta (2009) have revealed that there is no elections management processes framework model to guide all elections stakeholders on the use of Internet-based technologies for South African elections.

This is an information systems problem, as it relates to the acceptance and use of information systems artefacts by all the electioneering stakeholders. Offermann and Platz (2009) describe the use of design science in information system research areas, particularly because of the nature of an artefact supporting the hardware, software and the human interface deliverables within information systems (Mpekoa 2017). Hevner and Chatterjee (2004: 75-105) concur by stating that the problems in information systems which are addressed by design science may be those which depend on human abilities to provide for effectiveness in the solution, or where the environment is not well-defined and the requirements are not specific. Information systems can be developed by using design science, as it focuses on solving a problem.

The aim of the study is to develop a generic framework to guide the effective and efficient use of Internet-based technologies for elections management processes in South Africa. The primary research question and sub-questions have been discussed in Section 1.4 of Chapter 1.

4.8 **Mixed Methods Research**

Mixed methods research is a growing area of methodological choice for many academics and researchers from across a variety of discipline areas. The mixed methods research design is a mixed procedure for collecting and analysing the data by using both quantitative and qualitative research methods to investigate the research problem (Bergman 2008: 1; Creswell 2014: 1-21). The mixed methods research design involves philosophical assumptions which guide the direction of the collection and the analysis of the data, and it comprises the mixture of qualitative and quantitative approaches in the research process (Morse 2010: 229-244; Teddlie and Tashakkori 2011: 285-300). Mixed methods research provides more comprehensive evidence for studying a research problem than either quantitative or qualitative research alone.

The research methodology adopted for the thesis work is a mixed methods research design. Studies qualified that qualitative understanding corrects quantitative knowledge by pointing out new directions which might have been neglected (Morse 2010: 229-249; Creswell and Clark 2011: 107-143).

The study adopted the pragmatism paradigm for the mixed methods research design (Morse 2010: 229-244; Creswell and Clark 2011: 19-53), which is used as the research process for this thesis.

4.9 **Time Horizon**

There are two major choices with regards to the timing of the research, i.e. choosing between the cross-sectional design and the longitudinal design (Thomas 2010; Orlikowski and Baroudi 1991; Creswell 2014: 1-22, 2003). In comparing these choices, Table 4.5 presents the advantages and disadvantages of the cross-sectional and longitudinal designs.

Table 4.5 Advantages and Disadvantages of Cross-sectional and Longitudinal Studies (Mpekoa 2017: 23).

Time Horizon	Advantages	Disadvantages
Cross-Sectional Design	Relatively inexpensive and takes little time to conduct	Difficult to make causal inference
	Can estimate prevalence of outcome of interest because sample is usually taken from the whole population	Only a snapshot: the situation may provide differing results if another time-frame had been chosen
	Many outcomes and risk factors can be assessed	Prevalence-incidence bias
	There is no loss to follow-up	
Longitudinal Design	Helpful in determining patterns	Timeline which is completely dependent on respondents
	More data over longer periods of time allow for better and more concise results	It takes much time to collect all the data which is needed
	High in validity	Can be very expensive

In general, the research should drive the design, but sometimes the progression of the research helps to determine which designs are the most appropriate. Cross-sectional studies can be carried out more rapidly than longitudinal studies. This is why researchers might start with a cross-sectional study to first establish whether there are links or associations between certain variables. They should then set up a longitudinal study for cause and effect (Creswell 2014: 1-22, 2003). The next section presents the research tools and techniques which could be used for data collection.

4.10 **Research Tools and Techniques**

4.10.1 **The Literature Review**

The literature review is defined as an important summary and assessment of the existing body of recorded work dealing with information produced by other researchers (Yin 1989b: 1-6), scholars and practitioners in a given field (Davidson 2004: 1-21). A literature framework is informed by the key thesis research question. Denscombe (2010: 232) posits that a literature framework is not merely a gathering of loosely-related studies in a field, but in fact represents the background and the research developments related to a specific research question (Saunders 2011), interpreted and analysed by one in a synthesised way. Davidson (2004: 1-21) describes a literature framework in this list, with relevance to the researcher's topic:

- An examination of what has already been written (Elsheikh 2011)
- A collection of published research by recognised scholars and researchers (Myers 2006)
- A way for a researcher to examine what has already been done regarding the research question or problem (Neuman 2006)
- A summary and synthesis of research driven by a guiding concept(Labuschagne 2003; Pope and Mays 1995)
- Provides a background of a research problem and a rationale for a research project
- A literature review is not a research paper

4.10.2 **Expert Reviews**

An expert review is a process where experts and practitioners within a particular field are given an opportunity to offer feedback and input into the research study (Stufflebeam and Webster 1983: 1; Tory and Moller 2005: 8-11). This process aims at obtaining information from an informed perspective of valued experts. An expert reviewer is an evaluator who uses his/her perceptual sensitivities, past experiences, refined insights and abilities to assess an object and effectively communicate his/her assessments (Stufflebeam 2000). An expert review is carried out with the aim to identify issues pertaining to design in any product, and to identify specific areas where these issues occur. In an expert review, the reviewer brings in his/her expertise in a given substantive domain, and also sometimes his/her personal choices or bias (Tory and Moller 2005: 8-11).

4.10.3 **Questionnaires**

A questionnaire is a research instrument consisting of a series of questions and other prompts for gathering information from the respondents (Mackey and Gass 2015). Almost everyone has completed an online or paper-and-pencil questionnaire, hence it is the most widely-used data collection method

(Teddlie and Tashakkori 2011). Although questionnaires are frequently designed for statistical analysis of the responses, this is not always the case. Mackey and Gass (2015) state that a questionnaire provides a quantitative or numerical description of trends, attitudes, or opinions of a population, by studying a sample of that population.

4.10.4 **Pilot Testing**

Pilot testing, also known as a feasibility study, is the trial-run or pre-testing of research instruments to prepare for the complete study. Validity and reliability are key aspects of all research. Meticulous attention to these two aspects can make the difference between good and poor research and can help to assure that fellow scientists accept it as credible and trustworthy (Mackey and Gass 2015). Saunders (2011) states that the validity and reliability of collected data depend on the design of the questions, the structure of the questionnaire, and the diligence of the pilot testing. Mackey and Gass(2015) state that a pilot test enables the researchers to determine how well their questions and instructions are understood.

Pilot testing also allows the researcher to reduce non-sampling errors, such as interviewer bias and mistakes, non-response problems, design flaws in questionnaires, as well as data-processing and analysis errors. In part, these non-sampling errors are reduced through pre-testing, which allows for careful testing of the survey questionnaire and the procedures (Driscoll 2011: 153-174).

4.11 **Sampling Technique and Sample Size**

Mack *et al.* (2005) note that in most cases, it is impossible to collect information from all members of a target population of a research study. In such a case, a sample of a population is used to collect the data, which can then be generalised. A sample is defined by Fraley and Hudson (2014) as a subset of a population or universe. Sampling is a technique for defining research populations. It should be noted that there are widely-recognised constraints when selecting research participants. These include budget, time and accessibility (Morse 2010; Matthews and Ross 2014).

Sampling techniques include probability sampling and non-probability sampling (Saunders *et al.* 2009; Matthews and Ross 2014; Morse 2010; Myers 1997).Probability sampling is sometimes called random sampling. The researcher is aware of the possibility of selecting each member of the population. Probability samples can be rigorously analysed to determine their possible bias and probable error, and they are the only type of samples where the results can be generalised from the sample to the population. In non-probability sampling, sometimes called non-random sampling, the chance of being included in the sample is not known (Morse 2010; Myers 1997; Fraley and Hudson 2014).

Non-probability sampling is useful for researchers to achieve the particular objectives of the research, and they do not allow the study's findings to be generalised from the sample to the population. Qualitative research uses non-probability sampling, as it does not aim to produce a statistically-representative sample, or to draw any statistical inferences (Matthews and Ross 2014).

Notably, a phenomenon need only appear once in the sample. The choice to use probability or non-probability sampling depends on the goal of the research (Morse 2010). The probability and non-probability sampling methods are included in Table 4.6, and Figure 4.6 illustrates sampling techniques.

Table 4.6 Sampling Techniques: Advantages and Disadvantages (Morse 2010).

Technique	Description	Advantages	Disadvantages
Simple random	Random sample from whole population	Highly representative if all subjects participate; the ideal	Not possible without complete list of population members; potentially uneconomical to achieve; can be disruptive to isolate members from a group; time-scale may be too long; data/sample could change
Stratified random	Random sample from identifiable groups (strata), subgroups, etc.	Can ensure that specific groups are represented, even proportionally, in the sample(s) (by gender) by selecting individuals from strata list	More complex, requires greater effort than simple random; Stratified must be carefully defined
Purposive	Hand-pick subjects on the basis of specific characteristics	Ensures balance of group sizes when multiple groups are to be selected	Samples are not easily defensible as being representative of populations as the results of potential subjectivity of researcher
Snowball	Subjects with desired traits or characteristics give names of further appropriate subjects	Possible to include members of groups where no lists or identifiable clusters even exist (drug abusers, criminals)	No way of knowing whether the sample is representative of the population

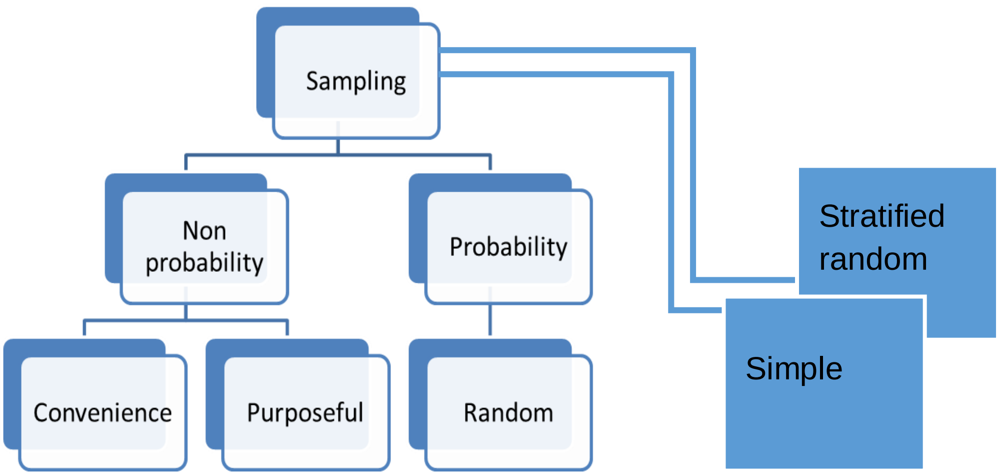


Figure 4.6 Sampling Techniques

This study adopted more than one sampling technique as a result of the size and nature of the study.

4.12 **Data Collection**

A questionnaire containing a combination of 33 qualitative and quantitative (Likert scale) questions was distributed to 500 participants who attended IESA and IEC meetings over a period of three months. The questions sought to elicit responses on the participants' understanding and use of IBTs, including ICT in general.

Each study participatory group was given more than three representatives, at least two officials (male and female), according to the requirements of IARS of ensuring 'gender balance' among the participation. However, a few participants were represented by more than two participants. The data collection process entailed explaining the nature, aim and ethical requirements of the study to all the participants before the commencement of the study, usually in a meeting rooms hall, it was within the approved appointments by the EISA board room and IEC board room, which was facilitated by the IEC officials, EISA and the researcher. Thereafter, they were given assurances that the research was being conducted for academic research purposes, based on DUT ethical principles aimed at protecting respondents in such studies. Furthermore, the participants were informed that they had the right to refuse to participate in the study, or to withdraw at any time during the study should they feel to do so. The participants were also informed that they did not have to state their biographical information, to avoid being identified in the study.

The data for this study was collected twice a year (March to June, and October to December) continuously between 2016 and 2018 at both IEC and EISA offices where the participants normally attended meetings and training workshops for the 2016 local government elections and preparation for the 2019 national elections. They were usually based in Pretoria and Johannesburg for about two weeks before they returned to their respective duty stations. Among the participants were also a few representatives of CSOs such as media groups, human rights organisations and other interest groups from across Gauteng and other South African provinces. An average group was made of eight people in a board room, and participants usually comprised 15-30 persons of different cultures, races, age groups, political orientations and world outlooks. Each board room meeting lasted, on average, for approximately three hours of interactive sessions between the election stakeholders and the research teams from DUT. Such diversity made the relevant discussions robust as they were characterised by active engagement on any election-related subject matter which was discussed. This study used five tools to collect data – these are discussed in the sections which follow.

4.12.1 **The Literature Review**

The review of the relevant literature helped the researcher to analyse the respondents' views in a purposive sample, as stated earlier. Evidence from several studies elsewhere in the world suggest that the difficulties faced by African countries in the use of IBTs and any voting technologies are not new and have been researched extensively (Allers and Kooreman 2009; Alvarez *et al.* 2013; Enguehard 2008; McGrath 2011; Roseman and Stephenson 2005; Schaupp and Carter 2005; Smith and Clark 2005; Tolbert and Mcneal 2003).

According to Team ET and van Zyl Slabbert (2003: 12-86), South Africa presently votes according to a PR system which features a pure list system of one national list (for 200 seats in a 400-seat National Assembly) and nine provincial lists (for another 200 seats, with the length of provincial lists varying according to the population size of the nine individual provinces) with no minimum threshold for parties to gain representation beyond the vote required to win one seat (Maphunye 2019: 11; Southall 2004: 154-165; Walther 2001: 1-75; Matlosa 2017: 1-15, 2008: 2-8; DDP 2019: 1). Overall, there is no doubt that this system has served South Africa remarkably well

(Maphunye 2019: 11; Southall 2004: 154-165; Walther 2001: 1-75; Matlosa 2017: 1-15, 2008: 2-8; DDP 2019: 1).

According to Diamond(2010: 69-83), few, if any, developments in recent decades have more profoundly transformed politics and civil society than the emergence of digital information and communication technologies (ICTs) (Maphunye 2019: 11; Southall 2004: 154-165; Walther 2001: 1-75; Matlosa 2017: 1-15, 2008: 2-8; DDP 2019: 1). Prominent among these have been the Internet and the sprawling blogosphere which it has spawned; the proliferating array of social media tools such as Facebook, Twitter, YouTube, and Flickr; and the galloping growth in access to these digital media through mobile phones(Diamond 2010 cited in Diamond and Plattner 2010: 1-12).

The above observations by Diamond and other scholars underscore the changes which have affected and now influence the political dynamics of contemporary societies, especially elections (Matlosa 2004: 3-10). Given such observations, it may be stating the obvious to proclaim that elections require constant innovations and improvements to be able to produce legitimate and accountable public representatives for all governance levels across the world (Maphunye 2019: 11; Southall 2004: 154-165; Walther 2001: 1-75; Matlosa 2017: 1-15, 2008: 2-8; DDP 2019: 1).

The main purpose of a literature review is to guide the building of a conceptual framework upon which the research is based (Davidson 2004: 1-21).The information above attests that the researcher conducted a literature review which helped to investigate and understand the challenges and weaknesses of the current elections system in South Africa. The current ICT trends were used to improve the elections processes and the institutional, legal and regulatory frameworks of the elections process. This assisted the researcher in developing a framework for the successful implementation of IBTs in South Africa (Davidson 2004: 1-21).

4.12.2 **Observations**

Conducting research can be challenging, and it requires a researcher to be neutral and unbiased towards his/her own research (Driscoll, 2011: 153-174). However, it is almost impossible for a researcher to distance himself/herself from the research (Driscoll, 2011: 153-174).The researcher must have a particular stance, as this represents the point of departure for the research (Driscoll, 2011: 153-174). The first observational study involved the 2009 and 2014 presidential elections within Gauteng using the paper-based system. The researcher observed and recorded information from 8 November 2018 to 15 November 2018, concluding the elections with a holistic description of the events and the behaviour of the participants. The observation helped the researcher to understand the current advantages and disadvantages of South African election technologies.

As suggested by Driscoll (2011: 153-174), the researcher did not participate in any of the election activities, but indulged in informal conversation and interaction with the members of the study population. This formed part of the method and it was recorded in the field notes. As with any other research method, observations have strengths and weaknesses. It is largely up to the researcher how to make up for the weaknesses. Table 4.7 summarises the strengths and weaknesses of observational study.

Table 4.7 Strengths and Weaknesses of Observations (Mpekoa 2017: 38).

Strengths	**Weaknesses**
Allows for insight into contexts, relationships and behaviour	Time-consuming
Can provide information previously unknown to researcher which is crucial for project design, data collection and interpretation of other data	Documentation relies on memory, personal discipline, and diligence of researcher
	Method is inherently subjective

4.12.3 **Focus Group Discussions**

Focus groups are panels facilitated by a moderator. They meet for a specified time period to exchange perspectives, knowledge and/or opinions on a particular topic (Davidson 2004: 1-20; Driscoll 2011: 153-174). Creswell *et al.* (2011: 1-18) further explain a focus group as a diligently-planned discussion intended to obtain in-depth perceptions on a defined area of interest in a non-judgmental and non-threatening environment. Focus groups can uncover a wealth of detailed information and obtain deep insights. When well-implemented, focus groups create an accepting environment which puts participants at ease, permitting them to thoughtfully answer questions in their own words, and to add meaning to their answers (Creswell *et al.* 2011: 1-18).The following steps are advisable when conducting a focus group:

- STEP 1: Define the purpose, i.e. the objectives of the focus group
- STEP 2: Establish a timeline
- STEP 3: Identify the participants
- STEP 4: Generate the questions
- STEP 5: Develop a script
- STEP 6: Select a facilitator
- STEP 7: Choose the location

On 8 November 2018, a team of researchers left the DUT campus to join a focus group discussion for the study of IBTs in Gauteng. The team was based in Gauteng for four days, covering both EISA focus group discussions and IEC focus group discussions at the IEC headquarters. The team was composed of four field researchers, of whom two were female and two were male, involving a combination of Black, Indian, White and Coloured. The study decided to use the English language from the planning stage to the final stage of delivering reports for data collection.

Focus group discussions were conducted to discover detailed impressions, ideas and concepts about factors which might influence the successful implementation of IBTs in SA from the election stakeholders. However, as presented in Table 4.8, there are five(5) focus groups with a maximum of eight people participating in each group. The number of people participating (eight) was large enough to provide a diversity of opinions, but also small enough to give all the participants an opportunity to express their opinion (Mackey and Gass 2015). The (five(5) groups were: the Electoral Commission (IEC) officials, NGOs, observer groups, the media, electorates, the legislative house, and political parties. For the focus groups and scheduled interviews, unstructured questionnaires comprising questions which elicited free responses were used. The focus groups were conducted by the researcher for two hours each, and all the discussions were recorded with the permission of the participants, to make the analysis easier and more accurate.

Table 4.8 Focus Group Discussions

Group Name	A number of targeted participants and narrative description	A number of focus group sessions
Elections management body	1 elections commission of South Africa (EMB)	1 group
Political parties	29 registered political parties, but to engage only five dominant political parties (African National Congress, Democratic Alliance, Economic Freedom Fighters, Freedom Front Plus and Inkatha Freedom Party)	4 groups
Non-governmental organisations	4 relevant EISA amongst registered NGOs who are involved in routine election observations and voter education	4 groups
Election observers	National and international. Each group has to be engaged with 34 domestic organisations (Pan African Parliament) and 12 international organisations (African Union)	2 groups
Electorates	500 registered voters. One focus group in each of the 10 municipalities	5 groups

4.12.4 **Expert Reviews**

The study conducted expert reviews in order to evaluate the proposed IBT framework. This study drew experts and practitioners from diverse but related fields within the study area, including elections officers; an IT security specialist; a government policy developer; and E-voting, IBT and M-voting researchers. The experts were chosen based on their expertise, and an evaluation tool was designed and developed using online forms for the evaluation of the proposed conceptual framework. The experts evaluated the IBT framework, and their inputs were used to modify and refine the framework. There were 15 elections experts who are informed from the following backgrounds: law, political systems, procurement, voter education, logistics, public relations, support services and administration, ICT, change management, ICT lectures, policy developers, and some were from civil organisation societies. The purpose was to exhibit the elections practice, norms and standards, and the meeting was planned for two days. At the time of working with the reviewers, they were working with the Electoral Commission of South Africa in Gauteng, training facilitators for EISA technical missions and consultants for UNDP election missions, and others were working with South African private ICT companies who are carrying out support work for elections within SADC countries. The meeting lasted for approximately 30 minutes. The process was completed after the individuals requested to take the evaluation forms to their working offices and promised to hand them over back to the researcher.

The attendance list for trainees was anticipated to target a pool of a satisfactory number of people who are working directly with EMBs, and those who are again directly responsible and participate in the procurement cycle to influence a decision in obtaining new technologies.

4.12.5 **Questionnaires**

The survey instrument selected for this study was an Online Monkey Questionnaire, with the intention to generalise from the proposed sample population. Creswell (2013a) describes an online questionnaire as an Internet surveying technique in which the interviewee follows a script provided in a website. Online questionnaires provide a cheaper way of surveying, since there is no need to meet face-to-face with the participants to conduct a survey (Davidson 2004). A scale system was adopted in the questionnaires to allow the researcher to elicit the more difficult quantifiable parameters. The self-administered structured questionnaire consisted of closed or prompted questions with predefined answers. It gathered straightforward information relating to the participants’ behaviours and basic attitudes or opinions about the current elections system and IBT model. Selective groups of voters from the Gauteng geo-political areas of the study, EISA staff members in the Gauteng office, IEC provincial staff members and HSRC staff members were amongst some of the participants who received the questionnaires.

A total of 500 forms were distributed, only 385 were received and 350 were processed with meaningful figures for the study. The survey was launched on 15 November 2018 and concluded on 15 March 2019. The questionnaires are attached in Appendices A and B.

4.13 **Data Analysis**

Content analysis is a procedure for the intuitive interpretation and categorisation of the content of text data, for classification, summarisation and tabulation. The main aim of this approach is to empirically and methodologically analyse text within the context of communication, through the systematic classification process of coding and identifying themes or patterns (Elo and Kyngäs 2008; Creswell 2013b). This study views content analysis in the same way as Patton (1999). Content analysis is a qualitative data-reduction process and sense-making effort which gathers a mass of qualitative material and endeavours to identify the core consistencies and meanings. Content analysis involves a set of systematic and transparent procedures for processing the data (Creswell 2013b). The steps used to analyse the qualitative data are shown in Table 4.9.

Table 4.9 Content Analysis Procedure for Processing Data (Elo and Kyngäs 2008).

Step Number	Actions Description
Step 1	Prepare data
Step 2	Define the unit of analysis
Step 3	Develop categories and a coding scheme
Step 4	Test coding scheme on a sample of text
Step 5	Code all the text
Step 6	Assess coding consistency

Step 7	Draw conclusions from the coded data
Step 8	Report methods and findings

4.13.1 **Descriptive Statistics**

Statistics is a collection of procedures for gathering, measuring, classifying, computing, describing, synthesising, analysing, and systematically interpreting the obtained quantitative data. Statistics has two dominant components: descriptive statistics and inferential statistics. Descriptive statistics allow the researcher to reduce, summarise and meaningfully describe the quantitative data acquired from the empirical evidence (Thomas 2010). Descriptive statistics were employed in this study, in order to simplify large amounts of data in a sensible way. There are two basic descriptive statistical methods: numerical and graphical. The numerical approach computes statistics such as the mean and standard deviation. These statistics convey information about the average and graphical methods used to identify any patterns in the data. The numerical and graphical approaches complement each other, hence both were used (*ibid*).

4.13.2 **Model Development, Validation and Testing Procedures**

This study developed a conceptual framework for the implementation of IBTs in South African elections management and control. This IT artefact model was developed by following the design science research process. The next section presents the research process which was conducted in order to produce the framework artefact, which was subsequently validated.

4.14 **Research Philosophy**

The two extreme and most-used paradigms are the positivist and the interpretivist approaches (Creswell 2013b). The main difference between the two approaches is very simple. Guba and Lincoln (1994) held that the positivist approach considers knowledge purely from an objective point of view, whereas an interpretivist approach considers knowledge from a subjective point of view. This study is neither a positivist nor an interpretivist approach, but rather takes a pragmatic approach, amalgamated with design science techniques.

The first paradigm which underpins this study is the pragmatism paradigm, which originated from the work of (Jonker 2009:5). Guba and Lincoln (1994:1) defined pragmatism as a worldview which arises out of actions, situations and consequences, rather than antecedent conditions. Pragmatism is not committed to any one system of philosophy and reality. A pragmatic paradigm is a philosophical underpinning for mixed-method studies, in which the researcher emphasises the research problem and uses diverse approaches in order to understand the problem.

Table 4.10 displays the choices made for this research, after having looked at various options. The remainder of this section describes the choices in narrative detail.

Table 4.10 Research Overview (Creswell and Clark 2007: 53-106).

Research Types	Research Alternatives	Adopted for the Study	Sources
Research Paradigms	Positivist Interpretivist Pragmatism Design Science	Pragmatism Design Science	Creswell and Plano 2007: 24
Research Approaches	Deductive Inductive	Inductive	Mpekoa 2017; Peffers *et al.* 2007
Research Strategies	Experiment Survey Case example Grounded theory Ethnography Archival research Argumentation	Case example	Mpekoa 2017; Peffers *et al.* 2007; Offermann and Platz 2009
Choices	Qualitative Quantitative Mixed methods	Mixed methods – parallel convergent research method	Saunders 2011
Time Horizon	Longitudinal Cross-sectional	Cross-sectional	Thomas 2010; Orlikowski and Baroudi 1991; Creswell 2013b
Data Collection Tools and Techniques	Questionnaires Interview Observations Literature review Simulations Focus groups Expert reviews	Literature Review Observations Focus groups Questionnaire Expert Reviews	Unertl 2008
Sampling	Convenience sampling Snowball sampling Purposeful sampling Quota sampling Typical case sampling Theoretical sampling Simple random sampling Systematic random sampling Stratified sampling Cluster sampling	Convenience sampling Stratified sampling Simple random sampling Purposeful sampling	Elyas, Tariq and Wassel 2014; Thomas 2010
Data Analysis and Triangulation	Descriptive statistics Inferential statistics Content analysis Hermeneutic analysis Framework analysis Thematic analysis Academic publications review	Descriptive statistics Content analysis Academic publication review	Wilson 2014; Eisenhardt 1989

Table 4.10 allows the researcher to choose the methods, techniques and procedures of research which best meet the needs and purposes of this

research (Patton 1990; Teddlie and Tashakkori 2011). In this study, the researcher made use of questionnaires, focus groups, observations and expert reviews, which combine both the qualitative and the quantitative research techniques.

The second paradigm which underpins this study is the design science paradigm, since the main purpose of this research is to develop an artefact in the form of an ICT framework. As conceptualised by Hevner *et al.* (2004), design science supports a pragmatic research paradigm which calls for the creation of peculiar artefacts to solve real-world problems.

4.14.1 **Research Approach**

This study developed an ICT framework which has the potential to successfully implement IBT adoption in the South African elections management design and control. The study emphasises the close understanding of the context being studied, and hence it followed an inductive research approach. The study collected qualitative data which formed the basis for the design and development of the IBT model for South African elections management design and control.

4.14.2 **Research Strategy**

The study investigated the current technical elections process and it proposed and evaluated a conceptual framework. This study, therefore, had to focus on contemporary processes –'elections' which did not require control over the processes. Consequently, a case-study research design was best suited for this research.

4.14.3 **Research Choice**

As stated earlier, this research involves a mixed-method study, and it adopted the convergent parallel design. In this research design, the research team used concurrent timing to implement the quantitative and qualitative strands during the same phase of the research process. This prioritised the methods equally, and kept the strands independent during analysis; it then mixed the results during the overall interpretation, as suggested by Creswell and Clark (2011). This model helped the researcher to compare or validate the results, to confirm or corroborate the quantitative results with the qualitative findings, and vice versa. The purpose of this model is to obtain valid and well-substantiated conclusions about a single phenomenon (Saunders 2011).

4.14.4 **Time Horizon**

This study is a cross-sectional study, since the researcher had limited time and budget to conduct the study (Mpekoa 2017: 48).

4.15 **Sampling**

The study received the required approval from the IEC, as indicated in Appendices O and P, to carry out sampling using the Elections Commission of South Africa as the focal point. The IEC South Africa is a permanent body created by the Constitution to manage free and fair elections at all levels of government. Although the IEC South Africa is publicly funded and accountable to Legislature, it is independent of the government (IEC South Africa 1994). For the purposes of study sampling, the proposed research was only carried out at the main head office based in Pretoria using the selected Gauteng geo-political areas to bring the main key players of the study together from media houses, senior government officials, NGOs, electorates and observers (Electoral Commission of South Africa 2014a: 1-21).

Sampling sizes would be grouped into five categories, namely: election management processes; stakeholder participation; information sharing; civil participation and elections observation management services for effective and efficient data collection (Hodgson 2013: 2-10). Based on this grouping, the researcher selected a pool of five samples with each of the five groups composed of one to eight officials. The decision would be made based on five groups, as they are key strategic partners in ensuring the delivery of election services to ordinary South Africans, since they are more reasonable in their responses and submissions for the study aims (Bradburn, Sudman and Wansink 2004).

The purposive and stratified sampling of participants comprised EMB officials, political parties, NGOs, observer groups, and the Legislative and Media house. To articulate the chosen sampling methods for this study, Table 4.11 summarises the chosen sampling methods, together with the associated data collection tools.

Table 4.11 Sampling Methods (Frey and Oishi 1995: 1; Morse 2010: 229-244).

Data Collection Methods	Sampling Method	Participants
Literature review	Internet services and products for elections services including IBT system, I-voting and Internet-based technologies	Journal articles, books and academic thesis
Observation	Convenience sampling Simple random sampling	5 EMB officials 3 political parties 2 NGOs 1 observer group Legislative house
Focus groups	Stratified sampling	500 voters (Elyas, Tariq and Wasse 2014; Thomas 2010)
Experts Review	Purposeful sampling	10 experts: IT elections analyst, elections officer, E-voting researcher, government policy developer

Table 4.12 presents a sampling size for the study where a Gauteng population within the province is divided into four geo-political areas, with each geo-political area being assigned a sizeable population representing the voters.

Table 4.12 Voters Stratified (500) as the Sample(Thomas 2010: 291-334).

Geo-Political Areas	Population per GPA	Population Samples	Sources
GP1 – City of Johannesburg Metropolitan	4 million	100	Elyas, Tariq and Wassel 2014; Thomas 2010
GP2 –City of Tshwane Metropolitan Municipality	1 million	50	Kendall 2008; Oppenheim 1992;

			Thomas 2010
GP3 –Ekurhuleni Metropolitan Municipality	5 million	200	Kendall 2008; Thomas 2010
GP4 – Sedibeng District Municipality	4 million	150	Creswell 2013; Thomas 2010
Total sample of 500 voters			

The EMB officials, political parties, voters, and observers had expressed an interest in improving the elections system from the current level of technology used to complete automation. This provided the researcher with an opportunity to develop and evaluate the IBT conceptual framework in a real-world environment. This was purely a voluntary case and a matter of convenience for the researcher. Convenience sampling includes participants who are readily available and agree to participate in a study (Frey and Oishi 1995; Morse 2010: 229-244).

The literature review was conducted through the collection and review of relevant documentation on the study area. In preparation for the focus groups, a stratified sampling method was used to divide the participants into three groups. Three focus groups, with a maximum of eight people participating, were created. These consisted of representatives from the election officials (EMB), and only selected political parties and observer officials responsible for elections. Simple-random sampling was further used to select eight members from the political parties. For the EMB group and the political officials, the researcher had no control over who would be available, as the institutions made the participants available for the study.

4.16 **Data Analysis and Triangulation**

4.16.1 **Data Analysis**

Peffers *et al.* (2006: 83-106) and Bak (2003: 1-59) describe data analysis as the process of bringing order, structure and meaning to the mass of collected data. It is described as messy, ambiguous and time-consuming, but Creswell and Clark (2011: 1-26) state that it is also a creative and fascinating process. Data analysis is the process of making sense of, interpreting and theorising data, which implies a search for general statements among the various categories of data (Schutt and Chambliss 2012: 154-177). Consequently, one could extrapolate that data analysis requires some sort or form of logic applied to research. In this respect, Lacey and Luff (2007: 13-14) clearly suggest that the analysis and interpretation of data requires the application of deductive and inductive logic to the research (Creswell 2013b).

Data analysis is the process of systematically examining the data with the purpose of highlighting any useful information within a study to fulfil specific goals (Creswell 2013b: 1-19). Dey (1993: 1-7), as well as Chambliss and Schutt (2012: 154-177), propose a useful outline of the differences and similarities between qualitative and quantitative methods of data analysis, as shown in Table 4.13.

Table 4.13 Data Analysis Methods (Mpekoa 2017: 53; Elo and Kyngas 2008: 107-115; Lacey and Luff 2007: 13-14).

Research Method	Analysis Methods	Definition
Quantitative	Content Analysis	This is a technique for gathering and analysing the content of text. The content can be words, phrases, sentences, paragraphs, pictures, symbols, or ideas. It can be done quantitatively as well as qualitatively, and computer programs can be used to assist the researcher (Elo and Kyngäs 2008: 107-115) .
	Hermeneutics	It is primarily concerned with the meaning of text or a text-analogue. The meaning is obtained by a process of interpretation, in which both the broader picture, as provided by the text as a whole, and the individual parts are constantly interacting, and they contribute to creating a more accurate and complete understanding of the text (Lacono *et al.* 2009; Hirschheim and Klein 1989).
	Framework Analysis	Provides systematic analytical stages, which are clearly defined and easily accessible to others. It is particularly well-suited to qualitative research where there are pre-set questions which need to be addressed, and where the timescale is limited (Creswell 2013b).
	Thematic Analysis	Identifies, analyses and reports patterns (themes) within the data. It organises and describes the dataset in rich detail, and it also interprets various aspects of the research topic (Lacey and Luff 2007).

Qualitative	Descriptive Statistics	Describes the relationship between variables (e.g. frequencies, mean, median, standard deviation). The results are presented in the form of graphs, representing quantities, frequencies, distributions and classifications of phenomena (Livari 2007; Thomas 2010).
	Inferential Statistics	Identify statistically-significant differences between groups of data and make inferences about the population from the sample (Livari 2007).

4.16.2 **Data Triangulation**

Triangulation has been defined earlier in this thesis, however it is important to refer to it again as a combination of two or more data collection techniques, methodological approaches, investigators, or theoretical perspectives (Siddiqui and Fitzgerald 2014: 137-147; Lacey and Luff 2007: 3-14). Krauss and Putra (2005: 758-770) and Eisenhardt (1989) describe triangulation as an attempt to map out, or explain more fully, the richness and complexity of human behaviour by studying it from more than one point of view. Johnson *et al.* (2007) argue along the same lines, stating that triangulation gives a more detailed and balanced picture of the situation.

This study incorporated methodological, investigator and data triangulation. Methodological triangulation is carried out to seek convergence, inconsistency and contradiction by investigating a research question from different vantage points (Eisenhardt 1989). The study made use of different data collection methods such as observations, focus group interviews, surveys and expert reviews. A team of investigators from the Durban University of Technology were used throughout the data collection process. The investigators were used during observations, focus group interviews and the survey. Assistance was needed for other data collection methods. For the primary researcher to be sure that the data collected was correct, the research assistants were trained. It was not necessary for the researcher and the assistants to be able to speak the local language, as the participants were mostly literate and could speak English very well. All the assistants were registered IT students at DUT, and most of them were postgraduate students. The training offered to the data collectors included: an introduction to the evaluation objectives; a review of the data collection techniques; a thorough review of the data collection items and instruments; practice in the use of the instruments; skill-building exercises on interviewing and interpersonal communication; and a discussion of the ethical issues.

Data triangulation was also used in this study to ensure that the research design was strengthened, and to increase the validity and the credibility of the findings. Figure 4.7 depicts types of data triangulation methods.

Figure 4.7 Types of Data Triangulation Methods (Rosenbaum 2005: 1451-1462).

4.17 **Ethical Considerations**

Research ethics is a system of moral values which is concerned with the degree to which research processes abide by professional, legal and sociological obligations to the study participants. Regardless of a perfect research design, a study which fails to consider research ethics is bound to be criticised. Ethical clearance was requested and obtained from the Durban University of Technology, Electoral Commission in South Africa and EISA to conduct the observations, focus groups, as well as the survey. The study took all possible measures to ensure that the participants remained anonymous. Field notes were treated as confidential documents, and care was taken to ensure that they were not read by others.

4.18 Summary

Chapter 4 presents the research design and the methodology utilised in this study. The research design and methodology were critical in answering the primary question and sub-questions of the study. The discussion was based on research philosophies and paradigms, research design, data collection and data analysis, in addition to sampling as well as ethical considerations chosen for this study. The five sub-questions will be answered in different sections of the thesis.

This research was developed by following the design science research process, as it allowed the researcher to develop an artefact (IBT framework) with the explicit intention of improving the functional performance of the IT artefact model. A comparative analysis of the design science process models was presented, and the science research process model of Peffer *et al.* (2007) was used in this study, since it helps to align the thesis arguments with the main research question.

The study falls within the human computer interaction field, as it brings together both humans and technology. This chapter compared several research approaches within the HCI field (design science, the traditional scientific approach, and the engineering approach), with the intention to choose the most appropriate approach for the study.

The researcher explained the objectives of the study to the participants, and requested their participation. Consent forms were signed by all the participants and their rights as participants were articulated and explained to all participants. The researcher produced the selected literature on the topic. Furthermore, it allows the researcher to utilise multiple entry points from a variety of contexts. This study used an inductive approach in conducting the study. Different research strategies and their applications were discussed, and a case example was found to be suitable for this study, as it offers a close understanding of the context being studied. The study used both qualitative and quantitative methods to collect and analyse the data (content analysis and descriptive statistics). These methods complement each other, and together they provide a more comprehensive method for studying a research problem.

Furthermore, the study also aligned with conceptual theories of safeguarding free and fair elections. In terms of theories of information systems, election management processes and technology adoption, it is argued in the study that the use of IBTs and ICTs cannot be isolated from the overall trend towards the use of technology in elections management processes for any African country, including South Africa, with specific reference to Gauteng. Similarly, with the increasing use of technology in elections, nowadays democratic elections are termed “e-democracy”, an “umbrella term that covers many democratic activities carried out through electronic means” Mpekoa (2017:88) cited in Achieng (2014: 1). Therefore, the use of Internet-based technology to manage the elections processes and communicate or disseminate ideas between the citizens and political offices of the state, becomes a critical research question which is of theoretical relevance.

Chapter 5 analyses the use of IBTs in election management processes, with specific evidence from Gauteng.

Chapter 5 ANALYSIS OF IBT USAGE IN EMPS: EVIDENCE FROM GAUTENG, SOUTH AFRICA

5.1 Introduction

This chapter presents Gauteng as a case example. A case example strategy was deployed as the principal research approach to respond to the research problems and objectives. This is also composed of mixed methods, qualitative, and quantitative research techniques and procedures. However, the Gauteng example informs the thesis about Gauteng for the 2009 and 2014 national elections. In summary, this chapter covers the following main themes: case example background and demographics, data collection procedures, training of field data-capturers, pilot testing and findings, case example data results and analysis, and conclusion.

Within this case example strategy, the most prevailing research sub-question which is being pursued in this section (research sub-question (v)) can be simply articulated as follows:

What are the current election challenges associated with the use of IBTs in South Africa's Gauteng province?

5.1.1 Case Example Background and Demographics

According to Mzekandaba (2015: 1), e-government policy framework in South Africa proposes the use of ICT to improve the government's efficiency and effectiveness, and make it convenient for citizens to access government services. The South African government has used taxpayers' monies for ICT development with larger projects especially for Gauteng.

Background information on Gauteng and e-government services has been stated earlier in Section 4.1.1 in Chapter 4. This background gives this research an opportunity to test the IBT conceptual framework proposed in Chapters 2 and 6, and which is further refined in Chapter 7. It is with this case example approach that this work had an opportunity to engage directly with major election stakeholders with an intention to review IBT leverage versus stakeholders' views and opinions.

5.1.2 **South African Elections System and Selected Procedures**

The South African elections system consists of a set of rules which must be followed for a vote to be considered as valid. The system sets out how votes are counted and aggregated to yield the result of an election (Reynolds *et al.* 2005: 147-162; ACE Elections Knowledge Network Project 2014). In SA, the elections system refers to all the segments managed by the IEC, including the IEC's vision and mission, Elections Act 18 of 2013, awareness campaigns, role players, infrastructure and the election (voting) system (EISA 2009; Counts 2014). An election model specifies whether the actual physical ballot takes the form of a piece of paper, a punch card, or a computer display. It also specifies how votes are kept secret, how to verify that votes are counted accurately, or who is allowed to vote (Reynolds *et al.* 2005: 147-162; De Klerk 2010: 27-33).

5.2 **Selected Elections Stakeholders and Special Characters**

5.2.1 **Electoral Commission of South Africa**

The study has discussed and identified the election stakeholders, including their roles and contributions in election processes, in Chapter 2. The Electoral Commission of South Africa is one of the most active stakeholders in this regard. It is playing a pivotal role to achieve a constitutional mandate based on the South African elections model. The IEC is an independent, impartial institution established by Chapter 9 of the Constitution of SA to strengthen constitutional democracy. The primary goal of the IEC is to achieve an inclusive, free and transparent election, thereby allowing every registered South African voter to participate in elections to make a choice when casting a vote. Therefore, the IEC-SA has a larger role as it develops relationships among all the different election stakeholders to understand how the IEC is prepared to deliver the elections, and which should be accepted by all stakeholders.

In 2016, according to Mpekoa (2017: 74-120), South Africa's democracy marked two decades. Figure 5.1 depicts and Table 5.1 describes the elections stakeholder structure, as described in Section 2.5 of Chapter 2, together with specific roles in election management processes.

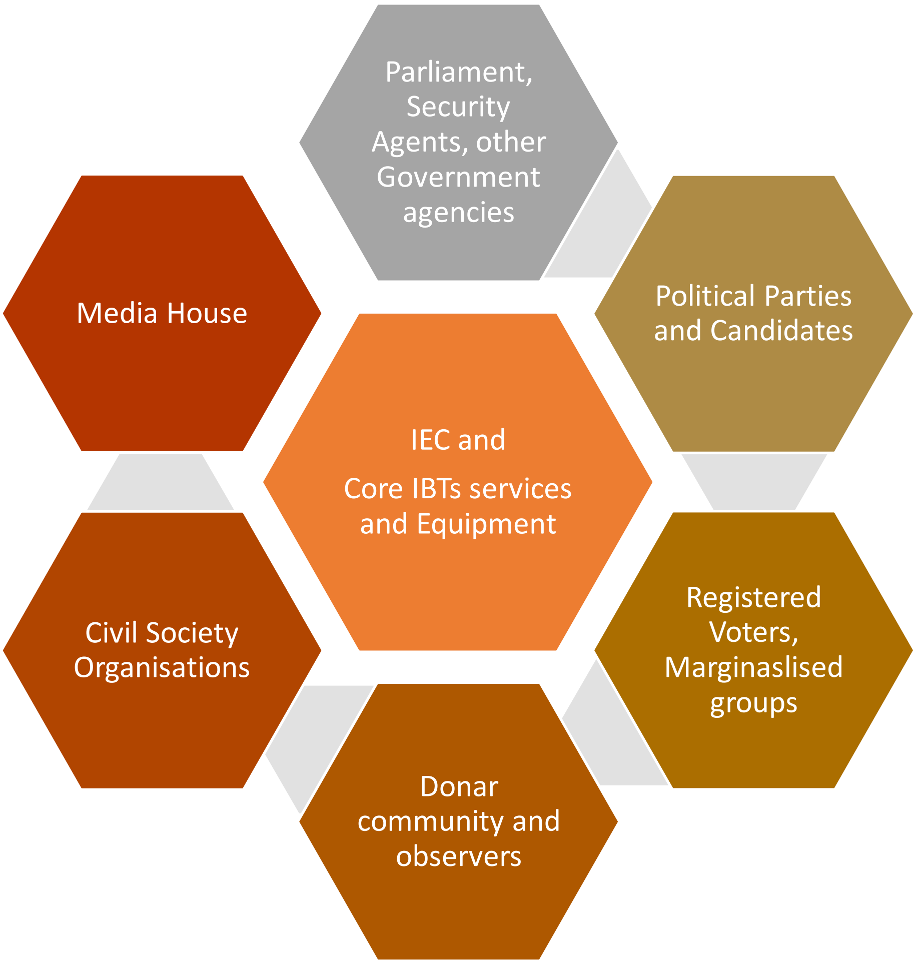


Figure 5.1 Elections Stakeholder Map (Mpekoa 2017: 74-120).

Table 5.1 Elections Stakeholders' Roles within Institutional Governance Structures (Mpekoa 2017: 89)

Stakeholder Description	Elections Mandate and Roles	IBT services and equipment which support the elections mandate for each stakeholder
IEC and staff members	Elections supervision	Voter register, voter ID, casting ballots, sorting, counting, tallying, transmitting results, verification, declarations and announcement
Political parties and candidates **Legislature and other government agencies**	Engage voters in party policies and monitor the executive about the public funds and amendments of country's legal acts	Nomination system, voter register, casting ballots, sorting, counting, tallying, transmitting results, verification, declarations and announcement of election results to allocate seats in the Parliament (results gazette)
Registered voters and marginalised groups	Casting the ballots	Voter register, voter ID, casting ballots, sorting, counting, tallying, transmitting results, verification, declarations and announcement
Media House and civil society organisations	Mobilising and sensitising voters on the value of participating in elections	Voter register, voter ID, casting ballots, sorting, counting, tallying, transmitting results, verification, declarations and announcement
International and local observer group	Observe and report what they see without attempting to intervene in the election process	Accreditation of observers

5.2.2 **The Election Laws**

The overarching law of the country is driven by the Constitution of the Republic of South Africa of 1996. Based on the current South African law, regulations and IEC institutional policy, there will be a need to re-align the several laws and introduce an IEC institutional IBT framework policy in order to make use of modern technology innovations in elections. The Electoral Commission Act No. 51 of 1996 and the Referendums Act No. 108 of 1983 (presented in Section 2.8.4 of Chapter 2) present some legal acts which may be affected. Figure 5.2 presents the hierarchy of election laws in South Africa.

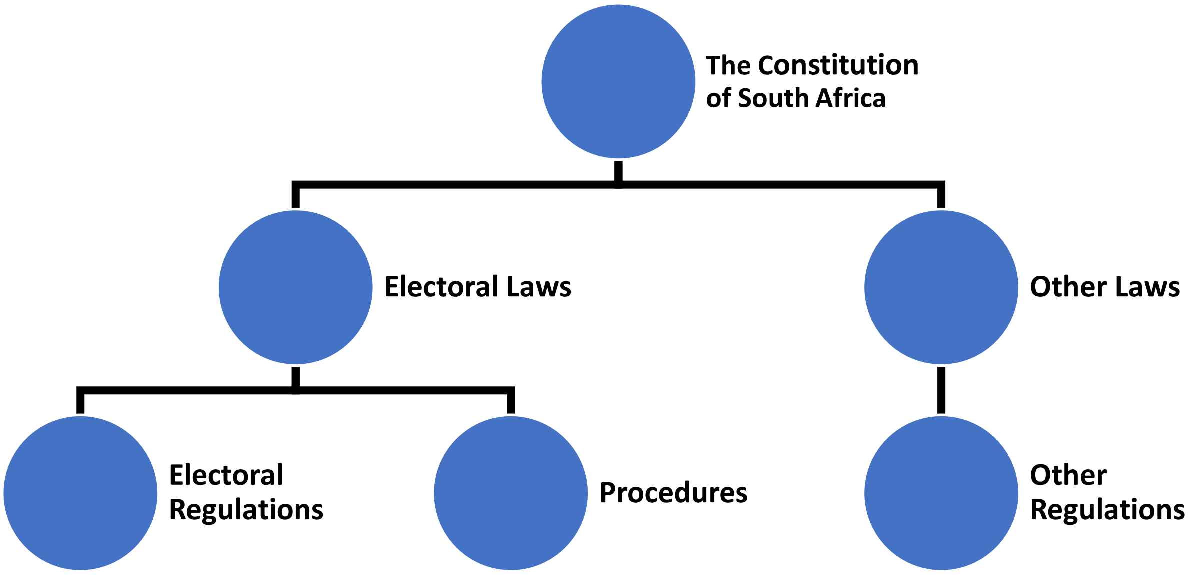


Figure 5.2 Hierarchy of Election Laws in South Africa (IEC 2009: 1-11).

5.2.3 **Electoral Amendment Act 18 of 2013**

The elections amendment Act 18 of 2013 has been mentioned in Section 2.8.4 of Chapter 2. The aim of the study was to develop a generic framework to guide the effective and efficient use of Internet-based technologies for elections management processes in South Africa, *therefore, legal aspects of elections systems are important but the study did not investigate them and rather paid close attention to the operational relationship with the proposed elections technology*, especially with the core elections components which include voters registration, voters identification at voting stations, ballot casting, results sorting, and the counting, tallying, transmission, declarations and public announcement of votes. The rationale is to ensure that the technology is a tool which conforms to the legal regulatory framework which guides the design and control of elections management.

5.2.4 **Geographic Map of the Area selected for the Study**

Gauteng's geography and selected statistics has been introduced in Section 4.1.1 of Chapter 4. Gauteng lies on the highest part of the interior plateau on the rolling plains of South Africa's Highveld. Its capital is Johannesburg and it also contains the city of Pretoria, as well as the East Rand, West Rand and Vaal areas. Gauteng continues to serve as the economic engine room of the country and the subcontinent, responsible for over 34.8% of the country's GDP. The most important sectors contributing to the GDP are finance, real estate and business services, manufacturing, and general government services. Gauteng is also the financial services capital of Africa. More than 70 foreign banks have their head offices in Gauteng, as do at least the same number of South African banks, stockbrokers and insurance giants. The major gold and diamond mining houses all have their headquarters in Johannesburg, the largest being Anglo American and De Beers. According to Makiti Guides and Tours (2013), gold mining constitutes 80% of Gauteng's mineral production output. Gauteng is divided into three metropolitan municipalities, the City of Ekurhuleni, the City of Johannesburg and the City of Tshwane Metropolitan Municipalities, as well as two district municipalities which are further subdivided into six local municipalities (Makiti Guides and Tours 2013). Figure 5.3 depicts a map of Gauteng showing the municipalities.

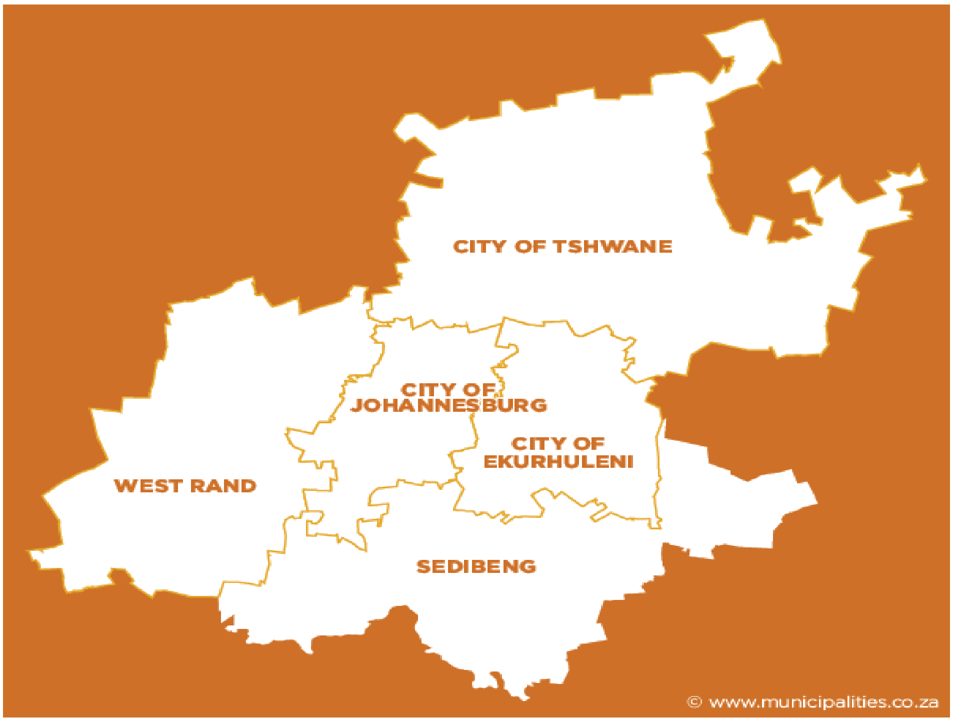


Figure 5.3 Gauteng Municipalities

5.2.5 **Gauteng Infrastructure Development**

The region contributes heavily in the financial sector, manufacturing, transport, technology and telecommunications infrastructure (Amedzo 2007: 1-25). To this end, the Gauteng Department of Infrastructure Development (GDID) builds infrastructure for the Departments of Health and Education, including acquiring and disposing of assets on their behalf (Modimogale and Jan 2011: 3; Modimogale and Kroeze 2009: 10). GDID also maintains facilities for Social Development, Agriculture, Roads and Public Transport, among other departments, serving as the custodian for all of the province's immovable assets (Nyasha 2011: 1-7; Isaacs 2007: 106; Fourie 2006: 1).

5.2.6 **Gauteng Municipalities**

Table 5.2 presents the Gauteng province divided into three metropolitan municipalities and two district municipalities. The district municipalities are in turn divided into six local municipalities (Municipal Demarcation Board 2016: 1; IEC-South Africa 2014a: 1-20).

Table 5.2 Gauteng Local and Metropolitan Municipalities (Municipal Demarcation Board 2016: 1).

Name	Area (km²)	Population 2016	Sources
City of Johannesburg Metropolitan Municipality	1,645	4,949,347	Municipal Demarcation Board 2016; Statistics South Africa 2018
City of Tshwane Metropolitan Municipality	6,298	3,275,152	Municipal Demarcation Board 2016; Statistics South Africa 2018
Ekurhuleni Metropolitan Municipality	1,975	3,379,104	Municipal Demarcation Board 2016; Statistics South Africa 2018
Emfuleni Local Municipality	966	733,445	Municipal Demarcation Board 2016; Statistics South Africa 2018
Lesedi Local Municipality	1,484	112,472	Municipal Demarcation Board 2016; Statistics South Africa 2018
Merafong City Local Municipality	1,631	188,843	Municipal Demarcation Board 2016; Statistics South Africa 2018
Midvaal Local Municipality	1,722	111,612	Municipal Demarcation Board 2016; Statistics South Africa 2018
Mogale City Local Municipality	1,342	383,864	Municipal Demarcation Board 2016; Statistics South Africa 2018
Rand West City Local Municipality	1,115	265,887	Municipal Demarcation Board 2016; Statistics South Africa 2018

5.2.7 **Elections Institute for Sustainable Democracy in Africa**

Since its inception in July 1996, EISA has established itself as a leading institution and influential player dealing with elections- and democracy-related issues in the African continent (EISA 2009: 1).

5.2.8 **South African Electoral System**

There are various ways to elect representatives into government; different countries use different electoral systems and variations or combinations of these systems exist around the world (EISA 2010; Resnick and Casale 2013; Nupenn.d.; Owuor 2008). There are three main types of electoral systems: the Constituency system, the Proportional Representation (PR) system, and the mixed system.

5.2.9 **Selected Registered Political Parties**

The governing African National Congress (ANC) has been the majority party in most municipalities across South Africa, with the exception of those in the

Western Cape, since 1994 (Smith 2014; Southall 2014; Booysen 2005; Rantete 1998). At the time of conducting the study, the party was led by His Excellence Cyril Ramaphosa. The official opposition, the Democratic Alliance (DA),increased its total share of the vote from 16.3% in 2006 to 24.1% in 2011, while assuming control of most Western Cape councils. The party contested an election for the first time under the leadership of Musi Maimane, who succeeded Helen Zille as leader in May 2015 (Alexandra 2016; Sunday Times 2016; News24 2016). The newly-formed Economic Freedom Fighters (EFF), led by Julius Malema, contested its first municipal election since its formation in 2013 (Smith 2014; Southall 2014; Rantete 1998).

5.2.10 **Election Figures (IEC2019)**

During the writing of this thesis, the following figures were recorded:

- Number of registered parties: 48 for the 2019 national elections
- Number of registered voters: 26,571,478 as of November 2019 for SA

5.2.11 **Gauteng Provincial Legislature**

The Legislature referred to in this study is the legislature of the South African province of Gauteng. It is a unicameral body of 73 members elected every five years (Porteus *et al.* 2001: 1; Shilowa 2009: 1). The Gauteng Provincial Legislature, like the other eight provincial legislatures in South Africa, was created on 27 April 1994 by the Interim Constitution of South Africa, which dissolved the four original provinces (and their provincial councils) and created the nine current provinces (Butler 2017:24; Lodge 2005). It is currently constituted by Chapter Six of the Constitution of South Africa, which defines the structure of the provincial governments (Butler 2017; Lodge 2005: 737-753). The provincial legislature's members are elected through a system of party lists in proportional representation with closed lists. In other words, each voter casts a vote for one political party, and seats in the legislature are allocated to the parties in proportion to the number of votes received (Lodge 2005: 737-753).

