A Process Model for E-Voting in South Africa

By

Eraneé Swanepoel

A Process Model for E-Voting in South Africa

By

Eraneé Swanepoel

Submitted in fulfilment of the requirements for the degree

Magister Technologiae

in

Information Technology

in the

FACULTY OF ENGINEERING, THE BUILT ENVIRONMENT AND INFORMATION TECHNOLOGY

of the

NELSON MANDELA METROPOLITAN UNIVERSITY

Supervisor: Dr. Kerry-Lynn Thomson

Co-supervisor: Prof. Darelle van Greunen

January 2012

DECLARATION

I, Eraneé Swanepoel (Student Number s20520190), hereby declare that the dissertation for Magister Technologiae in Information Technology is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

Eraneé Swanepoel
23 January 2012

Abstract

An election is a core part of any global democracy. Elections provide citizens with the opportunity to voice their opinions. South Africa achieved democracy for the first time in 1994 and has had four successful national elections since then. All of these elections have been declared “free and fair” according to the Independent Electoral Commission (IEC). However, there have been various challenges facing the current South African electoral process. This research, therefore examines alternative methods to improve the current South African electoral process.

This research firstly identifies the various challenges and characteristics associated with the current electoral process in South Africa. This research study proposes, to incorporate Information and Communication Technology (ICT) into the South African electoral process. Thus, arguing that utilizing ICT could potentially improve the process.

Various countries worldwide have investigated different methods to improve their electoral processes. Countries such as India, Brazil, Estonia and the USA have incorporated ICT into their electoral processes, known as electronic voting (e-voting). Therefore, this research study investigates countries such as India, Brazil, Estonia and the USA which opted to implement e-voting into their electoral process. In addition, various e-voting technologies and their capabilities are explored in detail in this research study. The conclusions drawn from the examination of the electoral processes of countries that utilize e-voting, contributed to the achievement of the primary objective in this research.

As a result, to address the various challenges facing the current electoral process in South Africa, a process model was developed called an E-voting Process Model, which depicts two electoral processes namely, an optical scan polling station voting process and an online voting process. This research argues that the E-voting Process Model could potentially improve the current electoral process in South Africa.

Acknowledgements

My sincerest gratitude to the following people:

- Our Heavenly Father who created me;
- My supervisor, Dr Kerry-Lynn Thomson, and my co-supervisor, Prof. Darelle van Greunen, for their guidance, patience, support and supervision;
- My parents, for their love and motivation; and
- Nelson Mandela Metropolitan University and Telkom, whose financial support made this research possible;
- My family and friends, for their support and understanding. I thank you all.