5.2.12 **Gauteng Provincial Election Data for 2014**

The results of South Africa's 2014 national and provincial elections were announced at the IEC centre in Pretoria on 10 May 2014. The number of registered voters was 25,388,082 and the number of votes counted was 18,654,771 (Booysen 2005: 129-147). Tables 5.3 and 5.4 present the election data for the study period between 2014 and 2016.

Table 5.3 Provincial Election Data for 2014

Party Name	Elections Turnover %	Sources
ANC	62.15%	(IEC 20141: 1-21)
DA	23%	(IEC 20141: 1-21)
EFF	6.35%	(IEC 20141: 1-21)
IFP	2.40%	(IEC 20141: 1-21)
NFP	1.57%	(IEC 20141: 1-21)

Table 5.4 South African 2016 Municipal Elections

Party Name	Elections Turnover %	Sources
ANC	53.9%	(IEC 20141: 1-21)
DA	26.9%	(IEC 20141: 1-21)
EFF	8.2%	(IEC 20141: 1-21)

5.3 **Data Collection Procedures**

The study adopted four types of data collection procedures, as discussed in Chapter 4, which cover the first observation, focus groups, interviews and study survey. Table 5.5 presents a summary of the research methods used and the total number of participants involved in the study. Figure 5.4 depicts the main objective to develop a conceptual framework.

Figure 5.4 Development of IBT Conceptual Framework

According to Newman (2005: 518), a sample is a smaller set of cases which the researcher has selected from the larger pool and the population. In summary, according to the researcher, a sample can therefore be described as a component of the overall population under study. The pool column, as indicated in Table 5.5, shows eligible sampling units available to sample data collection for the study.

Table 5.5 A Summary of Research Methods and Study Populations

Stakeholder Profile and Respective Roles	Geographic Area	Pool	Numbers of Participants	Data Collection Methods
Political parties	Gauteng	12	15	Focus group interviews Observation Number 1 Observation Number 2
IEC-Elections service Managers and Directors	Gauteng	15	20	Focus group interviews Observation Number 1 Observation Number 2
Election Officers	Head office/ MEC	120	250	Focus group interviews Observation Number 1 Observation Number 2
ICT Specialist-Consultant	Head office/ MEC	35	25	Focus group interviews Observation Number 1 Observation Number 2
Security and Logistics IEC and Police Force	Head office/ MEC	50	20	Focus group interviews Observation Number 1 Observation Number 2
Data Capturing Operators	Head office/ MEC	102	149	Study Questionnaires Observation Number 1 Observation Number 2
IEC-Commissioner and government institutions	Head office	6	3	Focus group interviews Observation Number 1 Observation Number 2
Field Registration Officer, IEC Official at field level	MEC	50	300	Focus group interviews Observation Number 1 Observation Number 2
IEC Provincial Manager	MEC	11	5	Study Questionnaires Observation Number 1 Observation Number 2
IEC Field Coordinator and Members of Judiciary	MEC	65	40	Study Questionnaires Observation Number 1 Observation Number 2

EISA Operational Director, Civil Societies and Media	Head office	4	5	Study Questionnaires Observation Number 1 Observation Number 2
Members of Pan African Parliament and SADC Secretariat as Elections Observers IEC-Voter education, Electorates	Head office Head office/ MEC	5 25	10 8	Focus group interviews Observation Number 1 Observation Number 2
		500	850	

5.3.1 **Training of Field Research Assistants**

Research assistants were appointed to help the study with the field data collection procedures described in Chapter 4. The literature review framework gives the study an opportunity to collect data for analysis by the principal researcher of IBT studies. Each research assistant was given specific roles within the four data collection methods.

The principal researcher provided training for the research assistant who can speak the local language, as Gauteng is populated with 11 South African languages, and the participants were mostly literate and could speak English fluently. All the assistants were registered voters who also understood the significance of having free and fair elections, therefore this embraced their efforts to give the study their maximum attention, as they appreciated that the findings of the study would add currency for South African democratic elections. The following were considered during the training sessions of the research assistants: introduction, a review of the data collection procedures, practice in using the instruments, respect for ethical considerations and practicing communication skills with more emphasis on interviews and interpersonal communication.

The training offered to the data collectors included: an introduction to the evaluation objectives, a review of the data collection techniques, a thorough review of the data collection items and instruments, practice in the use of the instruments, skill-building exercises on interviewing and interpersonal communication, and a discussion of the ethical issues. Training was scheduled for two days. Time for the training was very limited as the project experienced budget constraints in trying to keep trainees for more than three days.

5.3.2 **Pilot Testing and Findings**

Once the assistants were trained and the data collection instruments were ready, a pilot test was conducted. Pilot testing is defined and described in Section 4.10.4 in Chapter 4. The questionnaires were designed to achieve the research objective, as well as to obtain additional information.

A simulated election management process and design was prepared for this purpose, and the study observed that all put the same observations into the same categories. The study also observed that more separation was needed, with regards to different election processes and procedures and the stakeholders. Each of the steps, outlined in Figures 5.5 and 5.6, are detailed in the individual processes. These processes were used to help the study to structure and organise the election simulation.

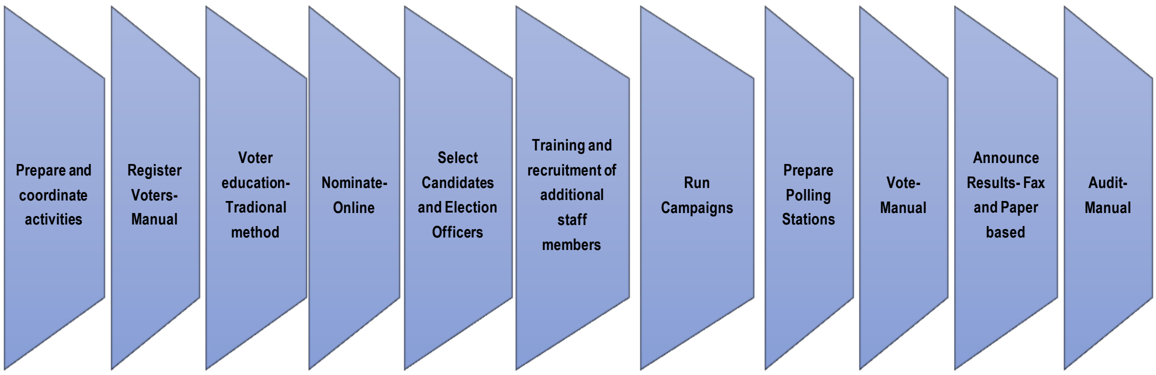


Figure 5.5 Original Election Process and Steps

During the preparation for the mock election, the research team realised that the observation form did not include the operational context, which includes the technical preparation and coordination, as well as the step-by-step election closure process, and the pilot testing indicated that these were necessary. The observation form was modified based on the findings of the mock election (simulated election management design).

The next pilot testing was for the focus group questions (IEC, EISA and political parties) for the Gauteng elections. The other municipalities and constituencies have only limited officers and pilot testing was impossible, as these officers were going to be part of the main study. The pilot test was eventually carried out by five lecturers from other academic departments at DUT. Minor errors were noted, and the comments were used to modify the questionnaire. The researcher requested members of Legislature and other political parties from Gauteng to participate in the pilot testing, but political-party officials were difficult to find and sometimes unavailable; as a result, the pilot testing was not possible.

The questions were given to three colleagues from different departments from DUT. No changes were necessary.

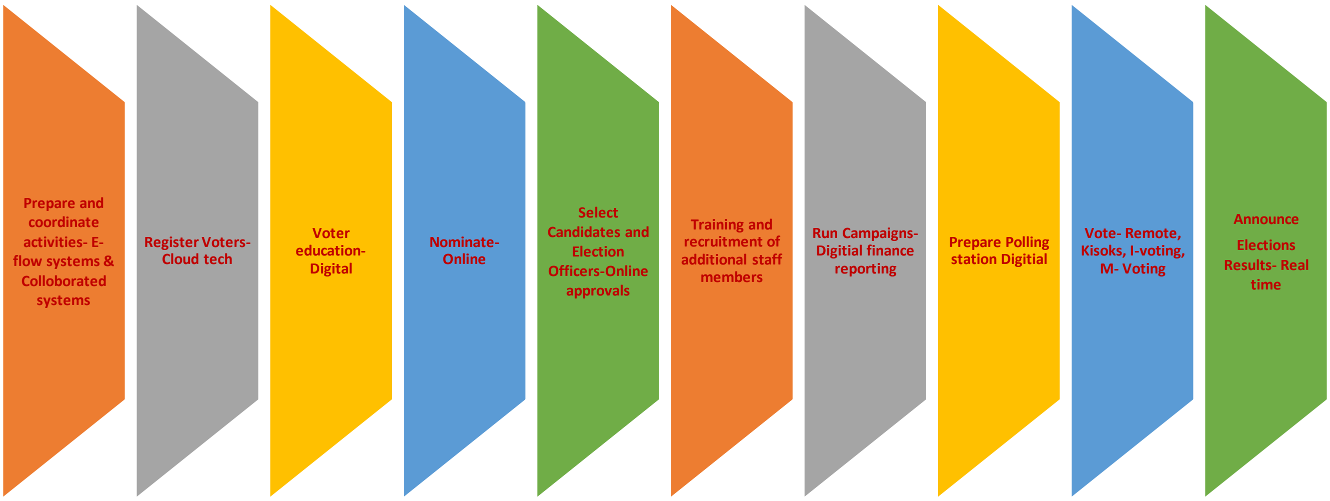


Figure 5.6 Refined Election Processes and Steps.

The pilot test was eventually carried out by three stakeholders. There were some notable deficiencies which were identified during the pilot test on the tool, therefore the observation form used was modified. More training was needed for the data collectors. Since the errors discovered were minor, the pilot tests confirmed that the research team was ready for the full-scale survey. The data collected from the pilot tests were not included with the data collected from the main study.

The next section presents the data collected during focus group discussions and data collected through the use of survey tools.

5.4 **Case Example: Observation, Discussion and Analysis of Data and Results**

5.4.1 **Preliminary Pilot Testing**

Upon completion of the research assistant sessions, the immediate task was to make use of the data collection methods and run a test. This is a pilot test which was used to prepare the Research Assistant (RA) to complete the study. As stated in Section 4.10.4 in Chapter 4, pilot testing allows the researcher to reduce non-sampling errors.

5.4.2 **Observation Form Analysis**

The existing literature informed the study that this type of survey, focus group notes and kurtosis values are to be used for continued analysis. The observation form used for the first round observation was piloted and each relevant elections process associated with elections and stakeholders was also tested. It is important to note that pilot tests were not set up in real elections mode but rather as election mock tests, which is a normal practice for elections practitioners in testing systems before any official elections.

5.4.3 **First Round Observation**

Mackey and Gass (2015: 48-58) define an observational study as a detailed examination of phenomena prior to analysis, diagnosis, or interpretation, without manipulating or interfering with the behaviour. The great advantage of this method is that the researcher can discover factors important for a thorough understanding of the research problem, factors which were unknown when the study was designed (Mpekoa 2017: 135; Rosenbaum 2005: 1451-1462).

The researcher observed and recorded the information from the first day of planning to the last day of concluding the elections, in a holistic description of the events and the behaviour. The participants were all the election stakeholders. The research project randomly selected approximately 500 participants from a total target study population of 100 which comprised IEC South Africa, political parties, NGOs, the media house, government institutions, elections observers, and ICT experts located in Gauteng. Potential participants were selected from the following groups: election stakeholders (EMBs, political parties, state organs, the media, observers, and NGOs).

5.4.4 **Focus Group Discussions**

The study collected data from the literature review in preparing for the focus group discussion sessions. The researcher was aware of the limitation of not interviewing all the political parties and government and public representatives, as this would have yielded valuable responses to answer the research questions.

The focus group discussion was used to extract views and opinions on the complete use of an IBT framework in South African elections. A stratified sampling method was used to divide the participants into three groups. Three focus groups, with a maximum of eight people participating, were created. These consisted of representatives from the IEC SA, political parties, NGOs, government institutions, elections observers, and ICT experts located in Gauteng. The focus groups were conducted in person over a period of two hours each, and all the discussions were recorded by using notes and an audio recorder. The researcher conducted the interviews, while two research assistants took notes. The researcher posed each question to the participants and allowed the participants to respond, discuss and sometimes used follow-up questions when the first question was answered or if it was not clear.

The data collected from the focus groups was categorised in the following order:

1. To evaluate the performance assessment for the use of Internet-based technologies in South African elections

2. To evaluate the use of Internet-based technologies in improving the following – voter registration, voter identification, voting, real-time election results, and elections management processes – within the South African context
3. To evaluate the use of IBTs in view of the legal framework in South African elections
4. To review the use of IBTs for elections management
5. To review the use of IBTs for constituency and polling district demarcation
6. To review the use of IBTs for voter education and voter registration
7. To review the use of IBTs for access to ballot papers and campaign regulation
8. To review the use of IBTs for polling activities and counting and tabulating the votes
9. To review the use of IBTs for resolving election-related complaints, verification and certification of final results
10. To review the use of IBTs for post-election procedures
11. To identify the risk and benefits of taking IBT beyond normal office automation
12. To consider the stakeholders' views and opinions about complete e-enabled South African elections
13. To refine the IBT conceptual framework post focus group interviews

5.4.5 **Second Observation**

The second observation was complemented by many activities in the first observation. Some of the activities involved additional members of legislature, media interviews and sessions with CSO organisations. These activities were meant to assist the members of the study population, as well as all the other stakeholders to prepare for IBT.

5.5 **Questionnaire Data Presentation and Analysis**

The questionnaires were sent several times within the same period between four to seven weeks. Online Monkey Survey (2018) and electronic copies of study questionnaires (Appendices A and B) were developed by using online forms. They were utilised during the study period between the 2009 and 2014 elections.

The design and layout of the self-administered questionnaires are well-structured and distributed to elicit responses from respondents in a confidential manner for reliability purposes. The questionnaires consisted of closed or prompted questions with predefined ideas, thinking, concerns, and opinions about IBT adoption at all election phases. The feedback facilitated questionnaire analysts to pay close attention to associated challenges towards enhancing voters' confidence and election integrity as well as the IBTs which EMBs thought might help correct them. The questionnaires allowed participants to establish a culture of urgently-needed technologies to be adopted within the election cycle phase.

The questionnaires were used to unearth detailed impressions, ideas and concepts about those factors which might influence the successful implementation of IBTs in SA. The questionnaires endeavoured to attain the following sub-objectives:

1. To investigate how the current IEC technology systems can support complete e-enabled elections
2. To identify the risk and benefits of taking IBTs beyond normal office automation
3. To consider the stakeholders' views and opinions on complete e-enabled South African elections
4. To refine the IBT conceptual framework post focus group questionnaires

Three hundred and fifty (350) questionnaires were returned by the voters, as they were being monitored by the research assistants. The selection criteria were based on the valid completion of the questionnaire, and 270 questionnaires were selected on this basis for analysis. The questionnaires were grouped into four sections: *background information, mobile phone ownership and use, voting behaviour and voting-system preferences*.

The next section presents a selected case example of empirical discussion emanating from the study questionnaires and interview questions attached in *Appendices A to D.*

5.5.1 **Selected Case Example Empirical Discussions**

The data captured here emanated from the study questionnaires and interviews (Appendices A to D). The issues presented in Appendixes A to D (points 1-38) are related to theories on the use of Internet-based technologies for elections management processes in South Africa. For instance, the questionnaires sought to link issues of IBTs and ICTs to those working for elections policy and election management or participating in conducting elections; the kind of hardware, software, services, products including, but not limited to, the electronic gadgets used; performance assessment for the use of Internet-based technologies in South African elections, core elections areas where IBTs can improve election management, the EMB's approach to ICT matters; and whether elections can be run effectively without ICT and the need for budgetary allocations from the public purse.

Questions on the role and frequent use of ICTs and the extent of participation of the voters, election stakeholders, political parties, or the use of ICTs by the EMBs, including the legislation, financing and procurement, sought to assess the effectiveness of technology in safeguarding democratic elections in the South African context – Gauteng province. Evidently, these are merely some variables which are tied to the theories and literature review. Moreover, these variables are used as understood by the respondents during the focus group discussions as well as in their questionnaire responses.

The next section presents the demographic characteristics of respondents' background information: this section of the questionnaire captured the background and biographical information, which included the participants' age, gender and race, as presented in Table 5.6. Sylvester (2009: 1) argues that South Africa's stark levels of inequality are highly racialised. With over

20 years of democracy, South Africa has also seen an increase in inequality within race groups, particularly among Black South Africans, thus how race and the use of technology can impact on the elections turnout is yet to be monitored.

Table 5.6 Summary of Participants' Background Information

Active and Registered Voter		**Gender**		**Race**		**Age Group**	
Yes	78%	Male	65%	African	79%	18-35	74%
No	20%	Female	35%	White	4%	35-50	15%
Why not	2%			Indian	2%	50-65	5%
				Coloured	5%	65-75	5%
				Others	0%	greater than 75	1%

From the data collected, 78% of the participants were registered to vote, and 20% of the participants were not registered to vote, because they were not interested in Gauteng politics, they did not have time, or they were busy at the time of voting. The participants who had not voted before stated that this was because they were too far from their regions, or that there was no registration site near them, or that the local elections were a waste of time in their opinion. In terms of gender, 35% of the participants were female and 65% were male.

Almost all (74%) of the participants were in the 18-35 age group, but some (15%) were in the 35-50 age group. Most of the participants (79%) were Africans, followed by 5% who were Coloured, 4% who were White, 2% who were Indian, and 0% who fell into the category of Others.

Table 5.7 presents a summary of the data collected in this section – it involves part of the captured questionnaires with some additional background information of the participants, which includes the involvement of respondents in any role pertaining to the South African election processes and procedures in the 2009 and 2014 national and provincial elections, exposure to technology and its use, and education and location within Gauteng. Only 15% of the participants voted between 2009 and 2014.

Table 5.7 Summary of Participants' additional Background Information

Thematic Area	Aggregation for a Period 2009 and 2014
Involved with the South African election processes and procedures?	15%
Role in the 2009 and 2014 national and provincial elections	5%
Exposure to technology and its use	65%
Education	5%
Location within Gauteng region	20%

In order for Internet-based technology to be successful, it is very important to gain some understanding of the voters' experiences and characteristics. It was expected that more than 95% of the participants would be exposed to the use of technology in the form of a smart phone or laptop with an Internet connection, but from the participants it was found that only 65% of the participants owned smartphones and laptops. Only 15% of the participants indicated that they used technology for elections, 5% played roles in the 2009 and 2014 national and provincial elections, and 20% were located within Gauteng.

Table 5.8 presents the gender distribution of the respondents who took part in the study, indicating that 65% of the respondents were male, while 35% were female.

Table 5.8 Gender of Respondents taking part in the Study

Gender	Frequency	Percent (%)
Female	45	35
Male	60	65
Total	**105**	**100**

Table 5.9 summarises the age of the respondents, indicating that 65% of the respondents were between 35-44 years of age, while 31% were between 18-34 years of age. The age of respondents is very crucial to the study due to the election laws in South Africa and the age at which one becomes an eligible voter.

Table 5.9 Age of Respondents taking part in the Study

Age	Frequency	Percent (%)
18-34	40	31
35-44	70	65
45-50	5	3
55-75	5	1
Total	**120**	**100.0**

Table 5.10 presents the educational qualification of the respondents which, in any study, goes a considerable way in determining the quality of data which is collected for the research.

Table 5.10 Educational Level of Respondents taking part in the Study

Educational Background	Frequency	Percent (%)
Matric	20	35
Diploma	50	20
BA/BSc Degree	30	20
MBA/MA/MPhil	10	15
PhD	10	10
Total	**120**	**100.0**

Table 5.10 indicates that 35% of the respondents had secondary education, 20% had college education, 20% had tertiary education, 15% had completed post-graduate education, and 10% had other forms of education.

Table 5.11 presents the length of service of the respondents – this is equally important for the study as it shows the level of competence and experience of the respondents.

Table 5.11 Length of Service of Respondents taking part in the Study

Years	Frequency	Percent (%)
1-10	14	20
11-20	10	15
21-30	15	35
31-40	11	30
Total	**50**	**100%**

Table 5.11 indicates that 20% of the respondents had one to ten years of experience in elections and technology, 15% had 11 to 20 years of experience, 35% had 21 to 30 years of experience, and 30% had 31 to 40 years of experience.

Table 5.12 presents the areas where IBT has been used to support elections. This will help the study to assess the effectiveness of technological innovations in election reforms.

Table 5.12 Election Areas where IBT has been Used

Area of Operation	**YES**	**%**	**NO**	**%**
Voter education		13%		
Delimitation and demarcation of elections boundaries		12%		
Voter registration		30%		
Issuance of voter ID		10%		
Nomination of candidates				5%
Conduct of polls				5%
Declaration of results		15%		
Communicating with stakeholders		7%		
Monitoring and evaluating elections processes		3%		

Table 5.12 shows that 30% of the respondents believed that the technological innovations thus far deployed in the implementation of electoral reforms have helped to improve the electoral process with specific reference to voter registration, while 3% thought that they have not helped in the implementation of election reforms and therefore have not improved the electoral process.

Table 5.13 presents the level of ICT expertise, which is also important to note for the study. Table 5.13 shows that 29% of the respondents confirmed that they were competent in the Microsoft Word application, while 10% had smart project management skills.

Table 5.13 Level of Expertise in ICT Systems or Services.

Services							**Level of expertise in ICT systems/services**				
	Excellent		**Very good**		**Good**		**Poor**		**Very poor**		**Total**
	(%)	freq	(%)	freq	(%)	freq	(%)	freq	(%)	freq	(%)
Word processing			29%	13							
Spreadsheet				16	10%						
Presentation tools				8	8%						
Internet/E-mailing			15%	20							
Statistical tools				15	10%						
Desktop publishing				10	10%						
Web-page designing				20	6%						
Programming				25	12%						
Database management			14%	12							
Smart Project management				15	10%						

Table 5.14 presents the ICT training for staff members. Regular ICT training of respondents in any study goes a considerable way in determining the quality of services which are offered by the EMBs. Table 5.14 indicates the responses to training as follows: 25% affirmative, 30% basic, 40% intermediate, and 5% advanced.

Table 5.14 Regular Training of Staff in ICT

Response to Training	Frequency	Percent (%)
Negative	0	0
Affirmative	20	25%
Basic	25	30%
Intermediate	50	40%
Advanced	15	5%
Total	**120**	**100**

Table 5.15 presents the required skills and the views of respondents on whether any form of interaction with comprehensive and modern technologies is useful.

Table 5.15 Skills Required for Work

Skills required	**Frequency**	**Percentage (%)**
Project Management	15	20%
Agile Methods	20	8%
Cyber Technology	5	6%
Cloud Technology	8	10%
Networking Engineering	10	15%
Smart Thinking	18	5%
Business Analysis	5	10%
Statistical Tools	3	10%
Scrum Masters	12	5%
Financial reporting skills	10	5%
Hardware	6	5%
Publishing Technology	7	2%
Total	**119**	**100%**

Table 5.15 indicates that a significant number of the respondents (20%) had worked on a Microsoft (MS) project, with the remaining skills with percentages as follows: Agile Methods (8%), Cyber Technology (6%), Cloud Technology (10%), Networking Engineering (15%), Smart Thinking (5%), Business Analysis (10%), Statistical Tools (10%), Scrum Masters (5%), financial reporting skills (5%), Hardware (5%),and 2% indicated that they had not seen Publishing Technology.

5.5.2 **Performance Assessment of Elections Management Processes**

Data was collected on the participants' performance assessment of the elections management processes. Technological innovations are meant to remove uncertainty and facilitate the functional life (Ajayi 2013: 1; Aker and Mbiti 2010: 207-233; Allers and Kooreman 2009: 159-170). With their deployment to facilitate the introduction of elections reforms in Gauteng, the study sought to find out if their adoption had made participation in the electoral process convenient for the respondents.

Figure 5.7 depicts IBT integrity – the integrity and accuracy of the electoral process is one of the most important currencies to maintain. The current thesis literature on elections integrity has identified a number of determinants of electoral integrity, ranging from structural factors, such as historical experiences with democratic elections and socio-economic features of societies, to institutional explanations focused on electoral systems and the presence of institutional checks and balances, to more proximate explanations which focus on the actors involved in electoral manipulation and electoral oversight (Birch 2011; Kelley 2012; Lehoucq 2003; Norris 2015; Simpser 2013; Van Ham 2012; van Ham and Lindberg 2015).

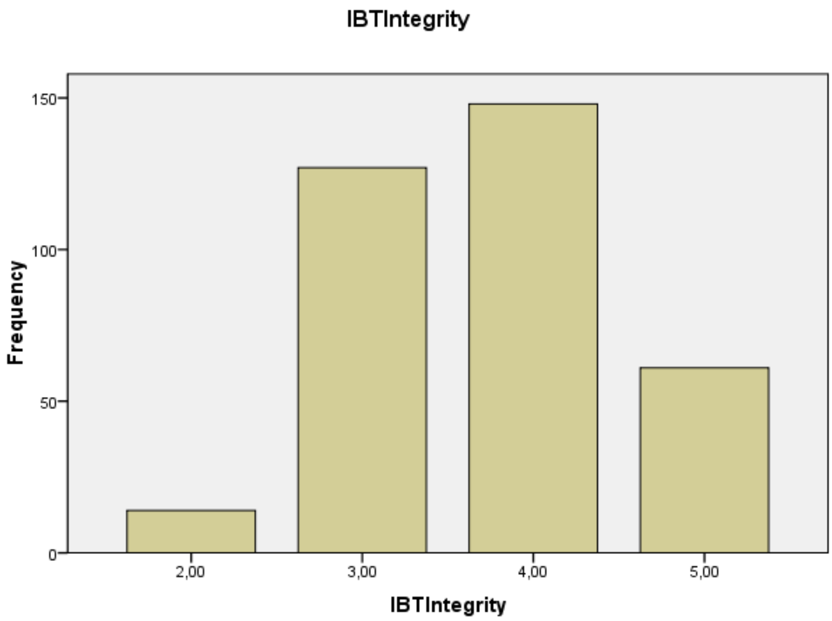


Figure 5.7 IBT Integrity

The thesis recorded that the majority of municipalities in Gauteng which were surveyed used technology for the tabulation of votes and voter registration. The use of technology for candidate registration was also relatively common. The integrity of the elections has to be upheld (Isong *et al*. 2013: 10-18). This confirms that applications of relevant information and communication technologies (ICTs) tools into the electoral process were useful in enhancing both voter registration and the identification of voter processes. Figure 5.7 indicates that there is positive feedback for those who trust the use of IBTs for integrity, and there are very few who suspect the integrity of technology.

To uphold the integrity of South African elections, elections must be made more transparent, trustworthy, accurate and reusable (Isong *et al*. 2013: 10-18). This begins with addressing election fraud, emanating from voters' authentication and verification during registration and the identification of voters (Isong *et al*. 2013: 10-18). Real-time registration is the exercise towards ensuring the integrity of the elections and guarding them against election fraud. The rationale behind real-time registration is that if a voter has finished registering in one centre and decides to go to another centre to register, even if he or she has more than one ID book, the information (i.e. the fingerprint or ID number) in the central database will be used to track him or her down, and they will be immediately denied another registration (Isong *et al*. 2013: 10-18).

Based on the integrity of IBTs' mode of operations, it is believed that the IBTs framework, if implemented, will set a simple and clear standard for protecting the integrity of South African elections (Isong *et al*. 2013: 10-18). It will be of more benefit to the IEC-South Africa in particular and other developing countries in Africa where impersonation and multiple registrations and voting are the order of the elections (Isong *et al*. 2013: 10-18). This is because where such situations are allowed to continue unnoticed, the integrity of the elections can be undermined and this can also threaten democracy (Isong *et al*. 2013: 10-18). In general, the study can summarise that when the elections system makes full utilisation of essential IBT tools in its processes, it will help to rid fraudulent elections and uphold their integrity (Isong *et al*. 2013: 10-18).

Therefore, the thesis accepts that the integrity of IBTs promises exciting developments into elections management, which involves *real-time voter registration, identification and results reporting.*

5.5.3 **Improvement in Use of Internet-Based Technologies**

This section has focused on the participants assessment of Internet-based technologies and how they improve the elections management processes, as presented in Tables 5.16-23.

Tables 5.16-23 indicate the IBT performance assessment between the 2009 and 2014 elections. This section has focused on the participants' assessment of the performance of the elections management processes in the following key areas: the legal framework assessment for the use of Internet-based technologies in South African elections, elections management, constituency and polling district demarcation, voter education, voter registration, access to ballot papers, campaigning regulations and the monitoring of funding for political campaigning, polling activities, counting and tabulating the votes, resolving election-related complaints, and verification.

Table 5.16 presents respondents' views on the use of IBTs to improve voter registration, indicating that 86.3% of the respondents agreed that IBT added value in improving the voter registration process, while 13.4% were not certain and 0.3% disagreed.

Table 5.16 Respondents' Views on IBTs aiding the Registration Process for Voters

	Num #	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	302	86.3	86.3	86.3
	2	47	13.4	13.4	99.7
	3	1	.3	.3	100.0
	Total	**350**	**100.0**	**100.0**	

Table 5.17 presents respondents' views on the use of IBTs to improve transparency in election processes, indicating that 38% of the respondents were very willing to agree that IBT added value in improving the transparency in election processes, 34.9% agreed, while 22.9% were not certain, and 4.3% disagreed.

Table 5.17 Respondents' Views on IBTs aiding the Transparency of Elections

	Num#	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	15	4.3	4.3	4.3
	3	80	22.9	22.9	27.1

	4	133	38.0	38.0	65.1
	5	122	34.9	34.9	100.0
	Total	**350**	**100.0**	**100.0**	

Table 5.18 presents the respondents' views on the use of IBTs in EMPs to reduce fraud in election processes, indicating that 38.3% of respondents were very willing to agree that the use of IBTs in EMPs reduced fraud in election processes, 31.7% agreed, while 23.1% were not certain, and 6.9% disagreed.

Table 5.18 Respondents' Views on the Use of IBTs in EMPs to Reduce Fraud in Election Processes

	Num#	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	2	24	6.9	6.9	6.9
	3	81	23.1	23.1	30.0
	4	134	38.3	38.3	68.3
	5	111	31.7	31.7	100.0
	Total	**350**	**100.0**	**100.0**	

Table 5.19 presents the respondents' views on the use of IBTs in facilitating the efficiency and effectiveness of EMPs in election processes, indicating that 37.4% of the respondents were very willing to agree that the use of IBTs facilitated the efficiency and effectiveness of EMPs in election processes, 36.9% agreed, while 4.3% were not certain, 0.3% disagreed and 2.9% strongly disagreed.

Table 5.19 Respondents' Views on the use of IBTs in Facilitating Efficiency and Effectiveness of EMPs in Election Processes

	Num#	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	1	10	2.9	2.9	2.9
	2	15	4.3	4.3	7.1
	3	131	37.4	37.4	44.6
	4	129	36.9	36.9	81.4
	5	64	18.3	18.3	99.7

	24	1	.3	.3	100.0
	Total	**350**	**100.0**	**100.0**	

Table 5.20 presents respondents' views on the use of IBTs in increasing the voters' trust in the IEC, indicating that 43.7% of the respondents were very willing to agree that the use of IBTs increased voters' trust in the IEC in election processes, 39.7% agreed, while 14.3% were not certain, and 2.3% disagreed.

Table 5.20 Respondents' Views on the use of IBTs in Increasing the Voters' Trust in the IEC in Election Processes.

	Num #	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	8	2.3	2.3	2.3
	3	153	43.7	43.7	46.0
	4	139	39.7	39.7	85.7
	5	50	14.3	14.3	100.0
	Total	**350**	**100.0**	**100.0**	

Table 5.21 presents respondents' views on the use of IBTs in reducing EMP time, indicating that 42.3% of the respondents were very willing to agree that the use of IBTs reduced EMP time in election processes, 40% agreed, while 12.9% were not certain, and 4.9% disagreed.

Table 5.21 Respondents' Views on the use of IBTs in Increasing the Voters' Trust in the IEC in Election Processes.

	Num#	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	17	4.9	4.9	4.9
	3	148	42.3	42.3	47.1
	4	140	40.0	40.0	87.1
	5	45	12.9	12.9	100.0
	Total	**350**	**100.0**	**100.0**	

Table 5.22 presents respondents' views on the use of IBTs in increasing public awareness and sensitisation, indicating that 37.7% of the respondents were very willing to agree that the use of IBTs increased public awareness

and sensitisation in election processes, 29.7% agreed, while 28.9% were neutral, and 3.7% disagreed.

Table 5.22 Respondents' Views on the use of IBT in Increasing Public Awareness and Sensitisation in Election Processes

	Num#	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	13	3.7	3.7	3.7
	3	101	28.9	28.9	32.6
	4	104	29.7	29.7	62.3
	5	132	37.7	37.7	100.0
	Total	**350**	**100.0**	**100.0**	

Table 5.23 presents respondents' views on the use of IBTs in improving the reliability of election processes and outcomes, indicating that 41.7% of the respondents were very willing to agree that the use of IBTs improves the reliability of election processes and outcomes, 28.0% agreed, while 26.9% were neutral, and 3.4% disagreed.

Table 5.23 Respondents' View on the use of IBTs in Improving the Reliability of Election Processes and Outcomes

	Num#	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	12	3.4	3.4	3.4
	3	94	26.9	26.9	30.3
	4	146	41.7	41.7	72.0
	5	98	28.0	28.0	100.0
	Total	**350**	**100.0**	**100.0**	

5.6 Performance Assessment of Elections Management Processes: Summary of Preliminary Findings

5.6.1 Major Problem with Potential Threats to Voter Confidence and Systems Trust

The data from this thesis suggests an overall hopefulness on election-related technology among IEC officials, EISA, and other civil society members who completed the relevant questionnaires, as reflected in Tables 5.16-23 and below as follows:

- In alignment with the study objective, this study revealed that IBTs improve the efficiency and effectiveness of the Electoral Commission.
- IEC and EISA participants were aware of the policies and legislation governing the use of election-related technologies, but only one specifically made reference to the IBT conceptual framework (refer to research question: *What are the components of an effective and efficient framework for EMPs for the implementation of an IBT system within the South African elections context?*).
- It is not surprising that input regarding the question of corruption, mismanagement, etc. in the procurement of certain ICTs for EMBs, was not mentioned by any participant, although this researcher knows that this remains a sensitive issue which undermines the modernisation or upgrading of the infrastructure of many EMBs.
- During focus group discussions, many participants cautioned about the use of certain IBTs but omitted this in their questionnaire responses. Quality control, monitoring and evaluation issues on IBTs remain constant problems for EMBs.

5.6.2 **The Role of Political Parties in promoting IBT**

The thesis found that major stakeholders concluded that the use of IBTs for elections processes was useful. The second important point to raise is that the electorates have established that technology offered benefits to the elections processes.

In Table 5.24, the analysis of political parties and other elections stakeholders' views towards the promotion and adoption of IBTs for elections is presented, indicating that 75% of the respondents were positive about stakeholders' views on technology, while 25% rejected IBTs.

Table 5.24 The Role of Political Parties and other Elections Stakeholders regarding the Promotion and Adoption of IBTs

Description of Variables	Frequency	Total Pool in Percentages	Valid and Counted Records
Yes	440	75%	75%
No	260	25%	25%
Total	**700**	**100**	**100**

5.6.3 **IBT Innovation in Elections Processes**

This involves the use of software, biometric technology with Iris features for voter IDs, digital printers and IP-based surveillance cameras at polling stations. The purpose was to evaluate whether the use of IBTs in elections processes had any impact on the contribution of international elections standards, the SADC regional code of good practice and the African Union charter for good elections (African Union 2007a:2007b: 1; Glen 2012).

Table 5.25 presents the results from the Online Monkey Survey (2018). The responses from Table 5.25 indicate that 85% of the respondents were happy to make use of technology for election reforms, while 15% were not happy.

Table 5.25 Respondents' Views on IBT Innovation in the Elections Process

Description of Variables	Frequency	Total Pool in Percentages	Valid and Counted Records
Yes	740	85%	85%
No	260	15%	15%
Total	**1000**	**100**	**100**

5.7 **IBT for Core Elections Management Processes**

When asked whether IBT plays an important role in core elections management processes in Gauteng, more than 85% of the respondents gave a 'Yes' response. From this number, many stated that ICT helps in communication across constituencies/districts/provinces, minimising the multiple registration which was recently used to transmit election results in voter registration; mapping polling stations; informing voters and relaying messages rapidly; and that the statement 'We live in a world of technology' helps in the production of the voters rolls/registers, encourages people (voters) to go and vote in large numbers, disseminates information to citizens, helps in information storage and sharing, and helps to reach the majority of citizens in rural areas – these last-mentioned points are specifically relevant to the theories of democracy (participatory and representative) and the consolidation of democracy (Maphunye 2019: 8-11).

Table 5.26 presents respondents' views on IBT for Innovation Transparent Elections Results, indicating that 85% of the respondents supported IBT for Innovation Transparent Elections Results, while 15% rejected IBT.

Table 5.26 Respondents' Views on IBT for Innovation Transparent Elections Results

Description of Variables	Frequency		Total Pool in Percentages	Valid and Counted Records
Yes	740		85%	85%
No	260		15%	15%
Total	**1000**		**100**	**100**

In terms of the theories of elections practice and standards, the data above suggests that the respondents were aware that the electronic transmission of results, the cross-regional or district communication, the need to minimise multiple voter registration as an aspect of election fraud, and the speedy transfer of election-related data and results were critical to the entrenchment of safeguarding democratic elections among the voters (Maphunye 2019: 8-11).

5.7.1 **Capacity of EMBs to implement and adopt IBTs**

The availability of the following items within EMBs, from the head office to field offices, supports the adoption and effective utilisation of IBTs:

- Technical support and relationships with ICT suppliers
- Budgets to finance long-term contracts
- Skilled human resources
- Policy direction of ICT usage
- Consumables

Table 5.27 presents respondents' views on the capacity of EMBs to implement and adopt IBTs, indicating that 60% of respondents confirm that EMBs have the capacity to implement and adopt IBTs.

Table 5.27 Respondents' Views on the Capacity of EMBs to Implement and Adopt IBTs

Description of Variables	Frequency	Total Pool in Percentages	Valid and Counted Records
Agree	340	60%	60%
Disagree	260	20%	20%
Not sure	200	20%	20%
Total	**800**	**100**	**100**

5.7.2 **Cost of Maintaining Technology Solution**

The budget for the ICT facility was reported to be R25 million (IEC 2014: 1-21).

5.8 **Overall Assessment of IBT Governance reforming the entire Election Process**

The study noted that there is a significant growth of IBT-use in South African elections, since the results obtained give the impression that the majority of the election stakeholders accept that IBTs have contributed to the election process. Overall, this data suggests that IBTs and some form of electronic voting can be a complex issue for any EMB, although certain trends are discernible indicating a general preference for the use of ICT to enhance elections. The complexity arises from the literature discussed in Chapters 2 and 3, where the following themes were noted in the study:

- There is no adopted or working IBT framework to guide the effectiveness of technology in safeguarding free and fair elections.
- EMBs need funds to purchase ICTs for elections, but such a budget is normally underpinned by ambiguous political priories of (governing) party hurdles which impede the procurement of effective technology by the EMBs without political interference from the incumbent and opposition parties.
- When to replace outdated technology

- The training and retaining of officials before the next election cycle
- The dangers arising from ICTs in elections and how best to secure the secrecy of the vote
- Africa's infrastructure and broadband challenges
- The brain drain phenomenon
- The legislation
- Many respondents acknowledged that ICTs are not the 'final solution' to Africa's election-related woes

Figure 5.8 presents the overall view from respondents on the overall assessment of IBT governance in election processes. Figure 5.8 indicates that there is understanding and optimism regarding the use of IBTs in Gauteng.

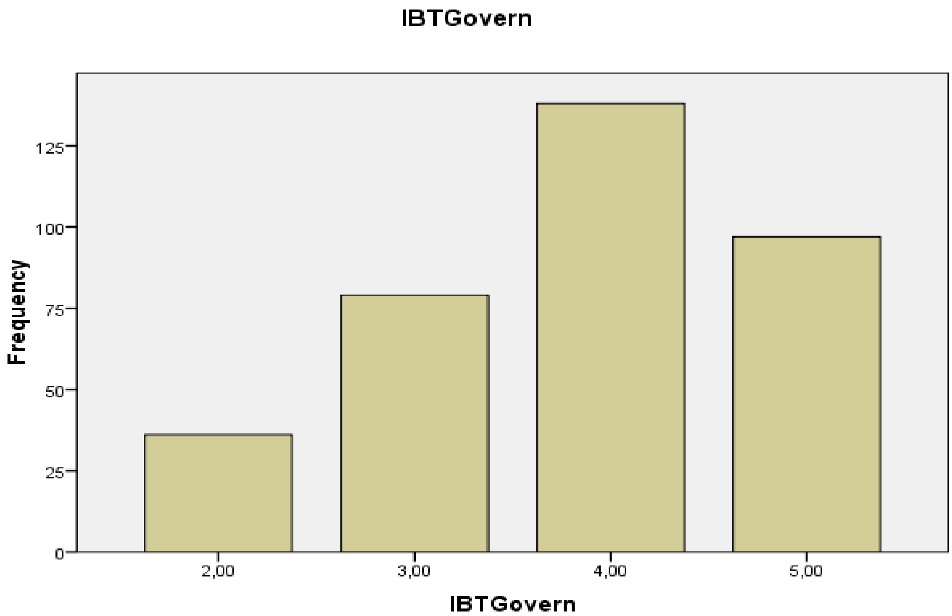


Figure 5.8 Overall Assessment of IBT Governance

5.9 **Summary**

This research has focused on elections management processes, and the case example involved the investigation and analysis of the use of IBTs in Gauteng for election processes within the election period from 2009 to 2014.

The chapter has examined the role of IBTs in Gauteng and suggested lessons for the EMBs will be presented in Chapter 7, especially regarding the effects and significance of IBTs in elections (Alvarez et al. 2013: 117-137). Overall, there seems to be empathy and optimism regarding the use of IBTs in South Africa, but there are equally worrisome conceptual frameworks, and constitutional, legal and political commitment which must be considered before the EMBs can implement election-related technologies. Some of the factors which the stakeholders mentioned include security, political factors, organisational factors, ICT infrastructure, legal factors, accessibility and elections staff training (Achieng and Ruhode 2013: 9).This opportunity intended to allow the researcher to evaluate the use of IBTs in real elections. This research used observations, focus groups, as well as questionnaires to collect the data from the participants. The aim of the first observations were to obtain a better understanding of the challenges of the current IBT system used in South African elections in Gauteng.

The focus groups were then used to explore the detailed impressions, ideas and concepts on factors which might influence the successful implementation of IBTs. The results from the focus groups indicate that the participants felt hopeless about the current IBT system, and they indicated their interest in using IBT complete e-enabled elections. The questionnaires were also used to investigate the detailed impressions, ideas and concepts on factors which might influence the successful implementation of IBTs in South African elections.

The results from the questionnaires indicated that the majority of the participants had mobile phones, and these are considered smart phones with an Internet connection almost everywhere in Gauteng. The study does not claim to be representative of the entire South African or SADC region, nor does it generalise its research findings across Africa. However, it seeks to share the ideas of some of the stakeholders who are directly involved in election management on continental views regarding IBT. These are the ideas of the experts which are present in South Africa and other countries.

The next chapter presents the proposed IBT conceptual framework for the sustainable use of IBTs within the EMPs in South Africa, and the investigation of key factors for effective election integrity models.

Chapter 6 TOWARDS SUSTAINABLE USE OF IBT IN ELECTIONS MANAGEMENT PROCESSES IN SOUTH AFRICA – INVESTIGATION OF KEY FACTORS FOR EFFECTIVE ELECTION INTEGRITY MODELS

6.1 **Introduction**

This chapter presents the IBT-use and election integrity models obtained from the analyses of the elections management processes adopting IBTs for South African elections based on the views of the voters, political parties, Electoral Commission (IEC) and EISA. The data analysed and used to develop the statistically-significant IBT models for election integrity were collected from respondents from the four categories (IEC, EISA, Voters and Political Parties) via surveys, questionnaires and interviews based on the 2009 and 2014 national elections in South Africa. This chapter, addresses research sub-questions (i) and (iv) posed by this study in Section 1.4 in Chapter 1, amongst other factors.

6.2 **Data Analysis**

The Statistical Package for Social Scientists (SPSS) version 16.0 (Nie 1975: 1) was used to analyse the gathered data. Furthermore, four datasets (respondents) were employed in the determination of the significant IBT variables corresponding to the integrity of elections in South Africa based on one for the voters and the other for the IEC, EISA and the political parties. Specific descriptions of the variables which constitute these questionnaires are presented in Tables 6.3 and 6.5 contained within this chapter. The first dataset is composed of 350 responses of voters to 72 variables relating to the use of IBTs in the EMPs and their use with regards to the integrity of election outcomes in South Africa.

The second dataset is composed of 15 responses of IEC members of staff to 42 variables on the use of IBTs in the EMPs and their use with regards to the integrity of election outcomes in South Africa. The third and fourth datasets were distinct, accumulated responses collected from EISA, the African National Congress, and Democratic Alliances. A total of 13 responses were obtained from EISA and five responses were obtained from political parties. These datasets were analysed and the results of the analyses are used to (i) determine the use of IBTs in the EMPs and their impact on the integrity of election outcomes; and (ii) present a framework model which guarantees election integrity via the use of IBTs in the EMPs in South Africa. Several statistical modules, including correlation and regression analyses in Microsoft Excel and SPSS applications, were employed for these purposes.

6.2.1 **Correlation Analysis**

The coefficient of correlation is used to measure the magnitude of the linear relationship between election integrity using IBTs and the IBT-use impact predictors. The formula employed includes Equations 6.1 and 6.2 (Astrid, Gerhard and Maria 2010: 776-782):

$$\mathbf{r} = \frac{\sum \mathbf{XY}}{\mathbf{n}\sigma_{\mathbf{x}} \cdot \sigma_{\mathbf{y}}}, \qquad (6.1)$$

where $\boldsymbol{\sigma}_{\mathbf{x}}$ and $\boldsymbol{\sigma}_{\mathbf{y}}$are the standard deviations of x and y respectively, while x and y are the variables for which a possible relationship is being investigated:

The next chapter presents the proposed IBT conceptual framework for the sustainable use of IBTs within the EMPs in South Africa, and the investigation of key factors for effective election integrity models.

$$\mathbf{r} = \frac{\sum \mathbf{XY}}{\sqrt{\sum \mathbf{X}^2 \cdot \sum \mathbf{Y}^2}}, \quad \mathbf{X} = \mathbf{x} - \bar{\mathbf{x}}, \ \mathbf{Y} = \mathbf{y} - \bar{\mathbf{y}}. \qquad (6.2)$$

When the deviations are taken from the actual mean, any of these methods can be applied. The correlation algorithm implemented in SPSS 16.0 was used to calculate the correlation between election integrity and the use of IBTs in elections management processes via selected predictors. Invariably, all the predictors contained in the questionnaire were correlated with election integrity using IBTs to determine the degree of correlation between them. The correlation between these predictors and election integrity was regarded as significant at a Sig. (2-tailed) value greater than or equal to 0.25.

A dataset of correlates was then generated from each of the four datasets on which the correlation analysis was performed.

6.2.2 **Regression Analysis**

Regression was used to measure the average relationship between election integrity correlated predictors and the use of IBTs in elections management processes. The multiple linear regression was used to precisely quantify the degree of influence of the independent variables on the dependent variables. This is because the relationship entails more than two variables. The functional relationship between election integrity and the use of IBTs in elections management processes can hence be expressed as in Equation 6.3:

$$Election\_Integrity = \boldsymbol{f}(\boldsymbol{x_1}, \boldsymbol{x_2}, \dots, \boldsymbol{x_n}), \tag{6.3}$$

where $\mathbf{x_1}, \mathbf{x_2}, \dots, \mathbf{x_n}$ are the several correlate predictors which are being considered. The internal consistency of the variables which make up the questionnaires was determined using a Cronbach's alpha, α. This measure helps to determine the scale reliability by revealing the level of closeness of the variables. A Cronbach's alpha value in the range of $0.8 \leq \alpha < 0.9$ is regarded as being in a very good range (Chayalakshmi, Jangamshetti and Savita 2018: 1-9; Fagbola *et al.* 2018). In Tables 6.1 and 6.2, reliability statistics with values of 0.847 and 0.831 were obtained for the two questionnaires, respectively. These values indicate that there exist close relationships among the variables used as predictors and are, as such, reliable.

Table 6.1 Reliability Statistics of the Voter Questionnaires' Variables

Cronbach's Alpha	N of Variables
Political Parties (PP.847)	72

Table 6.2 Reliability Statistics of the IEC, EISA and Political Parties Questionnaires' Variables

Cronbach's Alpha	N of Variables
.831	42

6.3 **Use of IBTs in EMPs towards Integrity of South African Elections: Voters' Perspective**

6.3.1 **Voters' IBT Model Parameters for Investigation**

In this study, all possible factors which could influence the integrity of election outcomes via the use of IBTs in the EMPs were explored and investigated. Subsequently, 71 variables were extracted from the voters' structured questionnaire and used to model and establish the relationship between the use of IBTs in EMPs and the integrity of election outcomes in South Africa. This set of variables served as the independent variable inputs into the voters' IBT predictive modelling task, while the integrity of election outcomes, with the use of IBTs to manage EMPs (*IBT integrity*), forms the dependent variable. The description of these variables is presented in Table 6.3.

Table 6.3 Description of Voter-Respondent Variables

S/N	Variables	Description
1	Gender	The gender orientation of the respondent
2	Race	The race of the respondent
3	age group	Age group of the respondent
4	Techexposure	Exposure of respondents to technology and its use
5	Education	Education of respondents
6	Gauteng_region_other	Location within Gauteng region
7	AVRdata	Actual voter registration
8	reg_voters	Use of IBT enhances registration by voters
9	IBTWasteful	Use of IBT in elections is wasteful
10	IBTustain	Use of IBT is perceived to be more sustainable than the paper-based procedures
11	VVVdata	Vote and voting verification
12	IBTEasyVote	IBT offered ease of voting
13	SAPPI	How long the voter has been involved with the South African election processes and procedures?
14	IBTFacilitate	Use of IBT facilitated participation from diasporas
15	IBTReducFraud	Use of IBT reduced election fraud
16	NPdata	Use of IBT improves nomination procedures
17	IBTVEduInfo	With IBT, voters in need of voter education are well-exposed to voter education which facilitates their effective participation
18	IBTReliability	The use of IBT for elections is perceived as reliable
19	Voters_role	Voters' role in the national and provincial elections
20	IBT_EMB_IMP	Use of IBT reduced degree of the EMB's transparency if applicable
21	VCdata	Vote counting
22	IBTIAE	Use of IBT improved accountability of the overall electioneering processes
23	IBTRPPEV	Use of IBT reduced probability of post-election violence
24	IBTPubAwa	Use of IBT increased public awareness and sensitisation
25	IBTVio	Use of IBT reduced violence and post-election conflicts
26	IBTIECStaffPr	Digital device / technical know-how of the IEC staff is a problem to the use of IBT

S/N	Variables	Description
27	IBTReducImp	IBT reduced IEC impartiality
28	IBTAIC	Use of IBT improved the availability of information about constituencies and lower level districts (demarcation, sizes, seat)
29	IBTTurnout	Use of IBT raised voter turnout
30	IBTAccExped	Use of IBT improved election accuracy and expediency
31	SVdata	Signing of votes
32	VCAdata	Vote consolidate and aggregation
33	IBTImperson	Use of IBT resolved impersonation and multiple voting
34	IBTTimeReduc	Use of IBT reduced time standing in queues to vote
35	IBTPP	Use of IBT increased public participation in elections
36	IBTFFElec	Use of IBT enhanced free and fair elections
37	IBTPC	Use of IBT increased public confidence
38	DVRdata	Delivering voting results
39	IBTGovern	Use of IBT promoted good governance / democracy via credible elections
40	RoPdata	Regulation of party / candidates
41	IBTPartMarg	Use of IBT increased participation of marginalised and disadvantaged groups in elections
42	IBTRTP	IBT is more reliable and trustworthy than paper- based procedures
43	VCCdata	Vote confidentiality
44	VTdata	Vote tabulation
45	IBTTrust_IEC	Use of IBT increased trust in the IEC
46	IBTIDS	Use of IBT improved quality of IEC’s delivery of service in elections
47	IBTcost	Use of IBT is perceived to be more cost-effective than the paper-based procedures
48	IBTLC	Use of IBT increased the level of compliance to the use of boundary limitation and seat allocation in place according to the rules
49	IBT_EMB_TRN	Use of IBT reduced degree of the EMB’s transparency
50	IECMembers	Challenged by highly-skilled IEC members
51	IBTVotAcc	Use of IBT increased voter accessibility
52	MCOdata	Monitor the conduct of observers
53	VAdata	Vote authentication
54	IBTTranssp	Use of IBT enhanced transparency of the overall electioneering process
55	IBTatis_NP	Use of IBT increased satisfaction with national and provincial elections
56	RTVSdata	Results tabulation per voting station
57	IBTMagGrId	Using IBT, the marginalised groups have been recognised and their identified needs adequately addressed
58	VAuditing	Vote auditing
59	BD2data	Boundary delimitation
60	IBTRI	Use of IBT reduced irregularities
61	IBTS	Use of IBT enhanced safety and security during elections 2009
62	RC2data	Results counting per voting station
63	VIVSdata	Voter identification at voting station
64	IBTProblem	Usability of the IBT devices was not a problem during the elections
65	POdata	Public outreach
66	VRdata	Voter registration
67	VIdata	Voter identification at voting station
68	MCPAdata	Monitor the conduct of party agents
69	RSVSdata	Results sorting per voting station
70	RTDdata	Results transmission and declarations per voting station
71	CVRdata	Compilation of voter register
72	IBTIntegrity	Integrity of elections outcome

6.3.2 **Voters' Correlation Information**

The result of the correlation analysis of the respondents' (voters) data revealed that six out of the 71 independent variables being investigated – i.e. *Gender*, *Race*, *age_group*, *techexposure*, *education* and *Gauteng_region_other* – do not have any correlation with the integrity of election outcomes via the use of IBTs. However, the remaining 65 variables correlated well with the integrity of election outcomes using IBTs, having produced correlation values greater than or equal to 0.25 (≥ 0.25). The correlation table for the voters respondent data is presented in Appendix E.

6.3.3 **Voters' Regression Model Information**

A multi-linear regression of the respondents' (voters) data associated with the correlated set of 65 variables with the integrity of the elections outcome using IBTs was conducted. The regression coefficient table is presented in Appendix F. However, 25 out of these variables were found to not have any significant relationship with the integrity of elections using IBTs, as they produced *P*-values greater than or equal to 0.05. These variables include *IBTustain*, *VVVdata*, *SAPPI*, *IBTFacilitate*, *NPdata*, *IBTReliability*, *IBT_EMB_IMP*, *VCdata*, *IBTPubAwa*, *IBTReducImp*, *IBTAccExped*, *SVdata*, *IBTTimeReduc*, *IBTPP*, *RoPdata*, *IBT_EMB_TRN*, *IECMembers*, *VAdata*, *IBTTrasnsp*, *IBTMagGrId*, *BD2data*, *IBTS*, *RC2data*, *VRdata* and *RSVSdata*. Table 6.3 includes the descriptions of these variables.

6.3.4 **Voters' Election Integrity Model with the Use of IBT**

Forty independent variables were found to be statistically significant for the use of IBTs and the integrity of elections outcomes, having yielded *P*-values lower than 0.05. Table 6.4 presents the possible range of input values for each of the variables contained in this model. Equation 6.4 depicts the voters' predictive model of the integrity of election outcomes using IBTs. The possible output values of *IBTIntegrity* range from '1' to '5' in increasing order of the integrity of elections using IBTs. This model can be used as a precautionary tool to anticipate and measure the possible integrity of elections using IBTs by varying the parameter values of the independent variables until a satisfactory outcome is obtained.

Table 6.4 Range of Input Values for Significant Predictors

S/N	Model Variable	Range of Possible Input Values (Likert Scale)
1	reg_voters	(1-2)
2	voters_role	(1-6)
3	IBTVio	(1-5)
4	IBTcost	(1-5)
5	IBTIAE	(1-5)
6	IBTGovern	(1-5)
7	IBTReducFraud	(1-5)
8	IBTPartMarg	(1-5)
9	IBTTumout	(1-5)
10	IBTFFElec	(1-5)
11	IBTRTP	(1-5)
12	IBTTrust_IEC	(1-5)
13	IBTRI	(1-5)
14	IBTatis_NP	(1-5)
15	IBTEasyVote	(1-5)
16	IBTImperson	(1-5)
17	IBTIECStaffPr	(1-5)
18	IBTPC	(1-5)
19	IBTVotAcc	(1-5)
20	IBTProblem	(1-5)
21	IBTWasteful	(1-5)
22	IBTRPPEV	(1-5)
23	IBTIDS	(1-5)
24	IBTAIC	(1-5)
25	IBTLC	(1-5)
26	IBTVEduInfo	(1-5)
27	VTdata	(1-5)
28	VCAdata	(1-5)
29	DVRdata	(1-5)
30	POdata	(1-5)

S/N	Model Variable	Range of Possible Input Values (Likert Scale)
31	VIdata	(1-5)
32	VAudting	(1-5)
33	VCCdata	(1-5)
34	MCOdata	(1-5)
35	MCPAdata	(1-5)
36	VIVSdata	(1-5)
37	RTVSdata	(1-5)
38	RTDdata	(1-5)
39	CVRdata	(1-5)
40	AVRdata	(1-5)
41	IBTIntegrity	(1-5)

IBTIntegrity = 0.185 (*reg_voters*) - 0.032 (*voters_role*)+ 0.182 (*IBTVio*) -
0.233 (*IBTcost*) + 0.310 (*IBTIAE*) - 0.440 (*IBTGovern*)
+ 0.187 (*IBTReducFraud*) + 0.198 (IBTPartMarg) + 0.143 (*IBTTumout*) -
0.4 (*IBTFFElec*) - 0.331 (*IBTRTP*) + 0.587 (*IBTTrust_IEC*)
+ 0.201 (*IBTRI*) - 0.362 (*IBTatis_NP*) + 0.159 (*IBTEasyVote*) -
0.288 (IBTImperson) - 0.17 (IBTIECStaffPr) + 0.689 (*IBTPC*) -
0.168 (*IBTVotAcc*) + 0.603 (*IBTProblem*) - 0.235 (*IBTWasteful*)
+ 0.136 (*IBTRPPEV*) - 0.168 (*IBTIDS*) + 0.199 (*IBTAIC*) - 0.139 (*IBTLC*)
+ 0.370 (*IBTVEduInfo*) + 0.117 (*VTdata*) + 0.16 (*VCAdata*)
+ 0.176 (*DVRdata*) + 0.393 (*POdata*) - 0.215 (*VIdata*) - 0.368 (*VAudting*)
+ 0.122 (*VCCdata*) + 0.625 (*MCOdata*) - 0.751 (*MCPAdata*)
+ 0.155 (*VIVSdata*) + 1.453 (*RTVSdata*) - 1.360 (*RTDdata*) -
1.376 (*CVRdata*) + 1.529 (*AVRdata*) - 0.183. (6.4)[2]

A higher value of *IBTIntegrity* tending towards '5' indicates an increasing integrity of the elections with the use of IBTs in the elections management processes. Figure 6.1 presents a normal probability plot showing that the residuals on the independent variables are normally distributed. It compares the observed Cumulative Distribution Function (CDF) of the standardised residual to the expected CDF of the normal distribution in a bid to test the

[2] Table 6.6 summarises that stakeholders are excited about the use of technology in the election process.

normality of the residuals. The residuals are the values of the dependent variable minus the predicted values.

Similarly, the scatter plot of the standardised residuals and predicted values for the voters' model is presented in Figure 6.2 and reveal that the standardised residuals are relatively evenly distributed on both sides of '0'. This indicates that the homoscedasticity is established and that the model is valid. Even when conditions of significance are satisfied, it is necessary to compare the residuals for normality. As many of the residuals differ in variance, it becomes very difficult to compare them. Hence, standardised residuals are used over the normal residuals. By standardising, the residuals are forced to have a unit variance for easy comparison.

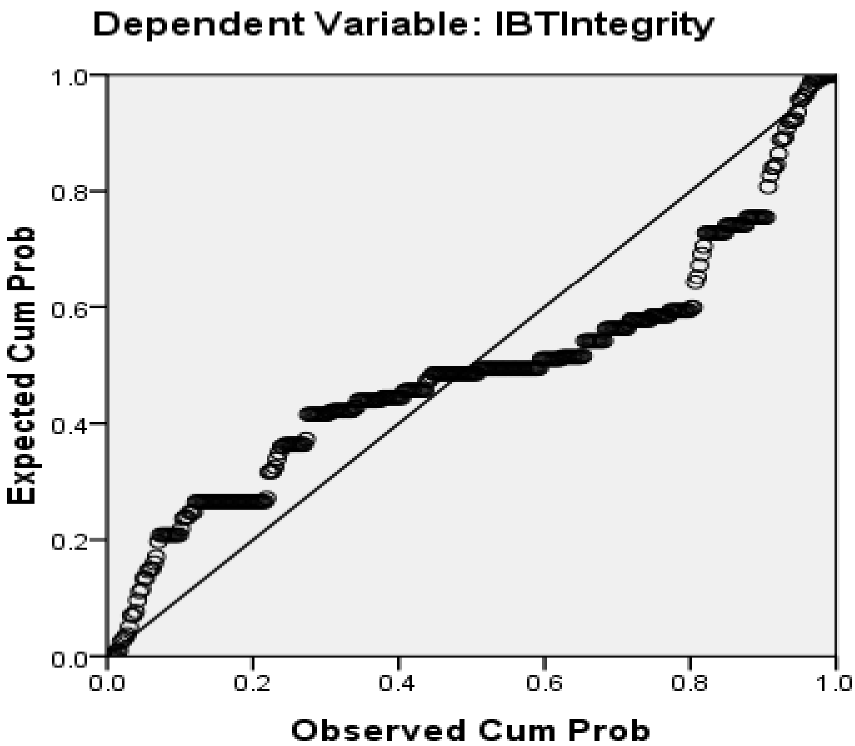


Figure 6.1 Normal Political Parties (PPP-P Plot of Regression Standardised Residual)

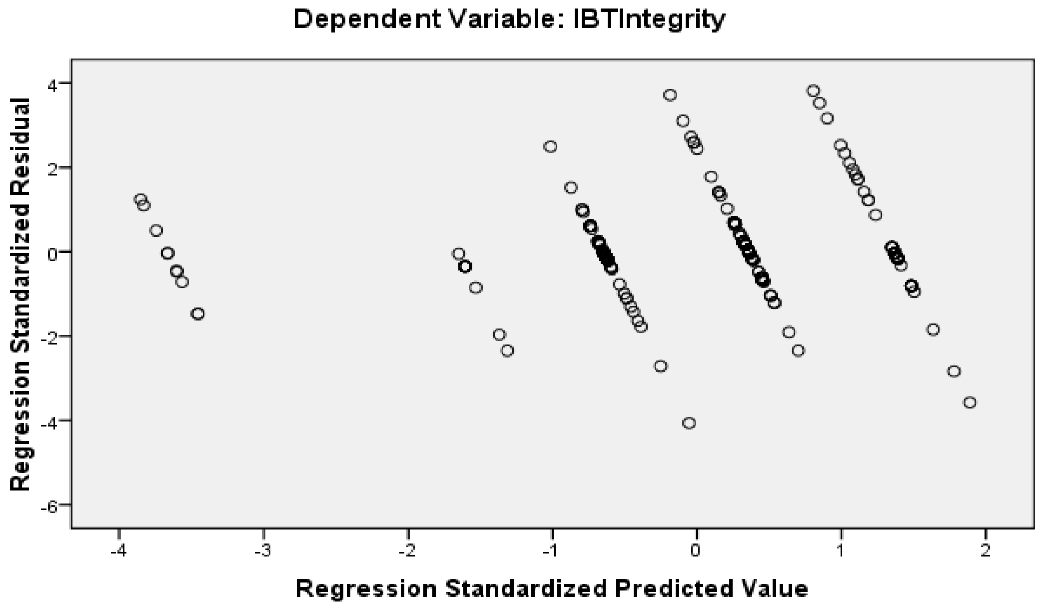


Figure 6.2 Scatter Plot for the IBT Integrity Variable

6.4 Use of IBTs in EMPs towards Integrity of South African Elections: IEC's Perspective

6.4.1 IEC's Election Integrity with IBT Model Parameters

The opinions of the IEC, obtained through structured questionnaires and interviews regarding the integrity of South Africa's election outcomes via the use of IBTs in the EMPs, were explored using 42 variables. The actual description of these variables is presented in Table 6.5. This set of variables served as the independent variable inputs into the IEC's IBT predictive modelling task, while the integrity of election outcomes with the use of IBTs to manage EMPs (*IBTVCIA*), forms the dependent variable.

Table 6.5 Description of Respondents' Variables (IEC, EISA, Political Parties)

S/N	Variables	Description
1	Gender	Gender of respondent
2	Race	Race of respondent
3	edu_background	Educational background of respondent
4	Experience	Length of experience of respondent with IEC, EISA or South African political party (in years)
5	age_group	Age group of respondents
6	avail_cons_leg_foundation	The availability of consolidated legal foundation for the use of IBT in elections

S/N	Variables	Description
7	IBTCA	The use of IBT comprehensibility and availability of elections timetable
8	implementation_level	The level of implementation of elections legislation on the use of IBT for elections
9	IBTLBE	The perceived legitimacy of the IBT-based elections framework
10	IBTLeg_voters	The level of legitimacy/acceptance of use of IBT by voters
11	IBTLeg_parties	The level of legitimacy/acceptance of use of IBT by parties
12	IBT_Constituency_struc_parties	The level of acceptance of the IBT-related constituency structure modality by parties
13	IBT_Constituency_struc_voters	The level of acceptance of the IBT-related constituency structure modality by voters
14	voting_age_population_first	Voting age population, higher percentage of those eligible to vote for the first time in the election actually voted
15	criteria_rag_accepted_inter	The criteria for registration are fair and reasonable and compliant with accepted international standards
16	appropriate_mech_public_reg	There are appropriate mechanisms for ensuring that the public can have confidence in the IBT-based register
17	approriate_mech_IBT_reg	There are appropriate mechanisms for ensuring that the information in the IBT- register is accurate
18	ability_to_register	Qualified people were able to register with minimal inconvenience
19	IBT_Bias_free	The IBT-assisted register is free from significant bias based on gender, age, ethnic or religious affiliation, or region
20	IBT_none_discr	The IBT-assisted method of voting is non-discrimination
21	PC_satisfaction_IBT	Parties and candidates who fulfil the requirements of registration are satisfied with the IBT-assisted registration without bias
22	Sys_allocating_funds	There is a system for the allocation of public funds to political parties in place and is implemented
23	IBTInde_Mechanism	There is an independent IBT-assisted mechanism for identifying bias in the state media and subjecting the bias to swift correction
24	IBTLLV	There is a low level of significant election-related violence as a result of IBT-related challenges (failure, non-availability, connection problems, verification bottlenecks)
25	IBT_preclude_fraud	IBT has assisted to preclude and/or rectify fraudulent voting

S/N	Variables	Description
26	IBT_Polling_accessibility	IBT has made polling more accessible, secure, and confidential
27	Observer_satis_IBT	Election observers are satisfied with the approach of the use of IBTs during elections
28	IBT_enabled_sys	IBT-enabled systems are in place to preclude vote buying
29	IBT_freewill	IBT allows the voters to express their free will without intimidation
30	IBTTTAR	The use of IBT has made the tabulation transparent and an accurate reflection of the polling booth count
31	IBT_quickes_results	The use of IBT made results more easily and rapidly available to interested members of the general public
32	IBT_votecount_no_delay	The use of IBT allows vote counting to take place with no undue delay
33	PC_confidence_IBT	Parties and candidates have high confidence in IBT being integrated into the election management processes
34	IBT_manage_complaints	Use of IBT helps manage significant election complaints more effectively for adjudication
35	IBT_dispute_resolution	There is an appropriate IBT-enhanced dispute resolution mechanism in place
36	IBT_manage_court_dis	The use of IBT in election helps manage court disputes more efficiently and effectively
37	EOO_IBT_confirm	Election observation organisations confirm that the use of IBT for the elections were without significant problems
38	IBT_IEC_timeframe	The use of IBT allows the IEC to meet the timeframe for the constitution of parliament
39	IBT_election_stats	The use of IBT allows for better documenting of election statistics and allows them to be more easily available without significant delay
40	IBT_EMB_easier_transp	The use of IBT makes the auditing of EMBs easier and more transparent
41	IBTICE	The use of IBT increases the capacity for election review
42	IBTVCIA	The use of IBT has helped to conduct voting with integrity and accuracy

6.4.2 **IEC's Correlation Information**

The result of the correlation analysis of the respondents' (IEC) data revealed that six out of the 41 independent variables being investigated – i.e.:

> *Gender*, *experience*, *age_group*, *avail_cons_leg_foundation*, *IBTCA* and *Implementation_level*

do not have any correlation with the integrity of election outcomes via the use of IBTs. However, the remaining 35 variables correlated well with the integrity of election outcomes using IBTs, having produced correlation values greater than or equal to 0.25 (≥ 0.25). The correlation table for the IEC's respondent data is presented in Appendix G.

6.4.3 **IEC Election Integrity using IBT – Regression Model Information**

A multi-linear regression of the respondents' (IEC) data associated with the correlated set of 35 variables with the integrity of elections outcome using IBTs was conducted. The regression coefficient table obtained from the analysis of the IEC's data of correlated variables is presented in Appendix H. However, 11 variables:

> *race*, *edu_background*, *IBTLBE*, *IBTLeg_voters*, *IBT_Constituency_struc_voters*, *PC_satisfaction_IBT*, *Sys_allocating_funds*, *IBTInde_Mechanism*, *IBTLLV*, *IBT_votecount_no_delay* and *IBTICE*

were used as predictors of election integrity using IBTs, while 24 independent variables were found to be multi-colinear and as such were excluded as predictors. Multi-collinearity is a condition in which the degree of intercorrelation between predictor variables in a regression model is high (Gunst 2018: 1-424).

This is most often caused by a limited number of data samples with a very low level of variance – in this case, the sample size of the IEC data used is 15. The collinear variables were excluded, as using them for prediction might lead to unstable and unreliable estimates of regression coefficients (Chayalakshmi, Jangamshetti and Savita 2018: 1-9). Three predictor variables – *race*, *edu_background* and *IBTLBE* – were found to not have any significant relationship with the integrity of elections using IBTs, as they produced *P*-values greater than or equal to 0.05.

6.4.4 **IEC's Election Integrity Model**

Eight independent variables were found to be statistically significant to the use of IBTs and the integrity of election outcomes, having yielded *P*-values lower than 0.05. Furthermore, Equation 6.5 explains the IEC's predictive model of the integrity of election outcomes using IBTs. The possible output values of *IBTVCIA* range from '1' to '5' in increasing order of the integrity of elections using IBTs.

This model can be used as a precautionary tool to anticipate and measure the possible integrity of elections using IBTs by varying the parameter values of the independent variables until a satisfactory outcome is obtained.

$$
\begin{aligned}
IBTVCIA = {} & 0.571(IBT\_Constituency\_struc\_voters) - 0.571(IBTLeg\_voters) \\
& + 0.333\,(PC\_satisfaction\_IBT) + 0.286\,(Sys\_allocating\_funds) - \\
& 0.429\,(IBTInde\_Mechanism) + 0.619\,(IBTLLV) - \\
& 0.048\,(IBT\_votecount\_no\_delay) + 0.238\,(IBTICE) - 1.248E\text{-}15.
\end{aligned} \tag{6.5}
$$

6.5 **Use of IBTs in EMPs towards Integrity of South African Elections: EISA's Perspective**

The total number of EISA stakeholders whose responses were collected and used in this study is 13. The description of the variables for the election integrity model with the use of IBTs from the perspective of EISA is presented in Table 6.5.

6.5.1 **EISA's Election Integrity with IBT Model Parameters**

The opinions of EISA obtained through structured questionnaires and interviews regarding the integrity of South Africa's election outcomes via the use of IBTs in the EMPs were explored using 42 variables. This set of variables served as the independent variable inputs into the EISA IBT predictive modelling task, while the integrity of election outcomes with the use of IBTs to manage EMPs (*IBTVCIA*) formed the dependent variable.

6.5.2 **EISA's Correlation Information**

The results of the correlation analysis of the respondents' (EISA) data revealed that eight out of the 41 independent variables being investigated, i.e.:

> *race*, *criteria_rag_accepted_inter*, *appropriate_mech_IBT_reg*, *ability_to_register*, *PC_satisfaction_IBT*, *Sys_allocating_funds*, *IBTTTAR* and *IBT_quickes_results*

do not have any correlation with the integrity of election outcomes via the use of IBTs. However, the remaining 33 variables correlated well with the integrity of election outcomes using IBTs, having produced correlation values greater than or equal to 0.25 (≥ 0.25). The correlation table for EISA's respondent data is presented in Appendix I.

6.5.3 **EISA Election Integrity using IBT - Regression Model information**

A multi-linear regression of the respondents' (EISA) data associated with the correlated set of 33 variables with the integrity of the elections outcome using IBTs was conducted. The regression coefficient table is presented in Appendix J. However, nine variables, i.e.:

> *gender*, *edu_background*, *experience*, *avail_cons_leg_foundation*, *implementation_level*, *IBTLBE*, *IBT_none_discr*, *IBT_election_stats* and *IBTICE*

were used as predictors of election integrity using IBTs, while 24 independent variables were found to be multicollinear and as such were excluded as predictors.

6.5.4 **EISA's Election Integrity Mode**

Eight independent variables were found to be statistically significant to the use of IBTs and the integrity of election outcomes, having yielded *P*-values lower than 0.05. Furthermore, Equation 6.6 shows EISA's predictive model of the integrity of election outcomes using IBTs generated from the table of coefficients of EISA's regressed data. The possible output values of *IBTVCIA* range from '1' to '5' in increasing order of the integrity of elections using IBTs. This model can be used as a precautionary tool to anticipate and measure the possible integrity of elections using IBTs by varying the parameter values of the independent variables until a satisfactory outcome is obtained.

$$IBTVCIA = 0.988 - 0.365\ (gender) - 0.071\ (edu\_background) + 0.024\ (experience) + 0.035\ (implementation\_level) + 0.365\ (IBTLBE) + 0.071 (IBT\_none\_discr) + 0.118\ (IBT\_election\_stats) + 0.365\ (IBTICE). \tag{6.6}$$

6.6 **Use of IBTs in EMPs towards Integrity of South African Elections: Political Parties' Perspective**

The total number of political parties (PP) stakeholders whose responses were collected and used in this study is five. The description of the variables for the election integrity model with the use of IBTs from the perspective of PP is presented in Table 6.5.

6.6.1 **Political Parties' Election Integrity Prediction with IBT Model Parameters**

The opinions of political parties obtained through structured questionnaires and interviews regarding the integrity of South Africa's election outcomes via the use of IBTs in EMPs were explored using 42 variables. This set of variables served as the independent variable inputs into the political parties' IBT predictive modelling task, while the integrity of election outcomes with the use of IBTs to manage EMPs (*IBTVCIA*) formed the dependent variable.

6.6.2 **Political Parties' Correlation Information**

The result of the correlation analysis of the respondents' (political parties) data revealed that *age_group* does not have any correlation with the integrity of election outcomes via the use of IBTs. However, the remaining 40 variables correlated well with the integrity of election outcomes using IBTs, having produced correlation values greater than or equal to 0.25 (≥ 0.25). The correlation table for the political parties' respondent data is presented in Appendix K.

6.6.3 **Political Parties' Election Integrity using IBT – Regression Model Information**

A multi-linear regression of the respondents' (PP) data associated with the correlated set of 40 variables with the integrity of the elections outcome using IBTs was conducted. The regression coefficient table is presented in Appendix L. However, four variables, i.e.:

gender, *IBTLBE*, *sys_allocating_funds* and *IBTICE*

were used as predictors of election integrity using IBTs, while 36 independent variables were found to be multicollinear and as such were excluded as predictors.

6.6.4 **Political Parties' Election Integrity Model**

Three independent variables were found to be statistically significant to the use of IBTs and the integrity of election outcomes, having yielded *P*-values lower than 0.05. Furthermore, Equation 6.7 shows the political parties' predictive model of the integrity of election outcomes using IBTs generated from the table of coefficients of political parties' regressed data. The possible output values of *IBTVCIA* range from '1' to '5' in increasing order of the integrity of elections using IBTs. This model can be used as a precautionary tool to anticipate and measure the possible integrity of elections using IBTs by varying the parameter values of the independent variables until a satisfactory outcome is obtained.

$$IBTVCIA = 0.5\,(IBTLBE) - 0.5\,(gender) + 0.5\,(IBTICE) + 1 \qquad (6.7)$$

6.7 **Discussion of Research Questions (i) and (iv)**

6.7.1 **Research Question (i)**

Research question (i), as stated in Section 1.4 of Chapter 1, is:

Which factors should be considered when designing a framework model for the implementation of IBTs in South African election processes?

The major factors to be considered when designing a framework for the implementation of IBTs in the South African elections processes include the integrity and accuracy of the election outcomes, the confidentiality of the votes, and a free, fair and transparent electioneering process. These are the most critical to a globally-acceptable basic process of fair conduct in an election (Haijun, Edwin Hou and Nirwan 2011), which in turn if not carefully followed through might lead to post-election destructive violence.

Based on the results of the regression analyses of data obtained from the voters, the IEC, EISA and the political parties, the linear relationship between these major factors were investigated using the variables *IBTIntegrity* and *IBTVCIA*, and the determinant independent variables significantly associated with these factors is established as relations for the voters, IEC, EISA and political parties, as presented in Equations 6.4, 6.5, 6.6 and 6.7, respectively.[3]

6.7.2 **Research Question (iv)**

Research question (iv), as stated in Section 1.4 of Chapter 1, is:

What is the role of IBT in the South African EMPs, what are election stakeholders' views on the use of IBTs for elections, and what are their perceptions and misconceptions?

The election stakeholders in this context include the voters, the IEC, EISA and the political parties considered in this study. With reference to the significant variables to the use of IBTs and election integrity, the views and perceptions of the voters, IEC, EISA and the political parties on the use of IBTs for elections are summarised in Table 6.6. However, the perceptions of the election stakeholders are further explored in order of relevance based on a five-scale system (Strongly agree, Agree, Neutral, Disagree and Strongly Disagree).

[3] Table 6.6 summarises that stakeholders are excited about the use of technology in the election process.

Table 6.6 Perceptions of Election Stakeholders on the Use of IBTs in Elections

Election Stakeholders	Views / Perceptions based on Significant Variables
Voters	reg_voters, voters_role, IBTVio, IBTcost, IBTIAE, IBTGovern IBTReducFraud, IBTPartMarg, IBTTumout, IBTFFElec, IBTRTP IBTTrust_IEC, IBTRI, IBTatis_NP, IBTEasyVote, IBTImperson IBTIECStaffPr, IBTPC, IBTVotAcc, IBTProblem, IBTWasteful, IBTRPPEV, IBTIDS, IBTAIC, IBTLC, IBTVEduInfo, VTdata, VCAdata, DVRdata, POdata, VIdata, VAudting, VCCdata, MCOdata, MCPAdata, VIVSdata, RTVSdata, RTDdata, CVRdata, AVRdata
IEC	IBTLeg_voters, IBT_Constituency_struc_voters, PC_satisfaction_IBT, Sys_allocating_funds, IBTInde_Mechanism, IBTLLV, IBTICE, IBT_votecount_no_delay
EISA	gender, edu_background, experience, implementation_level, IBTLBE, IBT_none_discr, IBT_election_stats and IBTICE
Political Parties	gender, IBTLBE and IBTICE

Table 6.6 summarises that stakeholders are excited about the use of technology in the election process, and that they have considered IBT deployment in election processes and procedures to be appropriate because problems such as impersonation have been eliminated, ensuring that all information produced during the elections process, particularly the election results and the elections roll, is correct, trustworthy and secure, thereby generating a broad acceptance that the elections outcome is a true and fair representation of the citizens' will, with increased administrative efficiency, reduced costs and strengthened trust among electioneering stakeholders.

It has also prevented multiple registration, and stakeholders are excited because the IBT adoption has met international standards.

The study set out to identify these core values of technology and to assess whether the use of technology has affected these values. In an interview with members of EISA and the Electoral Commission of South Africa, the members identified these core values to include freeness, fairness, transparency, accountability and probity, among others. The study sought to find out whether the deployment of the IBTs has protected these core values.

Table 6.6 presents the significant variables to validate the use of IBTs and election integrity, by ensuring transparency in operations and protecting the core values which are embedded within the local practice and international norms for acceptable elections.

(a) Voters' Perception

In decreasing order of relevance, as presented in Figure 6.3, voters' most strongly agreed perception of IBT-use in elections is its ability to increase the participation of marginalised and disadvantaged groups in elections (*IBTPartMarg*), for use in vote auditing (*VAuditing*), for improved accountability of the overall electioneering processes (*IBTIAE*), for public outreach (*POdata*), for efficient voters identification at voting stations (*VIdata*), to be more cost-effective than the paper-based procedures (*IBTcost*), promoting good governance and democracy via credible elections (*IBTGovern*), improving vote confidentiality (*VCCdata*), quick actual voter registration (*AVRdata*), seamless results transmission and declarations at voting stations (*RTDdata*),and for improving reduction in election fraud (*IBTReducFraud)*, among others. The definitions of these variables are presented in Table 6.3.

The 5-Likert scale reports of voters perception in order of relevance of the use of IBTs in elections are presented in Figures 6.3 to 6.8. It is also evident that most voters strongly disagreed that the use of IBTs enhances registration by voters (*reg_voters*). Another line of disagreements which surfaced included that the use of IBTs in elections is wasteful (*IBTWasteful*), or that it makes voting much easier (*IBTEasyVote*) or too relevant in vote tabulation (*VTdata*), among others.

(b) IEC's Perception

As presented in Figure 6.9, the most strongly agreed perception is that parties and candidates who fulfil the requirements of registration are satisfied with the IBT-assisted registration without bias (*PC_satisfaction_IBT*), followed by the use of IBTs to increase the capacity for election review (*IBTICE*), the level of acceptance of the IBT-related constituency structure modality by voters (*IBT_constituency_struc_voters*), a low level of significant election-related violence as a result of IBT-related challenges (failure, non-availability, connection problems, verification bottlenecks) (*IBTLLV*), and the use of IBTs in allowing vote-counting to take place with no undue delays (*IBT_votecount_no_delay*), in order of decreasing relevance.

Agreements were observed for *IBT_constituency_struc_voters*, *IBT_votecount_no_delay*, the level of legitimacy and acceptance of the use of IBTs by voters (*IBTLeg_voters*), an independent IBT-assisted mechanism for identifying bias in the state media and subjecting the major factors to be considered when designing a framework for the implementation of IBTs in the South African elections processes include the integrity and accuracy of the election outcomes, the confidentiality of the votes, and a free, fair and transparent electioneering process bias to swift correction (*IBTInde_Mechanism*), *IBTLLV*, and *IBTICE*.

IEC respondents were most neutral in their responses regarding an existing implementation of an IBT system for allocating public funds to political parties (*sys_allocating_funds*), *IBTLeg_voters*, satisfaction with IBT-assisted registration without bias by parties and candidates who fulfil the requirements of registration (*PC_satisfaction_IBT*), *IBTLLV*, *IBTInde_Mechanism*, and *IBT_votecount_no_delay*, in this order.

The only major disagreement recorded is associated with the acceptance of the IBT-related constituency structure modality by voters (*IBT_constituency_struc_voters*).

(c) EISA's Perception

As presented in Figure 6.10, the most significant perception of EISA is regarding the agreement on the use of IBTs in making election statistics more properly documented and more easily available without significant delay (*IBT_election_stats*), followed by peak neutrality in the use of IBTs to increase the capacity for election review (*IBTICE*) and the perceived legitimacy of the IBT-based elections framework (*IBTLBE*). The implementation of election legislation on the use of IBTs for elections (*implementation_level*) was also agreed to. The only strong disagreement recorded was the length of the experience of respondents with the IEC, EISA or South African political party (in years), which seems irrelevant to the use of IBTs in elections as perceived by the institution.

(d) Political Parties' Perception

As presented in Figure 6.11, a strong agreement was observed in *IBTICE*, while equal perception along agreement and neutrality indices reflecting *IBTLBE* and *IBTICE* is also evident. A disagreement was however observed for *IBTLBE*.

The major factors to be considered when designing a framework for the implementation of IBTs in the South African elections processes include the integrity and accuracy of the election outcomes, the confidentiality of the votes, and a free, fair and transparent electioneering process

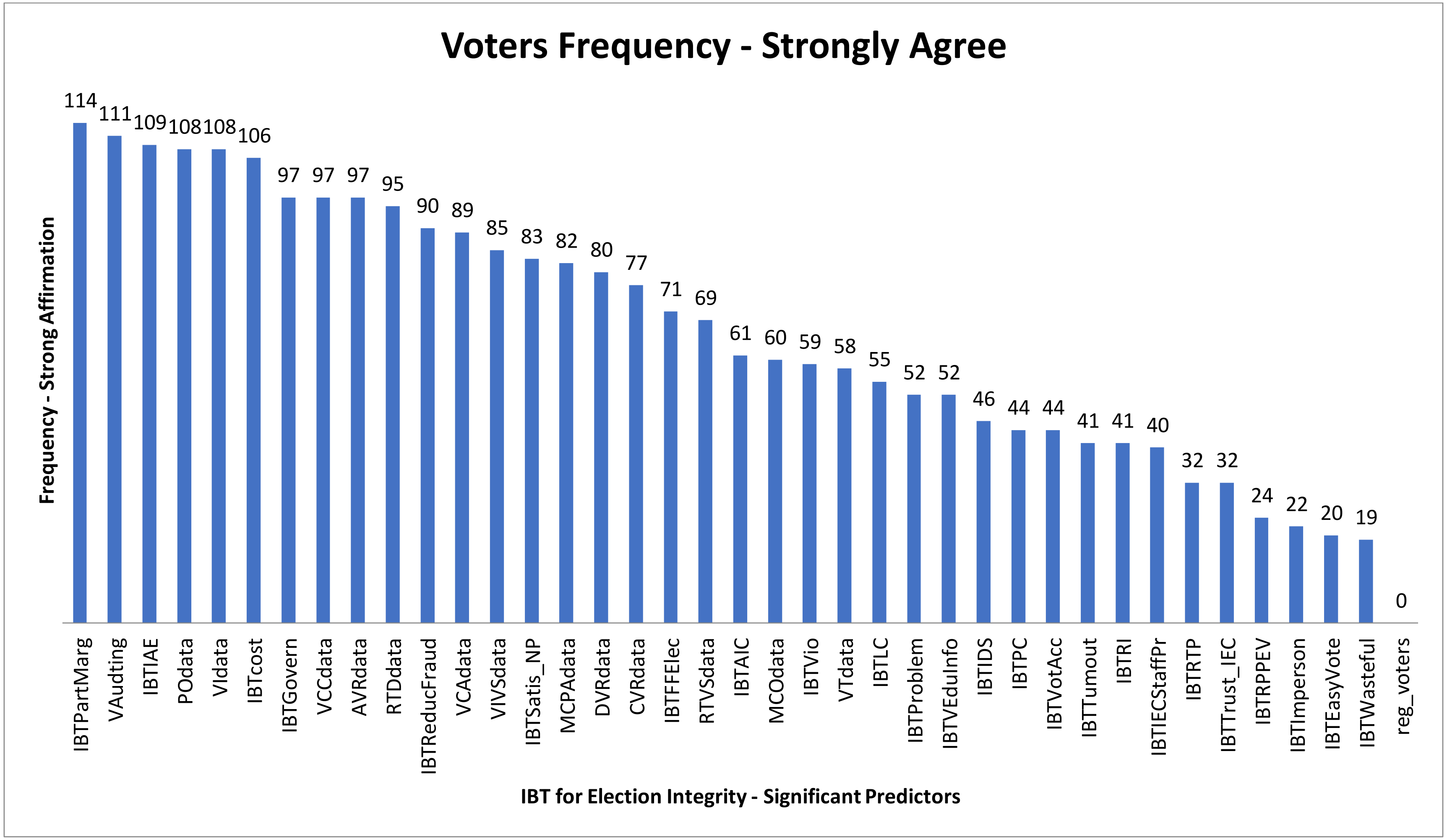


Figure 6.3 Summary of Voters' Perceptions on IBT-use in Elections – 'Strongly Agree' Responses

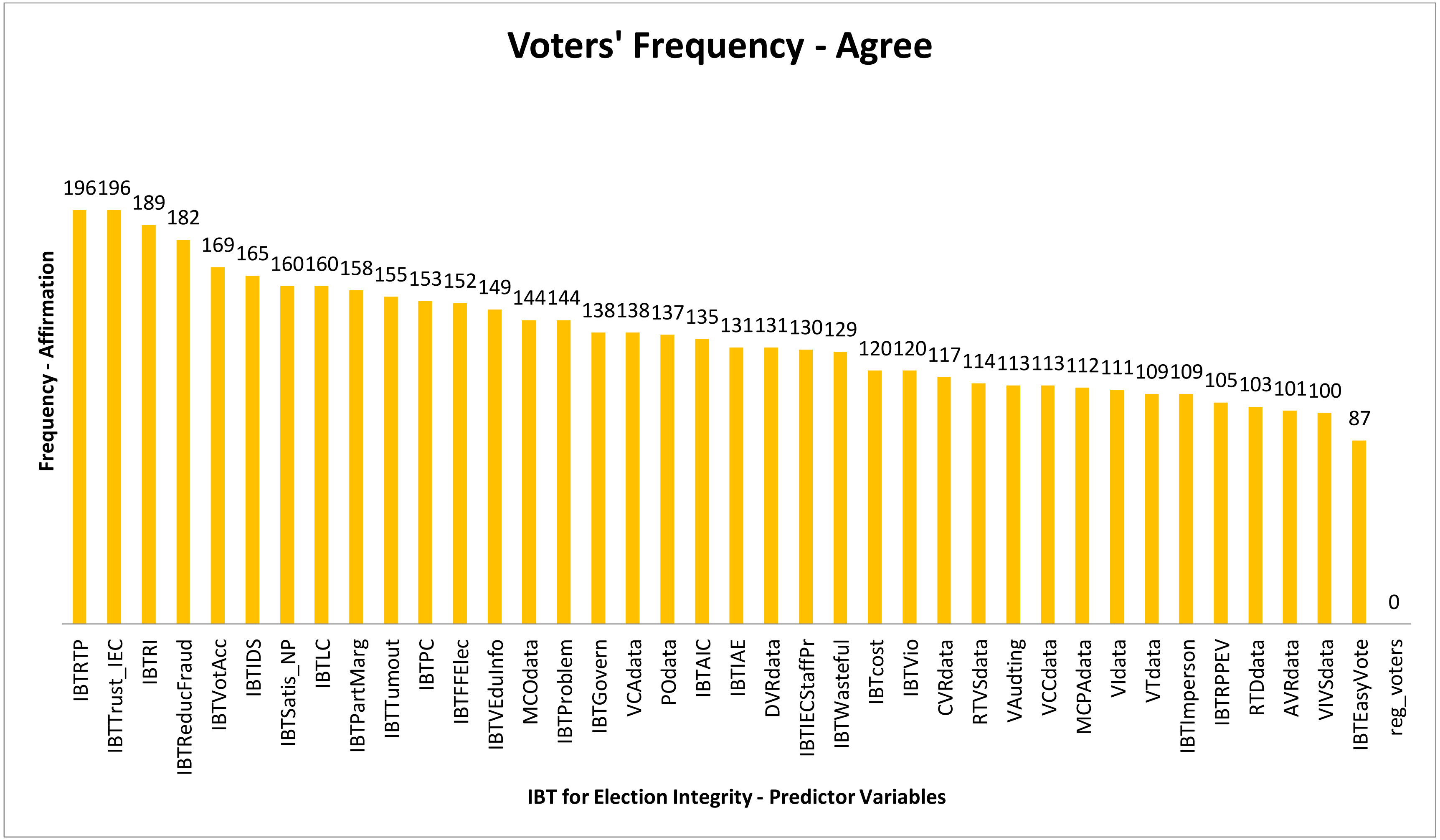


Figure 6.4 Summary of Voters' Perceptions on IBT-use in Elections – 'Agree' Responses

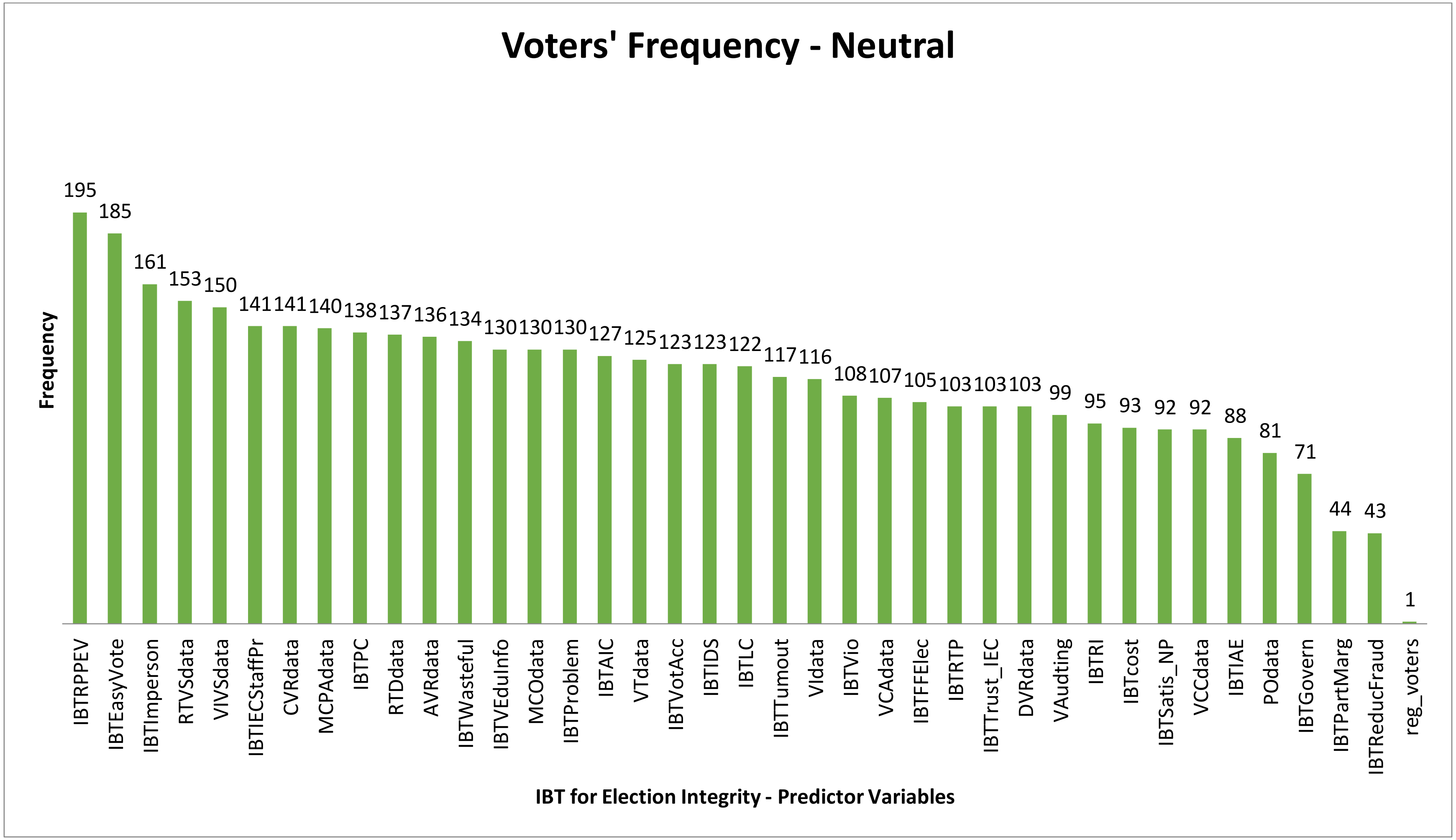


Figure 6.5 Summary of Voters' Perceptions on IBT-use in Elections – 'Neutral' Responses

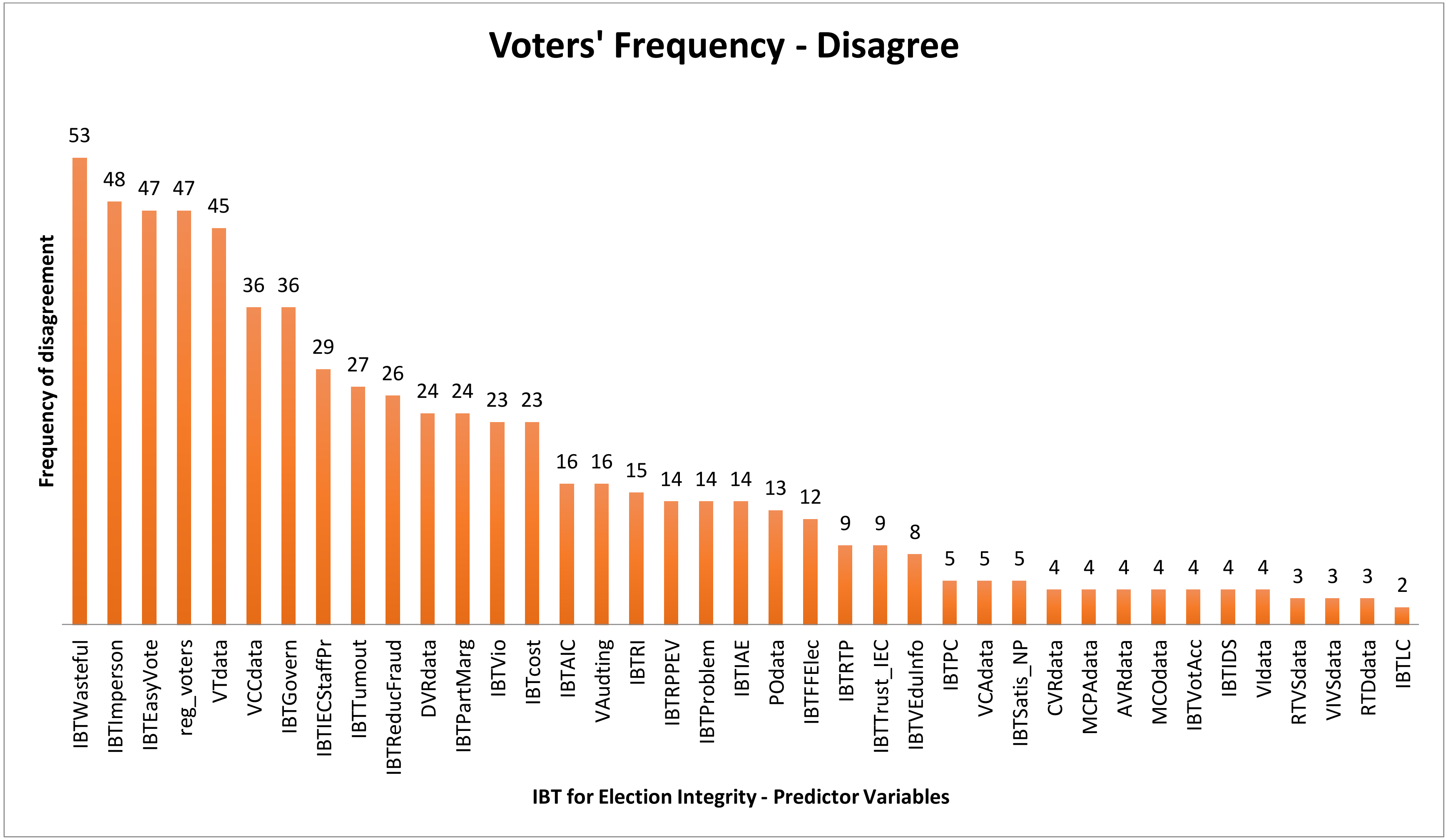


Figure 6.6 Summary of Voters' Perceptions on IBT-use in Elections – 'Disagree' Responses

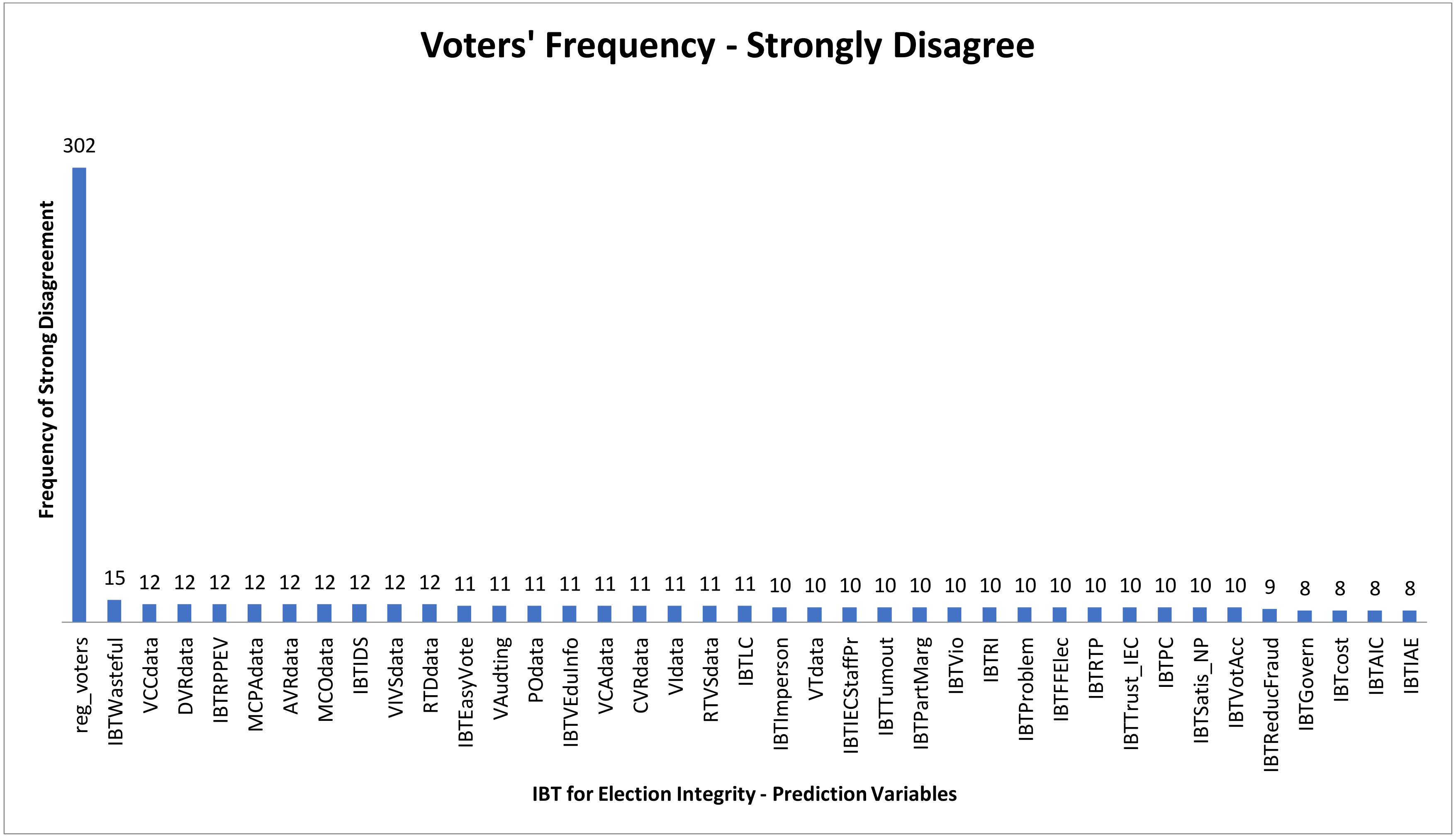


Figure 6.7 Summary of Voters' Perceptions on IBT-use in Elections – 'Strongly Disagree' Responses

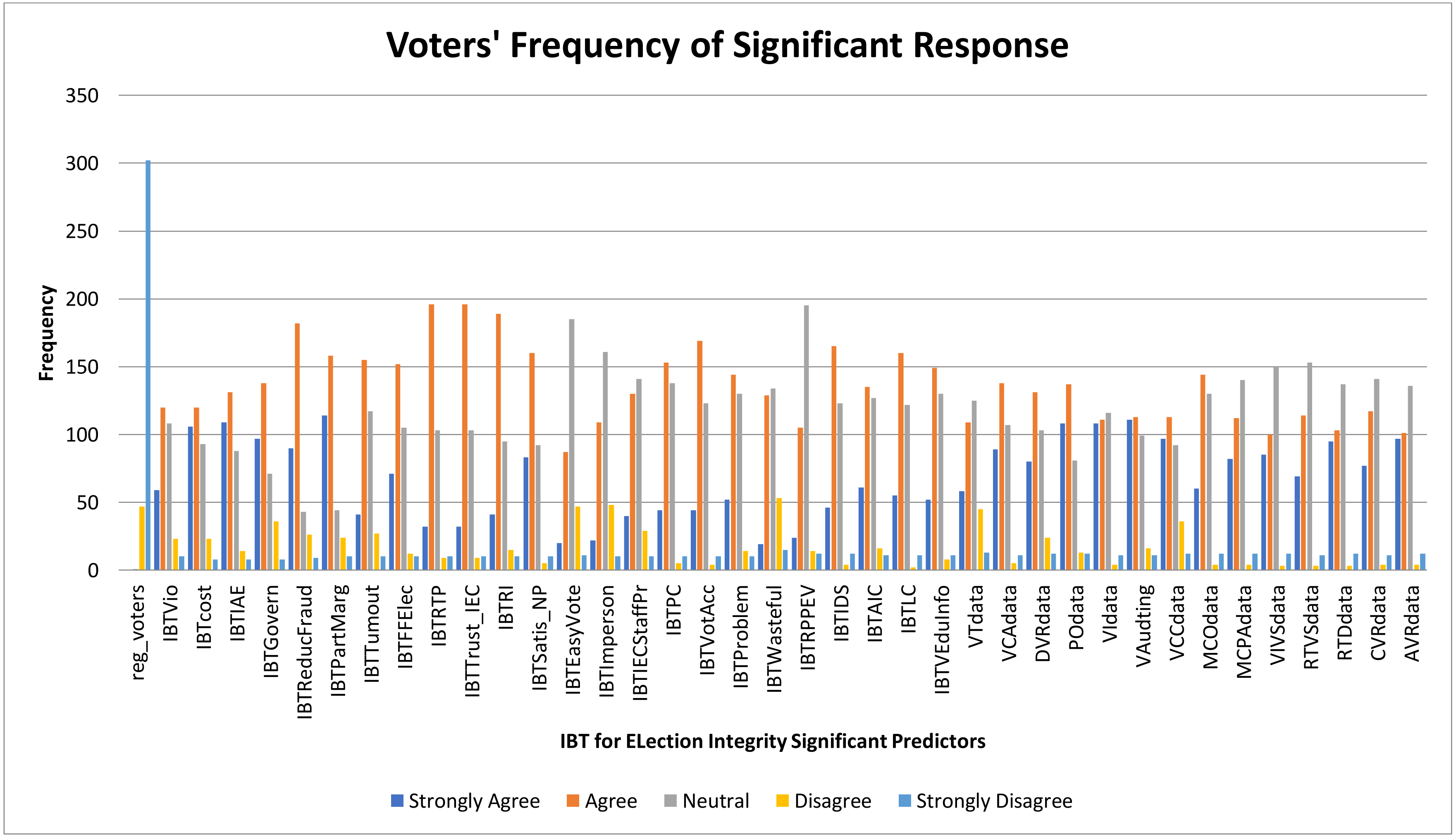


Figure 6.8 Summary of Voters' Perceptions on IBT-use in Elections – All Responses

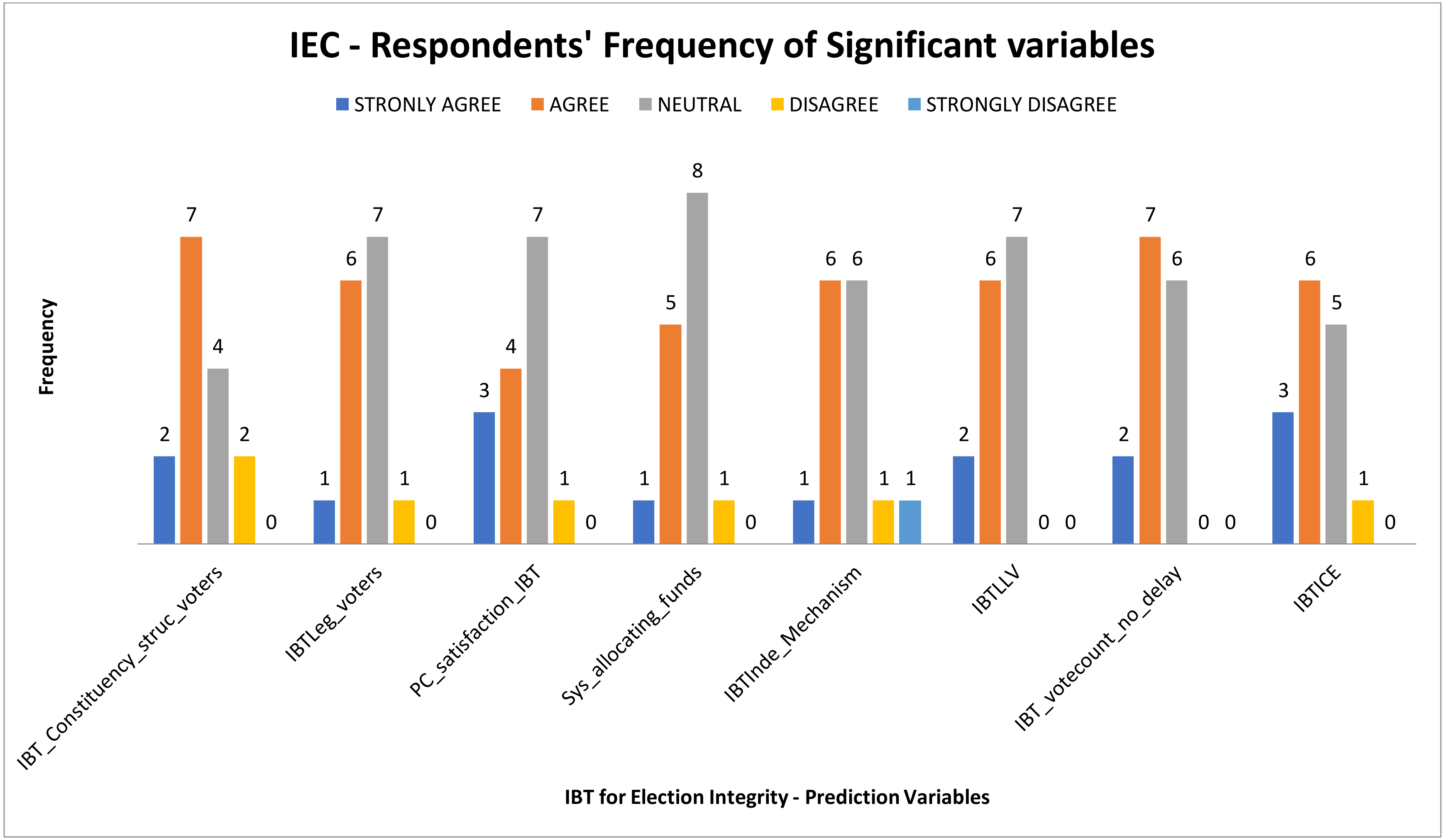


Figure 6.9 Summary of IEC's Perception on IBT-use in Elections – All Responses

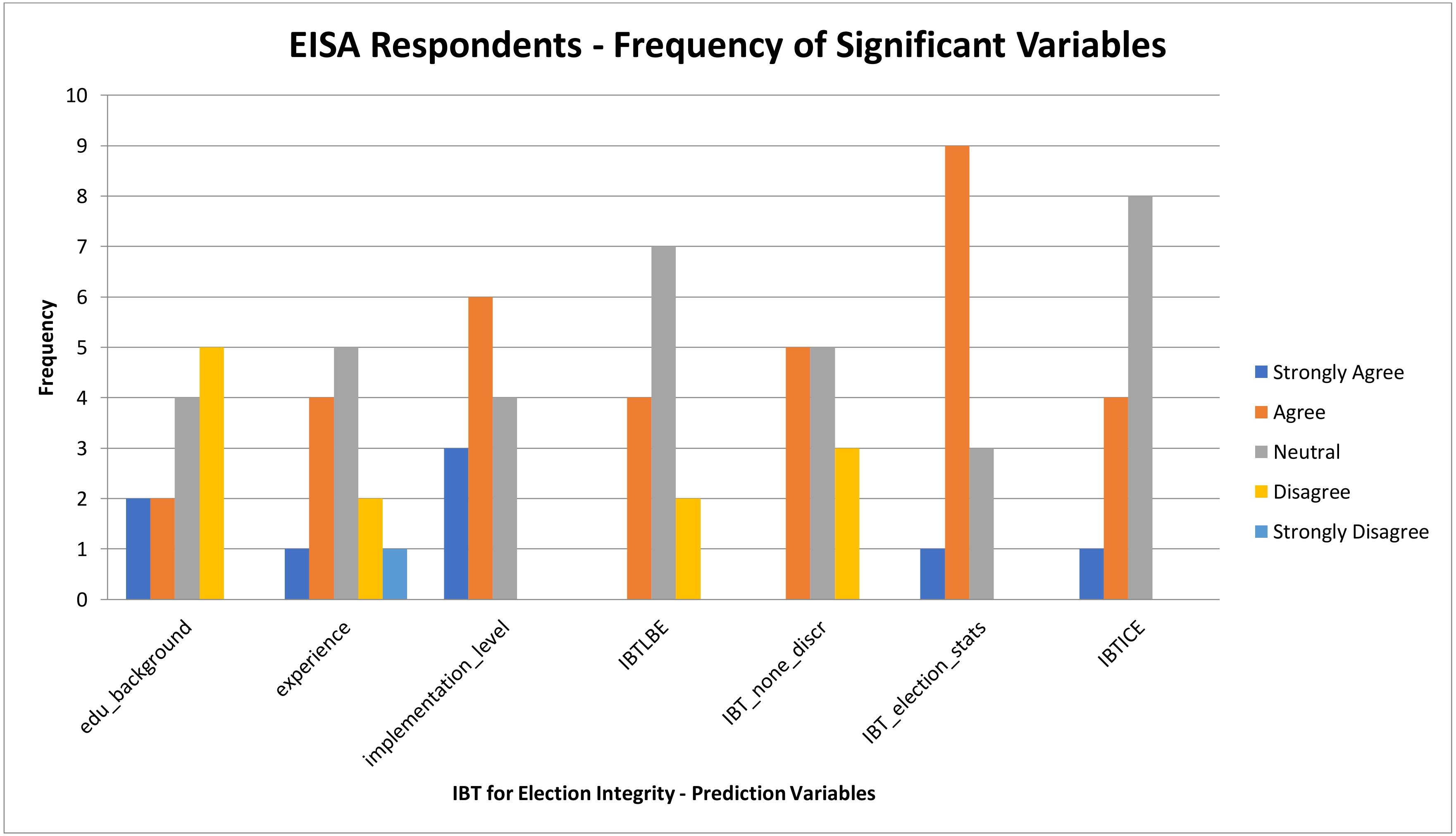


Figure 6.10 Summary of EISA's Perception on IBT-use in Elections – All Responses

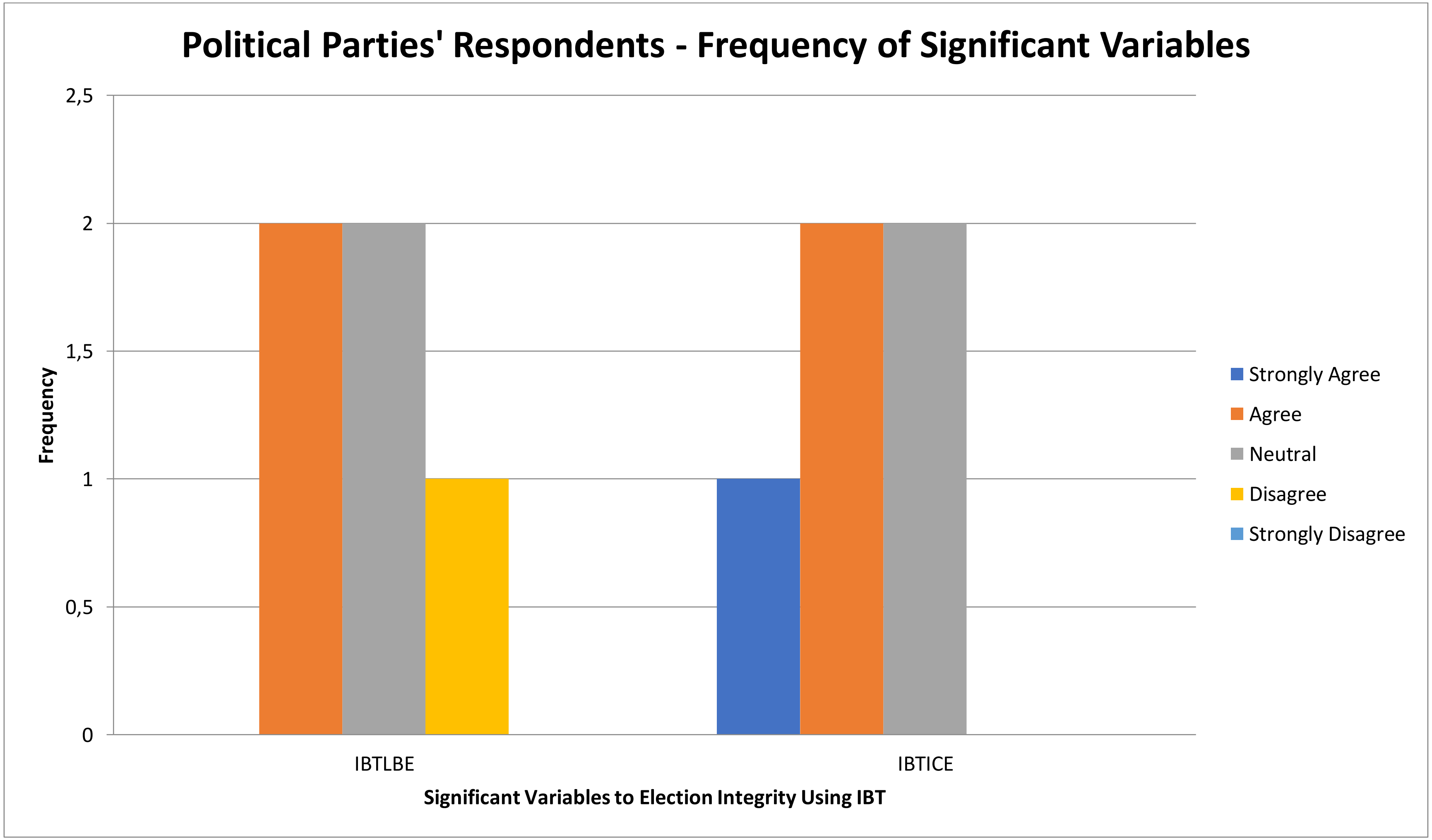


Figure 6.11 Summary of Political Parties' Perceptions on IBT-use in Elections – All Responses.