Table of Contents

List of Figures

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

List of Tables

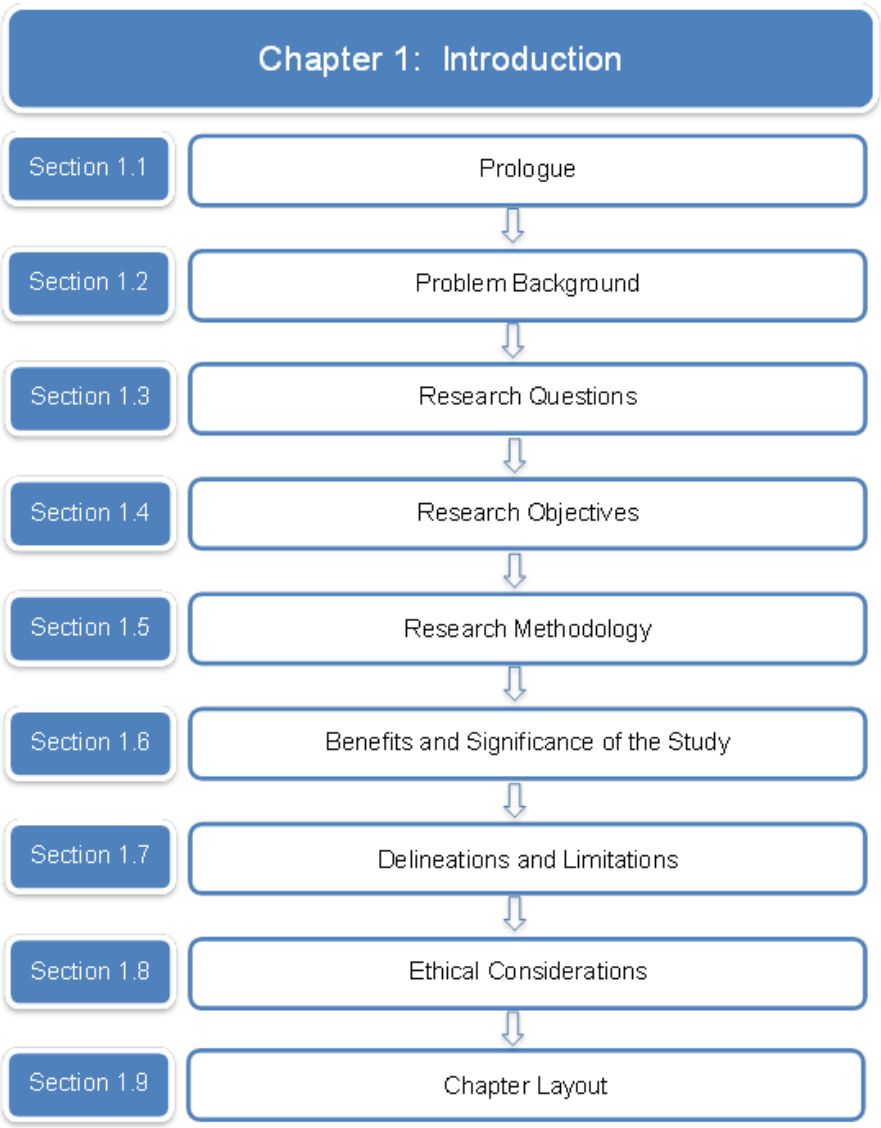
Chapter 2

Chapter 3

Chapter 6

Chapter 1

Introduction



1.1 Prologue

"Information can tell us everything. It has all the answers. But they are answers to questions we have not asked, and which doubtless don't arise." - (Baudrillard, 1987)

The Republic of South Africa held its first democratic elections in 1994. All citizens, regardless of their culture, had the opportunity to cast their vote during this historical event (Athiemoolam, 2003). This event was seen as one of the biggest achievements in South African history.

In 1997, the Independent Electoral Commission was established as a permanent body responsible for the entire voting process in South Africa. This includes pre-electoral, electoral and post-electoral processes. The IEC's vision is:

"To strengthen constitutional democracy through the delivery of free and fair elections in which every voter is able to record his or her informed choice".

Therefore, everyone should have the opportunity to participate and have confidence in the electoral system in South Africa (IEC, 2010c).

The South African paper-based voting method makes use of secret voting, also known as the "Australian Ballot" (Reynolds & Steenbergen, 2006). South Africa uses a single ballot, single box. This method requires that the voter marks an '✘' next to the party or candidate of choice. The voting process in South Africa allows the voter to cast his/her vote by going to a designated polling station. There are certain criteria that a voter needs to meet to qualify to participate in the South African elections. For example, a voter must be 18 years or older and he/she must be a South African citizen. The voter must also be registered in order to participate in any South African election. All registered voters' names are stored in the National Common Voters' Roll.

The National Common Voters' Roll is a document that contains all registered South African voters and includes information concerning the voter. There are more than 23 million registered voters' names on the National Common Voters' Roll (IEC, 2009b). According to the IEC the purpose of such a document is to help prevent fraud with regard to an election.

South Africa has had four successful national and provincial elections since 1994. However, there are numerous challenges associated with the South African electoral process. One such challenge is the presence of electoral fraud. Additionally, there are a number of other challenges associated with the current electoral process in South Africa. These are outlined in section 1.2.

Many countries are looking at alternative methods to improve electoral processes. In addition to this, Rubin (2002) states that despite treating elections as a delicate and fragile process, looking at new improvements in technology that can contribute to improving elections should be natural. The utilization of technology to cast and count a vote in an election can be defined as electronic voting (e-voting). There are two types of e-voting, namely; polling station e-voting and remote e-voting. Polling station e-voting requires that the voter physically goes to a polling station to participate in elections. Examples of this include, but are not limited to, punch cards, optical scan voting systems and direct record electronic voting systems (DRE). Remote e-voting allows a voter to participate in elections outside the physical polling station, for example, making use of the Internet to cast a vote.

According to the International Institute for Democracy and Electoral Assistance (IDEA), “the choice of electoral system is one of the most important institutional decisions for any democracy” (IDEA, 2010). In addition to this, having a free and fair election can only be achieved if the voter and all other parties involved have confidence and trust in the selected electoral system.

1.2 Problem Background

As discussed previously, the current South African electoral process makes use of paper ballots as a medium to cast votes (SouthAfrica.info, 2010a).

There are, however, various challenges facing the current South African electoral process. According to a survey conducted in 2008, a concern about confidence in the current ballot form was expressed by South African citizens, indicating a decrease in the trust that voters have in their electoral system (IDASA, 2008). A further hindrance to the current South African process is that there are approximately 24 percent of adults over the age of fifteen that are illiterate

(SouthAfrica.info, 2006). Election fraud occurred through previously marked ballot papers and ballot boxes going missing for example.

People living in rural areas might not have the necessary funds to travel to an election polling station, which can be a reason for voter turnout decreasing after the 1994 elections (Kersting, 2006). People with disabilities could also face some disadvantages when it comes to casting a vote, depending on their disability. In the 2009 election the IEC introduced a new Braille template called “Betty the Braille” (Mabandu, 2009). The Braille template allows voters to cast their votes without any assistance from an election official, thus increasing the integrity of the vote. Although seen as a step forward for disabled people wanting to vote, various issues concerning this new template were raised. These issues impact negatively on the idea of independent voting concerning disabled citizens (Van Zyl, 2009).