6.8 **Summary**

This chapter covered the IBT-use and election integrity models obtained from the analyses of the elections management processes adopting IBTs for South African elections based on the views of the voters, political parties, Electoral Commission (IEC) and EISA. The data analysed and used to develop IBT models for election integrity were collected from the study respondents from the four categories via surveys, questionnaires and interviews based on the 2009 and 2014 national elections in South Africa.

The main findings of the study pointed to a significant correlation between the use of Internet-based technologies and election integrity in Gauteng. Based on the results, the study developed four predictive models to estimate the integrity of elections outcomes with technology integration in elections.

These models were validated and found to be relevant to the context of South African elections. Furthermore, the major factors to be considered when designing a framework for the implementation of IBTs in the South African elections processes include the integrity and accuracy of the election outcomes, the confidentiality of the votes, and a free, fair and transparent electioneering process.

Chapter 6 further demonstrated that stakeholders are excited about the use of technology in the election process, and that they have considered IBT deployment in election processes and procedures to be appropriate because problems such as impersonation have been eliminated, ensuring that all information produced during the elections process, particularly the election results and the elections roll, is correct, trustworthy and secure, thereby generating a broad acceptance that the elections outcome is a true and fair representation of the citizens' will, with increased administrative efficiency, reduced costs and strengthened trust among electioneering stakeholders.

The next chapter reports on the design and development of the implementation of IBTs for South African elections. This framework is based on the information collected in Chapters 2,3,4,5 and 6. The chapter further evaluates the proposed IBT framework and interprets the research findings in relation to the formulated research questions and objectives.

Chapter 7 DEVELOPMENT AND EVALUATION OF IBT CONCEPTUAL FRAMEWORK FOR SOUTH AFRICAN ELECTIONS

7.1 **Introduction**

This chapter presents a framework designed and developed based on the data collected from a literature review, observations and focus groups. The main purpose of this chapter is to assess the IBT framework for South African elections for relevance and applicability. This chapter confirms whether the proposed framework presents a reasonable theory to experts in elections and democracy consolidation.

7.2 **Overview**

The chapter reviews and presents the development of an IBT conceptual framework for South African elections. It is prudent that proactive measures are researched such that young voters remain actively engaged. The adoption of modern innovative technologies and methodologies, as covered in Chapter 2, presents an opportunity which may persuade the majority of young South African people and marginalised groups to reconsider attitudes and perceptions to return to civil responsibilities. Studies have also established that new technologies can enhance South African elections with good performance, speed up voter identification processes, ensure quality and accurate data, and reduce human errors during elections (Thakur 2015; Mpekoa 2017).

7.2.1 **Background of IBT Framework and Theoretical Definitions**

This section seeks to understand what a framework is and how it can be developed. A conceptual framework is not merely a collection of concepts but rather a construct in which each concept plays an integral role. According to Miles and Huberman (1994: 440), a conceptual framework "lays out the key factors, constructs, or variables, and presumes relationships among them".

Shackel (2009: 339-346) and Zachman (1987: 276-279) define a framework as a skeleton, or an outline of interlinked ideas, which supports a particular approach to a specific objective which provides a frame of reference that can be modified as and when required. The purpose of constructing a framework is both descriptive and critical, since it provides the researcher with the ability to understand and communicate identified problems and gaps in the current theory and research, and it makes the original contribution of the study easier to comprehend (Zachman 1987: 276-279).

The current definition and usage of “conceptual framework” and “theoretical framework” are vague and imprecise. Some authors use the terms interchangeably (Parahoo 2014: 1-15; Sinclair 2007; Maxwell 2005: 33-63), because they consider conceptual and theoretical frameworks as the same concept which serves the same purpose. Other authors refer to or define the terms asymmetrically (Fain 2013: 5).

These interpretations are slightly different since, instead of suggesting that the concepts have been built into a theory (Fain 2013: 5), Parahoo (2014:-15) suggests that parts of multiple theories have been taken. This study uses the term “conceptual framework”, which Maxwell (2005: 33-65) defines as a network or “a plane” of interlinked concepts, assumptions, expectations, beliefs, and theories which together provide a comprehensive understanding of a phenomenon or of phenomena. The integrated concepts of a conceptual framework support one another, enunciate their respective phenomena, and construct a framework specific to the underlying philosophy.

7.2.2 **Purpose of Developing an IBT Framework for South Africa**

Conceptual frameworks are developed for a number of reasons; it is crucial for the researcher to demonstrate why it was necessary for the framework to be developed. The following are the main reasons which led to the development of an IBT conceptual framework in this study:

- No IBT research projects have been conducted to establish the level of IBT which supports elections processes around the world.

- Limited research has been carried out to determine the actual issues, challenges and key success factors for the successful implementation of IBTs to support elections procedures and processes within the South African context.
- There is an absence of a comprehensive IBT strategy with a particular focus on South African elections.
- The failure of E-voting, M-voting, and I-voting projects in other countries needs to be researched.

The field of E-voting, M-voting, especially complete IBTs system, is largely an undiscovered sphere; and its true extent is still uncharted. IBTs for elections processes is in its infancy throughout the world; it is not in full use to cover entire election cycle in most parts of Africa, including South Africa. No empirical research thus far has been done to investigate the factors and components that influence the successful implementation of complete E-voting and M-voting processes. Very few countries have endeavoured to implement M- and E- voting; and only one country, Estonia, India; Geneva; Namibia (Trechsel, 2011; Heiberg et al., 2011), has successfully implemented M-voting on a large scale – and it is considered to be a great success. A vast number of countries have either piloted or implemented E-voting (fully or partially); but very few have been successful.

A vast number of countries have either piloted or implemented E-voting (fully or partially), but very few have been successful. Despite the numerous benefits and advantages provided by E-voting, the IBT system, M-voting, and I-voting, the decision to build such a system in order to conduct elections over public networks is neither simple nor straightforward (Vlachokyriakos 2013: 271-272). There is a long list of multi-disciplinary requirements which must be met in order for such a project to be a success (Gibson and McGaley 2008: 283-290; Ikonomopoulos *et al.* 2002: 507-519). The implementation of an IBT framework may be challenging if the different procedures and techniques which aid successful IBT implementation are not in place (Vlachokyriakos 2013: 271-272). Introducing a fully-fledged IBT framework not only increases the transparency of the election technologies under evaluation, but also contributes to the division of power and thereby to the democratic nature of the election. Ideally, an IBT framework will give (almost) all election stakeholders a higher level of confidence that the election technologies will:

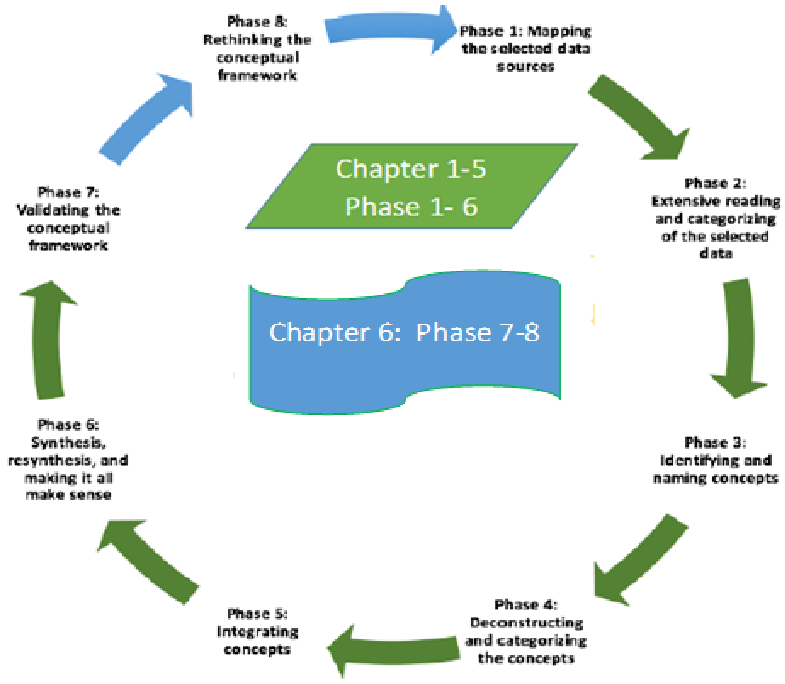
- live up to election stakeholder expectations;
- be free of obvious mistakes;
- be documented such that experts and future users can understand and operate the technologies properly; and
- provide an effective means of control to all election stakeholders, not just the immediate users within the EMB.

There is currently no local, regional or international agency monitoring election technologies (Alvarez *et al.* 2013; McGrath 2011: 41-44). There are a number of cited EMB initiatives to make one aware of the technology used in elections (Alvarez *et al.* 2013: 117-137; McGrath 2011).

7.2.3 **Procedure of Conceptual Framework Analysis**

A conceptual framework is "something that is constructed, not found" (Maxwell 2005). Maxwell (2005) also points out that the comprehensive organisation and unity of a conceptual framework "is something that is built, not something that exists ready-made", and it incorporates pieces which are borrowed from elsewhere. This study made use of the steps proposed by Jabareen (2009: 49-62) for the construction of the conceptual framework, as depicted in Figure 7.1.

Figure 7.1



Procedures for Building a Conceptual Framework (Jabareen 2009: 49-62).

(a) Phase 1: Mapping the Selected Data Sources

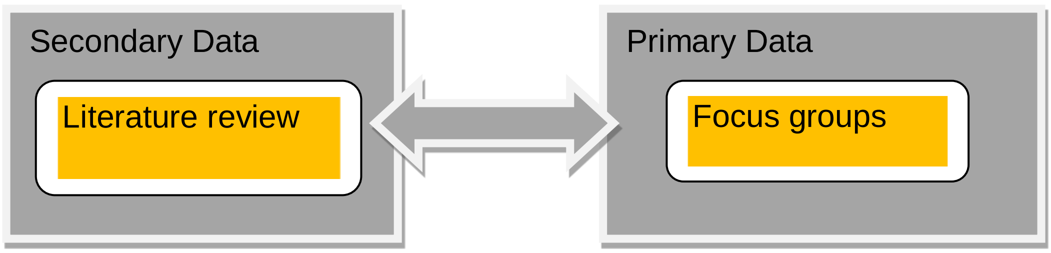
The first task is to map the spectrum of multidisciplinary literature regarding the phenomenon in question. This process includes identifying text types and other sources of data, such as existing empirical data and practices. It must begin with an extensive review of the multidisciplinary texts. According to Maxwell (2005: 33-62), four main data sources can be utilised to construct a conceptual framework:

- **Knowledge:** This is built on the researcher's technical knowledge, research background, and personal experiences.
- **Existing theory and research**: This is found in other people's published work, and also in theories and research in general.
- **Pilot and exploratory research:** This is based on pilot studies – specifically to test one's ideas or methods and to explore their implications, or to inductively develop grounded theory.
- **Thought experiments**: These help to explore the logical implications of models, assumptions, and expectations of the items in the planned study.

Working as a researcher and ICT expert, it is not easy to distance the researcher's thinking from a research study. The researcher also has personal opinions and ideas regarding IBT adoption and acceptance in the context of South African elections. Regarding the first data source in the above-mentioned list, Maxwell(2005: 33-62) believes that one's experiential knowledge is often overlooked as an essential conceptual source. As a result, the researcher's own experience was used as a source for developing the conceptual framework.

This research also relied heavily on existing theory and research to identify the factors which other researchers have investigated for constructing the IBT conceptual framework. A pilot and/or exploratory study is usually conducted before the study begins, in order to determine the best research design, data collection method and the selection of participants. Thought experiments assist the researcher to explore the logical implications of models, assumptions and expectations; they generate new theoretical models and insights; and they test the current theory for problems. All theory-building involves thought experiments to some extent. The factors for developing an IBT conceptual framework were derived from two sources of data: the literature review and the focus groups, as depicted in Figure 7.2.

Figure 7.2 Selected Data Sources



(b) Phase 2: Extensive Reading and Categorising of Selected Data

Recommendation from Literature Review

The aim in this phase is to read the selected data and categorise it both by discipline and by a scale of importance and representative power within each discipline. This process maximises the effectiveness of this inquiry and ensures the effective representation of each discipline.

Maxwell (2005: 33-62) asserts that existing theory and relevant research are significant and essential for developing a conceptual framework, since they facilitate the understanding of the phenomenon under investigation. A review of the literature revealed an insignificant number of frameworks which have been developed and adopted from other spheres. M-government or mobile government refers to the collection of services as the strategic use of government services and applications, which are only possible using cellular/mobile telephones and laptop computers (Patel and White 2005: 1-4).

Patel and White (2005: 1-4) identified both technical and non-technical issues which can encourage m-government development and create a comprehensive national m-government strategy. The identified issues include developing suitable costing, financing and cost-benefit analysis models; resolving concerns on the security of m-government solutions; and addressing legal and institutional issues. Heiberg *et al.* (2011: 208-233) also state that although the successful adoption of E-voting requires the availability of an ICT infrastructure, a legislative framework and a strategic organisational and technological design, the attitudinal mind-set of citizens towards the technology are central drivers to its adoption (Mpekoa 2017: 185). The factors which could affect the implementation of IBTs were identified from the literature and are presented in Table 7.1.

Table 7.1 IBT Implementation Factors Identified from the Focus Groups (Strauss and Corbin 1990).

Factors	**South African Election Stakeholders**			
	IEC	**EISA**	**Voters**	**COS and Media, Observers**
ICT Infrastructure				
Legal factors				
Organisational factors				
Availability				
Elections procedures cost				
Political factors				
Accessibility				
Piloting				
Voter education				
Elections staff training				
Project planning				
Community engagement				
Community communication				
Budget				
Procurement cycle				

IBT Conceptual Framework for SA EMP for efficiency and effectiveness, free and fair elections

As indicated in Table 7.1, the literature review suggests that there are numerous issues to consider in terms of the use of IBTs for elections management processes, and the relevance and improvement of technologies for elections. Such technologies are different in terms of reach, use, applicability, usefulness, reliability and transparency, and so they may enhance or compromise an election, and facilitate easier voting for the electorate or threaten voter turnout among some sections of the voters, for example, the elderly (Roseman and Stephenson 2005: 39). Similarly, there are cost factors, induction and training, piloting, and many other dynamics which must be considered in the use of election-related technologies. In short, some of these dynamics include technical-, financial-, political- or human-resource-related hurdles; they can also have legal, constitutional, and elections policy implications, as argued in this study.

Focus Groups

The theories held by the participants are the most crucial yet the most neglected sources of theory (Berger and Kellner 1981: 1). Hughes (2007: 2-30) suggests that these theories are important for two reasons. Firstly, these theories are real phenomena; they inform the participants' actions, and any attempt to interpret or explain the participants' actions without taking into account their actual beliefs, values and theories is probably fruitless (Maxwell 2012; Hughes 2007; Charmaz and Belgrave 2002). Secondly, the participants have far more experience with the matters which are being studied, and they may have important insights which a researcher might miss if they fail to take the participants' theories into account (Maxwell 2005).

In Chapter 5, the researcher conducted focus group discussions in order to gather information on factors which might influence the implementation of IBTs in SA. The following groups participated in the study: EMBs, NGOs, observers, government agencies and electorates, as indicated in Table 7.1.

(c) Phase 3: Identifying and Naming Concepts

The aim in this phase is to read and re-read the selected data and "discover" concepts (Strauss and Corbin 1990). A long list of factors affecting the successful implementation of IBTs was identified and compared from both the literature review and the focus groups, as presented in Table 7.1.

(d) Phase 4: Deconstructing and Categorising the Concepts

The aim of this phase is to deconstruct each concept; to identify its main attributes, characteristics, assumptions, and role; and subsequently, to organise and categorise the concepts according to their features and ontological, epistemological and methodological roles. The result of this phase is a table which contains four columns. The first column contains the names of the concepts; the second includes a description of each concept; the third categorises each concept according to its ontological, epistemological or methodological role; and the fourth presents the references for each concept. Figure 7.3 depicts six main factors which might affect the implementation of the IBT conceptual framework.

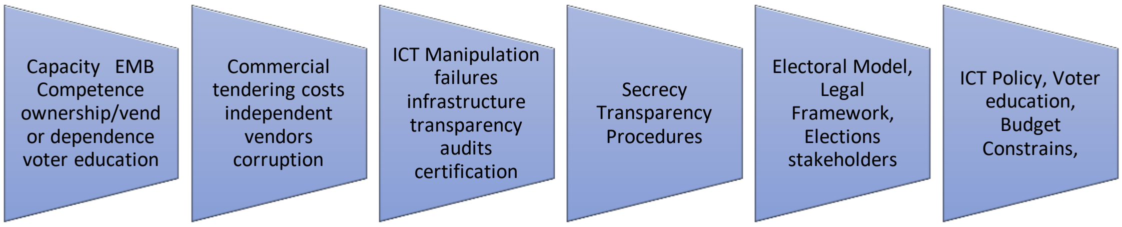


Figure 7.3 Six Main Factors for the Adoption of the IBT Conceptual Framework

(e) Phase 5: Integrating Concepts

The aim of this phase is to integrate and group together concepts which have similarities with the new concept. This phase significantly reduces the number of concepts and allows one to manipulate them into a reasonable number of concepts. The study adopted the elements in Figure 2.2 in Section 2.4 of Chapter 2 as the core concepts for the successful implementation of the IBT conceptual framework.

(f) Phase 6: Synthesis and Making Sense

The aim of this phase is to synthesise concepts into a theoretical framework. The researcher must be open, tolerant and flexible with the theorisation process and the emerging new theory. This process is iterative and includes repetitive synthesis and re-synthesis until the researcher recognises a general theoretical framework which makes sense. Researchers should know how to build their conceptual frameworks.

As Miles and Huberman (1994: 434) have suggested, researchers who use qualitative methods “need to know how they are constructing ‘theory’ as analysis proceeds, because that construction will inevitably influence and constrain data collection, data reduction, and the drawing and verification of conclusions”.

This phase reduced the number of concepts significantly to a reasonable number of core concepts. The core concepts and sub-concepts for the proposed IBT conceptual framework are presented in Figure 7.3 and Figure 2.2 (Section 2.4 of Chapter 2); through a synthesis and re-synthesis of the concepts, the researcher identified the final concepts for the IBT conceptual framework. The core concepts of the IBT conceptual framework include the legal framework, the regulatory framework, scheduling, infrastructure, technical factors, finance, political stability, as well as planning and implementation.

In the remaining sections of this chapter, the components of the final IBT framework, depicted in Figure 7.4, are discussed in more detail at the conceptual level. Towards the end of the chapter, methodological guidelines are developed in an attempt to explain how the conceptual framework might be put into practical operation.

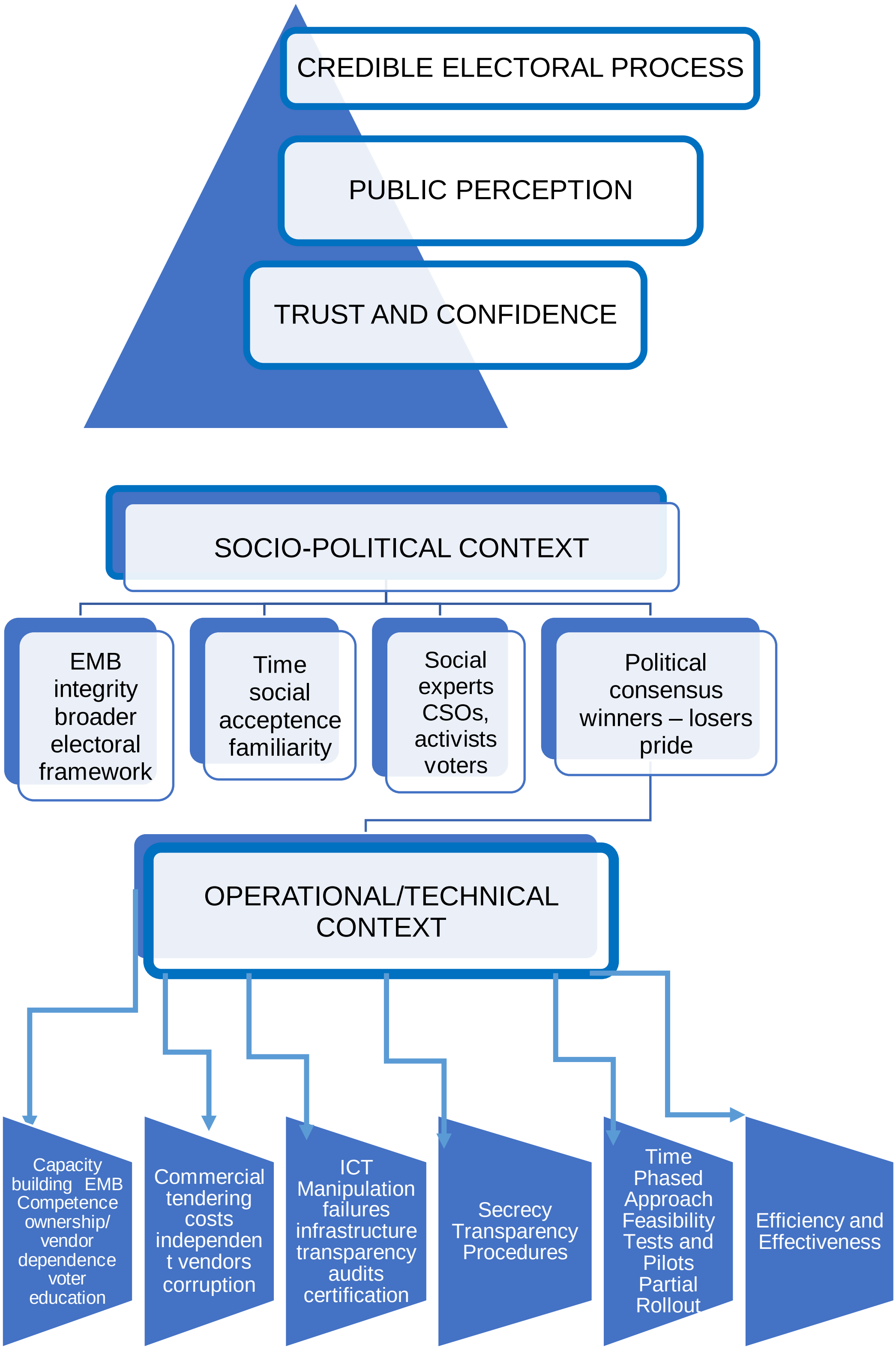


Figure 7.4 The Pyramid of Trust, bringing a Complete View of the IBT Framework for Election Processes and Procedures

(g) Phase 7: Validating the Conceptual Framework

The aim of this phase is to validate the conceptual framework. The question is whether the proposed framework and its concepts make sense not only to the researcher but also to other scholars and practitioners. This section validates the IBT conceptual framework. The proposed IBT conceptual framework was evaluated via expert reviews, with experts in the field of election management, an ICT elections security analyst and E-voting research, as presented in Chapter 5. The findings are presented in Chapter 6.

(h) Phase 8: Rethinking the Conceptual Framework

The proposed IBT conceptual framework was revised, according to new insights, comments and suggestions from the experts. Sections 7.3 to 7.16 explain the proposed framework for IBTs in detail and demonstrate how the eight phases were applied in Gauteng, as well as how the new model can fit into the current Gauteng environment or when applied in other parts of the world.

7.3 **Elections Management and Design for South Africa**

Elections in SA are spearheaded by the IEC which manages the elections at all levels of government to ensure that all such elections are free and fair (IEC 2014: 1-20). The Electoral Commission conducts only municipal and Local Government Elections (LGE), and National and Provincial Elections(NPE) (IEC 2014: 1-20). The acceptance and adoption of technology has been covered in Section 3.8.2 of Chapter 3.

7.3.1 **South African Information Communication Technology Policy**

The advent of ICT has provided the means for faster and better communication, efficient storage, the retrieval and processing of data, and the exchange and utilisation of information to users. Sallai (2012: 10) defines ICT policy as an integrated set of decisions, guidelines, laws, regulations and other mechanisms geared to directing and shaping the production, acquisition and use of ICTs. Policy is the key determinant of legislation and regulation. It sets out the vision for ICT development, together with its links to the national development goals. The three main areas covered by an ICT policy include telecommunications (telephone communications), broadcasting (radio and TV), and the Internet (Gillwald *et al.* 2012: 1-20).

7.3.2 **South African Information Communication Technology Infrastructure**

The ICT infrastructure in an area is defined as the telephone networks, cellular networks, broadband-Internet networks and electricity in the area (Heeks and Jagun 2007: 1).

7.3.3 **Mobile Infrastructure**

The telecommunications sector has seen phenomenal growth in the past decade (Mpekoa 2017a: 201). Comparing this with SA Connect ICT targets, SA is not meeting its sub-targets. Firstly, according to Costantini and Liberati (2014: 26-48), the increasing levels of ICT have led to a significant reduction in the costs of the transmission and communication of information around the world. However, the World Economic Forum's latest Global Information Technology Report in 2014 ranked SA at the 104th position for affordability, covering mobile and broadband tariffs, Internet and telephony (Schwab and Sala-i-Martín 2016). With regards to social ICT impacts, including impacts on access to basic services and Internet access in schools, SA ranked 112th(Mpekoa 2017: 201).

7.3.4 **Smart Phone Use among South African Consumers**

Algeo (2012) defines smart mobile phones as a telephone system which can move, or be moved, easily and quickly from place to place. Mobile phones were once the tool of rich and busy executives who could afford the luxury, and now it is the ICT which is reshaping and revolutionising communication globally. Mobile phones have become a necessity in the daily life of people all over the globe, including the developing world. The study accept that the impact on the economic activities of nations, businesses and small entrepreneurs is phenomenal.

7.3.5 **Security**

Moynihan (2004: 515-528) argues that the security of the elections process is critical for all elections throughout the world (Moynihan 2004). Making use of technology when casting a vote can lead to security challenges, through exposure to internal, external and physical attacks. These threats can attack at all levels of the IBT system including the software, human error, the hardware, and the communication level. These threats include, but are not limited to, viruses, worms, hackers and software engineering (Gibson and McGaley 2008: 283-290).

7.3.6 **The Finance Component**

Despite when there are existing IBTs which meet the requirements of elections and can offer significant benefits in elections, the financial feasibility and sustainability of their use must be assessed (Rivera 2014; Lauer 2004). NDI(2013) suggests that in order to do this, a number of possible products must be selected for analysis, and a full assessment of all the costs involved in the use of the technology compared with those of the existing elections procedures must be conducted. This assessment must take into consideration that, although the initial investment in E-voting technology might be high, the technology may be in use over several elections.

7.3.7 **Mobile Phone Use**

The introduction of very basic and cheap mobile phones offered an opportunity to the people at the bottom of the income pyramid to own a mobile phone (Powell 2015; Mitrovic and Klaas 2012). These people could now also participate in the telecommunication society which, according to Adeyinka and Olasina (2012), signals an important landmark for how people communicate. A critical number of adopters must be reached before any medium can be adopted as a mass medium. Rogers (1995) states that in general, the critical number of adopters for an innovation is approximately 16% of the population. IBTs can only become acceptable when the majority of eligible voters have access to mobile phones and the Internet (Achieng and Ruhode 2013: 1-12).

7.3.8 **The Digital Divide**

Bélanger and Carter (2010) define the digital divide as the unbalanced access to and use of ICT. This type of disparity not only relates to technology access, but also to the competence and confidence needed to use the technology. Although the number of people having access to mobile phones is very high, the distribution of the groups of people who operate the new technology with confidence is uneven. Mobile phone users cut across the socio-economic spectrum, and they are not restricted to an affluent or educated portion of the society. It is argued that while ICTs have the potential to improve the democratic process, to expand citizenship and to empower the people, they also have the ability to perpetuate or exacerbate existing disparities and other divides.

7.3.9 **Survey of Mobile Readiness**

DuPreez (2009) defines M-readiness as the extent to which m-services can be deployed. The literature review (chapter 2) focused partly on the work done by DuPreez (2009) and Mehlomakulu (2014), since their works were relevant to m-readiness in SA. DuPreez (2009) critically examines the extent to which the Provincial Government of the Western Cape (PGWC) has adopted m-government and related services. The study found that although there is a relatively high degree of adoption with regard to various aspects of mobile and wireless technology, there are many obstacles and barriers which need to be overcome in order to achieve a higher level of m-government maturity or readiness. The results also indicated that mobile technology has been widely adopted in the PGWC.

The focus of this study was on the relevance of the IBT system; m-services; I-voting; M-voting; E-voting which was deployed in PGWC; and the security, acceptance, legitimacy and feasibility of IBTs within Gauteng.

7.4 **Technical and Operational Factors**

This section discusses the technical design aspects of an IBT system which could be deployed in South African elections. It first discusses the usability issue of such a system, and then presents the functional requirements of e-enabled elections. It briefly discusses the major challenge associated with automated elections systems, which include security and functionality.

7.4.1 **Usability of Mobile Voting System**

Mpekoa (2017: 206) argues that voters are the end client in any voting system. For a voting system to successfully implement the requirements of a voting context, the system must be usable by those enfranchised by the electoral system (Adeshina and Ojo 2014: 403-412; Boulus-Rødje and Laanggaardsvej 2012a: 227-241; Bélanger and Carter 2010: 1-5; Mpekoa 2017: 206).

Advocates of M-government identify the citizens' needs and usability as two critical issues for developing public-sector M-services and applications. These proponents argue that the needs of M-services users should drive development, and that usability enables the creation of viable, usable and meaningful services, encouraging user acceptance of these services (Achieng 2014: 1-25; Krimmer 2012: 15-55; Chevallier *et al.* 2006; Mpekoa 2017: 206).

In the field of Human Computer Interaction (HCI), usability refers to the ability of a user to interact with a system in order to achieve the desired goals (Dix *et al.* 2004: 13-27; Bevan 1995: 885-890). ISO 9241-11 (2016) and Jokela *et al.* (2003: 53-60) refer to usability as: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." The usability of a system is not just the extent to which tasks are completed efficiently and quickly, but is also the degree of ease and satisfaction with which a user interacts with the system (Khader *et al.* 2013; Hussain and Kutar 2012: 1-15; Mpekoa 2017: 206).

7.4.2 **Security**

The security of the elections process is critical for all elections. There are always points at which those wishing to manipulate the system could attempt to manipulate the data. Security is as important to IBT systems as it is currently in the paper-based voting system. Although IBTs might introduce new vulnerabilities into an election process, if planned and implemented well, they promise to resolve some of the challenges associated with the manual voting systems(Das 2015; Gupta *et al.*, 2013).Figures 7.5 (a) and 7.5(b) summarise the factors affecting IBTs as derived from literature.

Functional requirement	Haziemeh (2011)	Zissis (2011)	Pavshrere (2016)	AlSammak (2015)	Bederson (n.d)	Kayode (2015)	Abu-Shanab (2013)	Bishop (n.d)	Olaniyi (2015)	Chondros (2014)	Stenbro (2010)	Adeosun (2015)	Neumann (2014)	McGaley (2008)	Olayini (2015)	Mursi (2013)
Scalability							√									√
Anonymity		√	√	√			√						√			√
Authenticity		√		√							√	√			√	√
Eligibility			√				√			√	√		√	√	√	√
Accuracy	√	√		√		√	√				√					√
Integrity		√		√		√	√	√			√		√		√	√
Uniqueness			√	√			√	√		√	√		√	√	√	√
Security	√	√				√	√	√				√				
Availability		√								√			√			
Accessibility					√		√			√			√			
Verifiability	√	√	√	√	√	√	√			√	√	√	√		√	√
Mobility			√													√
Simplicity																

Figure 7.5 (a): Functional Requirements of IBTs (Mpekoa 2017)

Functional requirement	Haziemeh (2011)	Zissis (2011)	Pavshrere (2016)	AlSammak (2015)	Bederson (n.d)	Kayode (2015)	Abu-Shanab (2013)	Bishop (n.d)	Olaniyi (2015)	Chondros (2014)	Stenbro (2010)	Adeosun (2015)	Neumann (2014)	McGaley (2008)	Olayini (2015)	Mursi (2013)
Transparency				√			√			√	√	√		√	√	√
Flexibility				√			√				√		√			√
Reliability		√		√						√	√	√				√
Robustness		√				√										√
Uniformity																
Auditability	√			√			√	√							√	√
Secrecy	√	√		√						√	√	√	√	√	√	√
Confidentiality		√				√									√	
Accountability		√			√						√		√			
Fairness			√													
Uncoercability			√	√				√		√	√			√		√
Universality				√												
Convenience				√							√				√	√
Efficiency						√						√				√
Privacy						√	√									
Democracy						√	√									
Receipt-freeness							√	√		√			√	√		√
Voting cost							√				√			√		√

Figure 7.5 (b): Functional Requirements of IBTs (Mpekoa 2017)

7.5 **Functional Requirements**

As indicated in Figures 7.5(a) and 7.5(b), the design of any voting system must meet the required standards to ensure the actual security of that voting system (Thakur *et al.* 2014; Gibson and Mcgaley 2008). According to Ekong and Ayo (2007), IBTs must satisfy a number of competing criteria for a credible, free and fair election to be assured (Elklit and Reynolds 2002: 86-119; Van Ham and Linderg 2018:213; Norris 2016: 1-25).Functional requirements are requirements which describe the system's behaviour or function. The IBT functional requirements from the literature are presented in Chapter 2 and Figures 7.5(a) and 7.5(b).

7.5.1 **Planning**

Planning is one of the most crucial project-management and time-management issues (Mpekoa 2017: 23-245). For a successful implementation of any kind of project, proper planning is necessary to be able to achieve the projects' goals.

7.5.2 **Engagement and Communication with Stakeholders**

The first step is to understand who the key stakeholders are, and to engage with them from the start to the end of the project (Mpekoa 2017). An understanding of citizen needs implies a degree of citizen participation in the development of services and applications. For the IBT system to be successful, it is crucial for citizens and all other stakeholders to be involved in the design and implementation process (Oostveen and Vanden 2004).

7.5.3 **Elections Staff Training**

EMBs have started to recognise that one of their most valuable assets is their own staff (Mpekoa 2017). However, this could also be the weakest link, as even the best-laid plan utilising the simplest forms and most user-friendly technologies risks failure if the staff are not properly trained. In addition, as new technologies are introduced into the elections process, greater emphasis could be put on the computer literacy skills of the recruited staff (Boulus-Rødje and Laanggaardsvej 2012b).

7.5.4 **Voter Education**

EMBs should ensure that the voters are informed about the changes in the ways in which they cast their vote. Voter education programmes which communicate the essential characteristics of the IBT system should be disseminated everywhere before the first use of these technologies. Demonstrations of the voting technology, through mock and pilot elections, should be deployed, such that the election authorities can ascertain whether voter education or other voter sensitisation programmes need to address any specific issues in preparing the voters for the introduction of IBTs. Special attention should be paid to the elderly and other groups of people who may not be familiar with modern technologies and the Internet. It is also important to set up an information desk where citizens can ask questions about the IBT system (Mpekoa 2017, 2014; Krimmer 2014: 1381-1389).

7.5.5 **Piloting**

Mpekoa (2017: 243-260) indicates that pilot tests are essential assessment tools for evaluating the possible use of new technologies. Pilot tests can be used to test assumptions of the possible benefits and challenges of using IBTs, as well as the costs of implementation and the reactions of the stakeholders. The pilot process should be transparent, and it should include mechanisms for feedback from the stakeholders. Pilot projects require all aspects of election administration to be adapted to the new technology, although being implemented on a smaller scale.

7.6 **Political Stability**

Political stability has been discussed earlier in Section 2.9.3(a) of Chapter 2, where it was stated that political consensus and support are important issues. The topic of political consensus has been discussed earlier in Sections 2.7.4 and 2.9.3(a) in Chapter 2.

7.6.1 **Maintenance**

Mpekoa (2017, 2012) recommends that there should be special attention directed towards ensuring that the voting equipment and computers are stored safely to prevent any kind of tampering. This is dependent on the chosen IBT system. Maintenance should include the software, the hardware and the network components of the entire IBT system. This concerns not only the voting devices themselves, but also those used on election day to receive, collate and compute the Internet voting results (Chevallier 2009: 29-44).

7.6.2 **Project Leadership**

Strategic leadership theory indicates that leaders' decisions directly affect a firm's performance (Maumbe and Owei 2006: 160-170). The relationship between leadership and the implementation of e-government in South Africa has been discussed in Section 2.7.6 in Chapter 2. For an IBT system to be successful, leadership skills would need to improve (Mpekoa 2017, 2012).

7.6.3 **Implementation Phases**

(a) The Planning Phase

During the planning phase, it is important to allow wider consultation and constitute different committees and groups to ensure wider participation. These groups would be composed of legal groups, ICT, procurement, finance, security, voter education, groups of voters, civil society organisations, non-governmental organisations, members of the international community, elections suppliers, regulatory bodies, academia and EMBs. The rationale is to allow sufficient time to understand the national elections model and therefore allow each development stage to go with therelevant stakeholder. Figure 7.6 depicts the steps or phases proposed for the implementation of IBT systems.

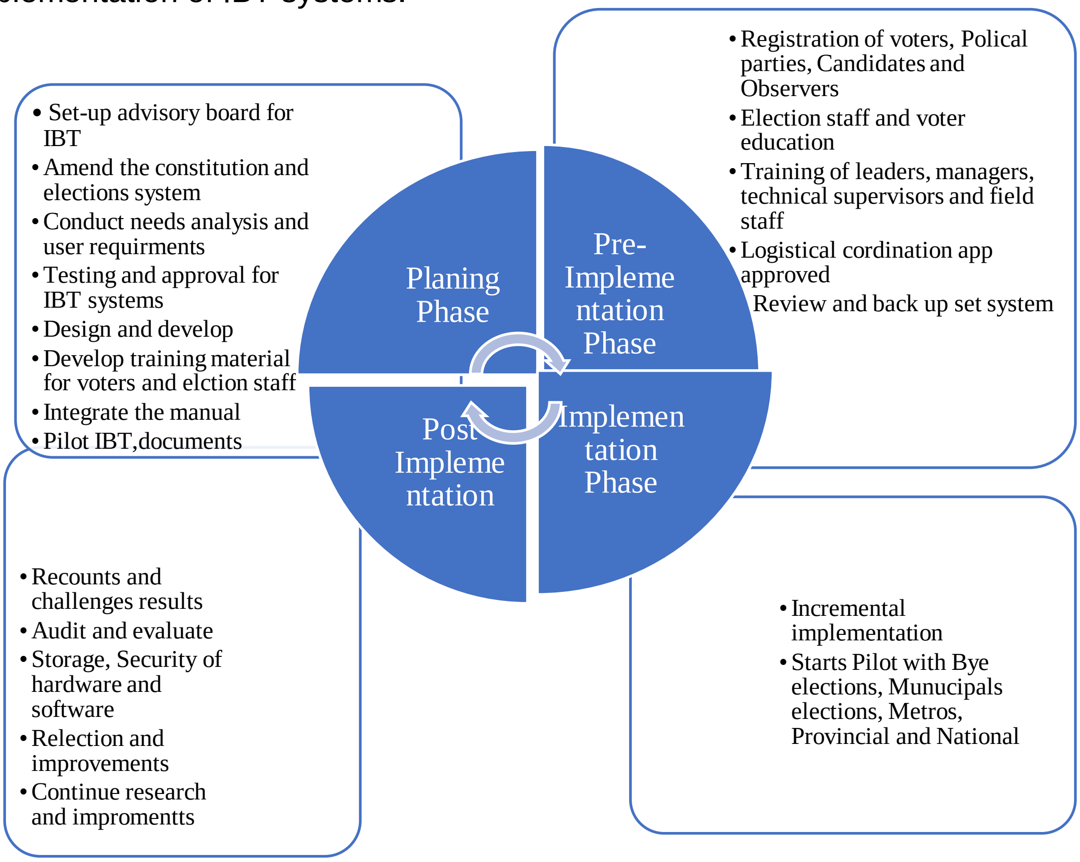


Figure 7.6 Implementation Phases for IBT Systems (Krimmer 2014: 1381-1389).

It is important to note from Figure 7.6 that IBT systems can create new and important stakeholder groups in the election process. These groups include technology vendors, certification bodies, academia and IT experts (Mpekoa 2017, 2012). All these groups may play a key role in providing, checking or overseeing the use of new technologies. If legal changes are required to use IBTs, it is prudent to start the process of making legal amendments as early as possible, since the process may be lengthy. This would allow sufficient time to develop or amend legislation in a manner inclusive of the citizens and political contestants. A full assessment of election requirements, the availability of technologies, and identifying the benefits and challenges of using such technologies can take many months. Once suitable technologies are identified, they must be procured and implemented (Mpekoa 2017, 2012).

The purpose of certification is to independently verify that the (IBTs) in the form of close and offline system, E-voting, M-voting and I-voting system complies with all the specifications and requirements established at the outset. It is important that certification be carried out by a body independent of the political parties, government and suppliers. An important part of the preparation for an E-enabled election is testing the software, hardware and the processes. Sufficient time must be allowed for the testing phase, and the representatives of civil society must participate in such tests. It may also be the case that the introduction of a new voting technology would represent an additional channel of voting to be implemented alongside the existing voting system. This is where voters are offered the choice between paper ballots or an IBT voting system. When the pilot tests are held, a full and thorough evaluation of the process must be conducted before any plans or decisions are made for further implementation. The EMB would also need to educate the voters and other stakeholders on any changes in the voting process (Mpekoa 2017, 2012).

(b) Pre-Implementation Phase

All election officials should receive training on the IBT framework, whether for a pilot scheme or for an experiment. During such training sessions, all the elections officials should be able to practice working with the system and experimenting with it. This would give them a better idea of how it works, and it would also enable them to answer any questions about the system. The time frame for the consideration and possible adoption of IBT systems is an issue which needs to be carefully considered. It is easy to underestimate the time which proper consideration and implementation can take, even for a pilot project. A back-up plan must be drawn up.

(c) Implementation Phase – Start Small and Build on the Base

The implementation phase consists of the following:

- Feasibility tests: Whenever possible, any new technology should be tested in small trials which involve representative samples of staff who will be required to use the technology, and persons who will be affected by it.
- Making use of bye-elections and local government elections

(d) Post-Implementation Phase

Audit trails play an important role within the elections processes, and they become particularly sensitive and controversial if the overall integrity of the elections system is a topic of public debate. An audit trail needs to be established for all aspects of the systems used in the election such that all the changes and decisions can be explained and defended.

7.6.4 **Concluding Remarks on Proposed IBT Framework**

The thesis has presented the South African history of elections in Chapter 3: the general background of South Africa, including its development towards democratic values; specific elections concepts such as voter registration; counting and ballot casting; election figures; and the ICT status for South African elections were discussed. The rationale was to review the current South African election challenges and identify areas of improvement from the point of view of technology deployment. The IBT conceptual framework was developed; there were limited research studies which had guided the adoption and implementation of IBTs in elections processes and procedures. The next section presents how the conceptual framework was evaluated and the received recommendation from the experts.

7.7 **Evaluation of IBT Conceptual Framework**

7.7.1 **Evaluating a Conceptual Framework**

TenBrink (1974) defines evaluation as the systematic way of obtaining information about some object and then using it to form judgments, which in turn are to be used in decision-making. Mpekoa (2017) stresses that both definitions concur that evaluation is a systematic venture, and they both use the phrase "object", which Mark *et al.* (2000) assert could refer to a program, policy, technology, person, need, or activity. The purpose of this evaluation is to determine whether the proposed conceptual framework is needed, whether it has been fully developed, whether it meets the needs of those who would use it, and to obtain comments and suggestions which will improve the framework.

7.7.2 **Evaluation Phases**

Evaluation is implemented in a sequence of phases, and it typically includes: the formulation of the major objectives or goals of the object; the conceptualisation and operationalisation of the major components of the evaluation (the program, participants, setting, and measures); the design of the evaluation and detailing how these components are to be co-ordinated; the analysis of the information, both qualitative and quantitative; and the utilisation of the evaluation results (Oetting and Cole 1978; Mpekoa 2017). Figure 7.7 depicts the evaluation phases.

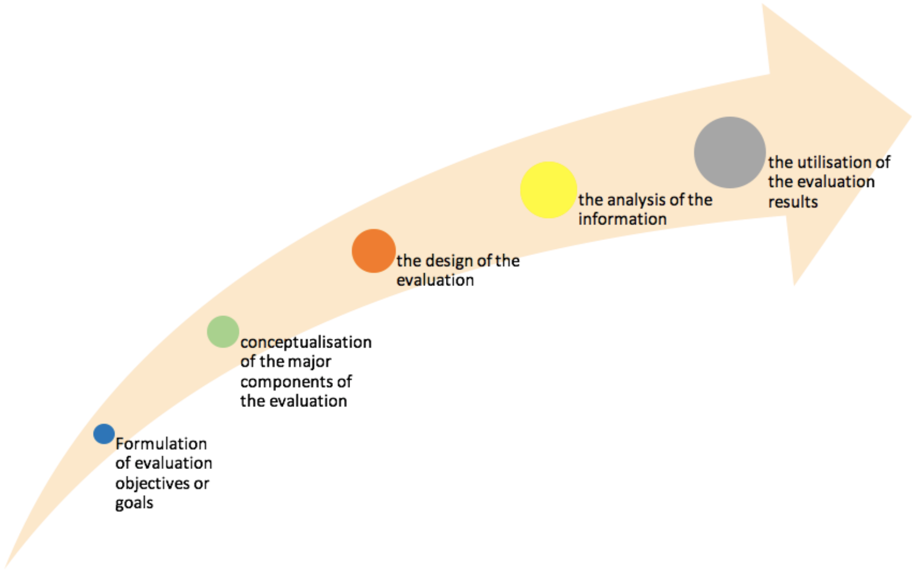


Figure 7.7 Evaluation Phases (Baker et al. 1973: 389: 418; Alkin 1973: 1-20).

The phases illustrated in Figure 7.7 were adopted for this study and are described in Table 7.2. The trajectory signifies a linear relationship among the different stages.

Table 7.2 Evaluation Phases used in this Study (Baker et al. 1973; Alkin 1973).

Evaluation Phase	**Implementation in this Study**
Formulation of objectives or goals	As already stated, the main aim for this evaluation is to determine whether or not the proposed conceptual framework is needed, whether it has been fully developed, and whether it meets the needs of those who would use it.
The conceptualisation of the major components of the evaluation	The evaluation made use of four experts: ICT elections analyst, elections officer, government policy developer and E-voting researcher.
The design of the evaluation	An online evaluation tool was developed using online forms (Appendix A).
The analysis of the information	The data collected from the evaluation was analysed both qualitatively and quantitatively.
The utilisation of the evaluation results	The analysed data was used as recommendations to improve on the proposed IBT conceptual framework.

7.8 **Expert Reviews**

An expert reviewer is an evaluator who uses his/her perceptual sensitivity, past experiences, refined insights and his/her abilities to assess an object and effectively communicate his/her assessments (Stufflebeam 2000: 1). An expert review is carried out with the focus being to identify any issues pertaining to the design in any product, and to identify specific areas where these issues occur. In an expert review, the reviewer brings in his/her expertise in a given substantive domain, and sometimes his/her personal choices or biases (Tory and Moller 2005). Tessmer (1993) suggests that in order to obtain the best out of expert reviews, one must involve multiple (ideally three to five) evaluators working independently of one another (*ibid*).

7.9 **Evaluating the Proposed IBT Conceptual Framework**

Two professionals in the area of ICT elections analysis, registration, the voting practice/domain, government policy development and E-voting research evaluated the proposed IBT conceptual framework. Their expertise is visually depicted in Table 7.3 in general, and also in the security domain, which covers expertise in information systems management, computer security and network security.

Table 7.3 Expert Review – Participants' Profiles

Expertise	Functional Title	Wider Experience
Secure E-Voting Technologies	Director: Nemisa KZN e-Skills Colab	The reviewer has been working closely with the IEC, researching and determining the impact that E-voting could have in SA in the future. The reviewer is currently the Director of the Enterprise Development Unit of the Durban University of Technology. He is also the Coordinator of the KwaZulu-Natal e-Skills Hub. He is an international elections observer and has delivered two keynote addresses on this topic. The reviewer has more than six years of experience in E-voting research and elections.

Policy Developer	Department Manager	The reviewer researches, writes and develops reports and policy documents. The reviewer leads and manages Policy Officers within the Policy and Standards Department and also establishes and reviews standards. The reviewer conducts research, writes and develops a variety of reports and documents related to consultations, policy, guidance and standards. The reviewer provides information and guidance to management on all policy and standards issues. The reviewer has more than 10 years of experience in policy development.

7.10 **Piloting the Evaluation Tool**

Once the evaluation tool was developed and ready, it was reviewed by the research supervisor and data collection experts –other academic staff members at the Durban University of Technology – prior to conducting the reviews. The evaluation tool was piloted to ensure that all the questions were concise and understandable, and that there was no ambiguity (Saunders 2011). Minor errors were noted, and the comments and suggestions were used to modify the evaluation tool (Saunders *et al.* 2009).

7.11 **Evaluation of the Observational Tool**

The evaluation tool consisted of four parts (Parts A - D).Part A is the introduction, which includes the main aim of the tool, the instructions on how the reviewers can use the tool, and a brief description of the proposed IBT conceptual framework. Part B collects the biographical information of the reviewers (e.g. age range, gender, years of service etc.).Part C presents the factors identified as influencing the successful implementation of the IBT framework, with a view to obtain comments from the reviewers. The research variables were measured against a four-point scale system, ranging from ‘strongly disagree’ to ‘strongly agree’, ‘very important’ to ‘least important’, or ‘very relevant’ to ‘least relevant’ Including description of Part D.

7.12 **Evaluation Findings**

This section of the evaluation collected the background and biographical information of the reviewers. The total number of females (50%) was the same as the total number of males (50%), and 50% of the participants were in the age range from 36 to 40, while the remainder (50%) were in the age range from 41 to 49. With regards to the years of service, two experts had between five to seven years of experience, and the other two experts had more than 10 years of experience.

7.13 **Framework Evaluation**

This section of the evaluation tool assessed the proposed factors for the IBT framework, and the research variables were measured against a four-point scale system: 'very important', 'important', 'not important' and 'least important'. The results reveal that most of the reviewers agreed that the factors proposed as influencing the implementation of IBTs were either 'very important' or 'important'. The factors which were evaluated by the experts are tabulated in Table 7.4, together with a percentage measure for each factor. The factors for the IBT framework were also assessed for relevance, and they were measured against a four-point scale system: 'very relevant', 'relevant', 'not relevant' and 'least relevant'. The factors are tabulated in Table 7.4, with a percentage measure of each factor.

Table 7.4 Framework Evaluation on Relevance

Factors to consider for IBT	Very Important	Important	Not Important	Least Important
Elections Operational Context		14%		
Elections Technologies	15%			
Political and Legal Fit	20%			
Legal Feasibility	22%			
Financial Feasibility		12%		
Technical Feasibility		11%		
Scheduling Feasibility		4%		

The results in Table 7.4 revealed that most of the reviewers agreed that the factors proposed as influencing IBT implementation are either very relevant or relevant.

7.14 **Overall Framework Evaluation**

This section of the evaluation presented statements to validate the framework, and the research variables were measured against a four-point scale system: ‘strongly agree’, ‘agree’, ‘disagree’, and ‘strongly disagree’. The statements are tabulated in Table 7.5, with a percentage measure for each statement.

Table 7.5 Overall Framework Evaluation

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
Efficient	20%			
Adoptable to elections operations		15%		
Well-designed and developed		14%		
Meets the needs of all election stakeholders		18%		
Useful and valuable		14%		
Adaptable and customisable		9%		
Requires much improvement			10%	

A total of 90% of the reviewers strongly agreed and agreed that the framework is efficient, operational, relevant and needed, meets the needs of all election stakeholders, and is useful and valuable. One reviewer (10%) thought that the framework is inefficient and required much improvement.

7.15 **Supplementary Comments and Recommendations**

The comments and recommendations of additional reviewers are presented below.

Rev-1: It does require improvement, but not very many modifications.

Rev-2: Efficiency needs to be tested holistically to determine its performance. This depends on the national development goals and availability of resources. Applicable, yes it is, though it needs to be piloted to have a practical evaluation. The system would be suitable for the rural and urban citizens in my opinion, as we have higher poverty levels in rural areas, which may imply a lack of supporting infrastructures and mobile devices. However, I suppose that it is part of the implementation consideration. I recommend the framework for adoption.

Rev-3: South Africa needs to be moving towards full-flesh E-voting, since it would help us to improve our effectiveness and efficiency as elections officers, and this might even increase our voter turn-out; it is worth the try.

7.16 **Revised IBT Conceptual Framework**

Based on the data collected and analysed, four factors (political support, management leadership, uniqueness and time) were recommended by the reviewers for removal or as an additional item, as presented in Table 7.6.

Table 7.6 Revised IBT Conceptual Framework

Item	Recommend	Do not Recommend
Political will and commitment	85%	30%
Management leadership	85%	35%
Uniqueness	60%	20%
Time	50%	0

The four factors are explained as follows:

i. **Political support**: One reviewer recommended that the political support factor should be removed: "*I don't think political support is key; as this is about citizens not politicians. Not underestimating their influence in the failure of the adoption though*". 85% of the other reviewers however recommended the factor; for this reason, the factor was not removed.

ii. **Management leadership**: One reviewer recommended that the project leadership factor should be removed: "*Management leadership is a secondary element to the success; although it is important, if all the other factors are adequately addressed, then success is guaranteed*". Firstly, the reviewer agreed that the factor is important, and secondly, the other reviewers (85%) recommended the factor and considered it as very important and relevant. For these reasons, the project leadership factor was not removed.

iii. **Uniqueness (function requirement)**: Two reviewers recommended that the function requirement should be removed, whereas the other two reviewers recommended that the functional requirement was very important and relevant: *"Although uniqueness is debatable, we need a system that addresses our needs as voters*."

iv. **Time**: One reviewer suggested that this factor should be considered as an additional factor in the IBT framework: "*Time is also important; there must be enough time to engage with the community, for piloting and testing so that people can get used to it and that is how they will accept the system.*"

The study and reviewers can conclude that there is a strong agreement that the IBT conceptual framework is efficient, operational, useful and valuable. Furthermore, it meets the needs of all the election stakeholders.

7.17 Summary

The purpose of this chapter was to develop, design and evaluate the IBT conceptual framework for South African elections, and the study has highlighted the major issues which affect the successful implementation of IBTs. The study adopted Jabareen's (2009) framework building steps in order to transparently develop the IBT conceptual framework. The procedures to develop the framework model were presented, and finally the framework model was supported by a strategic direction towards implementation.

The following aspects were also identified as major factors which have a direct influence towards the successful implementation of IBTs: the legal framework, socio-economic factors, infrastructure, technical factors, elections operations, elections scheduling, procurement timelines, finance and budget sustainability, political stability, and the planning and IBT framework for

South African elections. The current South African legal framework does not accommodate an IBT framework.

The chapter also covered the evaluation phases including the implementation phases, and it made use of the evaluation phases recommended by Alkin (1973). Table 7.2 in Section 7.7.2 presents the evaluation phases and how they were implemented in this study. The researcher developed an evaluation tool to assess the IBT framework. The online evaluation tool was developed by using online forms.

The results revealed that most of the reviewers agreed that the factors proposed as influencing IBT implementation, are very important and relevant. One reviewer suggested that ‘political support’ and ‘project leadership’ should be removed, but three other reviewers suggested they should remain part of the IBT factors. One reviewer suggested that ‘time’ should be added as an important factor, but this is one of the important resources which has been thoroughly discussed and included in the implementation steps; hence, it was not added. All the reviewers think that anonymity, authenticity, accuracy, accessibility, availability, reliability, integrity, verifiability, simplicity, flexibility, and transparency are very important and very relevant, whereas most reviewers think that convenience, scalability, robustness and auditability are important and relevant.

The reviewers strongly agreed that the framework is efficient, operational, useful and valuable. Furthermore, it meets the needs of all the election stakeholders. The proposed framework is considered important and relevant, as well as useful and valuable by experts in the related fields. The experts stated that the framework was adaptable and customisable, and required little improvement.

The following chapter presents the conclusion of the thesis. The chapter revisits the study’s main objectives, gives an overview of the study and the contributions, presents the limitations of the study, and suggests some future research endeavours.

Chapter 8 SUMMARY, CONCLUSION AND PROSPECTS FOR FUTURE RESEARCH AND PRACTICE

This chapter revisits the proposed IBT framework *vis-à-vis* the research aims and objectives.

8.1 **Summary**

Information and communication technologies increasingly play a critical role in organising elections globally (Clark 2016: 471-492; Jervier 2017: 461-468), and this innovation has not escaped many of Africa's elections management bodies, in particular the Electoral Commission of South Africa, Gauteng province. Thus, this study has examined the role of Internet-based technologies in elections management processes in South Africa and suggests lessons for the Electoral Commission of South Africa, especially regarding the effectiveness in safeguarding democratic elections. Furthermore, a literature review of new voting technologies was undertaken to discover the best practices in E-voting (James *et al.* 2019: 295-312: James 2019:44-325).The use of Internet-based technology has been demonstrated to be a valuable tool for elections (Picco 2016: 498-519; Loeber 2016: 139-160). There seems to be a positive feeling and optimism regarding the use of IBTs in South Africa, but there are equally worrisome constitutional and legal issues, as well as a lack of IBT policies, which must be considered before the EMBs can implement election-related technologies for election management.

By investigating all factors which could influence the integrity of election outcomes through the use of IBTs, the study established relationships between the use of IBTs in EMPs and the integrity of election outcomes in South Africa. Regression was used to measure the average relationship between election integrity correlated predictors and the use of IBTs in the EMPs. The correlation between these predictors and election integrity was regarded as significant at a Sig. (2-tailed) value greater than or equal to 0.25 (Dunleavy *et al.* 2006: 467-494).

8.2 Analysis and Discussion of IBT with respect to Research Aims and Objectives

The study's main research question, as stated in Section 1.4 of Chapter 1, is:

What are the components of an effective and efficient framework for EMPs for the implementation of an IBT system within the South African elections context?

The primary objective and sub-objectives of the study are included in Section 1.3.2 of Chapter 1. To fully achieve the primary objective, the sub-objectives were addressed, as explained in the sections which follow.

8.2.1 Study Objective (i)

The study's first research objective is:

Design a framework which could help to improve the South African elections, through an understanding of the dynamics of the province of Gauteng

In response, the study examines the role of IBTs within the global practice, and the regional and current South African practice (Thakur 2015a: 32; Mpekoa 2017: 32-77; Maphunye 2019: 11). The thesis evaluates IBT projects, covered in Chapters 2 and 3. The objective was further pursued via a comprehensive literature review, as well as through focus group discussions, voter questionnaires and interviews. In Chapter 5, the study presents the case example of Gauteng where stakeholders were identified and asked to identify challenges with the current paper-based elections processes. Certain factors were noted to influence the successful adoption of an IBT framework for South African elections, some of which – as mentioned by the stakeholders – include: security, political factors, organisational factors, ICT infrastructure, legal factors, accessibility, budget, different priorities for public spending and electoral staff training.

Moreover, the reviewed literature helped the thesis to achieve the first objective by focussing partly on the work done by the IEC (2010), IESA (2011), HRSC (2005), Thakur (2015) and Mpekoa (2017), as their work covered all the detailed information on elections in South Africa. The IEC

(2010) describes the South African electoral process intensively, from the preparation phase to closure, whereas IESA (2011) goes further and points out the weaknesses of the paper-based voting system. These authors, as well as many others, helped the researcher to understand the problems and challenges with which the current paper-based voting system is faced, and limitations and weaknesses of the current technology.

8.2.2 **Study Objective (ii)**

The study's second research objective is:

Identify all EMPs and which IBTs are used for each process

The study argues that the use of biometric technology in voter registration has enabled EMBs to improve the accuracy of voters rolls by providing an effective mechanism to identify duplicate entries into the voter registry. The use of biometric technology to verify voters' identities on election day has also contributed to enhancing trust in the electoral process. Similarly, technology is also providing EMBs with ways to count, tabulate and transmit election results more rapidly through measures such as electronic voting or transferring election data through mobile technology(Clark 2016: 471-492; Jervier 2017: 461-468). This enables election results to be announced sooner, potentially diffusing tension in closely-contested elections and strengthening trust in the process. According to studies such as Pomares (2012 cited in Alvarez *et al.* 2013: 117), despite its cost, biometric technology can be a worthwhile economic investment for a country even if it only decreases the likelihood of significant post-election violence by a few percentage points.

8.2.3 **Study Objective (iii)**

The study's third research objective is:

Examine the best global practices and identify gaps within the current South African EMPs in relation to the effective implementation of IBTs

In response, relevant literature helped the study to analyse the respondents' views in a purposive sample, as stated earlier in Chapter 4. Evidence from several studies elsewhere in the world suggests the effects that electronic voting (or E-voting),Internet-based technologies and other online technologies have had on political participation, election participation, new voting technologies, the use of new ICTs to monitor election violence and the use and effectiveness of mobile phones, including citizens' perceptions on the use of electronic voting technologies (EVTs) and ICTs for elections. Further research evidence refers to developing countries where the use of E-voting has proliferated more rapidly than in the established democracies (Pomares 2012 cited in Alvarez *et al.* 2013: 117). However, such proliferation in the African context still needs to be clearly visible given the continent's infrastructure and other development challenges which usually impede technological advancements.

Chapter 2 examines elections management processes and technology interventions in Gauteng, South Africa. Section 3.10 of Chapter 3 summarises the key areas where IBTs can improve elections processes and procedures, and the benefits of E-voting.

Chapter 3 The study argues that every country will approach the adoption of IBTs as per legal requirements and the needs of electorates. Again, it is important to consider numerous issues before adopting IBTs such as the use, relevance and improvement of technologies for elections. Section 7.2.3(b) of Chapter 7 discusses the differences in technologies and the impact they can have on elections processes.

8.2.4 **Study Objective (iv)**

The study's fourth research objective is:

Examine the factors which have influenced the adoption of IBTs for all stages of election cycle processes

The study refers to cost factors, induction and training, piloting and many other dynamics which must be considered in the use of election-related technologies. In short, some of these dynamics include technical-, financial-, political- or human-resource-related hurdles; they can also have legal and constitutional implications, as argued in this study (Pomares 2012 cited in Alvarez *et al.* 2013: 117). Technical dynamics specifically refer to the ability, expertise and technicalities of using or applying election-related technologies, for which certain skills have to be acquired by the EMBs and their service providers. Financial dynamics include the money and funding needed to purchase the IBTs and election-related technologies, public budgets and budgetary allocations, and auditing and accounting mechanisms required to ensure sound financial accounting for legislatures and taxpayers in a country.

The political aspects refer to the constitutional, political and legislative issues which all EMBs face to ensure that members of legislatures assist them to manage elections without any political hindrances or shenanigans. In terms of human resources, the major dynamics faced by the EMBs include recruitment, appointment, promotion and retention of the electoral officials, as well as their ever-ballooning salaries which require sustainable funding. Finally, IBTs or election technologies have legal and constitutional implications in the sense that normally no one can change or apply such technologies in a country's elections unless the laws and constitution make special provisions for such technologies (these were the views expressed by the IEC, EISA, Voters, ANC officials, DA EFF and selected staff members of DUT who were part of the study). Above all, the study also targeted largely on focus group discussions with the nominated experts from the ICT industry in South Africa, IEC elections experts and EISA missions reports, as stated in Chapter 4.

8.2.5 **Study Objective (v)**

The study's fifth research objective is:

Identify the current challenges associated with the use of IBTs for EMPs in South Africa's Gauteng province

The digital age presents South Africa with new opportunities and new threats as it faces daily economic challenges and other public discourses while being on the road to entrenching democracy: the holding of consistently free and fair elections which are accepted as legitimate by both voters and outsiders is a call for everyone participating in a public space. Technology offers benefits and yet poses fresh challenges to elections, democracy and good governance. Security and public trust are a few examples emerging as important topics in the discussion on how to prevent election interference or fraud, as stated in the study's problem statement and in other parts of the study.

Furthermore, the study presents ICT products and services in Section 2.8 of Chapter 2, followed by a SWOT analysis for South African elections in Section 2.9. Section 2.9.4 notes the drawbacks of traditional paper-based elections procedures, and describes the numerous challenges with which the current South African elections process is faced.

While the study acknowledges that the Electoral Commission of South Africa has been carrying out commendable work in ensuring free and fair elections, there continue to be challenges, as mentioned in Section 2.9.4, and recently the IEC is aiming to facilitate more efficient and secure election processes using new technologies, the enrolment of voter registration, efficient and cost-effective voting, geo-locating voters in real time, automatically updating the voters roll, voter identification at polling stations, and the casting of votes. E-voting allows for near real-time tallies and highly-effective election monitoring. The social media and fake news is another challenge which can undermine the credibility of elections in South Africa if it is not dealt with.

The study concurs with the opinion which states that South Africa is still a country with a young democracy and a growing population of 54 million – the country's democracy started in 1994 following the historic demise of Apartheid. Despite the rise in the number of young registered South African voters, it is worth noting that less than half of the country's youth voted in 2014. This comparatively low level of young people's involvement in the electoral process is even starker when considering the voter turnout for the 2011 municipal elections as a proportion of the country's population as a whole. The benefits to the voter of new election technology, such as Internet voting, are clear. The ability to vote from home, work, the market, or even an individual's customary voting place makes a strong case in favour of Internet voting. The absentee voters and those living abroad will be better able to vote, which is of critical importance to Africa, given its large Diaspora.

Based on the literature review, the study can also attest that currently, the waiting period between the voting station and obtaining the results provides fertile ground for the planting of seeds of discontent, sadly often justified, which threaten the credibility of polls. It is equally important to note that the South African election process consumed about 460 tonnes of paper in the 2009 general elections (and over 500 tonnes in 2014) (IEC 2014; Sampath 2013). Poushter and Oates (2015) assert that nine in 10 South African citizens have a cellphone, which explicitly provides access internet.

The study argues that unless South Africa and other countries rise to the challenge of understanding the opportunities and threats which arise from advances in technology, they risk becoming the playground of dark forces which are intent on abusing democratic elections to fulfil their unpleasant ends. The use of technology in elections is not merely a technical issue, but is becoming a public policy matter. South Africa is not an exception in its use of election technology.

8.3 **Validation of Study Research Objectives**

The thesis analysed five primary research questions, as stated in Section 1.4 of Chapter 1, to attain the study's overall aim.

The research design and methodology presented in Chapter 4 were critical in answering the primary research question and the sub-questions. The discussion in Chapter 4 is based on research philosophies and paradigms, research design, data collection and data analysis, in addition to the sampling and ethical considerations chosen for this study. A pragmatic view was taken, with inductive reasoning as the research approach. This research study employed a case example as the primary research strategy to address the research problem and the objectives. Mixed methods research, using both quantitative and qualitative research techniques and procedures, was utilised.

In order to adequately satisfy the main objective of the study, all the sub-objectives were to be attained. The sub-objectives of the study and the relevant data collection procedures were presented. The original research work presented in this project and reviewed to achieve the study objectives was focused on a number of recent existing technical ideas and elections philosophies to attain a more relevant IBT solution for South African elections (Mpekoa 2017a, 2015; Thakur 2015a; Krimmer *et al.* 2015; IDEA 2017, 2014a; Jain, Ross and Nandakumar 2011; EISA 2014, 2009). The ACE Elections Knowledge Network Project (2017, 2016) and the IEC-South Africa (2016, 2014a, 2014b, 2012, 1994) reports covered all the 450 global and 300 detailed information on technology use on South African elections. Mpekoa (2017:80-180) relevant framework model for implementing an IBT system by comparing the current manual paper-based system to her proposed model.

Thakur (2015: 100-138) also went further to discover a very important achievement of this current study in the discovery of Linear Prediction Cepstral Coefficients – Histogram of Oriented Gradients (HOG) algorithm (LPCC-HOG as viable and compact spectral features for implementing the authentication module of the SMIV architecture). These features are also very promising for other applications which require a voice biometric-based users' authentication module. The SMIV architecture therefore suggests that a multimodal remote authentication scheme which incorporates NFC and GPS, in addition to LPCC-HOG biometrics, will provide the necessary improved statistical confidence to accurately identify a voter. These authors, as well as many others, helped the researcher to understand the problems and challenges with which the current elections processes and procedures in South African elections are faced (Mpekoa and Van Greunen, 2016).

8.4 **Thesis Contributions**

The thesis presented an indigenous and sustainable framework for IBT integration and an effective use and management for South African elections. The elections technology framework is a blueprint for developing a complete elections system, something which has not been previously developed. The framework represents a substantial piece of work which can be used as a starting point, particularly in gathering input from national local elections officials, understanding their needs and drafting specifications. This study has added to the body of knowledge of IBTs as a subset of ICT, M-voting, I-voting, E-voting and m-government.

This study has also added value in line with the anticipated South African initiatives for a secure electronic voting implementation. The research has highlighted the different initiatives undertaken to promote ICT development in South Africa, and the available institutional, legal and regulatory frameworks required to support IBT framework development.

The study further identifies, evaluates and recommends ways to observe e-enabled elections within the SADC region, and contributes two areas of elections development components, namely:

i. An indigenous IBT conceptual framework for South African elections, and the implementation of an optimal application of technology; essentially, the thesis identifies several major barriers to the successful implementation of such. It also suggests routes through which those barriers might be overcome. The thesis further provides an important step forward in what is much needed research within Southern African region, regional and internationally. Moreover, the study identified the research gap which sought to fill and also palpable in terms of the situation in South Africa. It bringing's new insight into the subject thus add fresh impetus for more research on the subject. It has started an important journey towards adopting a working policy that could potentially underpin future directions around the use of technology in elections.

ii. Observing highly-automated elections processes in South Africa. This study presents the conceptual framework which can be used as a navigation tool, and a general overview of the elements of automation which might be observed at each stage of the elections process, defining the security objectives, functionality and anticipated output for each technological character.

The study conducts a comprehensive literature review to discover the best elections technologies for South African elections. Figure 2.2 (Section 2.4 of Chapter 2) and Figure 7.3 (Section 7.2.3(d) of Chapter 7) depict all phases of a concept's development into a visible theoretical framework for IBTs, ready to be tested for deployment.

8.5 **Reflections and Considerations**

The scientific reflection generalises contributions in the context of the research community, while the methodological reflection describes the stance taken to conduct IBT research, and the substantive reflection defines the scope of the study.

8.5.1 **Scientific Reflection**

Although the benefits of introducing elections technologies are frequently stated, there are concerns which may be raised from the introduction of this technology – this is not merely based on the security risks, but also on the organisational, sociological and political implications. Digitalising the communications between governments and citizens is a necessary development for viewing the proposed internet based technology within a wider framework.

8.5.2 **Substantive Reflection**

As the study has indicated earlier in Chapter 4, the research used the design science paradigm, which determines the production of a viable artefact. The study developed an IT artefact in the form of an ICT framework for IBTs for elections management processes in South Africa, using a case example of Gauteng province. This implied immersion in several fields, including: Human Computer Interactions (HCI), elections policy development and elections management practice. The research required the understanding and knowledge of:

- the different types of IBT systems available and their benefits;
- developing a policy in order to develop the IBT conceptual framework;
- manual paper work for elections procedures and process within the South African context; and
- evaluation criteria for the design of the IBT evaluation tool for the experts.

The IBT conceptual framework will benefit not only the elections management bodies, but also the voters, the government and the community at large. Many countries which have endeavoured to implement IBTs in a full election cycle will also benefit. Very few have succeeded. This framework will assist EMBs and other election stakeholders identified in the study in understanding the key factors which affect various technological implementations such that they can use the framework to assess their I-voting, M-voting, and E-voting readiness. Once they are ready, the proposed implementation steps can be used to prepare, plan and execute in real elections mode.

8.6 **Limitations of the Study**

As stated in Section 4.12.2 of Chapter 4, conducting research requires a researcher to be neutral and unbiased towards his/her own research. However, the researcher has to have a particular stance and cannot distance himself/herself from the research. As a voter, the researcher has opinions and ideas on the factors which might affect the implementation of IBTs in South Africa. The researcher’s experiential knowledge thus became an essential conceptual source for developing the framework.

Elections are very significant processes around the world, and their delimitation and limitations have been discussed in Section 1.8 of Chapter 1.

This study primarily investigates the use of IBTs in the elections management processes in Gauteng. Only IBTs being used in this study area were investigated and evaluated. The remaining eight IEC-SA provincial offices(Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga, North West, Northern Cape and Western Cape), were not included in the study. The study period was between 2009-2014. Important points to note include:

- The study did not concern electronic voting, but rather Internet-based technologies. While related, the two concepts cannot be conflated. Moreover, the question of considering electronic voting in the South African political environment is a contentious subject for another research study, the ramifications of which were not part of this study.
- There is the possibility that the researcher might have found it difficult to identify with the material presented in this study as a professional.
- This is not a case study but involves a case example approach, with Gauteng being the case example.
- The contents of this study are NOT generalisable to other parts of South Africa and elsewhere in the SADC region, but merely reflect the situation in Gauteng Province as a case example
- There is no demographically-representative sample of those who evaluated the framework.

8.7 **Possible Directions for Future Research**

This study has revealed the potential for IBT research in South African elections. Future research could replicate this study by considering other public agencies and examining the effectiveness of the models to measure technology acceptance and to determine its predictive validity. Research is not a terminal experience, but one which continues building upon the findings of the past and moving towards a future of greater knowledge and application.

This study focused on IBTs in Gauteng. It would be interesting to see if the results could be replicated within all of South Africa, and South Africa becoming a learning centre for regional development.

Conversely, there are important areas such as the organisation of EMBs' orientation towards paperless elections services and the social power. Continuous improvements on the thin line towards the accessibility of elections services and products, as well as making them more user-friendly but still having the highest degree of security, are important so as to realise the end-to-end encryption, integrity and auditability of elections and their outcomes.

8.8 **Thesis Conclusion**

The study's main conclusion is that eventually, the introduction of an IBT framework will require major changes within the elections legal framework for South African elections. Furthermore, it is important to note that it takes time to develop a robust and secure elections system, and the necessary research and development time must be set aside before any system can be effectively introduced.

Chapter 7 presents the planning and implementation strategies for the successful use of an IBT framework for South African elections. The study submits to the Electoral Commission of South Africa the need to consider endorsing the IBT conceptual framework, in order for the entire community to consider it and to make it a successful initiative. With this being stated, this thesis appreciates the recent achievements made within the elections operations. It cannot deny that further work lies ahead to be developed, as every election has its own challenges which require different elections systems for specific needs and problems. By leveraging the correct set of technologies, policies, procedures and practices, people will be able to see future elections taking place in a safer environment and without the fear of being influenced by malicious parties, whether foreign or domestic.

REFERENCES:

Abdulhamid, S.Í.M., Adebayo, O.S., Ugiomoh, D.O. and AbdulMalik, M.D. 2013. The Design and Development of Real-Time E-Voting System in Nigeria with Emphasis on Security and Result Veracity. *International Journal of Computer Network and Information Security*, 5(5):9-18.

Abraham, R., Bennett, E.S., Sen, N. and Shah, N.B. 2017. State of AADHAAR report 2016-17. ID insight. Available: http://stateofaadhaar.In: www.static1.squrespace.com (Accessed 20 November 2018).

Abraham, S., and Chengalur-Smith, I. 2010. An overview of social engineering malware: Trends, tactics, and implications. *Technology in Society*, 32(3): 183-196.

ACE Elections Knowledge Network Project. 2014. *Elections and Technology updates*. Available: http://aceproject.org/ace-en/topics/et (Accessed 19 February 2014).

ACE Elections Knowledge Network. 2013. Media and Elections. The ACE Encyclopaedia. The UN Electoral Assistance Division (UNEAD) New York. The ACE Project, 9-234.

Achieng, M. and Ruhode, E. 2013. The Adoption and Challenges of Electronic Voting Technologies. International Journal of Managing Information Technology, 5(4):1-12.

Achieng, M.S. 2014. The adoption and challenges of electronic voting technologies within the South African Master's Dissertation. CPUT.

Adeshina, S.A. and Ojo, A. 2014. Towards improved adoption of E-voting: Analysis of the case of Nigeria. In: Proceedings of the 8th International Conference on Theory and Practice of Electronic Governance 2015 Proceedings, Association for Computing, Machinery New York United States, ACM, 403-412. Available http://dl.acm.org/doi/10.1145/2691195.2691255 (Accessed 12 December 2018).

Adeyinka, T. and Olasina, G. 2012. *Voters' Perception of the Adequacy and Suitability of e-Voting in the Nigeria Polity*. Handbook of Research on E-Government in Emerging Economies: Adoption, E-Participation, and Legal Frameworks: Adoption, E-Participation, and Legal Frameworks, 123.

Adjei, B.A. 2018. Assessing the Effects of Elections Reforms in Ghana: The Case of Biometric Voter Registration and Verification. Doctoral dissertation. University of Ghana.

African Union. 2007. African charter on democracy, elections and governance. Addis Ababa: AU

African Union. 2002. Declaration on the principles governing elections in Africa. African Union. 2002. Charter. Addis Ababa: AU. Available: http://www.eisa.org.za/pdf/au2002declaration.pdf (Accessed 15 March 2017).

African Union. 2007. Declaration on the principles governing elections in Africa. African Union. 2007. Charter. Addis Ababa: AU.

Agun, A. and Heeks, R. 2007. *Mobile phones and development: the future in new hands?* Insights/id21 (Programme), (69) ID21 insights 69, IDS, University of Sussex, Brighton, UK, 6.

Ahmad, S. 2016. E-voting system adoption and its impact on voter turnout in Nigeria. Doctoral dissertation. University of Utara Malaysia, Sintok.

Ajayi, K. 2013, 'The ICT culture and transformation of electoral governance and politics in Africa: The challenges and prospects', 5th *African European Conference on African Studies*, Centro de Estudos Internacionais do Instituto Universitario de Lisboa, Madrid 27–29 June 2013.

Aker, J.C. and Mbiti, I.M. 2010. Mobile phones and development in Africa. *Journal of Economic Perspectives*, 24(3):207-232. Available: http://doi.org/10.1257/jep. 24.3.207. (Accessed 13 June 2017).

Akpan, N.E. and Adagba, S.O. 2018. Information technology: A contemporary tool to combat elections fraud in Nigeria. *International Journal of Social Sciences and Humanities Review*, 8(1):1-65.

Albright, S.D. 1942. *The American ballot*. Washington D.C. The American Council on Public Affairs. Washington, DC. Alesina.

Alebiosu, E.A. 2016. Smart Card Reader and the 2015 General Elections in Nigeria. *Journal of African Elections*, 15(2):69-89.

Alexandra, W. 2016. South African vote could unsettle ANC. Available: http://www.wsj.com/articles/South Africas-ruling-facing-election-challenge 1470216294 (Accessed September 06 2016).

Algeo, L. 2012. Citizen Inclusion for all: Enhancing South Africa's e-Government Strategy with an m-Government Framework.

Alkin, M.C. 1973. Evaluation and Decision-Making. Planning and Changing.

Allers, M.A. & Kooreman, P. 2009, 'More evidence of the effects of voting technology outcomes', Public Choice 139(1/2)159–170. Available: http://doi.org/10.1007/s11127- 008-9386-7 (Accessed 10 September 12 2016).

Allison, S. 2015. Lesotho's elections system can be categorised as democratic, but it must be questioned whether it is the best system for this fragile state. Available: http://issafrica.org/iss-today/think-again-democracy-reigns-in-lesotho-but-which-democracy-exactly (Accessed 16 June 2016).

Alsukkar, A. 2005. The application of information systems in the Jordanian banking sector: a study of the acceptance of the Internet, PhD thesis, School of Economics and Information Systems, University of Wollongong.

Altman, M. and Klass, G. M. 2005. Current research in voting, elections, and technology. *Social Science Computer Review*, 23(3):269-273.

Altun, A. and Bìlgìn, M. 2011. Web-based secure E-voting system with fingerprint authentication. *Scientific Research and Essays*, 6(12):2494-2500.

Alvarez, R. M., Atkeson, L. R. and Hall, T. E. 2012. *Evaluating Elections: A Handbook of Methods and Standards*. New York: Cambridge University Press.

Alvarez, R. M., Atkeson, L. R. and Hall, T. E. eds. 2012b. *Confirming Elections*. New York: Palgrave Macmillan.

Alvarez, R.M. and Hall, T.E. 2004. *Point, click and vote - The future of Internet voting*. Washington D.C.: Brookings Institution Press.

Alvarez, R.M. and Hall, T.E. 2010. *Electronic elections: The perils and promises of digital democracy*. Princeton: Princeton University Press.

Alvarez, R.M., Hall, T.E. and Trechsel, A.H. 2009. Internet voting in comparative perspective: The case of Estonia. *PS: Political Science and Politics*, 42(03):497-505.

Alvarez, R.M., Levin, I., Pomares, J. & Leiras, M. 2013. Voting made safe and easy: The impact of E-voting on citizen perceptions', Political Science Research and Methods 1(1) 117–137. Available :https://doi.org/10.1017/psrm.2013.2 (Accessed 12 August 2016).

Amedzo, E.K. 2007. The integration of information and communication technology into rural schools of South Africa: A case study of schools in Malamulele. Doctoral dissertation, University of Stellenbosch.

Amillo, A.G., Ntsangwane, L., Huld, T. and Trentmann, J. 2018. Comparison of satellite-Accessed high-resolution solar radiation datasets for South Africa. *Journal of Energy in Southern Africa*, 29(2):63-76.

Andersson, G. and Lindvall, N. 2018. Trust and Turnout: An Empirical Study of South African Voters. Stockholm: Uppsala University Publication, 33.

Angeles, R. 2013. Using the Technology-Organisation-Environment Framework and Zuboff's Concepts for Understanding Environmental sustainability and RFID. Two Case studies. *International Journal of Social Economics and Management Engineering*, 7(11):1599-1608.

Anglin, D.G. 1998. International election monitoring: The African experience. *African Affairs*, 97(389):471-495.

Apentsui, W.T., Osman, I., Yahaya, A., Fuseini, M.A.B. and Issah, G., 2015. Evaluation of effective use of information and communications technology (ICT) in election administration in Northern Ghana region. International Journal of Economics, Commerce and Management, 3(4):1-21.

Araida, S., Herrera, S. and Ping, M. 2016. Georgetown University Department of Government Democracy and Governance http://ieeexplore.ieee.org/abstract/document/6113931 Studies Program United States Agency for International Development (USAID) Elections Policy Study Group Report on Elections, Technology and Voter Confidence. Available:http://www.usaid.gov/sites/default/files/documents/1860/Mali_2014 DRG%20Assessment_public_FINAL.pdf (Accessed 10 June 2015).

Astrid, S., Gerhard, H., and Maria, B. 2010. Linear Regression Analysis: Part 14 of a Series of Evaluation of Scientific Publications, Dtsch Arztebl Int 107(44):776-782.

Athiemoolam, L. 2003. South Africa's peaceful transition to democracy: Nine years of peace in a troubled world. In Peace as a Global Language Conference II, Seisen University, Tokyo: 27-28

Atkeson, L.R. and Saunders, K.L. 2007. The Effect of Election Administration on Voter Confidence: A Local Matter? *PS: Political Science and Politics*, 40(4):655-660.

Avgerou, C., Masiero, S. and Poulymenakou, A. 2019. Trusting E-voting amid experiences of elections malpractice: The case of Indian elections. *Journal of Information Technology*, p0268396218816199. 34(3)

Ayee, J.R. 2001. Civil service reform in Ghana: A case study of contemporary reform problems in Africa. *African Journal of Political Science/Revue African Political Science*, 6(1):1-41.

Ayinde, A.F. and Idowu, A.O. 2016. Nigeria's 2015 elections: Permanent voter's cards, smart card readers and security challenges. *Journal of African Elections*, 15(2):50-68.

Ayo, C.K., Ifinedo, P., Ekong, U.O. and Oni, A. 2012. An Empirical Evaluation of the Effects of Gender Differences and Self-Efficacy in the Adoption of E-Banking in Nigeria. Leveraging Developing Economies with the Use of Information Technology. Trends and Tools, 1(1):179-192.

Ayo, C., Adewoye, J. and Oni, A. 2010. The state of e-banking implementation in Nigeria: A post-consolidation review. *Journal of Emerging Trends*, 1(1):37-45.

Ayo, C.K. and Azeta, A.A. 2009, June. A framework for voice-enabled m-Voting system: Nigeria a case Study. In 9th European Conference on e-Government, Westminster Business School, University of Westminster London UK: 96-104.

Ayo, C.K., Adebiyi, A.A. and Afolabi, I.T. 2008. E-Democracy: A requirement for a successful E-Voting and E-Government implementation in Nigeria. *International Journal of Natural and Applied Sciences*, 4(3):310-318.

Ayo, C.K., Ekong, U.O., Ikhu-Omoregbe, N.A. and Ekong, V.A. 2011. M-Voting implementation: The issues and trends.

Ayo, C.K., Ekong, U.O., Ikhu-Omoregbe, N.A. and Ekong, V.A., 2011. m-Voting implementation: The issues and trends. Available: http://www.academia.edu/download/3258019/EEE4041.pdf (Accessed 10 June 2015).

Azurin, R.B. 2016. Elections as an instrument of political control. *Chasing the Wind*, 1(1):140-142.

Babbie, E.R. 2013. The basics of social research, Cengage Learning.

Babich, V. and Hilary, G. 2019. *Distributed ledgers and operations: What operations management researchers should know about block chain technology. Manufacturing and Service Operations Management. Forthcoming in Manufacturing and Service Operations Management Georgetown McDonough School of Business Research Paper No. 3131250*. Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3131250 (Accessed 10 May 2019).

Bailey A., Minto-Coy I., Thakur D. 2017. IT Governance in E-Government Implementations in the Caribbean: Key Characteristics and Mechanisms. In: Rusu L., Viscusi G. (eds) Information Technology Governance in Public Organizations. Integrated Series in Information Systems, (38). Springer, Cham 38(1): 201-237

Bak, N. 2003. Guide To Academic Writing. *English Learning*, (September):1–59.

Baker, E.L. and Alkin, M.C. 1973. Formative evaluation of instructional development. *AV Communication Review* 21(4): 389–418.

Bam, B. 2009. *Elections 2009. To the Future*. Pretoria: Electoral Commission of South Africa.

Bam, B. 2015. *Democracy: More than just elections Pretoria*. Sandton: KMM Review Publishing Company (PTY) Ltd.

Bam, B. N. 2008. *Eternal vigilance and the value of Peace and Political Tolerance in advancing Democracy.* South Africa Peace Indaba Summit Kuala Lumpur, Malaysia 2-3 September 2017. Electoral integrity, A Kofi Anni Foundation Initiative. Available http://storage.googleapis.com/kofiannanfoundation.org/2018/04/Democracy-in-Southeast-Asia.pdf (Accessed 30 November 2018).

Beall, J., Crankshaw, O. and Parnell, S. 2000. Local government, poverty reduction and inequality in Johannesburg. Environment and Urbanization 12(1):107.

Beck, R. and Weber, S. 2014. Enhancing IT Artifact Construction with Explanatory and Predictive Knowledge in Design-Science Research. *Journal of Information Technology Case and Application Research*, 15(1):4-18.

Becker, K. and El-Said, H. 2013. *Management and international business issues in Jordan*. New York, London: Routledge, Taylor and Francis Group.

Beetseh, K. and Akpoo, T. 2015. The Analysis of the use of Smart Card Reader (SCR) and Credible Elections in Nigeria 2015. *Inter. Journal of Political Development*, 3(11):470-477.

Bélanger, F. and Carter, L. 2010. The impacts of the digital divide on citizens' intentions to use Internet voting. *International Journal on Advances in Internet Technology* 3(3):2010.

Belle, J. Van and Cupido, K. 2013. Increasing Public Participation in Local Government by Means of Mobile Phones: What do South African Youth Think? *The Journal of Community Informatics,* 1–21.

Bennett, D. 2015. Factors influencing the success of an E-participation project in South Africa. Doctoral dissertation, University of Cape Town.

Bereketeab, R. ed. 2017. *State Building and National Identity Reconstruction in the Horn of Africa.* New York City. Springer International Publishing.

Berger, P.L. and Kellner, H. 1981. *Sociology reinterpreted: An essay on method and vocation, Anchor Books*.

Bergman, M.M. 2008. Advances in mixed-methods research: Theories and applications, Sage.

Bevan, N. 1995. Human-computer interaction standards. Advances in Human Factors/Ergonomics 20(B):885–890.

Bhuiyan, S.H. 2011. Modernizing Bangladesh public administration through e-governance: Benefits and challenges. Government Information Quarterly, 28(1): 54-65.

Boast, J. 2014. Is little to be gained by lamenting the past?: Assessing the extent to which addressing the past legacy of the South African and Kenyan judiciaries by means of transitional justice mechanisms, has contributed to achieving the objectives of judicial. Doctoral dissertation. University of Cape Town.

Bogaards, M. 2018. Deliberative Democracy and Elections Reform in South Africa: A Campus Experiment. *Politikon*, 45(2):181-198.

Bollou, F. and Ngwenyama, O. 2008. Are ICT investments paying off in Africa? An analysis of total factor productivity in six West African countries from 1995 to 2002. *Information Technology Development*, 14(4): 294-307.

Booysen, S. 2005. The Democratic Alliance: Progress and Pitfalls. In Elections Politics in South Africa: 129-147. Palgrave Macmillan US.

Borra, R.Z. 1995. *Technology and Elections Reforms: Modernizing the COMELEC*. Quezon City: UP College of Public Administration and the University of the Philippines Press.

Bosch, T. 2017. Twitter activism and youth in South Africa: The case of #Rhodes Must Fall. *Information, Communication and Society*, 20(2):221-232.

Botchway, T.P. and Kwarteng, A.H. 2018. Elections reforms and democratic consolidation in Ghana: An analysis of the role of the elections commission in the fourth republic (1992-2016). *Asian Research Journal of Arts and Social Sciences*, 1(1):1-12.

Botes, A. 2010. South African Government Information. Available: http://www.info.gov.za/speech/DynamicAction?pageid=461andsid=10830andtid=10847 (Accessed 18 June 2013).

Boulus-Rødje, N. & Laanggaardsvej, R. 2012a. Mapping the literature: Socio-cultural, organizational and technological dimensions of E-voting technologies. In Electronic voting. *Citeseer,* 227–241.

Boulus-Rødje, N. 2012a. Mapping the literature: socio-cultural, organizational and technological dimensions of E-voting technologies. In: Kripp, M. J., Volkamer, M. & Grimm, R. (Hrsg.), 5th International Conference on Electronic Voting 2012 (EVOTE2012). Bonn: Gesellschaft für Informatik e.V. (S. 227-241).

Bouma, G. and Ling, R. 2004. The Research Process', 5th edn, Oxford University Press, Melbourne.

Bowyer, K.W. 2016. *Biometrics Research*. Washington: Noblis, Inc.

Bowyer, K.W. and Burge, M.J. eds. 2016. *Handbook of iris recognition*. London: Springer, 1-8.

Bowyer, K.W., Ortiz, E. and Sgroi, A. 2015b. Iris recognition technology evaluated for voter registration in Somaliland. *Biometric Technology Today*, 20152(2):5-8.

Bowyer, K.W., Ortiz, E. and Sgroi, A., 2015a. *May. Trial Somaliland voting register de-duplication using iris recognition.* In 2015 11th IEEE International Conference and Workshops on Automatic Face and Gesture Recognition (FG) EEE. 4-8 May 2015. Institute of Electrical and Electronics Engineers. Ljubljana, Slovenia. Available: http://ieeexplore.ieee.org/abstract/document/7284833 (Accessed 19 May 2017).

Braconnier, C., Dormagen, J.Y. and Pons, V. 2017. Voter registration costs and disenfranchisement: experimental evidence from France. *American Political Science Review*, 111(3):584-601

Brooks, F. P. and Iverson, K. E. 1963. *Automatic Data Processing*. Georgetown, Washington D.C.: Wiley, 94.

Bryman, A. 2001. Social Research Methods, Oxford, Oxford University Press.

Bryson, J.M. 2004. What to do when stakeholders matter: Stakeholder identification and analysis techniques. *Public Management Review*, 6(1):21-53.

Buckland, R. and Wen, R. 2012. The Future of E-voting in Australia. *Institute of Electrical and Electronics Engineers Security and Privacy*, 10(5):25-32.

Business live. 2019. *Discrepancies point to possible voter fraud*. Available:http:www.businesslive.co.za (Accessed 18 June 2019).

Butler, A. 2017. Contemporary South Africa. Springer.

Callen, M., Gibson, C., Jung, D. F. and Long, J. D. 2016. Improving Elections Integrity with Information and Communications Technology. *Journal of Experimental Political Science*, 3(1):4-17.

Campbell-Kelly, M. 2009. Historical reflections computing in the depression Era. *Communications of the ACM*, 52(10):21-22.

Cant, M.C., Wiid, J.A. and Hung, Y.T. 2015. Internet based ICT usage by South African SMEs: are the benefits within their reach? *Problems and Perspectives in Management*, 13(2)(Special issue 1):444-451.

Carter Center. 2007. *Developing a Methodology for Observing Electronic Voting*. Atlanta: The Carter Center. Available: http://www.cartercenter.org/documents/elec_voting_oct11_07.pdf (Accessed 14 March 2017).

Carter Centre. 2015. *Election Obligations and Standards a Carter Centre Assessment Manual*. Available: http://www.cartercenter.org/resources/pdfs/peace/democracy/cc-oes-handbook-10172014.pdf (Accessed 18 May 2017).

Carter, L. and Bélanger, F. 2005. The utilization of e-government services: Citizen Trust, Innovation and acceptance factors. *Information Systems Journal*, 15(1):5-25.

Carter, L. and Weerakkody, V. 2008. E-government adoption: A cultural comparison. *Information Systems Frontiers*, 1(4):473-482.

Castells, M. 2009. *Communication power*. Oxford, New York: Oxford University Press.

Castells, M. 2013. *Networks of outrage and hope: Social movements in the Internet age*. Cambridge: John Wiley and Sons, Polity.

Cecchini, S. and Raina, M. 2004. Electronic government and the rural poor: The case of Gyandoot. *Information Technologies and International Development*, 2(2):65-75.

Celis, N.J. And Watch, A. 2014. *Manifestation on Preparations for the 2016 Elections*. Quezon City: University of the Philippines Deliman.

Chambliss, D.F. and Schutt, R.K. 2012. Elementary Quantitative Data Analysis. Making Sense of the Social World: Methods of Investigation, Sage, Los Angeles, CA, USA: 154–177.

Chandramouli, R. and Lee, P. 2007. Infrastructure standards for smart ID card deployment. *Institute of Electrical and Electronics Engineers Security & Privacy*, 5(2): 92-96. Available: http://Institute of Electrical and Electronics Engineers explore. Institute of Electrical and Electronics Engineers.org/abstract/document/4140999 (Accessed 21 June 2019).

Chapman, R. 2017. Black Mirror: The Twin Abstractions of the American Dollar and the American Vote. *Unbound*, 11:37-91.

Charmaz, K. and Belgrave, L. 2002. *Qualitative interviewing and grounded theory analysis.* The SAGE handbook of interview research: The complexity of the craft 2, .2002.

Chayalakshmi, C.L., Jangamshetti, D.S. and Savita, S. 2018. Multiple Linear Regression Analysis for Prediction of Boiler Losses and Boiler efficiency. *International Journal of Instrumentation and Control Systems*, 8(2), 1-9.

Checkland, P. and Holwell, S. 2005. *Information, Systems and Information Systems*. Chichester: John Wiley.

Cheeseman, N. and Klaas, B.P. 2018. *How to rig an election*. London Yale University Press.

Cheeseman, N., Lynch, G. and Willis, J. 2014. Democracy and its discontents: understanding Kenya's 2013 elections. *Journal of Eastern African Studies*, 8(1):2-24.

Cheeseman, N., Lynch, G. and Willis, J. 2018. Digital dilemmas: The unintended consequences of election technology. *Democratization*, 25(8):1397-1418.

Cheeseman, N., Lynch, G. and Willis, J. 2018. Digital dilemmas: The unintended consequences of election technology. *Democratization*, 25(8):1397-1418.

Chevallier, M. 2009. Internet Voting, Turnout and Deliberation: a Study. Electronic Journal of e-Government, 7(1):29–44.

Chevallier, M., Warynski, M. and Sandoz, A. 2006. Success Factors of Geneva's e-Voting System. *Electronic Journal of e-Government,* 4(2):55-62.

Chieng, M. and Ruhode, E. 2013. The adoption and challenges of electronic voting technologies within the South African context. arXiv preprint arXiv: 1312.2406.

Chike, C.P. 2017. Technology and Elections: A Look at Elections Integrity, Results and Management in Nigeria. *Technology Integration and Transformation of Elections in Africa: An Evolving Modality*, 1(1):136.

Chirambo, K. and Motsamai, D. 2015. *Southern Africa Report*. Available: http://issafrica.s3.amazonaws.com/site/uploads/SAReport%205-2.pdf (Accessed 16 May 2017).

Clark, A. 2014. *Investing in Elections Management*. In: Norris, P., Frank, R. and Matinez, .F. Coma, I., eds. Advancing Elections Integrity. Oxford University Press, New York:

Clark, N.L. and Worger, W.H. 2016. South Africa: The rise and fall of apartheid. Abingdon, United Kingdom, Routledge.

Clark, A. 2016 Identifying the Determinants of Electoral Integrity and Administration in Advanced Democracies; The case of Britain. *European Political Science Review* 9(3):471-492.

Cloete, F. 2012. E-government lessons from South Africa 2001-2011: Institutions, state of progress and measurement: Section II: Country perspectives on e-government emergence. *African Journal of Information and Communication*, 2012(12):128-142.

Cloete, J.J.N. 1997. South African municipal government and administration. Van Schaik Publishers.

Clottey, P. 2014. *South Africa to Deploy Technology to Improve Election Credibility*. Available: http://www.voanews.com/a/south-africa-to-deploy-technology-to-improve-election-credibility/1849296.html (Accessed 15 March 2016).

Coghlan, D. 2019. *Doing action research in your own organization*. New York City SAGE Publications Limited.

Collard, S. and Fabre, E. 2014. *Electronic Voting in the French Legislative Elections of 2012*. In: Design, Development, and Use of Secure Electronic Voting Systems. 176-198. IGI Global. Zissis, D. ed. 2014. Design, Development, and Use of Secure Electronic Voting Systems. IGI Global.

Colomer, J. ed. 2016. *The handbook of elections system choice*. UK: Springer. Palgrave Macmillan.

COMELEC. 2016. *Calendar of Activities*. Available: http://www.comelec.gov.ph/php-tpls-attachments/2017BSKE/Resolutions/com_res_10177.pdf (Accessed 18 March 2017).

Commonwealth Observer Group. 2011. *Report of the Zambia General Elections 20 September 2011 Commonwealth*. Available: http:The-commonwealth.Org/Sites/Default/Files/News-Items/.../Zambiacogfinalreport.Pdf (Accessed 10 March 2014).

COMNET-IT. 2002. *Country Profiles of E-Governance*. Paris: UNESCO.

Contorer, A., Mostafavi, S., Goode, J., Kaplan, E., Hicks, C. and Thomason, J. EVERYONE COUNTS Inc. 2019. Systems and methods for remaking ballots. U.S. Patent Application 10/186,102.

Cortada, J. W. 1993. Before *The Computer: IBM, NCR, Burroughs, and Remington Rand and The Industry They Created 1865-1965.* Princeton University Press, New Jersey.

Costantini, V. & Liberati, P. 2014. Technology transfer, institutions and development. *Technological Forecasting and Social Change*, 88:26–48.

Counts, K.R.M.V. 2014. Election update 2014. Election update South Africa 199.

Cranor, L.F. 1996. Electronic voting: computerized polls may save money, protect privacy. *Crossroads* 2(4):12-16.

Creswell, J. 2003. Research Design: Qualitative, Quantitative and Mixed methods Approaches' 2nd edition, Sage Publications, Thousand Oaks, CA.

Creswell, J. 2009. Research design: Qualitative, quantitative, and mixed methods approaches, USA, Sage Publications.

Creswell, J. 2011. Best practices for mixed-methods research in the health sciences. National Institutes of Health: 4–10.

Creswell, J. and Clark, V.P. 2007. Choosing a mixed-methods design. Designing and conducting mixed methods research: 53–106.

Creswell, J. and Plano Clark, V. 2007. Designing and conducting mixed methods research’, Thousand, Oaks, Sage Publications.

Creswell, J. W., and Plano Clark, V. L. 2011. Designing and conducting mixed methods research (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Creswell, J.W. 2002. Educational research: Planning, conducting, and evaluating quantitative. New Jersey: Upper Saddle River.

Creswell, J.W. 2007. Understanding mixed-methods research. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches* 11(2):1–19.

Creswell, J.W. 2013a. Qualitative inquiry and research design: Choosing among five approaches, Sage.

Creswell, J.W. 2013b. Research design: Qualitative, quantitative, and mixed-methods approaches, Sage publications.

Creswell, J.W. 2014. Research design. Qualitative, quantitative and mixed-methods approaches, SAGE Publications, Inc. Los Angeles.

Creswell, J.W. and Poth, C.N. 2017. Qualitative inquiry and research design: Choosing among five approaches. Sage publications.

Crotty, M. 1998. Foundations of social research: Meaning and Perspective in the Research Process. 256.

Cruz, C., Labonne, J. and Querubin, P. 2017. Politician: Available: https:/www.ieeexplore.ieee.org/abstract/document/6113931mily networks and elections outcomes: Evidence from the Philippines. American Economic Review, 107(10):3006-3037.(Accessed 12 March 2018).

Cupido, K. and Van Belle, J.P. 2012. Increased public participation in local government through the use of mobile phones: What do young South

Africans think? In: Proceedings of the 12th European Conference on e-Government Cape Town, University of Cape Town. IST-Africa 2015 Conference Proceedings. May 2015. Available: https://www.researchgate.net/publication/308733125_Using_mobile_phones_for_public_participation_with_local_government_in_Cape_Town. (Accessed 12 January 2015).

Cutler, Z. 2016. 4 Ways Technology Has Impacted Presidential Elections. Available: http://www.entrepreneur.com/article/248450 (Accessed 18 August 2017).

Dada, D. 2006. The failure of E-government in developing countries: A literature review. *The Electronic Journal of Information Systems in Developing Countries*, 26(1):1-10.

Das, A. 2015. Usability of electronic voting system in India an innovatory approach. *International Journal of Applied Science and Engineering Research*, 4(5):633-642.

Daugman, J. 2014. *600 million citizens of India are now enrolled with biometric "id," SPIE newsroom, 7*. Available: http://www.cl.cam.ac.uk/~jgd1000/SPIE-Newsroom-article.pdf (Accessed 10 March 2019).

Davidson, R.M. 2004. Chapter Three: Research Methodology. City University of Hong Kong 1–20.

Davis, R., and Chelsea, B. 2012. *Observing ICT based elections*. Available: http://www.cmdkenya.org/files/Observing_ICT_based_elections_by_Davis_Roberts_and_Chelsea_Bergen.pdf (Accessed 12 June 2015).

De Kadt, D. 2017. Voting Then, Voting Now: The Long-Term Consequences of Participation in South Africa's First Democratic Election. *The Journal of Politics*, 79(2):670-687.

De Klerk, F. W. 2010. The recent election and the Zuma presidency. The Round Table, 99(406):27-33.

Debrah, E. 2011. Measuring governance institutions' success in Ghana: The case of the elections commission 1993-2008. *African Studies*, 70(1):25-45.

Debrah, E. 2015. Reforming Ghana's Electoral Process: Lessons and the Way Forward. *Journal of Politics and Law.* 8 (1):8

Democracy Development Program (DDP). 2019. Elections, Electoral Accountability and Youth Participation in Africa. Available: http: www.ddp.org.za (Accessed 17 July 2019).

Denscombe, M. 2007. The good research guide: for small scale research projects', 3rd ed. Maidenhead: McGraw-Hill Open University Press.

Denscombe, M. 2010 The good research guide: for small scale research projects', third edition Maidenhead: McGraw-Hill Open University Press.

Denscombe, M. 2014. 'The good research guide: for small scale research projects', 5th ed. Maidenhead: McGraw-Hill Open University Press.

Denzin, N. And Lincoln, N. 2005. Paradigms and perspectives in contention', In the Sage Handbook of Qualitative Research (3rd Eds.), Thousand Oaks, CA: Sage

Department of Telecommunication and Postal services- DTPS. 2016. *National Integrated ICT Policy White Paper*. Available: http://www.dtps.gov.za/images/phocagallery/Popular_Topic_Pictures/National_Integrated_ICT_Policy_White.pdf (Accessed 15 February 2017).

Dey, I. 1993. *Qualitative Data Analysis*.

Diamond, L. and Plattner, M.F. (eds.) 2010, Liberation technology: Social media and the struggles for democracy, John Hopkins University, Baltimore, MD.

Diamond, L. 2010. Liberation Technology. *Journal of Democracy*, 21(3):69-83.

Dickson, B. 2016 *What it takes to secure the elections*. Available: http://techcrunch.com/2016/10/12/what-it-takes-to-secure-the-elections. (Accessed 20 December 2016).

Dix, A. 2010. Human–computer interaction: A stable discipline, a nascent science, and the growth of the long tail. *Interacting with computers* 22(1):13-27.

Dizon, M.A.C. 2010. Participatory Democracy and Information and Communications Technology: A Legal Perspective. *European Journal of Law and Technology*, 1(3):1-36.

Dlamini, D.R., Mpekoa, N. 2017. M-Government Maturity Model: A Qualitative Investigation. In: Institute of Electrical and Electronics Engineers International Conference on Information Society (iSociety 2017). Dublin, Ireland, 17-19 July 2017. Under review.

Donaldson, T. and Preston, L.E. 1995. The stakeholder theory of the corporation: Concepts, evidence, and implications. *Academy of Management Review*, 20(1):65-91.

Doyle, S. 1985. *GCSE Computer Studies for you*. Deltta Place, Cheltenham GL53, United Kingdom: Stanley Thornes Publishers.

Driscoll, D. 2011. Introduction to Primary Research: Observations, Surveys, and Interviews. Writing Spaces: Readings on Writing 2:153–174.

Du Preez, J., 2009. Assessing the m-Government readiness within the provincial government Western Cape. Doctoral dissertation. Stellenbosch: University of Stellenbosch).

Dunleavy, P., Margett, H., Bastow, S., Tinkler, J. 2006 . New Public Management Is Dead- Long Live Digital-Era Governance. *Journal of Public Administration Research and Theory* 16(3):476-494.

Dunn, M. and Merkle, L. 2018 Overview of Software Security Issues in Direct-Recording Electronic Voting Machines. In: ICCWS 2018 13th International Conference on Cyber Warfare and Security. 8-9 March, 2018. Academic Conferences and Publishing International Ltd. 33 Wood Lane Washington, DC, Available: http://toc.proceedings.com/38822webtoc.pdf (Accessed 13 June 2019).

Effah, J. and Debrah, E. 2018. Biometric technology for voter identification: The experience in Ghana. *The Information Society*, 34(2):104-113.

Eilu, E. 2017. Embracing Biometric Voter Registration in Africa: Pros and Cons. In: Sustainable ICT Adoption and Integration for Socio-Economic Development IGI Global. Available: https://www.igi-global.com/chapter/embracing-biometric-voter-registration-in-africa/179518 (Accessed 18 September 2019).

Ekong, U. and Ekong, V. 2010. M-voting: A panacea for enhanced e-participation. *Asian Journal of Information Technology*, 9(2):111-116.

Ekong, U.O. and Ayo, C.K. 2007. The prospects of M-voting implementation in Nigeria. 3GSM and Mobile Computing: An Emerging Growth Engine for National Development: 172-179.

Elections Commission of Ghana, (EC). 2000. *Act Establishing Elections Commission of Ghana*. Available: http://www.ec.gov.gh (Accessed 29 June 2015).

Elections Commission of Ghana. 2000. Unpublished Elections Reforms Undertaken or taking place in Ghana's Elections System. Accra Elections Commission of Ghana.

Elections Institute for Sustainable Democracy in Africa. 2011a. 6th EISA Annual Symposium Pressing buttons for political change: Technology for efficient elections and democracy deepening and broadening; Concept Note. Available: http://www.eisa.org.za (Accessed 14 November 2017).

Elections Institute for Sustainable Democracy in Africa. 2014b. *Electronic Voting and the 2014 Namibian General Elections*. Available: http://www.eisa.org.za/pdf/nam2014eisa.pdf (Accessed 20 March 2016).

Electoral Commission of South Africa. 2008. Reflections on the State of Elections Democracy in South Africa. Available: http://www.elections.org.za (Accessed 26 February 2016).

Electoral Commission of South Africa. 2014a. Report of the Electoral Commission of South Africa: The South African Elections of April 2014. Available: http://www.elections.org.za (Accessed 24 February 2015).

Electoral Institute for Sustainable Democracy in Africa -EISA/ECF. 2003. Principles for Election Management, Monitoring and Observation, Auckland Park, EISA publications (mimeo).

Electoral Institute for Sustainable Democracy in Africa, EISA. 2009. *South Africa: National and Provincial Elections 22 April 2009*. Auckland Park: EISA publications.

Elkit J and Reynolds A. 2005. A Framework for the Systematic Study of Election Quality, Democratisation, University of North Carolina 12(2):147-162.

Elklit, J., Reynolds, A. 2002. Impact of Election Administration on the Legitimacy of Emerging Democracies: A New Comparative Politics Research Agenda', Commonwealth and Comparative Studies, (40)2:86-119.

Elo, S. and Kyngäs, H. 2008. The qualitative content analysis process. *Journal of advanced nursing*, 62(1):107–115.

Elsheikh, Y. 2011. A Model For The Adoption and Implementation of Web-Based Government Services and Applications. PhD. Dissertation, School of Computing, Informatics And Media University of Bradford.

EML 7.0. 2011. OASIS *Election Mark-up Language (EML) specification version 7.0committeespecification*. Available: https://docs.oasisopen.org/election/eml/v7.0/eml-v7.0.html (Accessed 10 June 2015).

Enguehard, C. 2008. Transparency in Electronic Voting: the Great Challenge. IPSA International Political Science Association RC 10 on Electronic Democracy. Conference on “E-democracy - State of the art and future agenda”, Jan 2008, Stellenbosch, South Africa. pp. édition électronique. ffhalshs00409465f. Available: https://halshs.archives-ouvertes.fr/halshs-00409465/document. (Accessed 18 May 2017)

Enikolopov, R., Korovkin, V., Petrova, M., Sonin, K. and Zakharov, A. 2013. Field experiment estimate of elections fraud in Russian parliamentary elections. *Proceedings of the National Academy of Sciences*, 110(2):448-452.

Enwere, C. and Ladan-Baki, I. 2015. Understanding the Role of Technology in Free and Fair Elections in Developing Countries. *Journal of Social and Administrative Sciences*, 2(3):135.

Estonia Authority. 2014. *Internet Voting in Estonia, Estonian National Elections Committee*. Available: http://www.vvk.ee/voting-methods-inestonia/engindex/ (Accessed 20 June 2015).

European Union. 2018 *Opportunities and Challenges in the Use of Technology in Elections*. Available: http://www.eces.eu/template/Opportunities%20and%20challenges%20in%20the%20use%20of%20technology%20in%20Elections.pdf (Accessed 12 January 2019).

Evrensel, A. 2010. Voter registration in Africa. Comparative analysis: Elections Institute for the Sustainability of Democracy in Africa. 14 Park Road, Richmond, Johannesburg, South Africa.

Fagbola Temitayo M., Adeyanju Ibrahim, A., Olatayo M., and Ayodele O. 2018. Development of Multi-Factored Predictive Models for improving Students' Performance in Programming Courses in a Nigerian Tertiary Institution*. Transylvanian Review* 26(25): 6809-6820.

Fagunwa, T.C. 2015 Voter Apathy and Nigeria's Electioneering Process: A Synopsis on the 2015 General Elections. In: *National Conference on "The 2015 General Elections in Nigeria: The Real Issues"*. Organized by The Electoral Institute (TEI) of the Independent National Electoral Commission (INEC). Available: https://www.inecnigeria.org/wp-content/uploads/2019/02/Conference-Paper-by-Christopher-Lambiko-Fagunwa.pdf (Accessed 12 September 2019).

Faik, I., Thompson, M. and Walsham, G. 2019. Designing for ICT-Enabled Openness in Bureaucratic Organizations: Problematizing, Shifting and Augmenting Boundary Work. University of Exeter, South West England, and United Kingdom. Association for Information Systems.

Fain, J.A. 2013. Reading, understanding, and applying nursing research, FA Davis.

Falk S., Römmele A., Silverman M. 2017. The Promise of Digital Government. In: Falk S., Römmele A., Silverman M. (eds) Digital Government. Springer, Cham 3-23.

Feltus, C. 2012. Introducing ISO/IEC 38500: Corporate Governance in ICT. ITSMF Jaarcongres 27-28. (Policy document).

Feng, R., Liu, Y., Huang, J., Sun, J., Wang, C.X. and Goussetis, G. 2018. *CAICT-An International ICT Policy and Planning Expert*. Available:

http://Institute of Electrical and Electronics Engineers explore. Institute of Electrical and Electronics Engineers.org/abstract/document/8387979/metrics#metrics (Accessed 30 June 2019).

Ferree, K.E. 2010. *Framing the race in South Africa: The political origins of racial census elections London* .Cambridge University Press.

Fourie, J. 2006. Some policy proposals for future infrastructure investment in South Africa. University of Stellenbosch: Stellenbosch.

Fraley, R.C. and Hudson, N.W. 2014. Review of Intensive Longitudinal Methods: An Introduction to Diary and Experience Sampling Research. The Journal of Social Psychology 154(1):89–91.

Franck, T. M. 1992. The Emerging Right to Democratic Governance. *The American Journal of International Law*, 86(1):46-91.

Freire, M.M. and Pereira, M. 2008. Encyclopedia of Internet Technologies and Applications. Information Science Reference. Available: https://www.igi-global.com/book/encyclopedia-internet-technologies-applications/364 (Accessed 09 June 2018).

Frey, J.H. and Oishi, S.M. 1995. *How to Conduct Interviews by Telephone and In Person. The Survey Kit,* (4)*,* ERICAlotaibi, J.H. 2017. Information and communication technologies in the Kuwaiti Parliament: A user acceptance and adoption study. Doctoral dissertation. University of Brighton.

Friedman, S. 2009. An Accidental Advance? South Africa's 2009 Elections. *Journal of Democracy*, 20(4):108-122.

Gable, G. 1994. Integrating Case Study and Survey Research Methods: An Example in Information Systems. European Journal of Information Systems, 3(2) 112.

Garrick, J. 1999. Doubting the philosophical assumptions of interpretive research. International journal of qualitative studies in education 12(2):147–156.

Gasser U., Gerlach J. (2011) Electronic Voting: Approaches, Strategies, and Policy Issues—A Report from Switzerland. In: van der Hof S., Groothuis M. (eds) Innovating Government. Information Technology and Law Series, (20). The Hague, Netherlands, T. M. C. Asser Press: 101-128.

Gaynor, G.H. ed. 1996. Handbook of technology mana*gement* .New York: McGraw-Hill.

Gefen, D., Rose, G.M., Warkentin, M. and Pavlou, P.A. 2005. Cultural diversity and trust in IT adoption: A comparison of potential e-voters in the USA and South Africa. *Journal of Global Information Management (JGIM)*, 13(1):54-78.

Geness, S. 2004. E-government: The South African experience. Paper presented at SADC E-government Workshop, Gaborone, 14-16 April 2004.

Gentles, D. and Sankaranarayanan, S. 2011. Biometric secured mobile voting. In: 2011 Second Asian Himalayas International Conference on Internet (AH-ICI) (1-6).4-6 Nov. 2011. Institute of Electrical and Electronics Engineers. Kathmandu, Nepal. Available: http://ieeexplore.ieee.org/abstract/document/6113931 (Accessed 17 March 2018).

Gentles, D. and Sankaranarayanan, S. 2012. Application of Biometrics in Mobile Voting. *International Journal of Computer Network and Information Security*, 4(7):57-68.

Glen, P.J., 2012. Institutionalizing democracy in Africa: a comment on the African Charter on Democracy, Elections and Governance. African Journal of Legal Studies, 5(2):119-146.

Gerlach, J. and Gasser, U. 2009. Three Case Studies from Switzerland: E-Voting. *Berkman Center Research Publication*, 17.

Germann, M. and Serdült, U. 2017. *Internet voting and turnout: Evidence from Switzerland. Elections Studies*. Available: https://www.cambridge.org/core/journals/ps-political-science-and-politics/article/Internet-voting-in-comparative-perspective-the-case-of-Estonia/8A8BCDACE0F361D1623D6F013025E624 (Accessed 04 May 2016).

Gerring, J., Hicken, A., Weitzel, D. and Cojocaru, L. 2018. Elections CoGerring, John and Hicken, Allen and Weitzel, Daniel and Cojocaru, Lee, Electoral Contestation: A Comprehensive Polity-Level Analysis (August 2018). V-Dem Working Paper 2018: 73. Available: https://ssrn.com/abstract=3230670 or http://dx.doi.org/10.2139/ssrn.3230670 (Accessed 15 October 2019).

Gibson, J.P., Krimmer, R., Teague, V. and Pomares, J. 2016. A review of E-voting: the past, present and future. Annals of Telecommunications, 71(7-8):279-286.

Gibson, P. and Mcgaley, M. 2008. Verification and maintenance of e-Voting systems and standards. *Proceedings of the European Conference on e-Government, ECEG*, 283–290.

Gillwald, A., Moyo, M. and Stork, C. 2012. What is happening in ICT in South Africa: A supply-and demand-side analysis of the ICT sector. Evidence for ICT Policy Action 1(7):1-20

Go, J.R.R. 2017. Of choices, changes, and challenges: The Philippines in 2016. *Philippines Political Science Journal*, 1(1):1-26.

Golden, M., Kramon, E., Ofosu, G. and Sonnet, L. 2015. Biometric Identification Machine Failure and Elections Fraud in a Competitive Democracy. Working Paper UCLA.

Goldsmith, B. and Ruthrauff, H. 2013a. *Implementing and overseeing electronic voting and counting technologies*. Washington DC: International Foundation for Elections Systems and National Democratic Institute for International Affairs, Washington, D.C.

Goldsmith, B. and Ruthrauff, H. 2013b. Implementing and overseeing electronic voting and counting technologies: Case study report on electronic voting in the Netherlands. Washington, D.C. United States Agency for International Development (USAID) under Award No. DFD-A-00-08-00350-00.

Goodman, J. 2005. Linking mobile phone ownership and use to social capital in rural South Africa and Tanzania. The Impact of Mobile Phones Moving the Debate Forward Vodaphone Policy Paper Series, 3(3):2005.

Goodwin-Gill, G. S. 2006. *Free and fair elections*. Geneva, Switzerland: Inter-Parliamentary Union.

Goodwin-Gill, G.S. 2014. The international law of refugee protection. The Oxford handbook of refugee and forced migration studies, Oxford Handbooks Online. 36-47.

Gopee A.K., Ujoodha P., Armoogum V., Ramma Y. 2019. A Novel Design Architecture to Address the Current Limitations of Fixed and Mobile Phone Data Logging System. In: Satapathy S., Bhateja V., Somanah R., Yang XS., Senkerik R. (eds) Information Systems Design and Intelligent Applications. Advances in Intelligent Systems and Computing, 863. Springer, Singapore.

Government of India. 2017. *Unique Identification Unit Authority*. Available: https://uidai.gov.in (Accessed 6 December 2017).

Graham, V. 2014. The Quality of South Africa Elections Accountability 1994-2014: Freedom, Flaws and Food Parcels. *Journal of Comparative Politics*, 7(2):52.

Greenleaf, G. 2016. *Philippines Appoints Privacy Commission in Time for Mass Electoral Data Hack. 141 Privacy Laws & Business International Report 22-23*. Available: https://ssrn.com/abstract=2824419 (Accessed 12 February 2017).

Guba, E.G. and Lincoln, Y.S. 1994. Competing paradigms in qualitative research. Handbook of qualitative research 2(163–194):105.

Gunst, R.F. 2018 *Regression analysis and its analysis application: a data-oriented approach.* London Routledge.

Gupta, A., Dhyani, P. and Rishi, O.P. 2013. Cloud based E-voting: One step ahead for good governance in India. *International Journal of Computer Applications*, 67(6):29-32.

Gupta, A., Kashyap, P. and Khera, R. 2017. *India's Aadhaar project: An Assault on Welfare, Privacy and Democracy, Need for an Urgent debate - South Asia Citizens Web*. Available: http://ww.sacw.net (Accessed 3 March 2017).

Habermas, J., Biko, S. and Alexander, N. 2018. Beyond ethnic nationalism: Lessons from South Africa. Pretending Democracy: Israel, and Ethnocratic State, Jeenah, N.E. ed., 2018. Pretending Democracy: Israel, and Ethnocratic State. Afro-Middle East Centre. Habib, A. and Naidu, S. 2006. Race, Class and Voting Patterns in South Africa's Electoral System. Africa Development, XXXI (3):81-92.

Haijun, P., Edwin H., and Nirwan *A. 2011. Ensuring voters and candidates confidentiality in E-voting Systems*. 3-4 May 2011, 34th Institute of Electrical and Electronics Engineers Sarnoff Symposium: 1-6., Princeton, USA, Hapsara, M. 2013. E-Voting Indonesia: A Safety-Critical-Systems model towards standard and framework for Indonesia's Presidential Election. In: International Conference on Information Technology: 81–86. 12 – 13 December 2013. Universitas Islam Indonesia Jalan Kaliurang K.M. 14, 4 Yogyakarta. Available: http://s3.amazonaws.com/academia.edu.documents/32791648/20130924_ICIT_Paper_Final_-_02.pdf (Accessed 06 May 2016).

Hapsara, M., Imran, A. and Turner, T. 2016. E-Voting in Developing Countries. In: International Joint Conference on Electronic Voting. First International ICST Conference, 2010 Maputo, Mozambique. 70-77. Cham: Springer: 36-55.

Hara, T. 2019. Information processing system and information processing method. Kyocera Document Solutions Inc. U.S. Patent Application 16/048,203.

Harel, A. 2008. Biometrics, identification and practical ethics. In: Mordini, E. and Green, M. eds. *Identity, Security and Democracy: The Wider Social and Ethical Implications of Automated Systems for Human Identification*. Amsterdam, NLD: IOS Press,: 69-83.

Harsh, M., Woodson, T.S., Cozzens, S., Wetmore, J.M., Soumonni, D. and Cortes, R. 2017. The role of emerging technologies in inclusive innovation: The case of nanotechnology in South Africa. *Science and Public Policy*, 45(5):597-607.

Harveston, K. 2016. *The Impact of Technology on the 2016 Presidential Election*. Available: http://onlyslightlybiased.com/2015/12/impact-of-technology-on-2016-presidential-election/ (Accessed 30 January 2017).

Heeks, R. 2001. Understanding E-governance for Development. I-Government Working Paper Series, Heeks, R. 2002. E-Government in Africa: *Promise and practice. Information Polity*, 7(2, 3):97–114.

Heeks, R. 2003 M*ost e-Government-for-Development Projects Fail: How Can Risks be reduced? (5)* Manchester: Institute for Development Policy and Management, University of Manchester.

Heeks, R. 2009. *The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development?* Development Informatics. Working Paper 1(42).

Heeks, R. 2010. Do information and communication technologies (ICTs) contribute to development? *Journal of International Development*, 22(5):625-640.

Heeks, R. and Jagun, A. 2007. Mobile Phones and Development: The Future in New Hands? *Id21 Ingsights* 69:1.

Heiberg S., Laud P., Willemson J. 2012. *The Application of I-Voting for Estonian Parliamentary Elections of 2011*. In: Kiayias A., Lipmaa H. (eds) E-Voting and Identity. Vote-ID 2011. Lecture Notes in Computer Science, (7187). Springer, Berlin, Heidelberg. Available: http://link.springer.com/chapter/10.1007/978-3-642-32747-6_13#citeas (Accessed 11 July 2017).

Heinz, E., Paul, D. W., Roger, G. 2018. *Election Political Science, periodic election, votes*. Available: http://www.britannica.com/topic/election-political-science (Accessed 2 July 2018).

Heit, E. and Rotello, C.M. 2010. Relations between inductive reasoning and deductive reasoning. Journal of Experimental Psychology: Learning, Memory, and Cognition, 36(3):805.

Hevner, A. and Chatterjee, S. 2010a. Design research in information systems: theory and practice, Springer Science and Business Media.

Hevner, A. and Chatterjee, S. 2010b. Design-science research in information systems, Springer.

Hevner, A. R., March, S.T. and Park, J. 2004. Design Science in Information Systems Research. MIS Quarterly 28(1):75–105.

Hevner, A.R. and Chatterjee, S. 2004. Design Research in Information Systems. Design Research in information Systems 28:75–105. Available: http://desrist.org/design-research-in-information-systems. (Accessed 19 September 2015).

Hicken, A., Leider, S., Ravanilla, N. and Yang, D. 2018. Temptation in vote-selling: Evidence from a field experiment in the Philippines. *Journal of Development Economics*, 131:1-14.

Hossain, M.J., Shakur, A.S., Ahmed, M.J. and Paul, B. 2015. Designing a Cost Effective, Reliable and Scalable Electronic Voting Machine for National Election of Bangladesh. Recent Advances in Circuits, Systems and Automatic Control: 79-88.

Hsu J., Bronson G. 2018. E-Voting Technologies Usability: A Critical Element for Enabling Successful Elections. In: Tadj L., Garg A. (eds) Emerging Challenges in Business, Optimization, Technology, and Industry. Springer Proceedings in Business and Economics. Springer, Cham.

Hughes, C. 2006. Qualitative and Quantitative Approaches to Social Research. Available: /https://www2.warwick.ac.uk/fac/soc/sociology/staff/academicstaff/chughes/hughesc_index/teachingresearchprocess/quantitativequalitative/quantitativequalitative (Accessed 20 March 2016).

Hughes, D. 2007. *Participant observation in health research. Researching health: Qualitative, quantitative and mixed methods*. SAGE Publications Ltd

Hussain, M.M. and Howard, P.N. 2012. Democracy's Fourth Wave? Information Technologies and the Fuzzy Causes of the Arab Spring. Paper presented at the International Studies Association, 20

Hussey, J. and Hussey, R. eds. 2003. Business Research: A practical guide for undergraduate and postgraduate students, New York Palgrave Macmillan.

Hussey, J. and Hussey, R. 1997. Business Research: A Practical Guide for Undergraduate and Postgraduate Students, Macmillan Press LTD, Basingstoke, Hampshire.

IDASA. 2008. *Concern about Ballot Secrecy*. Available: http://www.idasa.org/our_products/resources/output/afrobarometer_citizens_conce rns/?pid=afrobarometer (Accessed 2 September 2015).

Idrisa, A. and Yusofb, R. 2015. *Adoption of E-voting System in Nigeria: A Prospect for Poverty Alleviation*. Available: http://core.ac.uk/download/pdf/42984224.pdf (Accessed 5 January 2017).

IEC South Africa, 1994a. Report of the Electoral Commission of South Africa: The South African Elections of April 1994. Available: http://www.elections.org.za (Accessed 18 March 2014).

IEC South Africa, 2019. Report of the Electoral Commission of South Africa: The South African Elections of May 2019 Available: http://www.elections.org.za (Accessed 18 October 2019].

IEC South Africa. 2004. *Election Report: 2004 National and Provincial Elections*. Available: http://www.elections.org.za/content/Dynamic.aspx?id=1345andname=ElectionsandLeftMenuId=100andBreadCrumbId=220 (Accessed 18 March 2015).

IEC South Africa. 2008. *Reflections on the State of Elections Democracy in South Africa*. Available: http://www.elections.org.za (Accessed 26 February 2016).

IEC South Africa. 2009. *Report of the Electoral Commission of South Africa: The South African Elections of April 2014.* Available: http://www.elections.org.za (Accessed 26 February 2015).

IEC South Africa. 2010. *Report of the Electoral Commission of South Africa: The South African Elections 2010*. Available: http://www.elections.org.za (Accessed 26 February 2016).

IEC South Africa. 2014. Electronic voting, an enabler or disabler to strengthening elections democracy? In: *Seminar on Electronic Voting and Counting Technologies.* Cape Town, South Africa, 12 March 2013, 1-20.

IEC South Africa. 2017. *Click, check, confirm! It's that quick to ensure we have your correct address on the voters' roll*. Available: http://t.co/7FpSCpcZuXpic.twitter.com/2jY1bDpXB0October13 2017(@IECSouthAfrica) (Accessed 13 October 2017).

Iivari, J. 2007. A Paradigmatic Analysis of Information Systems as a Design-Science. Scandinavian Journal of Information Systems 19(2):39–64.

Independent National Commission of Nigeria, INEC. 2015. *The Election Management System (EMS) Project Report*. Available: http://www.inecnigeria.org/wp-content/uploads/2015/06/EMS-Project-Report-Final-Version.pdf (Accessed 18 May 2016).

Institute of Electrical and Electronics Engineers, Pretoria, South Africa. Available: http://ieeexplore.ieee.org/abstract/document/6524704 (Accessed 10 October 2016).

International Institute for Democracy and Electoral Assistance. 2014a. *Elections Management Design: An Overview of the International.* The

International IDEA Handbook. International IDEA. Available: http://www.idea.int/vt. (Accessed 23 February 2015).

International Institute for Democracy and Electoral Assistance. 2014b. *Voter turnout. Institute for Democracy and Elections Assistance (IDEA)*. Available: http://www.idea.int/vt (Accessed 23 February 2015)

Isaacs, S. 2007. ICT in education in South Africa. Survey of ICT and Education in Africa: South Africa Country Report, (10659).

Islam, M. A., Khan, M. A., Ramayah, T. and Hossain, M. M. 2011. The adoption of mobile commerce service among employed mobile phone users in Bangladesh: self-efficacy as a moderator. *International Business* Research, 4(2):80.

Isoe, G. M., Leitch, A. W. R. and Gibbon, T. B. 2019. Maximizing capacity, flexibility and efficiency in G-PON networks using VCSEL-based OOK and 2/4-PAM formats. .*Journal of Modern Optics*, 66(7): 747-752. Available: DOI: 10.1080/09500340.2019.1567842. (Accessed 18 June 2018).

Isoe, G.M., Wassin, S., Leitch, A. W. R. and Gibbon, T. B. 2019. *VCSEL-based broadband optical switch for ultra-wide high-speed traffic routing in Datacom, Proc. SPIE 10946, Metro and Data Center Optical Networks and Short-Reach Links II 1094608 (1 February 2019).* Available: https://doi.org/10.1117/12.2509421 (Accessed 23 April 2019).

Isong, B., Netshipise, N. and Dzawo, G., 2013. A New Approach for Protecting Elections Integrity in South Africa. *International Journal of Computer Applications*, 62(20):10-18

Iwuoha, V.C. 2019. ICT and elections in Nigeria: Rural dynamics of biometric voting technology adoption. *Africa Spectrum*, 53(3):89-113.

Jabareen, Y. 2009. Building a conceptual framework: philosophy, definitions, and procedure. *International Journal of Qualitative Methods*, 8(4):49–62.

Jacobs, B. and Pieters, W. 2009. Electronic voting in the Netherlands: From early adoption to early abolishment. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 5705 LNCS: 121-144.

Jacobs, C.T. and Roodt, G. 2019. Predictive performance models in the South African Business Process Services industry. *SA Journal of Industrial Psychology*, (45):16.

Jacobsen, K.L. 2012. Biometrics as security technology: Expansion amidst fallibility (No. 2012: 07). DIIS Report. Available: http://www.econstor.eu/handle/10419/59833 (Accessed 16 June 2014).

Jagun, A. and Heeks, R. 2007 Mobile phones and development: the future in new hands? Insights / id21 (Programme)(69). ISSN 1460-4205. Available: https://www.gov.uk/dfid-research-outputs/id21-insi (Accessed 14 April 2018).

Jaleel, A. 2013. Adoption of E-Voting System in Nigeria: A Conceptual Framework. *International Journal of Applied Information Systems*, 5(5):8-14.

James, J. 2014. Product use and welfare: The case of mobile phones in Africa. *Telematics and Informatics,* 31(3):356–363.

James, T.S., Garnett, H.A., Land van Ham, C. 2019. Electoral Management and Organisational determinants of electoral integrity: Introduction

James, T.S., 2019. *Comparative Electoral Management: Performance, Networks and Instruments*. London Routledge.

Jefferson, D., 2017. If I can shop and bank online, why can't I vote online? Verified Voting. Available: http://www.verifiedvoting.org/resources/Internet-voting/vote-online/ (Accessed 6 October 2018).

Jervier, T., James, T. 2017. The Cost of Elections: The effects of Public Sector austerity and voter engagement. *Public Money and Management* 37(7):461-468

Jewitt, C.E. 2019. The Primary Rules: Parties, Voters, and Presidential Nominations. Ann Arbor, Michigan, University of Michigan Press.

Johnson N., Jones B.M., and Clendenon K. 2017. E-Voting in America: Current Realities and Future Directions. In: Meiselwitz G. (eds) Social Computing and Social Media. Human Behavior. SCSM 2017. Lecture Notes in Computer Science, 10282. Springer, Cham. Available: https://link.springer.com/chapter/10.1007/978-3-319-58559-8_27 (Accessed 12 May 2019).

Jokela, T., Livari, N., Matero, J. and Karukka, M. 2003. August, The standard of user-centred designed and the standard definition of usability, analysing ISO 13407 against ISO 9241-11. In International Conference Proceeding Series (ICPS), of the Latin American conference on Human-Computer Interaction: 53-60. August 2003, Association for Computing Machinery. New York United States. Available: https://dl.acm.org/doi/proceedings/10.1145/944519 (Accessed 6 May 2016).

Jonker, HL. 2009. Security matters: privacy in voting and fairness in digital exchange'. Doctor of Philosophy, Department of Mathematics and Computer Science, Eindhoven University of Technology. Available: DOI: 10.6100/IR643467 (Accessed 19 July 2017).

Juma, C. 2017. Somaliland’s voting technology shows how Africa can lead the world. Available: http://mg.co.za/article/2017-11-14-somalilands-voting-technology-shows-how-africa-can-lead-the-world (Accessed 14 November 2017).

Kale, S. and Bhosale, V. 2015. Revised Approach for Smartphone Security Using Cloud and Android Applications. *International Journal of Advanced Research in Computer Engineering and Technology*, 4(9):3723-3729.

Kalinin, K. and Hicken, A. 2017. *Using Election Forensics to Detect Election Fraud in the Philippine Elections 2016*. Available: http://SSRN 3070592: https://ssrn.com/abstract=3070592www.papers.ssrn.com (Accessed 17 December 2018).

Kangah, D.A. and Sarfo-Kantanka, K. 1998. Getting the register Right: The Ghana Experience. In: Voting for Democracy: Conference of Commonwealth Chief Election Officers, Queens College Cambridge 23rd to 26th March 1998. England. Available: http://aceproject.org/main/samples/vr/vrx_w011.pdf (Accessed 17 June 2017).

Karan, K., Gimeno, J.D. and Tandoc Jr. E. 2009. The Internet and mobile technologies in election campaigns: The GABRIELA Women's Party during the 2007 Philippine elections. *Journal of Information Technology and Politics*, 6(3):326-339.

Karlan, P.S. 2017. Reapportionment, Non apportionment, and Recovering Some Lost History of One-Person, One Vote. Available: http://heinonline.org/HOL/LandingPage?handle=hein.journals/wmlr59&div=47&id=&page (Accessed 4 February 2018).

Karthikeyan, S. and Nithya, J. 2017a. Biometric Secured Electronic Voting Machine with Embedded Security.

Karthikeyan, S. and Nithya, J. 2017b. Secured Electronic Voting Machine Using Biometric. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology*, 2(2):586-591.

Kayisire, D. and Wei, J. 2016. ICT adoption and usage in Africa: Towards an efficiency assessment. *Information Technology for Development*, 22(4):630-653.

Kenya Supreme Court Order. 2017. *Kenya Supreme Court nullifies presidential election, Orders New Vote*. Available: http://edition.cnn.com/2017/09/01/africa/kenya-election/index.html (Accessed 10 October 2017).

Kersting, N. 2007. Elections reform in southern Africa: Voter turnout, elections rules and infrastructure. *Journal of African Elections*, 6(1):134-151.

Kersting, N. 2012. The future of electronic democracy. *Electronic democracy, International Journal Electronic Governance*, 6(4):11-44.

Khader, D., McCall, R. and Lopez Becerra, J.O.S.E., 2013. Studying boardroom e-voting schemes: Usability and trust (No. TR-SnT-2013-3). SnT. Available: http://orbilu.uni.lu/handle/10993/9487 (Accessed 9 May 2018).

Khera, R. 2011. The UID project and welfare schemes. *Economic and Political Weekly 46 (9):*38-43.

Khosa, M.M. and Muthien, Y.G. 2000. Election Management in South Africa: an Evaluation of the 1999 Election. International IDEA Conference – Towards Sustainable Democratic Institutions in Southern Africa, 8-10 May 2000. The International Institute for Democracy and Electoral Assistance (International IDEA), Government of Botswana and Southern Africa Development Community (SADC) Parliamentary and Election Fora. The Grand Palm Hotel, Molepolole Road, Gaborone. Available http://archive.idea.int/ideas_work/22_s_africa/Botswana_report.pdf (Accessed 12 September 2014).

Kimura, M. 2009 The Information and Communication Technology and Elections Modernization: Lessons from the Philippines. *Philippine Political Science Journal*, 30(53):59-88.

Klokmose, C.N., Badam, S.K., Mathisen, A., Rädle, R., and Elmqvist, N. 2019. Vistrates: A Component Model for Ubiquitous Analytics. Institute of Electrical and Electronics Engineers transactions on visualization and computer graphics 25(1):586-596.

Kogeda, O.P. and Mpekoa, N. 2013. Model for a Mobile Phone Voting System for South Africa. In: 2013 Conference, Areas. Conference: Proceedings of the 15th Annual Conference on World Wide Web Applications (ZAWWW September, 2013), At Cape Town, South Africa, and Volume : Cape Peninsula University of Technology. Available: http://www.researchgate.net/publication/256815099_A_Mobile_Transport_Scheduling_and_Coordination_System_for_Marginalized_Rural_Areas (Accessed 23 July 2018).

Konomopoulos S., Lambrinoudakis C., Gritzalis D., Kokolakis S., Vassiliou K. 2002. *Functional Requirements for a Secure Electronic Voting System*. In: Ghonaimy M.A., El-Hadidi M.T., Aslan H.K. (eds) Security in the Information Society. IFIP Advances in Information and Communication Technology, (86). Springer, Boston, MA

Korstad, R., Gutierrez, I. and Joyner, I. 2017. Session 1: Measuring Rights, Access and Voter Fraud in US Elections. Duke University Sanford School of Public Policy. 17 February 2017. Available: http://scholarship.law.duke.edu/djclpp_symposium/2017/events/3/ (Accessed 5 March 2019).

Krauss, S.E. and Putra, U. 2005. Research Paradigms and Meaning Making: A Primer. *The Qualitative Report* 10(4):758–770.

Krimmer, R. 2012. The evolution of E-voting: Why voting technology is used and how it affects democracy. Tallinn University of Technology Doctoral Theses Series I: Social Sciences 19.

Krimmer, R. 2019. A Structure for New Voting Technologies: What They Are, How They Are Used and Why. In: *The Art of Structuring*. Cham: Springer: 421-426.

Krimmer, R. 2019. A Structure for New Voting Technologies: What They Are, How They Are Used and Why. In The Art of Structuring Springer, Cham. 421-426. Available: http://link.springer.com/chapter/10.1007/978-3-030-06234-7_39 (Accessed 15 March 2019).

Krimmer, R. 2014. *Identifying building blocks of Internet voting: preliminary findings*. In: Plödereder, E., Grunske, L., Schneider, E. and Ull, D. (Hrsg.), Informatik 2014. Bonn: Gesellschaft für Informatik e.V.. S:1381-1389.

Krimmer R., Triessnig S., Volkamer M. 2007. The Development of Remote E-Voting Around the World: A Review of Roads and Directions. In: Alkassar A., Volkamer M. (eds) E-Voting and Identity. Vote-ID 2007. Lecture Notes in Computer Science, (4896). Springer, Berlin, Heidelberg. Available: http://link.springer.com/chapter/10.1007/978-3-540-77493-8_1#citeas (Accessed 12 September 2015).

Kroukamp, H. and Cloete, F. 2018. Improving professionalisms in South African Local Government. *Acta Academia*, 50(1):61-80.

Kuehlkamp, A. and Bowyer, K.W. 2016. An analysis of 1-to-first matching in iris recognition. In: 2016 Institute of Electrical and Electronics Engineers Winter Conference on Applications of Computer Vision (WACV) (1-8). 7-10 March 2016. Institute of Electrical and Electronics Engineers Lake Placid, NY, USA Available: https://ieeexplore.ieee.org/abstract/document/7477687 (Accessed 26 January 2017).

Kumar, R. 2019. Research methodology: A step-by-step guide for beginners. Sage Publications Limited.

Kuzmina, M.L.J. 2017. Outstripping of the eVoting Evolution. Second In, 2nd Joint International Conference on Electronic Voting E-VOTE-ID 2017 24–27 October 2017, Lochau/Bregenz, Austria Co-organized by the Tallinn University of Technology, Technische Universität Darmstadt, E-Voting.CC, and Gesellschaft für Informatik, Tallinn, Estonia Available: https://www.e-vote-id.org/wp-content/uploads/2017/10/TUTPress-2017.pdf (Accessed 21 January 2018).

Laanela, T.P. 2017. Beyond the Checklist: Addressing New Challenges in Election Observation Methodology. *Nordic Journal of Human Rights*, 35(4):327-340.

Labuschagne, A. 2003. Qualitative research-airy fairy or fundamental. The Qualitative Report. 8(1):100.

Lacey, A. and Luff, D. 2007. Qualitative data analysis. *Trowbridge, Wiltshire: The Cromwell*: 13–14

Lauer, T.W. 2004. The Risk of e-Voting. *Electronic Journal of e-Government* 2(3): 177–186.

Lee, J. and Kim, S. 2014. Active citizen e-participation in local governance: Does individual social capital and e-participation management matter? In: System Sciences (HICSS) 2014 47th Hawaii International Conference on (2044-2053)6-9 Jan. 2014, Waikoloa, HI, USA, Available: http://ieeexplore.ieee.org/abstract/document/6758857 (Accessed 03 May 2015).

LeRoux, W. 2009. Migration, street democracy and expatriate voting rights. SA Public Law: States of Statelessness. *Politicide and Constitution in the African Post-colony*, 24(2):370-399.

Levinson, S. 2001. One Person, One Vote: A Mantra in Need of Meaning. *NCL Rev.*, 80:1269.

Lewis, J.R. ed. 2019 Usability Evaluation: A Special Issue of the international journal of Human-Computer interaction CRC Press.

Lieberson, S. and O'Connor, J.F. 1972. Leadership and organizational performance: A study of large corporations. *American Sociological Review*, 37(2) 117-130.

Lin, F., Fofanah, S.S. and Liang, D. 2011. Assessing citizen adoption of e-Government initiatives in Gambia: A validation of the technology acceptance model in information systems success. *Government Information Quarterly*, 28(2):271-279.

Link, G.J. and Qureshi, S. 2017. The role of open source in new business formation: Innovations for development. *Twenty-third Americas Conference on Information Systems,* Boston 1 (1):1-10

Little, R.J. and Rubin, D.B., 2019. Statistical analysis with missing data (793).New Jersey:

Lodge, T. 1999a. Consolidating democracy: South Africa's second popular election. Witwatersrand University Press.

Lodge, T. 1999b. South African politics since 1994. David Philip.

Lodge, T. 2005. Provincial government and state authority in South Africa. Journal of Southern African Studies, 31(4):737-753.

Loeber, L. 2016. Legislating for E-enabled Elections : Dilemmas and concerns for the Legislator. In Krimmer Robert, et (eds) Proceedings of E-VOTE-ID 2016. Tallinn: TUT Press: 139-160

López-Pintor, R. 2000. Elections management bodies as institutions of governance Available:

http://www.eods.eu/library/UNDP.Electoral%20Management%20Bodies%20as%20Institutions%20of%20Governance.pdf (Accessed 25 June 2017).

López-Pintor, R. and Fischer, J. 2006. *Getting to the core. A Global survey on the cost of registration and elections*. Center for Transnational and Post-Conflict Governance, IFES and the Bureau for Development Policy, UNDP.

Luhusena, M.W. 2018. Technological Innovations in Elections Reforms in Ghana's Democratic Governance: Stakeholder Perspectives from Tamale Metropolis. Master's dissertation. The University for Development Studies.

Mack, N. 2005. Module 2: Participant observation. Qualitative research methods: a data collectors field guide: 13–27.

Mackey, A. and Gass, S.M. 2015. Second-language research: Methodology and design, Routledge.

Madise, Û. and Priit, V. 2011. Constitutionality of remote Internet voting: The Estonian perspective. *Juridica Int'l*, 18(4).

Mafirakurewa, M. 2009. *Marked ballot papers found*. Available: http://www.africanews.com/site/SA_Marked_ballot_papers_discovered/list_messages/24430 (Accessed 30 June 2015).

Mahajan, M., Wagh, M., Biswas, P., Alai, S. and More, S.2017. M-Vote (Online Voting System). *International Journal,* 2(10): 545–550.

Makiti Guides and Tours. 2013 General Overview of Gauteng, Available http://www.culturalguiding.com/Help/PDF/General_Overview_of_Gauteng.pdf (PDF). Pty) Ltd (Accessed 2 May 2013).

Makoza, F. 2019. Critical Mass of Women Legislators and Oversight for National ICT Policy of Malawi. In: Ebtihaj Al-A'ali, Ben Tran, Aparna Purushothaman, Lone Dirckinck Holmfeld, Moly Kuruvilla, Joshua Mugambwa, Danielle Gabay, Wubalem Arefaine Hagos, Wubalem Arefaine

Hagos, Airen Adetimirin, Winfred Yaokumah, Juliet W. Macharia Gender and Diversity: Concepts, Methodologies, Tools, and Applications. Hershey, Pennsylvania, IGI Global. (950-970).

Makulilo, A. 2017. Rebooting democracy? Political data mining and biometric voter registration in Africa. *Information and Communications Technology Law*, 26(2):198-212.

Makulilo, A. and Henry, R. 2018. The future of elections in Africa: Critical Issues and Perspectives. *Tanzania Journal of Sociology*, 2:103-115.

Maloka, E. 2000. The Gauteng legislature: the first five years. Democracy and Governance Review: Mandela's Legacy 1994-1999:107.

Mangcu, X. 2011. Elections and Political culture: issues and trends. *Journal of Public Administration*, 46(1):1153-1168.

Mangcu, X. 2015, 'Local government: The last frontier towards democratisation', in M. Ndletyana (ed.), Institutionalising democracy: The story of the Electoral Commission of South Africa 1993–2014:75–101, Africa Institute of South Africa, Pretoria.

Maphephe, J., Balkaran, R. and Thakur, C.S. 2016. The importance of the use of Internet-based technology in securing inclusive and legitimate elections. A review of the South African elections technology practice between 2014 and 2016. *African Journal of Democracy and Governance*, 3(3-4):186-216.

Maphunye, K.J. 2010. Evaluating election management in South Africa's 2009 elections. *Journal of African Elections*, 9(2):56-78.

Maphunye, K.J. 2017. Straining without training? Capacity-related problems facing African election executives and officials. *International Journal of African Renaissance Studies– Multi-, Inter-and Trans-disciplinarity*, 12(1):55-75.

Maphunye, K.J. 2019. The feasibility of electronic voting technologies in Africa: Selected case examples. The Journal for Transdisciplinary Research in Southern Africa 15(1):11.

March, S.T. and Smith, G.F. 1995. Design and natural science research on information technology. Decision support systems 15(4):251–266.

Mark, M.M., Henry, G.T. and Julnes, G. 2000. *Evaluation: An integrated framework for understanding, guiding and improving policies and programs*. Jossey-Bass Inc. San Francisco, California, United States

Marx, E.W. 2019. Voices of Innovation: Fulfilling the Promise of Information Technology in Healthcare. CRC Press.

Maseko, T.W. 2009. The right of blind and visually impaired citizens to vote in secret: Is there a duty to do more? case notes. *SA Public Law: States of Statelessness: Politicide and Constitution in the African Post-colony*, 24(2): 623-639.

Mashile, L. 2014. *Independent Elections Commission on its roles, mandates and challenges*. Available: http://pmg.org.za/committee-meeting/17384/ (Accessed 12 May 2015).

Masuku, W.K. 2006. An exploratory study on the planning and design of a future E-voting system for South Africa. Doctoral dissertation. University of the Western Cape.

Matavire, R., Chigona, W., Roode, D., Sewchurran, E., Davids, Z., Mukudu, A. and Boamahabu, C. 2010. Challenges of e-Government project implementation in a South African context. *Electronic Journal Information Systems Evaluation*, 13(2):153-164.

Matlosa, K. 2004. Managing democracy: A review of SADC Principles and Guidelines Governing Democratic Elections.

Matlosa, K. 2008. Consolidating democratic governance in the SADC region: Transitions and prospects for consolidation.

Matlosa, K. 2017. The State of Democratisation in Southern Africa: Blocked Transitions, Reversals, Stagnation, Progress and Prospects. *Politikon*, *44*(1),5-26.

Matney, T.D. 2017. *Binary Democracy: Voter Confidence and Voting Technologies*. Edmond, Oklahoma. University of Central Oklahoma.

Mattes, R. and Richmond, S. 2014. South Africa’s youth and political participation 1994-2014. Working Paper. University of Cape Town.

Mattes, R. B. 2002. South Africa: Democracy without the people? *Journal of Democracy*, 13(1):22-36.

Matthews, B. and Ross, L. 2014. Research methods, Pearson Higher Ed.

Maumbe, B.M. and Owei, V. 2006. Bringing M-government to South African Citizens: Policy Framework, Delivery Challenges and Opportunities. *Proceedings of Euro mGov*, 1(1):160–170.

Maundeni, Z., Musekiwa, N. and Seabo,. B. 2017. Elections observation and its political impart in Southern Africa. African Journal of Political Science and International Relations 11(2):21-28.

Mawson, N. and McConnachie, K. 2011. *Vodacom meltdown*. Available: http://www.itweb.co.za/index.php?option=com contentandview=articleandid=45031:vodacommeltdownand catid=76 (Accessed 16 March 2015).

Maxwell, J.A. 2005. Conceptual framework: What do you think is going on? *2005) Qualitative research design: An interactive approach*: 33–63.

Maxwell, J.A. 2005. Conceptual framework: What do you think is going on? 2005) Qualitative research design: *An interactive approach*: 33–63.

Mayen, J. 2011. COMELEC resumes voter registration. The Philippine Star. Available: http://www.philstar.com/headlines/2016/04/28/1577632/comelec-aborts-mall-voting-plan (Accessed 16 October 2015).

Mayen, J. 2016. COMELEC Aborts mall voting plan. *The Philippine Star*. Available: http://www.philstar.com/headlines/2016/04/28/1577632/comelec-aborts-mall-voting-plan (Accessed 7 May 2016).

Mazeka, B., Sutherland, C., Buthelezi, S. and Khumalo, D. 2019. Community-Based Mapping Methodology for Climate Change Adaptation: A Case Study of Quarry Road West Informal Settlement, Durban, South Africa. In The Geography of Climate Change Adaptation in Urban Africa: 57-88. Palgrave Macmillan, Cham.

McBride, K.A., MacMillan, F., George, E.S. and Steiner, G.Z. 2019. The Use of Mixed methods in Research. Handbook of Research Methods in Health Social Sciences: 695-713.

McCormack, C.B. 2016. *Democracy Rebooted: The Future of Technology in Elections*. Available: http://publications.atlanticcouncil.org/election-tech/ (Accessed 18 June 2017).

McFarlane, F.W. 1984. Information technology changes the way you http://pdfs.semanticscholar.org/c94e/c8489c020f682f494c0985fd6ace1740ef22.pdf *Harvard Business Review*, Reprint Service (1):98-109.

McGrath, M. 2011, 'Technology, media, and political participation', *National Civic Review* 100(3):41–44. http://doi.org/10.1002/ncr.20075

McMurray, A., Cross, J. and Caponecchia, C. 2019. The Risk Management Profession in Australia: Business Continuity Plan Practices. In Emergency and Disaster Management: Concepts, Methodologies, Tools, and Applications: 486-499. IGI Global.

Mehlomakulu, S., 2014. The readiness for m-government in a South African provincial government. Doctoral dissertation. University of the Western Cape.

Meier, P. 2012. Ushahidi as a liberation technology. *Liberation technology: Social media and the struggle for democracy 1 (1)*:95-109. Available: http://pdfs.semanticscholar.org/c94e/c8489c020f682f494c0985fd6ace1740ef22.pdf (Accessed 11 March 2015).

Mensah, I.K. 2016. Citizens' Readiness to Adopt and Use Electronic Voting System in Ghana. *World Academy of Science, Engineering and Technology, International Journal of Social, Behavioural, Educational, Economic, Business and Industrial Engineering*, 10(3):780-786.

Mensah, I.K. 2016. Citizens' Readiness to Adopt and Use Electronic Voting System in Ghana. World Academy of Science, Engineering and Technology, International Journal of Social, Behavioural, Educational, Economic, Business and Industrial Engineering 10(3):795-801.

Micheni, E. and Murumba, J. 2018. The Role of ICT in Elections Processes: Case of Kenya. In: 2018 IST-Africa Week Conference (IST-Africa).Institute of Electrical and Electronics Engineers, 1. Gaborone, Botswana 9-11 May 2018.2018 IST-Africa Week Conference (IST-Africa). Available: http://ieeexplore.ieee.org/abstract/document/8417188 (Accessed 12 June 2019).

Miles, M. B., and Huberman, A. M. 1994. *Qualitative data analysis: An expanded source book (2nd Ed.)*. Newbury Park, CA: Sage.

Miller, H.E. and Engemann, K.J. 2019. Business Continuity Management in Data Center Environments. International Journal of Information Technologies and Systems Approach (IJITSA) 12(1):52-72.

Mishra, D.K., Nayak, M.K. and Joshi, A. 2016. Information and Communication Technology for Sustainable Development. *Proceedings of ICT4SD* 1:1-56

Misra-Dexter, N. and February, J. eds. 2010. *Testing Democracy: Which Way is South Africa Going?* Cape Town: African Books Collective, ABC Press.

Mitrovic, Z. and Klass, N. 2013. *The perceived benefits of introducing Cloud Computing based m-government services in the Western Cape.* In: the 15th Annual Conference on World Wide Web Applications Cape Town, South Africa, 10-13 September 2013, University of the Western Cape Bellville South Africa. Available: http://www.researchgate.net/profile/Zoran_Mitrovic3/publication/251571078_The_perceived_benefits_of_introducing_Cloud_Computing_based_m-government_services_in_the_Western_Cape/links/0f3175356cb95b9e90000000/The-perceived-benefits-of-introducing-Cloud-Computing-based-m-government-services-in-the-Western-Cape.pdf (Accessed 19 June 2016)

Modimogale, L. and Jan, H. 2011. The role of ICT within Small and Medium Enterprises in Gauteng. Communications of the IBIMA.

Modimogale, L. and Kroeze, J.H. 2009. Using ICTs to become a competitive SME in South Africa.

Moepya, M. 2010. *The Role of Multiparty Liaison Committees in Preventing and Managing Conflict in South Africa. When Elephants Fight: Preventing and Resolving Election-Related Conflicts in Africa*. Johannesburg: EISA.

Moloja, M.D. 2018. A Cloud-based Intrusion Detection and Prevention System for Mobile Voting in South Africa. Doctoral dissertation. Central University of Technology, Free State.

Montjoy, R. S. 2008. The Public Administration of Elections. *Public Administration Review*, 68(5):788-799.

Moore, B.N., Parker, R. and Rosenstand, N. 2011. *Critical thinking*. New York: McGraw-Hill.

Morgan, D. and Parsovs, A. 2017. Using the Estonian Electronic Identity Card for Authentication to a Machine. In: Nordic Conference on Secure IT Systems (175-191). University of Tartu, Tartu, November 9, 2017, Springer, Estonia, Available: http://eprint.iacr.org/2017/880.pdf (Accessed 13 May 2019).

Morgan, D.L. 1997. Focus groups as qualitative research. Journal of Chromatography A 16, 4402–10.

Morse, J.M. 2003. Principles of mixed methods and multimethod research design. Handbook of mixed methods in social and behavioural research 189–208.

Morse, J.M. 2010. Sampling in grounded theory. The Sage handbook of grounded theory: 229–244.

Mossberger, K., Tolbert, C.J. and McNeal, R.S., 2007. Digital citizenship: The Internet, society, and participation. Massachusetts, United States. MIt Press

Moynihan, D.P. and Lavertu, S. 2012a. Cognitive biases in governing: Technology preferences in election administration. P*ublic Administration Review,* 72(1):68–77.

Moynihan, D.P. and Lavertu, S. 2012b. Does involvement in performance management routines encourage performance information use? Evaluating GPRA and PART. *Public Administration Review*, 72(4):592-602.

Moynihan, D.P., 2004. Building secure elections: e-voting, security, and systems theory. *Public administration review,* 64(5):515-528.

Mozaffar, S. 2002. Patterns of elections governance in Africa's emerging democracies. *International Political Science Review*, 23(1):85-101.

Mpekoa, N. 2017. A Framework for M-Voting Implementation in South Africa. Doctoral Dissertation. Nelson Mandela Metropolitan University.

Mpekoa, N. and Bere, A. 2013. Factors affecting student attitudes toward mobile voting adoption: a case of a university of technology in South Africa. Available: http://www.researchgate.net/profile/Okuthe_Kogeda/publication/256815434_Model_for_A_Mobile_Phone_Voting_System_for_South_Africa/links/00463523c9c776f48d000000.pdf (Accessed 24 May 2015).

Mpekoa, N. and Bere, A. 2015. An Extension and Validation of the Task-Technology Fit: A Case of a Mobile-Phone Voting System. In: International Conference on Human Aspects of Information Security, Privacy, and Trust: 538-546. August 2015, Springer, .Berlin, Heidelberg.

Mpekoa, N. and Greunen, D., 2016. m-Voting: Understanding the complexities of its implementation. *International Journal for Digital Society,* 7(4):1214-1221.

Mpekoa, N. and van Greunen, D. 2016a. Factors affecting successful implementation of m-Voting in South Africa. In: Institute of Electrical and Electronics Engineers International Conference On Information Society (iSociety 2016). Dublin, Ireland 10-13 October 2016.

Mpekoa, N. and van Greunen, D. 2017a. E-voting experiences: A case of Namibia and Estonia. In: Institute of Electrical and Electronics Engineers International Conference on IST-Africa 2017. 31 May – 02 June 2017. Windhoek, Namibia, Mpekoa, N. and van Greunen, D. 2017b. How and why m-Voting implementation at CUT failed. In: Institute of Electrical and Electronics Engineers International Conference on Information Society (iSociety 2017). Dublin, Ireland, 17-19 July 2017. Under review.

Mpekoa, N., Kogeda, P. 2013. A model of a Mobile Phone-Voting System for South Africa. In: Annual Conference on World Wide Web Applications (ZA-WWW 2013). Cape Town, South Africa 10-13 September 2013.

Mphindi, H. 2008. Digital Divide and e-governance in South Africa. Research, Innovation and Partnerships. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.544.2678&rep=rep1&type=pdf (Accessed 15 March 2019).

Mpumlwana, T. 2011. *Democracy doesn't discriminate against disabled*. Available: http://www.citypress.co.za/Columnists/Democracy-doesnt-discriminate-againstdisabled-20110507 (Accessed 15 January 2014).

Msuya, C.A., Mjema, E.A. and Kundi, B.A. 2018. ICT adoption and use in Tanzania SMEs. *Tanzania Journal of Engineering and Technology*, 36(1):23-34.

Mtyala, Q. 2011. *People don't know how to vote*. Available: http://www.iol.co.za/news/south-africa/westerncape/ people-don-t-know-how-to-vote- 1.1073034?ot=inmsa. ArticlePrintPageLayout.ot (Accessed 5 January 2012).

Municipal Demarcation Board. 2016. Municipal Demarcation Board Shape Files Available: http://www.demarcation.org.za/site/shapefiles/ (Accessed 18 January 2017).

Muse, M.A. *The Role of Telecommunications in State-building: The Case of Somaliland*. Available: http://www.somalilandintellectualsinstitute.org/wp-content/uploads/2017/07/The-Role-of-Telecommunications-In-State.pdf (Accessed 18 June 2018).

Mutanga, S.S. 2017. Technology transformation and changing demographic patterns: Perspectives for Africa's future elections. International Journal of African Renaissance Studies-Multi-, Inter-and Trans-disciplinarity 12(1):107-119.

Mutula, S.M. and Mostert, J. 2010. Challenges and opportunities of e-government in South Africa. *The Electronic Library*, 28(1):38-53.

Mutung'u, G. 2017. *A Brief on Technology and Elections in Kenya 2017*. Available: http://www.diploInternetgovernance.org/profiles/blogs/a-brief-on-technology-and-elections-in-kenya-2017. (Accessed 18 October 2017).

Myers, M. 2006. Qualitative Research in Information Systems. Available at: http://www.misq.org/discovery/MISQD_isworld/.

Myers, M.D. 1997. Qualitative research in information systems. Management Information Systems Quarterly 21(June) 1–18.

Mzekandaba, S. 2015. Gauteng establishes e-govt department Available: http://www.itweb.co.za/content/8RgeVDqPWZoMKJN3 (Accessed 12 October 2015).

Nagar, M.F. 2015. Democratic development states in Southern Africa: A study of Botswana and South Africa. Doctoral dissertation. University of Cape Town.

Nazlee Siddiqui, Janna Anneke Fitzgerald. 2014 Elaborated integration of qualitative and quantitative perspectives in mixed methods research: A profound enquiry into the nursing practice environment, International Journal of Multiple Research Approaches, 8:2 137-147, Available: DOI: 10.1080/18340806.2014.11082056. (Accessed 13 February 2017).

NDI - National Democratic Institute USA. 2017. The Constitutionality of Electronic Voting in Germany. Available: http://www.ndi.org/e-voting-guide/examples/constitutionality-of-electronic-voting-germany (Accessed 31 May 2017).

Ndletyana, M. ed. 2015. Institutionalising Democracy: The story of the Electoral Commission of South Africa: 1993-2014. Pretoria, Africa Institute of South Africa.

Nduati, N.L., Ombui, K. and Kagiri, A. 2015. Factors affecting ICT adoption in small and medium enterprises in Thika Town, Kenya. *European Journal of Business Management*, 2(3):395-414.

Neuman, W.L. 2003. Social research methods: qualitative and quantitative Approach. Sydney, Person education, Inc. Newbury Park, California.

News 24 2019. Available: http://www.news24.com/SouthAfrica/News/more-than-80-of-new-voters-younger-than-30-but-6-million-still-unregistered-iec-20190129 (Accessed 24 July 2019).

News24. 2016. NFP to approach ConCourt to fight disqualification from elections. Available : http://www.news24.com/elections/news/nfp-to-approach-concourt-to-fight-disqualification-from-elections-20160706 (Accessed 6 July 2016).

Nganje, F. and Nganje, K. 2019. Liberal internationalism meets third worldism: the politics of international election observation in the DRC's post-war elections. Third World Quarterly:-22.

Nie, N.,H., Bent, D.H., and Hull, C.H. 1975. SPSS; *Statistical Package for Social Science* (v.227). McGraw-Hill, New York.

Nijland, N., van Gemert-Pijnen, J., Boer, H., Steehouder, M.F. and Seydel, E.R. 2008. Evaluation of Internet-based technology for supporting self-care:

Problems encountered by patients and caregivers when using self-care applications. *Journal of Medical Internet Research*, 10(2):13.

Nilekani, N. and Shah, V. 2016. Rebooting India: Realizing a Billion Aspirations. London: Penguin.

Ninsin, K.A. 2006. Institutional Development and Democratic Consolidation. In: Boafo, A. eds. *Voting for Democracy in Ghana; The 2004 Elections in Perspective,* (1). Accra: Freedom Publications, 59-78.

Njoh, A.J. 2018. The relationship between modern Information and Communications Technologies (ICTs) and development in Africa. *Utilities Policy*, 50:83-90.

Nohlen, D., Krennerich, M. and Thibaut, B. eds. 1999. Elections in Africa: A data handbook. Oxford University Press.

Nohlen, D., Krennerich, M. and Thibaut, B. eds., 1999. Elections in Africa: A data handbook. London. Oxford University Press.

Nolan R.L. 1979. managing the crises in data processing. Harvard Business Review, Available: http://web.ebscohost.com.ezproxy.liv.ac.uk/ehost/pdf?vid=1andhid=14andsid=0aeedd1a -181e-4cb9-9394-fa335725d331%40sessionmgr9 (Accessed 2 June 2014).

Norris, P. 2015. Why elections fail. London. Cambridge University Press.

Norris, P. 2016. Elections Integrity in East Asia. *Taiwan Journal of Democracy*, 12(1):1-25.

Norris, P. 2017. *Strengthening Elections Integrity. London*. Cambridge University Press.

Norris, P. and Grömping, M., 2017. Populist Threats to electoral integrity: The year in elections, 2016-2017. Electoral Integrity Project, PEI, 5. KS

Working Paper No. RWP17-0 18.May 2017; May 2017 Available: http://ssrn.com/abstract=2965729 or http://dx.doi.org/10.2139/ssrn.2965729 (Accessed 12 March 2018).

Norris, P., Frank, R.W. and i Coma, F.M. eds. 2014. *Advancing elections integrity London* .Oxford University Press.

Norris, P. 2012. *Are there global norms and universal standards of elections integrity and malpractice? Comparing public and expert perceptions. HKS Working Paper No. RWP12-010.* Available: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2087611 (Accessed 12 June 2018).

Nutt, P.C. and Backoff, R.W. 1993. Organizational publicans and its implications for strategic management. *Journal of Public Administration* Research and Theory, 3(2):209-231.

Nwangwu, C. 2015a. Biometric voting technology and the 2015 general elections in Nigeria. In: Two-Day National Conference on “The 2015 General Elections in Nigeria: The Real Issues” organized by The Elections Institute between 27- 28 July 2015. The Electoral Institute Complex, INEC Annex, Opposite Diplomatic Zone, Central Business District, Abuja Nigeria. Available: http://www.researchgate.net/publication/281624424_BIOMETRIC_VOTING_TECHNOLOGY_AND_THE_2015_GENERAL_ELECTIONS_IN_NIGERIA (Accessed 12 July 2016).

Nwangwu, C. 2015b. Biometric Voting Technology and the 2015 General Elections in Nigeria. *Department of Political Science, University of Nigeria, Nsukka*. Available: http://inecnigeria.org/wp-content/uploads/2019/02/Conference-Paper-by-Chikodiri-Nwangwu2.pdf (Accessed 10 March 2016).

Nyasha, T. 2011. The impact of organisational change: a study of the Gauteng Provincial Department of Infrastructure Development. Doctoral dissertation. University of South Africa.

O'Brien, K. 2018. Raila Amolo Odinga and Another V Independent Elections and Boundaries Commission and Others Presidential Petition No. 1 of 2017.

Obaidat M.S., Maitra T., Giri D. 2019. Protecting the Integrity of Elections Using Biometrics. In: Obaidat M., Traore I., Woungang I. (eds) Biometric-Based Physical and Cybersecurity Systems. Springer, Cham

Odeyemi, T.I. and Abioro, T. 2019. Digital Technologies, Online Engagement and Parliament-Citizen Relations in Nigeria and South Africa. In Perspectives on the Legislature and the Prospects of Accountability in Nigeria and South Africa: 217-232. Springer, Cham.

Odhiambo., O. 2016. Reforming elections management and administration in Kenya: the case for independent elections and boundaries commission (IEBC).Thesis Submitted to the University of Nairobi in partial fulfilment of the requirements for the award of the Degree of Master of Laws (LLM) Law, Governance and Democracy, University of Nairobi.

Odukoya, J. A., Bowale, E. I.K. and Okunlola, S. 2018. Formulation and implementation of educational policies in Nigeria. *African Educational Research Journal*, 6(1). ISSN 2354-2160.

Oetting, E.R. and Cole, C.W. 1978. Method, design, and instrumentation in evaluation. *New Directions for Student Services* 1978(1):35–55.

Offermann, P. and Platz, E.R. 2009. Outline of a Design-Science Research Process. 4th International Conference on Design-Science Research in Information Systems and Technology, 11.

Ofori-Dwumfuo, G.O. and Paatey, E. 2011. The design of an electronic voting system. Research Journal of Information Technology 3(2):91-98.

Oke, B.A., Mikail, O., Aboaba, A. and Diran, A. 2019. Securing Electronic Voting System Using Crystographic Technique. ATBU Journal of Science, Technology and Education, 7(1):88-105.

Okong'o, G. and Matatu, N. 2017. *Kenya: The potential and limitations of elections technology*. Available: http://www.idea.int/news-media/news/kenya-potential-and-limitations-elections-technology (Accessed 5 November 2017).

Okoro, E. 2017. Electronic voting operations and capabilities in sub-Sahara Africa: A cost-benefit analysis. Technology Integration and Transformation of Elections in Africa: An Evolving Modality, Lenham Maryland. Rowman & Littlefield.

Olanipekun, L. 2015. *Assessment of Card Readers and its Effect on the Credibility of the 2015 Presidential Election in Nigeria* Available: http://s3.amazonaws.com/academia.edu.documents/48447317/Card_Reader.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3AandExpires=1557854443andSignature=oye5ldgBQStPYjw%2B%2FowuJwDVomY%3Dandresponse-content-disposition=inline%3B%20filename%3DAssessment_of_Card_Readers_and_its_Effec.pdf (Accessed 14 September 2016).

Olusola, O. and Adesina, R. 2015. A Framework for Electronic Voting in Nigeria. *International Journal of Computer Applications*, 129(3):12-16.

Online Monkey Survey 2018. The Use of Internet-Based Technologies for Elections Management Processes in South Africa. Available: https://www.surveymonkey.com/summary/wyQAJM_2FvVfRLnXEANLoOK6fiD5xvB7k1d_2BDJwphBvhcpjOGgN9estIGvZxSASq33 (Accessed 18 December 2018).

Oostveen, A.-M. And Van den Besselaar, P. 2004. Security as belief User's perceptions on the security of electronic voting systems. *Electronic Voting in Europe: Technology, Law, Politics and Society*, 47:73–82.

OpiyoOpiyo, R.O. 2019. Smart peace and security in Africa. In Smart Economy in Smart African Cities; 347-370. Springer, Singapore.

Orlikowski, W. and Baroudi, J. 1989. IS Research Paradigms: Method versus Substance.

Orlikowski, W.J. and Baroudi, J.J. 1991. Studying information technology in organizations: Research approaches and assumptions. Information systems research 2(1):1–28.

Ormrod, R.P. and Henneberg, S.C. 2010. Understanding voter orientation in the context of political market orientation: Is the political customer king? *Journal of Marketing Management*, 26(1–2):108-130. Available: http://doi.org/10.1080/02672570903574270 (Accessed 12 September 2016).

Osah, J. and Khene, C. 2018. Group structural elements in e-Government strategy formulation at local municipal level in South Africa. *Transforming Government: People, Process and Policy*, 12(1):2-15.

Osei, D. 2010. ICT and Elections in Africa, Ghana Telecom University College Available: http://www.gtuc.edu.gh/uploads/speeches/ict_and_election.pdf. (Accessed 2 July 2018).

Osho, O., Yisa, V.L. and Jebutu, O. J. 2015. E-voting in Nigeria: A survey of voters' perception of security and other trust factors. In: Cyberspace (CYBER-Abuja) 2015 International Conference on 1(1), 202-211.4-7 Nov. 2015 Institute of Electrical and Electronics Engineers. Abuja, Nigeria Available: http://ieeexplore.ieee.org/abstract/document/7360511 (Accessed 20 January 2018).

OSISA. 2016. *A review by Open Society Initiative for Southern Africa and ECF-SADC*. Available: http:www.africanminds.co.za/wp.../OSISA-EMB-CASE-STUDIES-29MAR1200-WEB.pdf (Accessed 18 March 2017).

Owusu-Oware, E.K., Effah, J. and Boateng, R. 2017. Institutional Enablers and Constraints of National Biometric Identification Implementation in Developing Countries: The Case of Ghana. Twenty-third Americas Conference on Information Systems, Boston, 1(1) 1-10 Available: http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1497&context=amcis2017 (Accessed 19 July 2018).

Oyedemi, T. and Mahlatji, D. 2016. The 'born-free' non-voting youth: A study of voter apathy among a selected cohort of South African youth. Politikon, 43(3):311-323.

Oyier, C.R., Odundo, P.A., Lilian, G.K. and Wangui, K.R. 2015. Effects of ICT Integration in Management of Private Secondary Schools in Nairobi County, Kenya: Policy Options and Practices. *World Journal of Education*, 5(6):14-22.

Oyier, C.R., Odundo, P.A., Lilian, G.K. and Wangui, K.R. 2015. Effects of ICT Integration in Management of Private Secondary Schools in Nairobi County, Kenya: Policy Options and Practices. *World Journal of Education*, 5(6):14.

Pallav, S., Dhanalakshmi, S. and Aiswarya, S. 2012. Mobile Voting using Global System for Mobile Communication (GSM) Technology and Authentication using Fingerprinting Biometrics and Wireless Networks International *Journal of Smart Sensors and Ad Hoc Networks.* 1(4):63-68.

Pallister, K. 2017. Election Administration and the Politics of Voter Access. London. Routledge.

Parahoo, K. 2014. *Nursing research: principles, process and issues. Macmillan International Higher Education*, UK. London.

Pastor, R. A. 1999b. The role of elections administration in democratic transitions: Implications for policy and research. *Democratization*, 6(4):1-27.

Patel, I. and White, G. 2005. M-government: South African Approaches and Experiences. *EURO mGOV*: 313-323. Available: http://mobility.grchina.com/lab/Archives/EuromGov2005/PDF/32_R374IP.pdf (Accessed 18 November 2017).

Patel, P. B. 2012. Mobile store management system. Master's dissertation. San Diego State University

Pather, S., Erwin, G. and Remenyi, D. 2003. Measuring e-Commerce effectiveness: a conceptual model. In Proceedings of the 2003 annual research conference of the South African institute of computer scientists and information technologists on Enablement through technology. South African Institute for Computer Scientists and Information Technologists: 143–152.

Patton, M.Q. 1990. Qualitative evaluation and research methods. SAGE Publications, Inc.

Patton, M.Q. 1999. Enhancing the quality and credibility of qualitative analysis. Health services research, 34(5 Pt 2):1189.

Pazhyanur, S. 2015. A "Universal Value"? Perceptions Of Democracy Across Race Among Young Voters In Durban, SA. Available: http://digitalcollections.sit.edu/isp_collection/2044 (Accessed 4 March 2016).

Peffers, K. 2006. The Design Science Research Process: A Model for Producing and Presenting Information Systems Research. *The Proceedings of Design Research in Information Systems and Technology DESRIST'06* 24:83–106.

Peffers, K. 2006. The Design Science Research Process: A Model for Producing and Presenting Information Systems Research. The Proceedings of Design Research in Information Systems and Technology DESRIST'06 24:83–106.

Peffers, K.E.N. 2007. A design science research methodology for information systems research. Journal of Management Information Systems 24(3):45–77.

Petter, S.S. and Gallivan M. J. 2004. Toward a Framework for Classifying and Guiding Mixed methods Research in Information Systems', Proceedings of the 37th International Conference on System Sciences: 1-10 Hawaii.

Piccolino, G. 2016. Infrastructural state capacity for democratization? Voter registration and identification in Côte d'Ivoire and Ghana compared. *Democratization*, 23(3):498-519.

Pope, C., and Mays, N 1995. Qualitative research: reaching the parts other methods cannot reach: an introduction to qualitative methods in health and health services research, British Medical Journal, 311(6996).

Porteus, K., Patel, F., Fleisch, B. and Ruth, T. 2001. Budget analysis for the education portfolio committee of the Gauteng provincial legislature–Budget statement 2001/02: Vote 5 Budget. Gauteng Department of Education.

Powell, C. 2015. "Uphi?" ICTs and the mitigation of distance in a South African township. *Technology in Society*, (42):39–48.

Prandini, M., Sartori, L. and Oostveen, A.M., 2014. *Why electronic voting? Conference for E-Democracy an Open Government*.MV-Verlag, Singapore.

Presser, M., Zhang, Q., Bechmann, A. and Beliatis, M.J. 2019. The Internet of Things as Driver for Digital Business Model Innovation. In Digital Business Models: 27-55. Palgrave Macmillan, Cham.

Price, M. and Stremlau, N. eds. 2017. Speech and Society in Turbulent Times. United Kingdom. Cambridge University Press.

Prosser, A. and Krimmer, R. 2004. The dimensions of electronic voting technology, law, politics and society. *Electronic Voting in Europe Technology, Law, Politics and Society,* 21-28.

Prosser, A. ed. 2004. Electronic Voting in Europe-Technology, Law, Politics and Society. Ges. für Informatik. Workshop of the ESF TED Programme together with GI and OCG. July, 7th – 9th, 2004 in Schloß Hofen/Bregenz, Lake of Constance, Austria. Available: http://pdfs.semanticscholar.org/eb02/5c3f9ab5441b7bf233a35eaf3036e249376d.pdf (Accessed 16 May 2018).

Qantas. 2012 *Perth to Canberra*. Available: http://book.qantas.com.au/pl/QFOnline/wds/OverrideServlet. (Accessed 30 March 2015).

Qureshi, H.A., Salman, Y., Irfan, S. and Jabeen, N. 2017. A systematic review of e-government evaluation. *Pakistan Economic and Social Review*, 55(2): 327-362.

Rabindra, J. 2012. *Effective Use of Information and Communications*. Available: http://www.dflcaribbean.com/investment-conference/DJagganauth.pdf (Accessed 12 March 2013).

Rajendiran, M.S., Indrakumar, M.R., Iyyappan, M.S. and Sudhakaran, M.M. 2017. AADHAR based electronic voting system and providing authentication on Internet of things. *International Research Journal In Advanced Engineering And Technology (IRJAET)*. E - ISSN: 2454-4752 P - ISSN :2454-4744 3(2) 1711-1718.

Rampa, T., P. 2017. Why youth make a decision not to vote in elections: perspectives of youth in the Siyabuswa community of Mpumalanga. Master’s Thesis. University of the Witwatersrand.

Rantete, J. 1998. The African National Congress and the Negotiated Settlement in South Africa. Van Schaik Publishers.

Rao, U. 2019. Re-Spatializing Social Security in India. *Spaces of Security: Ethnographies of Securityscapes, Surveillance, and Control*, 1(1):231-235.

Ravarini, A. 2010. Information capability within Small-Medium Enterprises. Doctoral dissertation. School of Computer and Security Science Faculty of Computing, Health and Science Edith Cowan University, Perth.

Reddick, C.G. ed., 2009. Handbook of Research on Strategies for Local E-Government Adoption and Implementation: Comparative Studies: Comparative Studies. IGI Global, New York.

Rexha, B., Dervishi, R. and Neziri, V., 2011, December. Increasing the trustworthiness of e-voting systems using smart cards and digital certificates–Kosovo case. In Proceedings of the 10th WSEAS International Conference on E-Activities (E-ACTIVITIES'11), Jakarta, Island of Java, Indonesia: 208-212.

Rexha, B., Neziri, V. and Dervishi, R., 2012. Improving authentication and transparency of e-Voting system–Kosovo case. International Journal of Computers and Communications, 6(1):84-91.

Riggs, A.J. and Earls, A.S. 2017. The Only Clear limitation on Improper Districting Practices: Using One-Person, One-Vote to Combat Partisan Gerrymandering. *Duke Journal of Constitutional Law and Public Policy*, 12(3):23-56.

Rivera, A.J. 2014. A socio-technical systems approach to studying interruptions: *Understanding the interrupter's perspective. Applied Ergonomics,* 45(3):747–756.

Rogers E.M. 1995. Diffusion of Innovations: Modifications of a Model for Telecommunications. In: Stoetzer MW., Mahler A. (eds) Die Diffusion von

Innovationen in der Telekommunikation. Schriftenreihe des Wissenschaftlichen Instituts für Kommunikationsdienste, (17). Springer, Berlin, Heidelberg.

Rooyen, A.H. and Rena, R. 2019. Factors Effecting the Late-Payment of SASSA Creditors: A Case of North-West Province. Available: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=3308739 (Accessed 7 February 2019).

Rosenbaum, P.R. 2005. Observational study. Encyclopaedia of Statistics in Behavioural Science, 3:1451–1462.

Russon, R.,D. 2017. Voters roll crises and the need for electoral reforms in South Africa. Journal of African elections. 16(2):150-165.

Sæbø, Ø. 2011. Understanding Twitter use among parliament representatives: A genre analysis. In: Tambouris, E., Macintosh, A. and de Bruijn, H. eds. *Electronic Participation*. Berlin: Springer :1-12.

Sagoe-Moses, L. 2017. *How to stop elections corruption-What Kenya's NASA can learn from Ghana's N, Africa at LSE*. Available: http://eprints.lse.ac.uk/83796/1/africaatlse-2017-07-03-how-to-stop-elections-corruption%25e2%2580%258a-what.pdf (Accessed 5 February 2018).

Sahana, H.S., Sandeep, V.S., Shwetha, R., Sowmya, J. and Krupa, K.S. 2017. Office Automation System Using Internet of Things. *International Research Journal of Engineering and Technology*, 4(07): 1619-1622.

Sallai G. 2012. *Defining Infocommunications and Related Terms, in: Acta Polytechnica Hungarica,*9(6). Available: http://www.uni-obuda.hu/journal/Sallai_38.pdf (Accessed 14 November 2017).

Salvador, P., Vivar, P.C., de Vera, E., Inocian, R.B. and Rosaroso, R.C. 2017. Influence of Facebook to Voters' Political Practices. *Asia Pacific Journal of Education, Arts and Sciences*, 4(1):15-23.

Samaranayaka, C. and Premaratne, S. 2019. Enhancing Call Center Operations through Semantic Voice Analysis. In Emerging Technologies in Data Mining and Information Security: 385-395. Springer, Singapore.

Sapa. 2009a. *April 22. ANC told people who to vote for*. Available: http://www.news24.com/Elections/News/ANC-told-peoplewho- to-vote-for-20100625 (Accessed 8 December 2010).

Saralaya, P.K., Anjali, R., Shivaprasad, G. and Reddy, N.S. 2017. Biometric authentication usage for Internet banking. In: 2017 2nd Institute of Electrical and Electronics Engineers International Conference on Recent Trends in Electronics, Information and Communication Technology (RTEICT):1810-1814. 19-20 May 2017. Institute of Electrical and Electronics Engineers. Bangalore, India. Available: https://ieeexplore.ieee.org/abstract/document/8256911 (Accessed 13 July 2017).

Sarkar, S.2014. The unique identity (UID) project, biometrics and re-imagining governance in India. *Oxford Development Studies*, 42(4):516-533.

Sarker, M.M. and Islam, M.N. 2013. Management of sustainable, credible and integrated electronic voting (E-voting) system for Bangladesh. *Management of Sustainable Development*, 5(1):15-21.

Saunders, M., Lewis, P. and Thornhill, A. 2009. Understanding research philosophies and approaches. Research methods for business students: 106–136.

Saunders, M.N.K. 2011. Research methods for business students, 5/e, Pearson Education India.

Scholl, H.J. 2004. Involving salient stakeholders: Beyond the technocratic view on change. *Action Research*, 2(3):277-304.

Schueller, M.L. and Walls, M. 2017. *Report by International Observers on the 2016 Voter Registration Process in Somaliland. Progressio*. Available: http://www.progressio.org.uk/sites/progressio.org.uk/files/progressio_voter_registration_process_in_somaliland_final_170317.pdf (Accessed 17 April 2019).

Schulz-Herzenberg, C. 2014. Voter participation in the South African elections of 2014. Institute for Security Studies. Policy Brief 61. *Science*, 597:189-208.

Schürmann, C., Barrat, J., Bolo, E., Bravo, A., Krimmer, R., Neumann, S., Parreno, A.A., Volkamer, M. and Wolf, P. 2015. Certification of ICTs in Elections. At research institution. Available: http://www.forskningsdatabasen.dk/da/catalog/2306027581 (Accessed 17 May 2018).

Schwab, K. and Sala-i-Martín, X. 2016, April. T*he global competitiveness report 2013–2014*: Full data edition. World Economic Forum. Available: http://repositorio.colciencias.gov.co/handle/11146/223 (Accessed 21 April 2019).

Schwartz, B.P. and Grice, D. 2012. Establishing a Legal Framework for E-Voting in Canada. *Man. LJ*, 36:301.

Sepeame, M. and Ajala, E. 2013. Investigating Factors Affecting Adoption and Implementation of m-Government in the South African Department of Home Affairs: An on-going Research. *International Journal of Computer Science and Business Informatics*, 5(11–12):1-12.

Shackel, B. 2009. Usability–Context, framework, definition, design and evaluation. *Interacting with Computers* 21(5–6):339–346.

Shakiba, N.M., Doostari, M.A. and Mohammadpourfard, M. 2017. ESIV: an end-to-end secure Internet voting system. *Electronic Commerce Research*, 17(3):463-494.

Shamos, M. and Yasinsac, A. 2012. Realities of E-voting security. Institute of Electrical and Electronics Engineers Security and Privacy, 10(5):16-17.

Shamos, M.I. 2004. Paper vs. electronic voting records– An assessment. In: Proceedings of the 14th ACM Conference on Computers, Freedom and Privacy. 1-23. Pittsburgh, Pennsylvania. School of Computer Science Carnegie Mellon University, April 2004 Available http://www.cfp2004.org/cfp2004/program/materials/p12-shamos.pdf (Accessed 10 July 2019).

Shamos, M.I. 2004. Paper vs. electronic voting records– An assessment. In: Proceedings of the 14th ACM Conference on Computers, Freedom and Privacy. 1-23. Pittsburgh, Pennsylvania. School of Computer Science Carnegie Mellon University, April 2004 Available: http://www.cfp2004.org/cfp2004/program/materials/p12-shamos.pdf (Accessed 10 July 2019).

Sheldon, M.D. 2019. A Primer for Information Technology General Control Considerations on a Private and Permissioned Block chain Audit. Current Issues in Auditing, 1(1):1-30.

Sheriff, F. C.A., Oni, A. and Gberevbie, D. 2014. Challenges and Prospects of e-Elections in Nigeria. In: Proceedings of the 14th European Conference on e-Government: ECEG 2014. Ogun State Nigeria, 12-13 June 2014, Academic Conferences Limited, 93. Social Science Computer Review, 23(3):269-273. Available: http://ssc.sagepub.com/cgi/content/abstract/23/3/269 (Accessed 18 March 2013).

Shi, M. and Yuan, H. 2019. Impact of E-Commerce Website Usability on User Satisfaction. Journal of Advanced Computational Intelligence and Intelligent Informatics 23(1):91-96.

Shilowa, M. 2009. Address at the Launch of the Strategy to Build Gauteng as a Globally Competitive City Region. Gauteng Provincial Legislature.

Shin, D. 2019. How do users experience the interaction with an immersive screen? Computer in Human behaviour, 98:302-310

Simons, B. 2017. *Virginia Board of Elections Votes to Remove All Paperless Voting Machines*. Available: http://org.salsalabs.com/o/199/t/0/blastContent.jsp?email_blast_KEY=1372947 (Accessed 10 September 2017).

Sin Tan, K., Choy Chong, S., Lin, B. and Cyril Eze, U. 2009. Internet-based ICT adoption: evidence from Malaysian SMEs. *Industrial Management and Data Systems*, 109(2):224-244.

Sinclair, M. 2007. A guide to understanding theoretical and conceptual frameworks. *Evidence-Based Midwifery*, 5(2):39–40.

Singh, H., Kar, A.K. and Ilavarasan, P.V. 2019. Adoption of e-Government Services: A Case Study on e-Filing System of Income Tax Department of India. In Operations Research in Development Sector: 109-123. Springer, Singapore.

Smartmatic. 2016. *Smartmatic: PH now world reference point for automated elections*. Available: http://newsinfo.inquirer.net/785083/smartmatic-ph-now-world-reference-point-for-automated-elections. (Accessed 1 June 2016).

Smith, K.B. 2018. The public policy theory primer. Routledge. Available: http://doi.org/10.4324/9780429494352 (Accessed 13 May 2019).

Song, J. and Tang, S. 2010, August. Operator's mobile Internet strategy in the process of converged network. In 2010 International Conference on Management and Service Science: 1-4.

South African Development Corporation– Parliamentary Forum SADC-PF. 2014. Norms and Standards for Elections in the SADC Region, Windhoek, and Namibia (mimeo).

South African History Online 2013 South African History Online. Available: http://www.sahistory.org.za/places/gauteng (Accessed 3 May 2016).

South African Human Rights Commission (SAHRC). 2002. *Towards a barrier-free society*. Available: http://www.info.gov.za/view/DownloadFileAction?id=70265 (Accessed 18 January 2013).

Southall R. 2004. Post-elections South Africa: the continuing case for electoral reform. Journal of African Elections.

Southall, R. 2014. The South African Election of 2014: Retrospect and Prospect. *Strategic Review for Southern Africa*, 36(2):80.

Southall, R. and Daniel, J. eds. 2009. *Zunami!: The South African elections of 2009*. Sunnyside, Auckland Park: Jacana Media.

Southall, R. and Daniel, J. eds. 2009. Zunami!: the South African elections of 2009. Jacana Media.

Spencer, B.D., May, J., Kenyon, S. and Seeskin, Z. 2017. Cost-benefit analysis for a quinquennial census: the 2016 population census of South Africa. Journal of Official Statistics, 33(1): 249-274

Stair, R. and Reynolds, G. 2013. Principles of information systems. Boston, Massachusetts, United States Cengage Learning.

Stanlib. 2010. Nover Report Available: http://www.stanlib.com/EconomicFocus/Documents/Domestic/SAGDPQ32011.pdf (Accessed 14 April 2016).

Statistics South Africa. 2017. Statistical release Mid-year population estimates. Africa, P0302: 1–8.

Stenbro, M. 2010. A survey of modern electronic voting technologies. Master's dissertation. Institutt for telematikk.

Strauss, A. and Corbin, J. 1990. *Basic of Qualitative Research: Grounded Theory Procedures and Techniques*. London: Sage

Strielkowski, W., Gryshova, I. and Kalyugina, S. 2017. Modern technologies in public administration management: A comparison of Estonia, India and United Kingdom. *Administrative Management Public*, 1(28):174-185

Struwig, J., Roberts, S. and Gordon, S.,L., Davids, and Marco, J. 2015 IEC election satisfaction survey 2014

Struwig, J., Roberts, S. and Vivier, E. 2011. A vote of confidence: Election management and public perceptions elections processes in South Africa. *Journal of Public Administration*, 46(Special issue 1):1122-1138.

Stufflebeam, D.L. 2000. *Guidelines for developing evaluation checklists: the checklists development checklist (CDC)*. Kalamazoo, MI: The Evaluation Center. Available: http://wmich.edu/sites/default/files/attachments/u350/2014/guidelines_cdc.pdf (Accessed 20 March 2016).

Stufflebeam, D.L. and Webster, W.J. 1983. An analysis of alternative approaches to evaluation. In Evaluation models. Springer :23–43.

Sunday Times 2019. Surge of youth registrations - but millions still not enrolled for poll Available: http://www.timeslive.co.za/politics/2019-01-29-surge-of-youth-registrations-but-millions-still-not-enrolled-for-poll/

Sunday Times. 2016. Mmusi Maimane elected as new DA leader. Available: http://www.timeslive.co.za/politics/2015-05-10-mmusi-maimane-elected-as-new-da-leader (Accessed 6 July 2016).

Swanepoel E., Thomson K., van Niekerk J.F. 2010. E-Voting: A South African Perspective. In: Villafiorita A., Saint-Paul R., Zorer A. (eds) E-Infrastructures and E-Services on Developing Countries. AFRICOMM 2009. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, (38). Springer, Berlin, Heidelberg

Swanepoel, E. 2012. A Process Model for E-Voting in South Africa. A dissertation submitted in partial fulfilment of a Master's dissertation. Nelson Mandela Metropolitan University.

Swanepoel, E., Thomson, K. and Niekerk, J.F. 2010. E Voting: A South African Perspective. *E-Infrastructures and E-Services on Developing Countries*, 38:70–77.

Swanepoel, E., Thomson, K. and Van Niekerk, J.F. 2009. E-voting: A South African perspective. In: E-Infrastructures and E-Services on Developing Countries First International ICST Conference (70-77),December 3-4, 2009. Proceedings, AFRICOM Maputo, Mozambique. Available: https://link.springer.com/chapter/10.1007/978-3-642-12701-4_8#citeas (Accessed 5 August 2016).

Sylvester, J. 2009. Understanding issues of race and class in Elections 09. IDSA Cape Town.

Team, E.T. and van Zyl Slabbert, F., 2003. Report of the Electoral Task Team. Electoral Task Team. Available: http://www.sun.ac.za/fvzs/wp-content/uploads/2016/06/Electoral-Task-Team-Report.pdf (Accessed 19 May 2018).

Teddlie, C. and Tashakkori, A. 2011. Mixed methods research. The Sage handbook of qualitative research: 285–300.

TenBrink, T.D. 1974. *Evaluation: A practical guide for teachers*, McGraw-Hill, Pennsylvania Plaza, New York City.

Tessmer, M. 1993. *Planning and conducting formative evaluations: Improving the quality of education and training*, Mortimer Street, London, Psychology Press.

Thakur, C. And Millham, R. 2018. The decision to adopt electronic voting in South Africa. Muma Case Review, 3(14):1-16

Thakur, S. 2012. *Electronic voting: the cross-national experience*. Commissioned Research Pretoria South Africa. The Elections Commission of South Africa (IEC).

Thakur, S. 2015a. System architecture for secure mobile Internet voting. Doctoral dissertation. Durban University of Technology.

Thakur, S. 2015b. E-voting: India and the Philippines – a comparative analysis for possible adaptation in Africa. In: Sodhi, I. ed. *Emerging Issues and Prospects in African E-Government*. Hershey, PA: Information Science Reference, 28-55. doi: 10.4018/978-1-4666-6296-4.ch003.

Thakur, S. and Singh, S. 2012. A study of some e-Government activities in South Africa. In: Sustainable e-Government and e-Business Innovations (E-LEADERSHIP). 2012 e-Leadership Conference on. 4-5 Oct. 2012

Thakur, S. and Singh, S. 2013. A Study of Some e-Government Activities in South Africa. *African Journal of Computing and ICT*, 6(2):41-54.

Thakur, S., Adetiba, E., Olugbara, O.O. and Millham, R. 2015. *Experimentation using short-term spectral features for secure mobile Internet voting authentication. Mathematical Problems in Engineering 2015*. Available: http://www.hindawi.com/journals/mpe/2015/564904/abs/ (Accessed 12 November 2016).

Thakur, S., Adetiba, E., Olugbara, O.O. and Millham, R. 2015. Experimentation using short-term spectral features for secure mobile Internet voting authentication. Mathematical Problems in Engineering 2015.

Thakur, S., Olugbara, O.O., Millham, R., Wesso, H.W., Sharif, M. and Singh, P. 2014. Asia-Pacific Institute of Management. Transforming the voting paradigm – the shift from inline, to online to mobile voting. International Summer School on Information and Communication Technology for Democracy. New Delhi, India, 9-15 March 2014.

Thapa, D. 2011. The role of ICT actors and networks in development: The case study of a wireless project in Nepal. *The Electronic Journal of Information Systems in Developing Countries*, 49(1):1-16.

Thapa, D. and Sæbø, Ø. 2014. Exploring the link between ICT and development in the context of developing countries: A literature review. *The Electronic Journal of Information Systems in Developing Countries*, 64(1):1-15.

The Guardian. 2017. *Kenya elections annulled after result called before votes counted, says Court*. Available: http://www.theguardian.com/international. (Accessed 04 September 2017).

The Sowetan. 2010. Elections reports. Available: http://www.sowetanlive.co.za (Accessed 06 July 2016).

Therese, L. 2001. Election and Technology, Regional Workshop on Capacity Building in Elections Administration in Africa Tangier. Available: http:www.cafrad.org. (Accessed 16 May 2016).

Therese, L. 2001. Election and Technology Regional Workshop on Capacity Building in Elections Administration in Africa. Challenging the Norms and Standards of Election Administration The International Foundation for Electoral Systems (IFES) Tangier Morocco 24-28 September 2001. Available: http://ifes.org/sites/default/files/2_ifes_challenging_election_norms_and_standards_wp_embsint.pdf (Accessed 11 March 2017)

Thomas, G. and Gibson, R. 2014. *Comparative Assessment of Central Elections Agencies, A Report Commissioned by Elections Canada.* Available: http://ww.elections.ca/content (Accessed 14 June 2014).

Thomas, G. 2015. How to do your case study. London. *Sage.*

Thomas, P. 2010. Research Methodology and Design. *Research Methodology and Design*: 291–334

Thomson, A. 2016. *An introduction to African politics*. London: Routledge.

Tibane, E. and Vermeulen, A. 2014. South Africa Yearbook 2013/2014. South Africa Yearbook. Government Communication and Information System, Republic of South Africa, Pretoria

Tlakula, P. 2007. Democratic elections in a global context. Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad 10(2):1-20.

Tolbert, C.J. and Mcneal, R.S. 2003, 'Unravelling the effects of the Internet on political participation?', Political Research Quarterly 56(2) 175–185. Available: http://doi.org/ 10.1177/106591290305600206 (Accessed 16 March 2017).

Tory, M. and Moller, T. 2005. Evaluating visualizations: do expert reviews work? Institute of Electrical and Electronics Engineers computer graphics and applications 25(5):8–11.

Tory, M. and Moller, T. 2005. Evaluating visualizations: do expert reviews work? *Institute of Electrical and Electronics Engineers computer graphics and applications* 25(5):8–11.

Tracey, L. 2016. Do you want my vote? Understanding the factors that influence voting among young South Africans. Institute for Security Studies Monographs 2016(193):1-56.

Tran, D.S. 2019. Voting Technology. In Unrigging American Elections: 127-149. Palgrave Macmillan, Cham.

Trauth, E.M. 2001. Qualitative research in IS: issues and trends, Hershey, PA, USA Idea Group Publishing.

Trauth, E.M., and Jessup, L.M. 2000. Understanding Computer-Mediated Discussions: Positivist and Interpretive Analyses of Group Support System Use, MIS Quarterly 24(1),43.

Travelmath. 2010. *The driving distance from Brisbane to Canberra*. Available: http://www.travelmath.com/distance/ (Accessed 10 September 2014).

Trechsel, A.H. 2011. Internet Voting in Estonia. Doctoral Dissertation. Tallinn University of Technology.

Trochim, W. 2016, Research Methods: The Essential Knowledge Base. Available: http://www.vitalsource.com/za/products/research-methods-the-essential-knowledge-base-trochim-donnelly-kanika-v9781305445185?duration=perpetualandgclid=Cj0KCQjwjpjkBRDRARIsAKv-0O2EekBd6FmPdrBPpMTs3y7bc1yiV7QdaAWymyXZCUj-B9ucpkCuCrwaAkQoEALw_wcB. (Accessed 18 December 2018).

Trujillo, H.R., Elam, D., Shapiro, G. and Clayton, M. 2014. The Role of Information and Communication Technology in Preventing Election-Related Violence in Kenya 2013. *Perspectives on Global Development and Technology*, 13(1-2):111-128.

Tsunga, A. 2005. SADC principles and guidelines governing democratic elections analysis: A bird's eye view. In: PEPSA Expert Meeting, Parktonian Hotel, Johannesburg (28).

Unertl, K.M. 2008. Traversing the many paths of workflow research: developing a conceptual framework of workflow terminology through a systematic literature review. Journal of the American Medical Informatics Association: JAMIA 17(3):265–73.

United Nations Development Programme, (UNDP). 2007. Democratic Governance Group, Bureau for Development Policy, Implementation Guide on Elections Assistance.

United Nations Development Programme, (UNDP). 2009: *Elections and Conflict Prevention: A Guide to Analysis, Planning and Programming*. New York: UNDP.

United States Election Assistance Commission 2017. The Election Administration and Voting Survey 2016 Comprehensive Report: A Report to the 115th Congress.

Van Gyampo, R.E. 2017. The State of Elections Reforms in Ghana. *Africa Spectrum*, 52(3):95-109.

Van Ham, C., Linderg, S.I. 2018. 9 Elections. Institutions and Democracy in Africa; How the rules of the Game Shape Political Development. *Institutions and Democracy in Africa: How the Rules of the Game Shape Political Developments*,. (1):213

Van Wart, M., Roman, A., Wang, X. and Liu, C. 2017. Integrating ICT adoption issues into (e-) leadership theory. *Telematics and Informatics*, 34(5):527-537.

Van Zyl Slabbert, F. 2003. Report of the Elections Task Team.

Van Zyl, L. 2009. *How effective was the IEC's braille template?* Available: http://medusa.cybersmart.co.za/sancb/press.asp.(Accessed 29 September 2010).

Vankov, N. 2013. The strategic dimensions of political marketing. *Economic Alternatives*, 3(3):74-80.

Venkataraman, M., Henry, W., Shrestha, A., Lagneaux, A.M., Dearing, S.M., Garey, R.E. and Dunn, S.N., US Postal Service (USPS). 2019. Cryptographically tracked and secured vote by mail system. U.S. Patent Application 16/101,248.

Vlachokyriakos, V. 2013. *Designing voting technology for participation. In Proceedings of the 14th Annual International Conference on Digital Government Research.* ACM: 271–272. June 17 - 20, 2013. Quebec, Canada ACM New York, NY, USA. Available: http://dl.acm.org/doi/10.1145/2479724.2479768 (Accessed 12 April 2019).

Von Alan, R.H., March, S. T., Park, J., and Ram, S. 2004. Design science in information systems research. MIS quarterly 28(1):75-105.

Wakefield Metropolitan District Council. 2007. *Culture And Leisure/Museums*. Available: http://www.wakefield.gov.uk/cultureandleisure/museums/Object/2007_01.htm?wbc_purpose=...default.htmdefault.htm (Accessed 5 June 2007).

Walther, W.,K. 2001. Examining the impact of Internet on the Electoral Process. Doctoral dissertation., Kalamazoo College.

Waltz, S., E. 2001. Universalizing human rights: : The role of small states in the construction of the universal declaration of human rights. *Human Rights Quarterly*, 23(1):44-72.

Wiebusch, M., Aniekwe, C.C., Oette, L. and Vandeginste, S., 2019a. Introduction: The African Charter on Democracy, Elections and Governance at 10. Journal of African Law, 63(S1):3-7.

Wiebusch, M., Aniekwe, C.C., Oette, L. and Vandeginste, S., 2019b. The African Charter on Democracy, Elections and Governance: past, present and future. Journal of African Law, 63(S1):9-38.

Windt, C., D. 2014. Organization of American States (OAS). *Yearbook of International Environmental Law*, 25(1):622-635.

World Bank Group. 2014. World development indicators 2014. Washington, DC: World Bank Publications.

Xingwana, L. 2011. *Budget Vote 2011/12 speech by the Minister for Women, Children and People with Disabilities*. Available: http://www.info.gov.za/speech/DynamicAction?pageid=461andsid=18926andtid=34677. (Accessed 5 January 2012).

Yang, W., Y. and Gelb, J. 2019. Is democratic nomination good for women's candidacy? Examining the case of Taiwan. Asian Journal of Women's Studies 25(1):2-29.

Yin, R.K. 1989a. Case study research: Design and methods, revised edition. Applied Social Research Methods Series, 5.

Yin, R.K. 1989b. Research design issues in using the case study method to study management information systems. The information systems research challenge: Qualitative research methods 1(1):1–6.

Yin, R.K. 2003. Case study research design and methods third edition. Applied social research methods series, 5.

Young, A. Asgarkhani, M. 2010. Industry view of ICT roles and skills: needs in Canterbury. In S. Mann & M. Verhaart (Eds.). Proceedings of the 1st Annual Conference of Computing and Information Technology Education and Research in New Zealand (incorporating 23rd Annual NACCQ) 1(1) 17-25). Dunedin, New Zealand: Available: http://tekete.ara.ac.nz/items/04a7a423-79c4-44f1-a231-343bc4250f2d/1/ (Accessed 13 June 2015).

Zachman, J.A. 1987. A framework for information systems architecture. *IBM systems journal* 26(3):276–292.

Zhang, Q., Cheng, L. and Boutaba, R. 2010. Cloud computing: State-of-the-art and research challenges. *Journal of Internet Services and Applications*, 1(1):7-18.

Zissis, D., ed. 2014. Design, Development, and Use of Secure Electronic Voting Systems. IGI Global.

Zukerman, T.D., 1925. The Voting Machine: Report on the History, Use, and Advantages of Mechanical Means for Casting and Counting Ballots. Available: http://home.heinonline.org/titles/New-York-Legal-Research-Library/Voting-Machine-Report-on-the-History-Use-and-Advantages-of-Mechanical-Means-for-Casting-and-Counting-Ballots/?letter=V (Accessed 13 July 2017).

Zulu, B. 2011. *Bantu Watch helps Zambia turn ICT into a mass vote monitoring tool*. Available: http://bantuwatch.blogspot.co.za/2011/09/bantu-watch-helps-zambia-turn-ict-into.html (Accessed 23 November 2015).

Zuppo, C.M. 2012. Defining ICT in a boundaryless world: The development of a working hierarchy. *International Journal of Managing Information Technology*, 4(3):13. Washington, DC.

APPENDIX A: **VOTERS' IBT USE QUESTIONNAIRE**

RESEARCH TITLE

The Use of Internet-Based Technologies for Electoral Management Processes in South Africa

RESEARCH QUESTIONNAIRE

BIODATA SECTION

- Are you a registered voter? YES ☐ NO ☐

  If No, Why………………………………………………………………………………………………………..

  ………

  Gender: Male ☐ Female ☐ others ☐

- **Race**: Indian ☐ Coloured ☐ White ☐ African ☐
- **Age Group:** 18-35 ☐ 35-50 ☐ 50- 65 ☐ 65- 75 ☐ greater than 75 ☐

1 How long have you been involved with the South African election processes and Procedures?	
1-3 year	
3-6 years	
7-10 years	
10-15 years	
15-25 years	
not directly involved	
2. What was your role in the 2014 national and provincial elections:	
Electoral official	

Voter	
Political party representative	
Member of donor community	
Not directly involved	
Observer, researcher, media, other (Please specify) below …………………………………………………………………	

3. What was your role in the 2016 Local Government election:	
Electoral official	
Voter	
political party representative	
member of donor community	
not directly involved	
Observer, researcher, media, other (Please specify) Below.. *…………………………………………………………………*	

4. Exposure to Technology and its use	
Strongly exposed	
Basic Exposure	
Weakly Exposed	
Not Exposed	

5. Education	
No formal Education	
Matric	
Diploma	

Degree	
Post Graduate	
Master’s	
PhD	
Professor	

6. Location within Gauteng region	
City of Johannesburg Metropolitan	
City of Tshwane Metropolitan Municipality	
Ekurhuleni Metropolitan Municipality	
Sedibeng District Municipality	

SECTION TWO
Performance Assessment for the Use of Internet-based Technologies in South African Elections

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
1	Use of IBT increased public participation in elections										
2	Use of IBT reduced violence and post-election conflicts										
3	Use of IBT is perceived to be more cost-effective than the paper-based procedures										
4	Use of IBT is perceived to be more sustainable than the paper-based procedures										
5	Use of IBT enhanced transparency of the overall electioneering processes										
6	Use of IBT improved accountability of the overall electioneering processes										
7	Use of IBT promoted good governance / democracy via credible elections										
8	Use of IBT reduced election fraud										
9	Use of IBT increased public awareness and sensitization										

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
10	Use of IBT increased participation of marginalized and disadvantaged groups in elections										
11	Use of IBT improved election accuracy and expediency										
12	Use of IBT facilitated participation from diasporas										
13	Use of IBT increase voters' turnout										
14	Use of IBT enhanced free and fair election										
15	IBT is more reliable and trustworthy than paper-based procedures										
16	Use of IBT increased trust in the IEC										
17	Use of IBT reduced voting irregularities										
18	Use of IBT increased satisfaction with National and Provincial elections										
19	Use of IBT reduced time standing in queues to vote										
20	Use of IBT enhanced safety and security during elections										
21	IBT reduced IEC Impartiality										
22	IBT offered ease of voting										
23	Challenged by highly skilled IEC staff										
24	Use of IBT resolved impersonation and multiple voting										

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
25	Digital divide / technical know-how of the IEC staff is a problem to the use of IBT										
26	Use of IBT increased public confidence										
27	Use of IBT improved the integrity of election results										
28	Use of IBT increased Voter accessibility										
29	Usability of the IBT devices was not a problem during the elections										
30	The IBT used for the election are perceived as reliable										
31	Use of IBT in election is wasteful										
32	Use of IBT reduced probability of post-election violence										
33	Use of IBT improved quality of IEC's delivery of service in elections										
34	Use of IBT reduced degree of the EMB's impartiality if applicable										
35	Use of IBT reduced degree of the EMB's transparency if applicable										
36	Use of IBT improved the availability of information about constituencies and lower level districts (demarcation, sizes, seats)										

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
37	Use of IBT increased the level of compliance to the use of boundary limitation and seat allocation in place according to the rules										
38	With IBT, voters in need of voter education are well exposed to voter education which facilitates their effective participation										
39	Using IBT, the marginalized groups have been recognized and their identified needs adequately addressed										

SECTION THREE

Do you think the use of Internet-Based Technologies improves the following Electoral Management Processes?

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	Electoral Management Processes	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**
1	Vote authentication										
2	Vote and voting verification										
3	Vote Counting										
4	Vote tabulation										
5	Vote consolidate and aggregation										
6	Delivering voting results										
7	Voter registration										
8	Boundary delimitation										
9	Regulation of party / candidates										
10	Public outreach										
11	Voter identification										
12	Signing of votes										
13	Vote auditing										
14	Vote confidentiality										
15	monitor the conduct of observers										
16	monitor the conduct of party agents										
17	Nomination procedures										

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	Electoral Management Processes	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**	**2009 Elections**	**2014 Elections**
18	Voter identification at voting station										
19	Results sorting per Voting station										
20	Results counting per Voting station										
21	Results tabulation per voting station										
22	Results transmission and declarations per voting station										
23	Compilation of Voter register										
24	the actual voter registration										

APPENDIX B: **IEC, EISA AND POLITICAL PARTY'S QUESTIONNAIRE**

RESEARCH TITLE

The Use of Internet-Based Technologies for Electoral Management Processes in South Africa

RESEARCH QUESTIONNAIRE

BIODATA SECTION

Gender:		**Race:**		**Educational Background:**		**Years of Experience with EISA or IEC:**	

Age group: 18-35 ☐ 35-50 ☐ 50-65 ☐ 65-75 ☐ greater than 75 ☐

PERFORMANCE ASSESSMENT OF THE ELECTORAL MANAGEMENT PROCESSES

Legal Framework Assessment for the Use of Internet-based Technologies in South African Elections

S/N	Questions	Very Good		Good		Fair		Poor		Very Poor	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
1.	Rate the availability of a consolidated legal foundation for the use of IBT in elections										
2.	Rate the impact of IBT on the comprehensibility and availability of electoral timetable										
3.	Rate the level of implementation of electoral legislation on the use of IBT for elections										
4.	Rate the perceived legitimacy of the IBT-based electoral framework										

S/N	Questions	Very Good		Good		Fair		Poor		Very Poor	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
Electoral Management											
5	Rate the level of legitimacy/ acceptance of use of IBT by parties										
6	Rate the level of legitimacy/ acceptance of use of IBT by voters										
Constituency and Polling District Demarcation											
7	Rate the level of acceptance of the IBT-related constituency structure modality by parties										
8	Rate the level of acceptance of the IBT-related constituency structure modality by voters										
Voter Education											
9	In terms of voting age population, higher percentage of those eligible to vote for the first time in the election actually voted										

S/N	Questions	Very Good		Good		Fair		Poor		Very Poor	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
Voter Registration											
10	The criteria for registration are fair and reasonable and compliant with accepted international standards										
11	There are appropriate mechanisms for ensuring that the public can have confidence in the IBT-assisted based register										
12	There are appropriate mechanisms for ensuring that the information in the IBT-assisted register is accurate										
13	Qualified people were able to register with a minimum of inconvenience										
14	The IBT-assisted register is free from serious bias based on gender, age, ethnic or religious affiliation, or region										
Access to Ballot Paper											
15	The IBT-assisted method of voting is non-discriminatory										
16	P and candidates who fulfil the requirements of registration are satisfied with the IBT-assisted registration without bias										

S/N	Questions	Very Good		Good		Fair		Poor		Very Poor	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
Campaign Regulation											
17	There is a system for allocation of public funds to political parties in place and implemented										
18	There is an independent IBT-assisted mechanism for identifying bias in the state media and subjecting the identified bias to swift correction										
Polling											
19	There is a low level of serious election related Violence as a result of IBT-related challenges (failure, non-availability, connection problems, verification bottlenecks)										
20	IBT has assisted to preclude and/or rectify fraudulent voting										
21	IBT has make polling more accessible, secure, and secret										
22	Election observers are satisfied with the approach of the use of IBT during election										
23	IBT-enabled systems are in place to preclude vote buying										

S/N	Questions	Very Good		Good		Fair		Poor		Very Poor	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
24	IBT allows the voters to express their free will without intimidation										
Counting and Tabulating the Vote											
25	The use of IBT has helped to conduct vote count with integrity and accuracy										
26	The use of IBT has make the tabulation transparent and an accurate reflection of the polling booth count										
27	The use of IBT made results more easily and quickly available to interested members of the general public										
28	The use of the IBT makes vote counting take place with no undue delay										
29	Parties and candidates strong have confidence in the IBT integrated into the election management processes										
Resolving Election Related Complaints, Verification and Certification of Final Results											
30	Use of IBT helps manage serious election complaints more effectively for adjudication										
31	There is an appropriate IBT-enhanced dispute resolution mechanism in place										

S/N	Questions	Very Good		Good		Fair		Poor		Very Poor	
		2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections	2009 Elections	2014 Elections
32	The use of IBT in election helps manage court disputes more efficiently and effectively										
33	Election observation organizations confirm that the use of IBT for the elections were without serious problems										
34	The use of IBT allows the IEC to meet the timeframe for the constitution of parliament										
Post-election Procedures											
35	The use of IBT make election statistics more properly documented and more easily available without serious delay										
36	The Use of IBT makes the auditing of EMBs more easier and transparent										
37	The use of IBT increases the capacity for election review										

APPENDIX C: **SELECTED INTERVIEW QUESTIONS FOR IEC MEMBERS OF STAFF**

1. What kind and type of technologies does the IEC South Africa currently employ?
2. Who owns the IBTs, who developed and produced?
3. What is the scope of IBTs used in the election?
4. What were the reasons for the use and adoption of IBTs?
5. What are the biggest challenges that affect voter register credibility?
6. What is the biggest challenge that affect voter confidence, and
7. What is the biggest challenge that can affect the outcome of elections results during election and post elections?
8. Can these challenges be resolved through use of technologies? If yes how?
9. Is the IEC South Africa currently using technologies to address these challenges? And if so, which aspects of the election process and what technologies are being used?
10. If you are not yet using new technologies, when do you expect to implement the new technologies?
11. Do you have a training and management plan to implement the new technologies?
12. Do you have any new technologies enhancement that you will use before the 2019 elections? If Yes CAN you explain them?
13. What is the estimated cost of implementing the new technologies, including equipment, staff training, and raising public awareness about the new technologies?
14. What are estimated funding sources to implement the new technologies?
15. How will the IEC South Africa educate voters about the new technologies?
    If relevant, what cultural, socio political, policy direction and IEC South Africa priorities, are barriers to the adoption of new technologies?
16. Do you think that IEC needs to adopt a standardise framework model in order to make us of effective and efficient use of technology, if there is a need for framework, what kind of model do you think IEC needs and can you explain what it should be covered?

APPENDIX D: **INTERVIEW QUESTIONS FOR OTHER ELECTORAL STAKEHOLDERS**

1. What were the problems or challenges that the technology intends to address?
2. To what extent are voters familiar with new information technologies in general, such as automated banking machines, smart phones, computers and the Internet
3. What are the views of political parties regarding the introduction and use of IBTs?
4. Did any political parties oppose introduction of IBTs?
5. What extent is there public confidence in IBTs?
6. To what extent are political parties and candidates familiar with IBTs?
7. What are the views of domestic observer and media organizations?
8. What are the views of information technology experts and academics?
9. What is the extent of public discussion regarding IBTs issues?
10. What facilities have been incorporated to increase access for voters with disabilities?
11. Has the IEC- South Africa made efforts to facilitate observer access?
12. How is the use of IBTs defined and regulated by law?
13. Are the laws and/or regulations regulating the election sufficiently detailed so as to provide clear guidance on all IBTs issues?
14. Has the use of IBTs been previously challenged in court?
15. Does the legislation provide a means for full verification that the results represent the authentic choices of the voters?
16. Does the law establish what happens in the event that IBTs fail to function properly?
17. In what ways does the law provide for observer or ICT auditors access to IBTs?
18. Are observers legally entitled to obtain the source code of any IBT system working for elections, as well as certification and auditing reports?
19. Do the legal provisions for complaints and appeals allow for effective review of IBT-related complaints?

20. Who is entitled to file a complaint regarding the use of IBTs? What can be considered as evidence, does the legal framework provide enforceable sanctions for attacks on the IBT system, does the legal framework provide adequate time frames for key decisions related to IBTs, including procurement and testing?
21. Do you think that IEC needs to adopt a standardise framework model in order to make us of effective and efficient use of technology, if there is a need for framework, what kind of model do you think IEC needs and can you explain what it should be covered?

Appendix E: **VOTERS CORRELATION TABLE – A CROSS SECTION**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1		*reg_voters*	*gender*	*race*	*age_group*	*SAPPI*	*voters_role*	*techexposure*	*education*	*Gauteng region_other*	*IBTPP*	*IBTVio*	*IBTcost*	*IBTSustain*	*IBTTrasnsp*	*IBTIAE*	*IBTGovern*	*IBTReducFraud*	*IBTPubAwa*	*IBTPartM*
2	reg_voters	1																		
3	gender	0,066929542	1																	
4	race	0,027079667	-0,05859016	1																
5	age_group	-0,24698778	0,032228457	-0,10856415	1															
6	SAPPI	0,511478703	0,031256439	-0,11181222	0,174051167	1														
7	voters_role	0,713920807	0,237025394	-0,1328747	-0,03476326	0,581617153	1													
8	techexposure	-0,0588101	0,232095525	0,048871721	0,54925783	0,097102382	0,093398104	1												
9	education	-0,02976747	-0,07703496	-0,10575421	0,056333264	-0,11958614	-0,04996481	-0,309926339	1											
10	Gauteng region_c	0,20196078	-0,17156377	0,296591633	-0,03697323	0,358393154	0,102044815	0,055267916	-0,2911086	1										
11	IBTPP	-0,36485656	-0,11566199	0,140272029	0,123679612	-0,29616866	-0,44875959	-0,185775135	0,219618217	-0,067352482	1									
12	IBTVio	-0,31458172	-0,14092034	0,212867599	-0,0424227	-0,23175718	-0,36743585	-0,303293179	0,225535269	0,009182872	0,86554	1								
13	IBTcost	0,113006172	-0,36103645	-0,07619372	-0,18387773	0,107096951	-0,05867105	-0,37017593	0,333686448	0,136076159	0,59854	0,6336	1							
14	IBTSustain	0,119969422	-0,27518194	-0,03858594	-0,30185938	0,079194639	-0,00805015	-0,434534971	0,311854508	0,158536704	0,5316	0,65537	0,89845	1						
15	IBTTrasnsp	0,050294825	-0,17563513	0,021279287	-0,03434079	0,080432852	-0,08154217	-0,276259065	0,392938476	0,257587115	0,66154	0,66016	0,77341	0,77530367	1					
16	IBTIAE	0,073829172	-0,19156548	0,230273861	0,06132263	0,093511716	-0,09496198	-0,188126588	0,297857686	0,336562475	0,67253	0,65372	0,72829	0,67385233	0,84616523	1				
17	IBTGovern	0,037476513	-0,19608246	0,147711266	-0,10727797	0,016030864	-0,11262039	-0,368462623	0,47789921	0,277823256	0,6145	0,69628	0,71266	0,72767683	0,87649649	0,81001	1			
18	IBTReducFraud	-0,23977668	-0,13598922	0,086992954	0,126346202	-0,12603013	-0,32228046	-0,224395342	0,384034453	0,082155085	0,71503	0,66222	0,56773	0,58583439	0,69455059	0,68977	0,72956	1		
19	IBTPubAwa	0,082744988	-0,20364717	0,05872961	-0,06992791	0,030405099	-0,11899043	-0,368620073	0,429996314	0,160318839	0,65531	0,65575	0,69911	0,6709913	0,80746912	0,77599	0,87353216	0,691114548	1	
20	IBTPartMarg	-0,0186049	-0,24688765	0,174743644	0,072448885	-0,04017917	-0,2927766	-0,264516251	0,459220914	0,148438472	0,64101	0,62886	0,63481	0,62562545	0,73583897	0,74457	0,7980963	0,775849144	0,83538954	
21	IBTAccExped	-0,28241941	-0,07653034	0,132838098	0,124239622	-0,16963417	-0,42593736	-0,186000706	0,335948086	0,071909256	0,76118	0,72924	0,50374	0,52301856	0,63966558	0,64893	0,7110295	0,696786503	0,73595032	0,76080
22	IBTFacilitate	-0,18252415	-0,12576774	0,172262526	0,069846751	-0,19963128	-0,30530805	-0,116086285	0,109499147	-0,004902379	0,53666	0,54531	0,3139	0,29038524	0,26717309	0,39178	0,34580475	0,331507351	0,37015076	0,455150
23	IBTTumout	-0,3128779	-0,20518061	0,234457357	-0,03985829	-0,18281708	-0,44828649	-0,218741823	0,002771753	0,101441166	0,72292	0,74768	0,55254	0,52443214	0,49805182	0,51333	0,52847885	0,554542699	0,54416832	0,622952
24	IBTFFElec	-0,38160921	-0,19371699	0,052728751	-0,04987883	-0,27552887	-0,47915914	-0,305953505	0,206224603	-0,078164798	0,75154	0,74699	0,53836	0,55787491	0,5075156	0,50213	0,57234141	0,694358308	0,63853784	0,668576
25	IBTRTP	-0,30823287	-0,05282266	0,060442537	0,080115175	-0,1312306	-0,39543183	-0,190321345	0,186215996	0,114763435	0,74557	0,72634	0,50601	0,51498539	0,60723392	0,57178	0,64978029	0,704489432	0,71680709	0,718058
26	IBTTrust_IEC	-0,26462401	-0,10974772	0,122625566	0,047737537	-0,26385152	-0,37340851	-0,22467301	0,157651132	0,008838166	0,78059	0,78683	0,52988	0,55524648	0,57168378	0,56639	0,57640525	0,664801288	0,63863462	0,67046
27	IBTRI	-0,37619906	-0,13185356	0,115046959	0,084082998	-0,18334897	-0,49454726	-0,211754923	0,229422082	0,077745653	0,71003	0,69515	0,43644	0,46453976	0,54108066	0,50785	0,61638946	0,680392363	0,65307068	0,746203
28	IBTSatis_NP	-0,3518443	-0,051707	0,064916932	0,121638111	-0,17229856	-0,43994022	-0,161910281	0,268423967	0,033895004	0,79023	0,70346	0,52448	0,46915005	0,64899609	0,62604	0,63153659	0,648238586	0,69086493	0,71337
29	IBTTimeReduc	-0,23493363	-0,19236748	0,094868557	0,05119825	-0,14383569	-0,34919401	-0,229645674	0,088466026	0,141590593	0,79092	0,76758	0,64723	0,61040402	0,69770238	0,66842	0,60874684	0,594984258	0,66209915	0,640147
30	IBTSS	-0,20776687	-0,18771113	0,214643026	-0,05352541	-0,24852078	-0,32051588	-0,268483906	0,017580963	0,131641084	0,74909	0,77721	0,57575	0,56310703	0,59265871	0,62576	0,54131229	0,522232703	0,58081005	0,550639
31	IBTReducImp	-0,12657023	-0,23757237	0,021897904	0,00854328	-0,02576522	-0,19672758	-0,170012023	0,056038325	0,015582113	0,56976	0,5803	0,51272	0,51691948	0,38824066	0,46962	0,40366808	0,438962075	0,50370614	0,50209
32	IBTEasyVote	-0,11646478	-0,21715432	0,137442239	0,110938202	-0,0037679	-0,11304751	-0,005958952	-0,06203698	0,26363129	0,54031	0,56621	0,42295	0,37859231	0,44864464	0,49576	0,45800854	0,361232545	0,50339203	0,405352
33	IECMembers	-0,10504227	-0,17728613	0,047377039	0,006555535	-0,10069549	-0,15089652	-0,183274213	0,113410838	0,018177133	0,57199	0,62502	0,51859	0,57991497	0,43313666	0,47703	0,44420612	0,455095813	0,43454749	0,519461
34	IBTImperson	-0,13466162	-0,21775426	0,201980095	-0,08298781	-0,11192842	-0,2022479	-0,15427921	-0,03930486	0,121526399	0,7019	0,76467	0,58714	0,59918592	0,53906123	0,604	0,53719746	0,479258225	0,60736992	0,506514
35	IBTIECStaffPr	-0,20373427	-0,07301619	0,165475454	0,027275252	-0,14868986	-0,30617336	-0,205898751	0,1212154	0,120200302	0,7177	0,75726	0,60686	0,61858595	0,59272457	0,61905	0,57658697	0,541142094	0,52290481	0,62879
36	IBTPC	-0,27790206	-0,12903585	0,102366789	-0,04884111	-0,23295628	-0,33343902	-0,172818094	0,104213762	0,161003998	0,71641	0,78288	0,54443	0,59928936	0,58880476	0,50952	0,61694007	0,569051996	0,59888632	0,613311
37	IBTVotAcc	-0,30425653	-0,20867679	0,064183063	-0,05936004	-0,18135379	-0,39360878	-0,22829145	0,131585866	0,105806995	0,75671	0,73711	0,57387	0,57898063	0,61661768	0,5154	0,60420554	0,591452084	0,63400994	0,612122

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
32	IBTEasyVote	-0,1164648	-0,2171543	0,1374422	0,1109382	-0,0037679	-0,1130475	-0,005959	-0,062037	0,26363129	0,5403	0,5662	0,4229	0,3785923	0,4486446	0,4958	0,4580085	0,361232545	0,503392	0,4053527	0,4842554	0,3655396	0,4993484	0,4848765	0,4757	0,603295	0,4243
33	IECMembers	-0,1050423	-0,1772861	0,047377	0,0065555	-0,1006955	-0,1508965	-0,1832742	0,1134108	0,018177133	0,572	0,625	0,5186	0,579915	0,4331367	0,477	0,4442061	0,455095813	0,4345475	0,5194615	0,555724	0,5078782	0,5720792	0,5953253	0,5068	0,735275	0,4904
34	IBTImperson	-0,1346616	-0,2177543	0,2019801	-0,0829878	-0,1119284	-0,2022479	-0,1542792	-0,0393049	0,121526399	0,7019	0,7647	0,5871	0,5991859	0,5390612	0,604	0,5371975	0,479258225	0,6073699	0,5065149	0,6245062	0,4910365	0,7002997	0,6741961	0,6369	0,8018738	0,5836
35	IBTIECStaffPr	-0,2037343	-0,0730162	0,1654755	0,0272753	-0,1486899	-0,3061734	-0,2058988	0,1212154	0,120200302	0,7177	0,7573	0,6069	0,618586	0,5927246	0,619	0,576587	0,541142094	0,5229048	0,628794	0,7232199	0,5835142	0,766225	0,6937312	0,6822	0,8138036	0,6538
36	IBTPC	-0,2779021	-0,1290358	0,1023668	-0,0488411	-0,2329563	-0,333439	-0,1728181	0,1042138	0,161003998	0,7164	0,7829	0,5444	0,5992894	0,5888048	0,5095	0,6169401	0,569051996	0,5988863	0,613312	0,740932	0,541001	0,8009124	0,7803324	0,8194	0,8144057	0,7943
37	IBTVotAcc	-0,3042565	-0,2086768	0,0641831	-0,05936	-0,1813538	-0,3936088	-0,2282914	0,1315859	0,105806995	0,7567	0,7371	0,5739	0,5789806	0,6166177	0,5154	0,6042055	0,591452084	0,6340099	0,6121227	0,7398017	0,4920229	0,8050415	0,7957633	0,8216	0,7552985	0,8486
38	IBTProblem	-0,2666503	-0,2222716	-0,0175886	-0,0872129	-0,1023345	-0,3509307	-0,2207214	0,1460296	0,011145823	0,6924	0,6325	0,6397	0,5661477	0,5012047	0,4732	0,5002388	0,530836611	0,5493349	0,5776656	0,6427934	0,4666431	0,7966534	0,7956003	0,7452	0,6699174	0,7515
39	IBTRelibility	-0,2602869	-0,0974779	0,1831653	-0,1539665	-0,1517295	-0,3156789	-0,2145441	0,0581543	0,076662032	0,6548	0,6378	0,498	0,4562328	0,4374279	0,505	0,5158116	0,507864227	0,5619455	0,5102733	0,6664698	0,4838687	0,743349	0,8085061	0,6925	0,6418412	0,7423
40	IBTWasteful	-0,1193272	0,021565	0,2243363	0,1883371	0,0597368	-0,1892175	-0,0679547	0,0932894	0,096812704	0,4764	0,5205	0,2925	0,3344309	0,3158289	0,4254	0,3636735	0,392052372	0,3635362	0,5524238	0,5602857	0,503099	0,4928534	0,4991528	0,5031	0,5812331	0,5201
41	IBTRPPEV	-0,1754057	-0,0538449	0,0781765	0,090608	-0,000287	-0,2334733	-0,1270701	0,0921939	0,175005607	0,5953	0,6486	0,524	0,5526285	0,4986426	0,5742	0,5140402	0,547802052	0,5662928	0,597107	0,7186693	0,4285932	0,6672635	0,6211109	0,7361	0,6934993	0,6678
42	IBTIDS	-0,2873759	-0,007658	0,0213573	0,1835921	-0,0658885	-0,3415103	-0,1348631	0,2216528	0,105471478	0,7071	0,6984	0,555	0,5221576	0,5829499	0,6259	0,5800885	0,634132074	0,6280722	0,7072085	0,7598748	0,4818933	0,6876414	0,7315016	0,8331	0,7536138	0,7388
43	IBT_EMB_IMP	-0,2093385	-0,0617871	-0,0532466	0,0427265	0,0449635	-0,2685432	-0,1353005	0,1301823	0,175976147	0,6031	0,5643	0,6506	0,5668893	0,5541918	0,5616	0,5142995	0,576873043	0,5954853	0,5604014	0,6418838	0,3133524	0,6347859	0,6340538	0,7394	0,6422128	0,6565
44	IBT_EMB_TRN	-0,2944817	-0,1307704	-0,0033577	0,0129746	-0,1349011	-0,3896566	-0,1983589	0,2225089	0,043257987	0,695	0,6654	0,5746	0,5547752	0,5435208	0,436	0,5425975	0,612630275	0,5952045	0,6498406	0,713589	0,4799961	0,755735	0,7873421	0,8438	0,7615945	0,8285
45	IBTAIC	-0,2682923	-0,1358183	-0,066088	0,1007465	-0,1488063	-0,2806887	-0,1183668	0,1731295	0,1347695	0,6866	0,5935	0,5861	0,4928204	0,6323461	0,5391	0,5496748	0,558887927	0,5855215	0,5447292	0,611223	0,3330299	0,5567277	0,6105832	0,6507	0,6341871	0,5477
46	IBTLC	-0,3223721	-0,1288792	-0,1343569	0,0488857	-0,1239274	-0,3434327	-0,1996961	0,2353415	0,042761267	0,7001	0,5919	0,568	0,5215134	0,5761917	0,4972	0,5330062	0,619115209	0,6129086	0,5994262	0,7127841	0,3916116	0,5993909	0,7438934	0,7577	0,6168419	0,7314
47	IBTVEduInfo	-0,290729	-0,1161264	-0,0850272	0,0662937	-0,0648844	-0,332795	-0,1548367	0,2597576	-0,036492758	0,6499	0,6114	0,5546	0,5322644	0,5688449	0,4516	0,5125954	0,593068007	0,5649686	0,5995749	0,6550787	0,3890312	0,5488608	0,7392676	0,6974	0,645583	0,6462
48	IBTMagGrId	-0,3403194	-0,1187279	-0,0665603	0,1582273	-0,1022449	-0,4139492	-0,0770665	0,2394159	0,017511867	0,6901	0,6358	0,5337	0,472894	0,5690614	0,4577	0,5220102	0,575215476	0,5746365	0,6426483	0,6673478	0,4510068	0,6141442	0,7532356	0,7395	0,6822364	0,711
49	VA	-0,3562435	0,066782	0,0243005	0,0222202	-0,2045995	-0,413718	-0,2506987	0,3456766	0,026833756	0,6845	0,6675	0,4471	0,4723642	0,6195068	0,4637	0,6352247	0,60611131	0,6074153	0,6349525	0,752324	0,4071517	0,6320996	0,7320836	0,7928	0,657747	0,7787
50	VVV	-0,2138213	0,0544601	0,1095879	0,0864419	-0,137471	-0,2747997	-0,1169524	0,1013657	0,130055854	0,3979	0,4057	0,2035	0,2096434	0,2914529	0,2817	0,3314354	0,322932235	0,3233214	0,3826235	0,447713	0,3261326	0,4002262	0,4201268	0,4514	0,3924347	0,4775
51	VC	-0,1949626	-0,0358964	0,1846095	0,148073	-0,1737482	-0,3030682	-0,121082	-0,0310525	0,17976667	0,6209	0,6009	0,3466	0,3216612	0,4251816	0,5011	0,449864	0,459795638	0,467624	0,5463419	0,6412379	0,5051371	0,6772847	0,5883161	0,6579	0,6291649	0,6602
52	VT	-0,170172	-0,0953867	0,1484903	-0,0042679	-0,2499631	-0,2389776	-0,2295826	-0,0416074	0,144437802	0,6632	0,6537	0,4666	0,4391219	0,4745542	0,5279	0,4771484	0,44649942	0,5074575	0,4799327	0,5898153	0,4800279	0,6825446	0,6180465	0,642	0,6912063	0,5966
53	VCA	-0,3386425	-0,0416458	0,1158685	-0,0522984	-0,2363335	-0,3890997	-0,1807179	0,1256918	0,085152424	0,7147	0,6448	0,463	0,4635796	0,5868289	0,4951	0,5629444	0,584409492	0,6049174	0,573203	0,6912963	0,3758959	0,7217462	0,7621485	0,8141	0,7148041	0,7611
54	DVR	-0,2826467	-0,0042198	0,1042575	0,0076503	-0,2229722	-0,3580944	-0,1706003	0,0171138	0,071758083	0,6323	0,5918	0,4385	0,4325539	0,4676837	0,4379	0,4315575	0,521550385	0,476308	0,5672234	0,5935286	0,3998443	0,7540109	0,6767551	0,7448	0,6781942	0,7106
55	VR	-0,3389551	-0,072234	0,1093958	0,0439079	-0,3095125	-0,4343742	-0,163047	0,1408836	-0,032593622	0,7524	0,6703	0,4017	0,378451	0,4819342	0,4782	0,5018043	0,632708394	0,6023592	0,634734	0,7417318	0,5041912	0,7706607	0,8235119	0,8296	0,7497588	0,8208
56	BD2	-0,3372899	-0,0289905	0,0510869	-0,0056283	-0,2545432	-0,4255822	-0,1971887	0,2034674	-0,019024711	0,7595	0,7042	0,4951	0,4550797	0,5992223	0,5165	0,5848628	0,608183288	0,6552667	0,6305713	0,7286486	0,4325791	0,7312926	0,8251471	0,8293	0,7386479	0,7809
57	RoP	-0,3356824	-0,0015269	0,1425815	0,1470581	-0,2414814	-0,4398283	-0,0639226	0,1938143	0,051123548	0,7535	0,6566	0,4073	0,3386543	0,5661858	0,53	0,560954	0,636304537	0,6132706	0,6667665	0,7518603	0,4761993	0,7534372	0,7399244	0,824	0,7217788	0,7955
58	PO	-0,3386309	0,0467432	0,0751041	0,0544427	-0,2210194	-0,4253012	-0,1455156	0,2354255	-0,002252013	0,7359	0,652	0,4724	0,3902587	0,5980727	0,5249	0,6025723	0,60093429	0,6520385	0,6503383	0,7343032	0,4314828	0,7013336	0,7655665	0,8047	0,6804897	0,7611
59	VI	-0,322631	-0,003073	0,1666674	0,1320437	-0,2950868	-0,4005766	-0,1077883	0,159167	0,033283266	0,7664	0,6773	0,3732	0,3391902	0,547515	0,5386	0,5424469	0,662653958	0,6138785	0,6456271	0,7476359	0,4724387	0,7189373	0,7295502	0,8173	0,765169	0,7815
60	SV	-0,2521225	0,0111379	0,1822067	-0,0196717	-0,3027381	-0,3472651	-0,2456292	0,1265744	-0,012199598	0,737	0,7148	0,4498	0,4558164	0,5622385	0,52	0,5349347	0,631439513	0,5761673	0,6030121	0,6849579	0,4541183	0,7149028	0,7237757	0,7292	0,7768108	0,6957
61	VA	-0,30847	-0,0475146	0,0163569	0,055162	-0,2377239	-0,3729349	-0,1601913	0,2061863	0,004615346	0,7447	0,6367	0,4539	0,3999242	0,564947	0,5435	0,5553415	0,674832104	0,666626	0,5941796	0,7540281	0,3952837	0,6203059	0,7734212	0,7786	0,6995594	0,7417
62	VC	-0,244421	-0,1637811	0,0731557	-0,1049239	-0,3262381	-0,3822092	-0,293508	0,1240225	-0,062076742	0,741	0,6904	0,5193	0,4735843	0,4731981	0,4441	0,4649549	0,557408481	0,57061	0,542008	0,6362848	0,4803918	0,7361869	0,7722633	0,7182	0,7443229	0,7256
63	MCO	-0,2888327	-0,0407099	0,2409452	9,062E-05	-0,2332848	-0,3882358	-0,1651222	0,0079499	0,16706677	0,6759	0,6662	0,4377	0,4236896	0,4741304	0,5088	0,4784995	0,531102089	0,4857389	0,5531816	0,6409331	0,511153	0,8063179	0,7363478	0,7769	0,722375	0,7397
64	MCPA	-0,286133	-0,1054278	0,2419104	0,0668842	-0,2719856	-0,4035538	-0,1319502	0,0242021	0,144961749	0,7401	0,7026	0,45	0,3828951	0,5047991	0,5439	0,4893224	0,506013547	0,5266825	0,5516701	0,6139394	0,5369894	0,7915338	0,7028394	0,7525	0,7724656	0,7095
65	NP	-0,1297332	0,0165659	0,0990332	0,1254278	-0,1545463	-0,2315812	-0,1396061	-0,0284128	0,070569322	0,5522	0,5311	0,391	0,3406426	0,3904542	0,4424	0,3722306	0,404806656	0,4029866	0,4089265	0,4879622	0,3880656	0,6043394	0,5421843	0,5769	0,5791511	0,5342
66	VIVS	-0,2799846	-0,1145975	0,2226165	0,0672702	-0,2743201	-0,3765895	-0,1496265	0,0509144	0,165422295	0,7241	0,7046	0,4465	0,3956511	0,5025877	0,5499	0,5009386	0,471978596	0,5143157	0,529571	0,6384676	0,5690496	0,75592	0,6977731	0,7362	0,7602876	0,6943
67	RSVS	-0,269816	-0,0778347	0,1910672	0,0445224	-0,2151719	-0,3462104	-0,171369	0,05615	0,204321836	0,6963	0,6881	0,4965	0,4625711	0,5349774	0,5847	0,5233343	0,499819186	0,5179375	0,5299444	0,6452025	0,5174183	0,7506165	0,6889751	0,7505	0,7292841	0,6954
68	RC2	-0,2865228	-0,1298663	0,1964633	0,0767912	-0,2753984	-0,3705576	-0,1422129	0,0547492	0,146504757	0,7202	0,6995	0,4543	0,3941862	0,4956375	0,5511	0,499228	0,478355116	0,5143708	0,531472	0,6208956	0,5626514	0,7527299	0,6976497	0,7312	0,7505934	0,6868
69	RTVS	-0,304021	-0,0895009	0,1532098	0,00907	-0,2616285	-0,3612422	-0,1974217	0,0063448	0,128722487	0,7043	0,6682	0,4699	0,4284688	0,4951744	0,5485	0,4659288	0,526095353	0,519542	0,5013954	0,6114225	0,4701306	0,7281949	0,6818783	0,7262	0,7326957	0,6734
70	RTD	-0,3114062	-0,0876662	0,2330735	0,0538128	-0,3016762	-0,4016607	-0,1175507	0,0054112	0,106826578	0,7241	0,6633	0,4067	0,3381356	0,4782319	0,4921	0,4479633	0,513591623	0,5065776	0,5233022	0,5712897	0,4757405	0,7681866	0,6820039	0,7347	0,7546107	0,69
71	CVR	-0,3091148	-0,0473794	0,204115	0,0184864	-0,2407272	-0,3737747	-0,1456144	-0,0224972	0,147178532	0,684	0,6348	0,4237	0,3892621	0,4932914	0,4952	0,4485524	0,525845023	0,4941162	0,5089622	0,5751855	0,4135823	0,7514355	0,6671717	0,7441	0,7228899	0,6891
72	AVR	-0,2962068	-0,0820431	0,2423479	0,0573817	-0,2920644	-0,3861601	-0,117118	0,0084693	0,113918624	0,727	0,6606	0,4049	0,3508183	0,4887544	0,4938	0,4523381	0,518569426	0,5144793	0,5238287	0,5773577	0,4704211	0,761825	0,6851392	0,7421	0,7575241	0,6998
73	IBTIntegrity	-0,2830024	-0,1383769	0,086033	-0,0974006	-0,2864729	-0,3548747	-0,2424035	0,046917	0,071119229	0,7338	0,7382	0,5856	0,6148557	0,532722	0,5116	0,4905497	0,577432558	0,5218138	0,5566687	0,6604485	0,4983661	0,8100638	0,7718758	0,7399	0,7831266	0,7294

Appendix F: **COEFFICIENT TABLE – VOTERS REGRESSION MODEL**

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.183	.100		-1.828	.069
	reg_voters	.185	.066	.064	2.802	.005
	SAPPI	-.004	.011	-.007	-.362	.717
	voters_role	-.032	.013	-.044	-2.471	.014
	IBTPP	.071	.041	.068	1.722	.086
	IBTVio	.182	.036	.185	5.100	.000
	IBTcost	-.233	.049	-.251	-4.724	.000
	IBTustain	.012	.048	.012	.246	.806
	IBTTrasnsp	-.076	.052	-.079	-1.462	.145
	IBTIAE	.310	.058	.321	5.333	.000
	IBTGovern	-.440	.043	-.484	-10.270	.000
	IBTReducFraud	.187	.032	.193	5.878	.000
	IBTPubAwa	.070	.043	.077	1.604	.110
	IBTPartMarg	.198	.053	.215	3.753	.000
	IBTAccExped	-.038	.039	-.037	-.957	.339
	IBTFacilitate	.000	.008	.000	.035	.972
	IBTTumout	.143	.047	.142	3.065	.002
	IBTFFElec	-.400	.050	-.404	-8.048	.000
	IBTRTP	-.331	.061	-.297	-5.426	.000
	IBTTrust_IEC	.587	.068	.563	8.637	.000
	IBTRI	.201	.077	.190	2.624	.009
	IBTatis_NP	-.362	.063	-.359	-5.792	.000
	IBTTimeReduc	.117	.061	.114	1.917	.056
	IBTS	-.049	.067	-.053	-.729	.467
	IBTReducImp	-.056	.068	-.052	-.815	.416
	IBTEasyVote	.159	.033	.148	4.826	.000
	IECMembers	-.074	.070	-.074	-1.058	.291
	IBTImperson	-.288	.051	-.275	-5.696	.000
	IBTIECStaffPr	-.170	.044	-.168	-3.854	.000
	IBTPC	.689	.077	.640	8.894	.000
	IBTVotAcc	-.168	.075	-.155	-2.243	.026
	IBTProblem	.603	.074	.592	8.189	.000
	IBTRelibility	.023	.073	.024	.318	.751
	IBTWasteful	-.235	.035	-.237	-6.616	.000
	IBTRPPEV	.136	.046	.123	2.977	.003

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	IBTIDS	-.168	.062	-.161	-2.733	.007
	IBT_EMB_IMP	-.084	.049	-.087	-1.714	.088
	IBT_EMB_TRN	-.117	.062	-.109	-1.889	.060
	IBTAIC	.199	.038	.205	5.228	.000
	IBTLC	-.139	.048	-.133	-2.865	.004
	IBTVEduInfo	.370	.093	.362	3.962	.000
	IBTMagGrId	-.140	.072	-.133	-1.947	.052
	VAdata	-.002	.048	-.003	-.050	.960
	VVVdata	-.012	.009	-.019	-1.464	.144
	VCdata	-.045	.039	-.049	-1.153	.250
	VTdata	.117	.036	.130	3.259	.001
	VCAdata	.160	.041	.166	3.884	.000
	DVRdata	.176	.044	.194	4.037	.000
	VRdata	-.129	.085	-.137	-1.522	.129
	BD2data	.057	.085	.061	.675	.500
	RoPdata	.020	.058	.021	.336	.737
	POdata	.393	.101	.426	3.871	.000
	VIdata	-.215	.092	-.232	-2.346	.020
	SVdata	.017	.048	.020	.361	.719
	VAudting	-.368	.056	-.412	-6.611	.000
	VCCdata	.122	.041	.143	2.969	.003
	MCOdata	.625	.103	.628	6.080	.000
	MCPAdata	-.751	.094	-.796	-7.960	.000
	NPdata	-.010	.010	-.012	-.920	.358
	VIVSdata	.155	.077	.165	2.002	.046
	RSVSdata	-.079	.113	-.081	-.697	.486
	RC2data	-.127	.086	-.136	-1.470	.143
	RTVSdata	1.453	.131	1.471	11.110	.000
	RTDdata	-1.360	.130	-1.459	-10.455	.000
	CVRdata	-1.376	.180	-1.417	-7.623	.000
	AVRdata	1.529	.143	1.666	10.676	.000

a. Dependent Variable: IBTIntegrity

Appendix G: **IEC CORRELATION TABLE – CROSS SECTION**

gender	1															
race	-0,435	1														
edu_background	-0,3769	0,5916	1													
experience_EISA	0,5856	-0,4558	-0,155551048	1												
age_group	0,4125	0,0083	-0,035216671	0,082792351	1											
avail_cons_leg_foundation	-0,1789	0,0222	0,023455402	-0,264682987	0,1235934	1										
IBTCA	0,1572	-0,0684	0,048098607	0,045230814	0,1126425	0,675211036	1									
implementation_level	-0,0894	0,0082	-0,002159691	-0,284329289	0,0328757	0,92974803	0,6286	1								
IBTLBE	0,0403	-0,149	0,143273062	-0,121692211	0,0920008	0,389279139	0,6504	0,488533071	1							
IBTLeg_parties	0,1679	0,1461	0,231134228	-1,28699E-17	0,0451079	0,120173174	0,4929	0,287693244	0,7577	1						
IBTLeg_voters	0,189	0,1644	0,260132991	0,195698422	-0,0507673	0,135250445	0,6472	0,224160967	0,6396	0,888523317	1					
IBT_Constituency_struc_par	0,1217	0,1636	0,299388259	-0,038174613	-0,0118837	0,126638938	0,5032	0,294426858	0,7736	0,987940989	0,8778086	1				
IBT_Constituency_struc_vot	0,0304	0,1851	0,334670208	-0,104905366	0,0489854	0,058001479	0,342	0,208282345	0,7543	0,952596985	0,75047877	0,9599318	1			
voting_age_population_first	0,2245	0,1687	0,271553318	0,088056013	0,0191882	-0,094936889	0,3295	0,119690706	0,6504	0,959514992	0,8639188	0,944784376	0,903062715	1		
criteria_rag_accepted_inter	0,1823	0,1851	0,334670208	0,052452683	-0,032657	-0,087002219	0,342	0,12817375	0,6686	0,952596985	0,85769003	0,9599318	0,913793103	0,989895669	1	
appropriate_mech_public_reg	-0,1703	0,3306	0,499023048	-0,113077034	0,0070402	0,112535173	0,2308	0,214144783	0,6504	0,862512102	0,69337525	0,868341745	0,936654128	0,816164623	0,825147684	
approriate_mech_IBT_reg	-0,1703	0,3306	0,499023048	-0,113077034	0,0070402	0,112535173	0,2308	0,214144783	0,6504	0,862512102	0,69337525	0,868341745	0,936654128	0,816164623	0,825147684	
ability_to_regisetr	-0,2548	0,2771	0,409223796	-0,219899749	0,0342273	0,364743326	0,374	0,386219304	0,6828	0,778754987	0,60677988	0,789091253	0,867381748	0,637058989	0,650536311	0,9
IBT_Bias-free	-0,0637	0,4434	0,496914609	-0,087959899	-0,1711366	-0,182371663	0,0935	-0,016792144	0,3593	0,778754987	0,74161985	0,789091253	0,75895903	0,855479214	0,867381748	0,79
IBT_none_discr	0,1012	0,1211	0,185811131	0,087366238	-0,0237974	0,389452707	0,7986	0,40195931	0,6924	0,83299891	0,93750934	0,826872594	0,710760259	0,712306217	0,710760259	0,65
PC_satisfaction_IBT	-0,0103	0,3403	0,335364878	-0,195440159	-0,0027655	-0,154718785	-0,0151	0,058340613	0,4413	0,822816136	0,59920818	0,80651815	0,85850486	0,870622127	0,85850486	0,85
Sys_allocating_funds	-0,0375	0,2613	0,18950501	-0,324011115	-0,1613831	0,465773337	0,5878	0,583919959	0,5507	0,764970624	0,7284928	0,790626412	0,681622917	0,654389928	0,681622917	0,63
IBTInde_Mechanism	-0,0945	0,0411	0,021677749	-0,277239431	-0,0253837	0,811502671	0,7627	0,79701677	0,613	0,53311399	0,5	0,555945449	0,482450641	0,296972086	0,32163376	0,45
IBTLLV	-0,0637	0,1108	0,233842169	0,04397995	-0,0684546	0,638300821	0,8415	0,68847789	0,6828	0,658946528	0,74161985	0,670727565	0,542113593	0,527848877	0,542113593	0,51
IBT_preclude_fraud	0,0334	0,0581	0,137956351	-0,057658201	-0,0358979	0,621637295	0,7845	0,7573052	0,7349	0,73299434	0,70710678	0,7448453	0,625430886	0,610882839	0,625430886	0,53
IBT_Polling_accessibility	-0,1684	0,0733	0,012878502	-0,339098045	-0,0452404	0,816899166	0,7827	0,806427164	0,57	0,483873048	0,44556639	0,504112819	0,429927585	0,24860268	0,270695146	0,3
Observer_satis_IBT	-0,0642	0,3071	0,397632525	-0,166188622	-0,0172448	-0,045942292	0,1413	0,194589441	0,5794	0,855146364	0,62275237	0,854773369	0,892237375	0,889546452	0,892237375	0,84
IBT-enabled_sys	-0,0496	0,1835	0,16509282	-0,235550899	-0,1133233	0,586055366	0,7466	0,722762744	0,6579	0,758347377	0,72218538	0,776096905	0,654605017	0,634544346	0,654605017	0,56
IBT_freewill	-0,0496	0,1835	0,16509282	-0,235550899	-0,1133233	0,586055366	0,7466	0,722762744	0,6579	0,758347377	0,72218538	0,776096905	0,654605017	0,634544346	0,654605017	0,56
IBTTTAR	-0,0714	0,3418	0,360510439	0	-0,2110706	0,034079909	0,4193	0,216519142	0,3425	0,615688786	0,69293487	0,619323537	0,486264539	0,683673469	0,688874764	0,4
IBT_quickes_results	-0,2182	0,4113	0,475594866	-0,125540596	-0,1074719	-0,069410561	0,2135	0,110246151	0,4308	0,712484967	0,60942528	0,709524247	0,71183213	0,763762616	0,763414168	0,68
IBT_votecount_no_delay	-0,3669	0,3306	0,318653272	-0,316615696	-0,0985622	0,487652415	0,6154	0,525000114	0,5396	0,616080073	0,5547002	0,624881443	0,602134796	0,479215925	0,490628353	0,56
PC_confidence_IBT	-0,2864	0,3915	0,413016594	-0,211849756	-0,1318973	0,234260643	0,4804	0,355903335	0,5078	0,705360117	0,64951905	0,709524247	0,673145601	0,666343915	0,673145601	0,63
IBT_manage_complaints	-0,2864	0,3915	0,413016594	-0,211849756	-0,1318973	0,234260643	0,4804	0,355903335	0,5078	0,705360117	0,64951905	0,709524247	0,673145601	0,666343915	0,673145601	0,63
IBT_dispute_resolution	-0,2864	0,3915	0,413016594	-0,211849756	-0,1318973	0,234260643	0,4804	0,355903335	0,5078	0,705360117	0,64951905	0,709524247	0,673145601	0,666343915	0,673145601	0,63
IBT_manage_court_dis	-0,1737	0,3994	0,449735612	-0,085654872	-0,1466536	-0,035518507	0,2913	0,150439304	0,4129	0,700012963	0,65653216	0,699255627	0,654605017	0,758617262	0,760186472	0,60
EOO_IBT_confirm	-0,1161	0,3535	0,38617953	-0,130234634	-0,1247444	-3,63201E-17	0,2982	0,22185159	0,4584	0,736850972	0,64500987	0,736952503	0,69152317	0,787759441	0,790312194	0,6
IBT_IEC_timeframe	-0,0642	0,3071	0,323996873	-0,166188622	-0,1034688	0,030628195	0,2983	0,279193546	0,4888	0,754540909	0,62275237	0,755381117	0,710148115	0,797840632	0,801192745	0,61
IBT_election_stats	-0,0642	0,3071	0,323996873	-0,166188622	-0,1034688	0,030628195	0,2983	0,279193546	0,4888	0,754540909	0,62275237	0,755381117	0,710148115	0,797840632	0,801192745	0,61
IBT_EMB_easier_transp	-0,0565	0,2456	0,12954933	-0,194920294	0,0303393	0,242482802	0,4144	0,43165469	0,5096	0,743391942	0,5976143	0,699454638	0,672745276	0,709899067	0,672745276	0,5
IBTICE	0,0209	0,2632	0,181936927	-0,090046981	0,0056063	0,014935913	0,2603	0,253045362	0,4297	0,735907394	0,60737339	0,691489239	0,65709238	0,784100565	0,745888647	0
IBTVCIA	-0,0642	0,3071	0,397632525	-0,166188622	-0,0172448	-0,045942292	0,1413	0,194589441	0,5794	0,855146364	0,62275237	0,854773369	0,892237375	0,889546452	0,892237375	0,84

Appendix H: **IEC REGRESSION TABLE OF COEFFICIENTS**

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1	(Constant)	-1.248E-15	.000		.000	1.000	.000	.000
	race	7.509E-17	.000	.000	.000	1.000	.000	.000
	edu_background	-4.682E-16	.000	.000	.000	1.000	.000	.000
	IBTLBE	1.745E-15	.000	.000	.000	1.000	.000	.000
	IBTLeg_voters	-.571	.000	-.493	-1.287E7	.000	-.571	-.571
	IBT_Constituency_struc_voters	.571	.000	.603	1.113E7	.000	.571	.571
	PC_satisfaction_IBT	.333	.000	.352	5.023E6	.000	.333	.333
	Sys_allocating_funds	.286	.000	.244	5.391E6	.000	.286	.286
	IBTInde_Mechanism	-.429	.000	-.485	-6.165E6	.000	-.429	-.429
	IBTLLV	.619	.000	.520	7.126E6	.000	.619	.619
	IBT_votecount_no_delay	-.048	.000	-.039	-8.075E5	.000	-.048	-.048
	IBTICE	.238	.000	.244	3.428E6	.000	.238	.238

a. Dependent Variable: IBTVCIA

Appendix I: **EISA CORRELATION TABLE – CROSS SECTION**

	IBTLBE	IBTLeg_voter	BT_Constituency_struc_partie	BT_Constituency_struc_vote	voting_age_population_firs	criteria_rag_accepted_inte	appropriate_mech_public_re	approriate_mech_IBT_re	ability_to_regisetr	BT_Bias-free	BT_none_disc	PC_satisfaction_IB	Sys_allocating_fund	IBTInd
gender														
race														
edu_background														
experience_EISA														
age_group														
avail_cons_leg_foundation														
IBTCA														
implementation_level														
IBTLBE	1													
IBTLeg_voters	0,8674428	1												
IBT_Constituency_struc_part	0,7893374	0,96919749	1											
IBT_Constituency_struc_vot	0,7673618	0,83561904	0,830922726	1										
voting_age_population_first	0,8674428	1	0,969197487	0,835619045	1									
criteria_rag_accepted_inter	0,4326151	0,46423835	0,523979173	0,865688393	0,464238345	1								
appropriate_mech_public_reg	0,7726033	0,8029505	0,815882642	0,914002231	0,802950499	0,771833322	1							
approriate_mech_IBT_reg	0,3431002	0,33709993	0,351806021	0,782793688	0,337099931	0,943141478	0,712245602	1						
ability_to_regisetr	0,3431002	0,33709993	0,351806021	0,782793688	0,337099931	0,943141478	0,712245602	1	1					
IBT_Bias-free	-0,0419473	0,02307965	-0,008305694	0,401956651	0,023079655	0,57715228	0,079941185	0,661831424	0,661831424	1				
IBT_none_discr	0,4414938	0,6502211	0,569536424	0,522294285	0,650221099	0,227817032	0,235841076	0,194099873	0,194099873	0,5315644	1			
PC_satisfaction_IBT	0,0515765	0,2175628	0,20935268	0,457619178	0,2175628	0,523448631	0,09337765	0,523799298	0,523799298	0,93497582	0,740393624	1		
Sys_allocating_funds	0,2043748	0,23151128	0,30350154	0,704002503	0,231511278	0,945792433	0,652965516	0,970203745	0,970203745	0,61947199	0,071412127	0,490960007	1	
IBTInde_Mechanism	0,717496	0,88823479	0,834641043	0,572946313	0,888234788	0,134396419	0,632409339	0,097590007	0,097590007	-0,1670383	0,603782882	0,027384416	-0,015957673	
IBTLLV	0,7428024	0,86484094	0,834539761	0,525767282	0,864840945	0,096642401	0,652130005	0,007567943	0,007567943	-0,3834248	0,404875726	-0,191125454	-0,081674412	
IBT_preclude_fraud	0,5267854	0,73354767	0,782289265	0,398152762	0,733547674	0,059802315	0,446188385	-0,123840475	-0,123840475	-0,3391511	0,405631471	-0,067018774	-0,130179105	
IBT_Polling_accessibility	0,6816212	0,82243962	0,781366083	0,461540085	0,822439619	0,024435712	0,47858004	-0,097590007	-0,097590007	-0,2672612	0,550507922	-0,027384416	-0,191492071	
Observer_satis_IBT	0,6816212	0,82243962	0,781366083	0,461540085	0,822439619	0,024435712	0,47858004	-0,097590007	-0,097590007	-0,2672612	0,550507922	-0,027384416	-0,191492071	
IBT-enabled_sys	0,6816212	0,82243962	0,781366083	0,461540085	0,822439619	0,024435712	0,47858004	-0,097590007	-0,097590007	-0,2672612	0,550507922	-0,027384416	-0,191492071	
IBT_freewill	0,6816212	0,82243962	0,781366083	0,461540085	0,822439619	0,024435712	0,47858004	-0,097590007	-0,097590007	-0,2672612	0,550507922	-0,027384416	-0,191492071	
IBTTTAR	0,3229101	0,28426762	0,313292573	0,704804518	0,284267622	0,875387272	0,584618152	0,843274043	0,843274043	0,5893784	0,147055697	0,492975839	0,833085723	
IBT_quickes_results	0,2940858	0,24720662	0,279018568	0,630583804	0,247206616	0,792906553	0,502074768	0,733333333	0,733333333	0,52490078	0,121312421	0,448970827	0,7303781	
IBT_votecount_no_delay	0,5151274	0,60359346	0,580815788	0,279310194	0,603593463	-0,068225343	0,259061472	-0,233549683	-0,233549683	-0,293151	0,396654685	-0,065535621	-0,292785836	
PC_confidence_IBT	0,5151274	0,60359346	0,580815788	0,279310194	0,603593463	-0,068225343	0,259061472	-0,233549683	-0,233549683	-0,293151	0,396654685	-0,065535621	-0,292785836	
IBT_manage_complaints	0,5151274	0,60359346	0,580815788	0,279310194	0,603593463	-0,068225343	0,259061472	-0,233549683	-0,233549683	-0,293151	0,396654685	-0,065535621	-0,292785836	
IBT_dispute_resolution	0,2566678	0,3922787	0,338807153	0,151821097	0,392278697	-0,11655092	-0,081524332	-0,232737334	-0,232737334	0,15934436	0,677614306	0,391846025	-0,304452988	
IBT_manage_court_dis	0,0290619	0,1687839	0,105496479	0,034380708	0,1687839	-0,125369534	-0,295386014	-0,184466197	-0,184466197	0,4330127	0,728884761	0,621149557	-0,249925717	
EOO_IBT_confirm	0,1678604	0,30785965	0,249276818	0,106382979	0,307859648	-0,122503075	-0,171375418	-0,217442691	-0,217442691	0,27541474	0,71221948	0,494228713	-0,288001024	
IBT_IEC_timeframe	0,5151274	0,60359346	0,580815788	0,279310194	0,603593463	-0,068225343	0,259061472	-0,233549683	-0,233549683	-0,293151	0,396654685	-0,065535621	-0,292785836	
IBT_election_stats	0,503367	0,52313884	0,531564395	0,595491334	0,523138837	0,502865353	0,495635347	0,365148372	0,365148372	0,1875	0,31561636	0,268965648	0,328394789	
IBT_EMB_easier_transp	0,5151274	0,60359346	0,580815788	0,279310194	0,603593463	-0,068225343	0,259061472	-0,233549683	-0,233549683	-0,293151	0,396654685	-0,065535621	-0,292785836	
IBTICE	0,1973594	0,36196138	0,474516136	0,125078198	0,361961383	-0,019204155	0,147760865	-0,255654996	-0,255654996	-0,3588218	0,111650855	-0,118368561	-0,175577061	
IBTVCIA	0,6816212	0,82243962	0,781366083	0,461540085	0,822439619	0,024435712	0,47858004	-0,097590007	-0,097590007	-0,2672612	0,550507922	-0,027384416	-0,191492071	

Appendix J: **EISA REGRESSION TABLE OF COEFFICIENTS**

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.988	.000		1.213E7	.000
	gender	-.365	.000	-.365	-3.085E7	.000
	edu_background	-.071	.000	-.152	-1.079E7	.000
	experience_EISA	.024	.000	.048	7.773E6	.000
	avail_cons_leg_foundation	-2.031E-15	.000	.000	.000	1.000
	implementation_level	.035	.000	.052	2.330E6	.000
	IBTLBE	.365	.000	.484	4.875E7	.000
	IBT_none_discr	.071	.000	.109	5.328E6	.000
	IBT_election_stats	.118	.000	.126	1.222E7	.000
	IBTICE	.365	.000	.464	4.790E7	.000

a. Dependent Variable: IBTVCIA

Appendix K: **POLITICAL PARTIES CORRELATION TABLE – CROSS SECTION**

gender	1																													
race	-0,9186	1																												
edu_background	0,16667	-0,4082	1																											
experience_EISA	0,16667	-0,4082	1	1																										
age_group	0	0,27951	-0,4564	-0,4564	1																									
avail_cons_leg_foundation	-0,4082	0,375	0,61237	0,61237	0	1																								
IBTCA	0,40825	-0,375	-0,6124	-0,6124	0	-1	1																							
implementation_level	-0,4082	0,375	0,61237	0,61237	0	1	-1	1																						
IBTLBE	0,32733	-0,1336	-0,7638	-0,7638	0,5976143	-0,8018	0,80178	-0,8018	1																					
IBTLeg_parties	0,32733	-0,1336	-0,7638	-0,7638	0	-0,8018	0,80178	-0,8018	0,64286	1																				
IBTLeg_voters	0,21822	-0,0334	-0,8729	-0,8729	0,14940358	-0,8686	0,8686	-0,8686	0,78571	0,96429	1																			
IBT_Constituency_struc_parti	0,21822	-0,0334	-0,8729	-0,8729	0,14940358	-0,8686	0,8686	-0,8686	0,78571	0,96429	1	1																		
IBT_Constituency_struc_vote	0,10206	0,0625	-0,9186	-0,9186	0,2795085	-0,875	0,875	-0,875	0,8686	0,8686	0,96882	0,96882	1																	
voting_age_population_first	0,10206	0,0625	-0,9186	-0,9186	0,2795085	-0,875	0,875	-0,875	0,8686	0,8686	0,96882	0,96882	1	1																
criteria_rag_accepted_inter	0,21822	-0,0334	-0,8729	-0,8729	0,14940358	-0,8686	0,8686	-0,8686	0,78571	0,96429	1	1	0,96882	0,96882	1															
appropriate_mech_public_reg	0	0,19764	-0,9682	-0,9682	0,35355339	-0,7906	0,79057	-0,7906	0,84515	0,84515	0,9508	0,9508	0,98821	0,98821	0,9508	1														
approriate_mech_IBT_reg	-0,1667	0,40825	-1	-1	0,45643546	-0,6124	0,61237	-0,6124	0,76376	0,76376	0,87287	0,87287	0,91856	0,91856	0,87287	0,96825	1													
ability_to_register	-0,1667	0,40825	-1	-1	0,45643546	-0,6124	0,61237	-0,6124	0,76376	0,76376	0,87287	0,87287	0,91856	0,91856	0,87287	0,96825	1	1												
IBT_Bias-free	-0,1667	0,40825	-1	-1	0,45643546	-0,6124	0,61237	-0,6124	0,76376	0,76376	0,87287	0,87287	0,91856	0,91856	0,87287	0,96825	1	1	1											
IBT_none_discr	0	0,19764	-0,9682	-0,9682	0,35355339	-0,7906	0,79057	-0,7906	0,84515	0,84515	0,9508	0,9508	0,98821	0,98821	0,9508	1	0,96825	0,96825	0,96825	1										
PC_satisfaction_IBT	0,14003	0,08575	-0,9102	-0,9102	0,19174125	-0,7717	0,77174	-0,7717	0,73336	0,96253	0,98545	0,98545	0,94324	0,94324	0,98545	0,94907	0,91018	0,91018	0,91018	0,94907	1									
Sys_allocating_funds	0	0,27951	-0,9129	-0,9129	0,25	-0,559	0,55902	-0,559	0,59761	0,89642	0,89642	0,89642	0,83853	0,83853	0,89642	0,88388	0,91287	0,91287	0,91287	0,88388	0,95871	1								
IBTInde_Mechanism	-0,1667	0,40825	-1	-1	0,45643546	-0,6124	0,61237	-0,6124	0,76376	0,76376	0,87287	0,87287	0,91856	0,91856	0,87287	0,96825	1	1	1	0,96825	0,91018	0,91287	1							
IBTLLV	0,10206	0,0625	-0,9186	-0,9186	0,2795085	-0,875	0,875	-0,875	0,8686	0,8686	0,96882	0,96882	1	1	0,96882	0,98821	0,91856	0,91856	0,91856	0,98821	0,94324	0,83853	0,91856	1						
IBT_preclude_fraud	0,40825	-0,375	-0,6124	-0,6124	0	-1	1	-1	0,80178	0,80178	0,8686	0,8686	0,875	0,875	0,8686	0,79057	0,61237	0,61237	0,61237	0,79057	0,77174	0,55902	0,61237	0,875	1					
IBT_Polling_accessibility	0,40825	-0,375	-0,6124	-0,6124	0	-1	1	-1	0,80178	0,80178	0,8686	0,8686	0,875	0,875	0,8686	0,79057	0,61237	0,61237	0,61237	0,79057	0,77174	0,55902	0,61237	0,875	1	1				
Observer_satis_IBT	0,40825	-0,375	-0,6124	-0,6124	0	-1	1	-1	0,80178	0,80178	0,8686	0,8686	0,875	0,875	0,8686	0,79057	0,61237	0,61237	0,61237	0,79057	0,77174	0,55902	0,61237	0,875	1	1	1			
IBT-enabled_sys	0,40825	-0,375	-0,6124	-0,6124	0	-1	1	-1	0,80178	0,80178	0,8686	0,8686	0,875	0,875	0,8686	0,79057	0,61237	0,61237	0,61237	0,79057	0,77174	0,55902	0,61237	0,875	1	1	1	1		
IBT_freewill	0,40825	-0,375	-0,6124	-0,6124	0	-1	1	-1	0,80178	0,80178	0,8686	0,8686	0,875	0,875	0,8686	0,79057	0,61237	0,61237	0,61237	0,79057	0,77174	0,55902	0,61237	0,875	1	1	1	1	1	
IBTTTAR	0,58333	-0,6634	-0,25	-0,25	-0,2282177	-0,9186	0,91856	-0,9186	0,6001	0,6001	0,62738	0,62738	0,61237	0,61237	0,62738	0,48412	0,25	0,25	0,25	0,48412	0,4901	0,22822	0,25	0,61237	0,91856	0,91856	0,91856	0,91856	0,91856	
IBT_quickes_results	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBT_votecount_no_delay	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
PC_confidence_IBT	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBT_manage_complaints	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBT_dispute_resolution	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBT_manage_court_dis	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
EOO_IBT_confirm	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBT_IEC_timeframe	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBT_election_stats	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBT_EMB_easier_transp	0,6455	-0,7906	0	0	-0,3535534	-0,7906	0,79057	-0,7906	0,42258	0,42258	0,42258	0,42258	0,39528	0,39528	0,42258	0,25	0	0	0	0,25	0,27116	0	0	0,39528	0,79057	0,79057	0,79057	0,79057	0,79057	0,96
IBTICE	0,76376	-0,8686	0,21822	0,21822	-0,5976143	-0,5345	0,53452	-0,5345	0,07143	0,42857	0,28571	0,28571	0,13363	0,13363	0,28571	0	-0,2182	-0,2182	-0,2182	0	0,18334	0	-0,2182	0,13363	0,53452	0,53452	0,53452	0,53452	0,53452	0,76
IBTVCIA	0,40825	-0,375	-0,6124	-0,6124	0	-1	1	-1	0,80178	0,80178	0,8686	0,8686	0,875	0,875	0,8686	0,79057	0,61237	0,61237	0,61237	0,79057	0,77174	0,55902	0,61237	0,875	1	1	1	1	1	0,91

Appendix L: **TABLE OF COEFFICIENTS – POLITICAL PARTIES**

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.000	.000		1.112E7	.000	1.000	1.000
	gender	-.500	.000	-.612	3.330E6	.000	-.500	-.500
	IBTLBE	.500	.000	.935	4.665E7	.000	.500	.500
	Sys_allocating_funds	-8.498E-17	.000	.000	3.128E6	.000	.000	.000
	IBTICE	.500	.000	.935	2.111E7	.000	.500	.500

a. Dependent Variable: IBTVCIA

Appendix M: **ETHICAL CLEARANCE APPROVAL DURBAN UNIVERSITY OF TECHNOLOGY**

DUT
DURBAN
UNIVERSITY OF
TECHNOLOGY

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

28 November 2018

Rev J Maphephe
Flamingo House 2256
Pox 1848
Ladybrand
South Africa
9745

Dear Rev Maphephe

THE USE OF INTERNET BASED TECHNOLOGIES IN ELECTORAL MANAGEMENT PROCESSES IN SOUTH AFRICA: A CASE STUDY OF THE GAUTENG REGION.

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tools for review.

We are pleased to inform you that the data collection tools have been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely,

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2018 -11- 28
INSTITUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

Appendix N: **ETHICAL CLEARANCE APPROVAL – ELECTORAL COMMISSION OF SOUTH AFRICA**

ELECTORAL COMMISSION

OFFICE OF THE CHIEF ELECTORAL OFFICER

Tel: +27 12 622 5542 | Fax: +27 12 622 5398

Mr John Maphephe **26 March 2014**

ICT Adviser Electoral Projects

E-Gov. and ICT Forensic Audits

Durban University of Technology

P O Box 1334

DURBAN

4000

Per email: jmaphephe@msn.com

Dear Mr Maphephe,

DOCTORAL DEGREE IN TECHNOLOGY PUBLIC MANAGEMENT- PARTICIPANT BRIEFING AND CONSENT LETTER (INTERNET BASED TECHNOLOGIES TO ENHANCE ELECTORAL PROCESSES AND BUILD POLITICAL COHESION IN REPUBLIC OF SOUTH AFRICA. (A CASE STUDY FOR GAUTENG PROVINCE)

I write to confirm that you have been granted permission to conduct your research within the Electoral Commission (EC).

Your contact person in this regard will be Mr Libisi Maphanga, our Chief Information Officer. Mr Maphanga may be reached via email at maphangal@elections.org.za or telephone at 012 622 5589.

Wishing you well in your studies.

MS Moepya, Mr

Chief Electoral Officer

cc: Mr Libisi Maphanga

Chief Information Officer

E L E C T O R A L C O M M I S S I O N

ENSURING FREE AND FAIR ELECTIONS

S O U T H A F R I C A

IEC

Appendix O: **ETHICAL CLEARANCE APPROVAL IEC - SOUTH AFRICA**

SOUTH AFRICA

Mr John Maphephe
Doctoral Candidate
Durban University of Technology
PO Box 1334
Durban
4000

Email: jmaphephe@gmail.com & jmaphephe@msn.com

13 July 2018

Dear Mr Maphephe

APPROVAL TO SCHEDULE STUDY INTERVIEWS AND TO SEND STUDY QUESTIONNAIRES IN PURSUIT OF RESEARCH STUDY

It is my pleasure to endorse your research study on The Use of Internet Based Technologies in Electoral Management Processes in South Africa: A Case Study of the Gauteng Region.

You are hereby granted permission to schedule interviews with and to send out study questionnaires to Electoral Commission staff members in the Gauteng region in pursuit of your research.

Should you have any difficulties or queries kindly contact either Mr Libisi Maphanga, Chief Information Officer at maphangal@elections.org.za or Mr Masego Sheburi, Provincial Electoral Officer, Gauteng at sheburim@elections.org.za

We wish you all the best with your study and look forward to you sharing your results with us.

Sincerely

Chief Electoral Officer

Electoral Commission

Ensuring Free and Fair Elections

Commissioners: Mr V.G. Mashinini (Chairperson) | Mr I.T. Tselane (Vice Chairperson) | Rev. B.B. Finca | Ms J.Y. Love
National Office: Election House, Riverside Office Park, 1303 Heuwel Avenue, Centurion, 0157 | P/Bag X112, Centurion, 0046
info@elections.org.za | www.elections.org.za

Appendix P**: ETHICAL CLEARANCE APPROVAL EISA**

14 Park Road • Richmond 2092
P O Box 740 • Auckland Park 2006
South Africa

Electoral Institute for Sustainable Democracy in Africa NPC (RF)
NPO registration number: [illegible]
NPC (RF) registration number: [illegible]

Telephone +27 11 381 60 00
Fax +27 11 482 61 63
Email eisa@eisa.org.za
Web www.eisa.org.za

11th November 2014

TO WHOM IT MAY CONCERN

This letter serves to confirm that Mr John Maphephe who is registered with the Durban University of Technology for a doctoral degree in "Technology Public Management" has been given permission to use the EISA library for purposes of research. Should Mr Maphephe require further information, insofar as we are able to assist him, we will do so.

Sincerely

Ilona Tip
Operations Director