Furthermore, a large percentage of South Africans live abroad and, as from 2009, are eligible to take part in elections (Mbola, 2009). Approximately two million South Africans are disseminated worldwide. Some challenges facing the expatriates are that access to an embassy to register and cast their votes can be difficult. According to the Constitutional Court Ruling in 2009, all expatriates that are eligible to take part in elections must go to a South African embassy, High Commission or Consulate abroad (Mbola, 2009). An example is when a voter lives in Perth, Australia, and is eligible to vote, he/she would have to travel to Canberra, Australia, as that is where the embassy is situated. This may be costly and could contribute to hindering election participation by expatriates.

Many of the above mentioned challenges could contribute to a decrease in trust and a lack of confidence in the South African electoral system. Therefore, looking at alternative methods to address the various challenges, could potentially improve the current South African electoral process.

1.2.1 Problem Statement

As discussed in section 1.2, the current electoral process in South Africa has various challenges associated with it. These challenges could potentially hamper confidence and trust in the electoral system.

For the purposes of this research, a distinction must be made between the South African electoral system and the electoral process. The South African electoral system refers to all the components managed by the IEC, including, but not limited to, the Independent Electoral Commission Vision and Mission, Electoral Act 73 of 1998, Awareness Campaigns, Role Players, Infrastructure and Electoral Process. The South African electoral process is one of the components of the electoral system and can be defined as all the processes that include the voter registration, vote casting and counting processes. This research study will focus primarily on the South African electoral process.

Therefore, it can be concluded that the following problem statement can be formulated to guide this research study:

The current paper-based electoral process does not sufficiently address the unique needs of the South African democratic society.

This suggests that the current South African electoral process should be investigated in detail. Additionally, there is a need to improve the current South African electoral process, addressing the unique needs of the South African democratic society. By providing alternative methods of voting, it may be possible to address the various challenges faced by the South African electoral process, thus, contributing to increased confidence and trust in the electoral process.

Following the problem background and problem statement, a number of research questions are listed, which will be answered throughout this research study.

1.3 Research Questions

The previous section discussed the research challenges associated with this research study. It concluded that the current paper-based electoral process does not sufficiently address the unique needs of the South African democratic society. There are numerous challenges identified, which could potentially hamper confidence and trust in the South African electoral system.

Therefore, this research study aims to answer the following primary research question:

How can an e-voting process model be used to address challenges in the current paper-based electoral process?

In order to answer the primary research question, the following secondary research questions were identified:

- What are the challenges facing the current South African electoral process?
- How is ICT currently being used to support the election process in countries worldwide?
- How can ICT enhance the South African electoral process?
- What are the different e-voting technologies and their capabilities?
- What are the security challenges facing e-voting?

1.4 Research Objectives

The primary objective of this dissertation is to ***develop a process model demonstrating how e-voting can address challenges in the current South African electoral process.***

To achieve the primary objective a number of secondary objectives have been defined.

The secondary objectives are:

- To investigate the current South African electoral process challenges and characteristics;
- To investigate the use of ICT in current electoral processes in countries worldwide;
- To evaluate the applicability of ICT in the South African electoral process;
- To identify and evaluate e-voting technologies and their capabilities;
- To define the information security requirements with regard to the confidentiality, integrity and availability in the context of e-voting.

1.5 Research Methodology

In order to address the research questions and objectives detailed in the previous sections, an appropriate research methodology must be utilized. The research methodology is used to solve a research problem using an orderly approach (Kothari, 2008). Additionally, a research method is utilized to reach the conclusion (2006). The purpose of this section is to briefly discuss the research methodology that was followed, which contributed to achieving the various objectives outlined in this research study. A more detailed discussion on the research methodology used in this research can be found in Chapter 5.

The research in this dissertation was primarily based on a qualitative approach as described in Creswell (2009) and Olivier (2004). In addition, there were some quantitative elements associated with the expert review in this research study.

Creswell (2009, p. 232) defines a qualitative study as “a means of exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures; collecting data in the participants setting; analysing the data inductively; building from particulars to general themes; and making interpretations of the meaning of the data.”

According to Kothari (2008, p. 3) quantitative research is concerned with quantity. Therefore, the phenomena can be expressed in terms of quantity or measured in numbers. This theory is based upon variables and evaluated by analysis of numerical data. Thus, the data can be analysed by comparing statistical procedures to the hypothesis to provide the effectiveness and truth about the specific research.

The research approach taken in this study was based on deductive reasoning following a predominant qualitative approach. Data was collected and evaluated which contributed to the developed theory in this research.

An E-voting Process Model was developed that included all facets that are significant to the proposed solution for voting in South Africa. According to Olivier (2004) a model does not include insignificant characteristics of a process; therefore it only encapsulates the important characteristics of a process.

The following research and data collection methods were utilized throughout this research study, which contributed to achieve the various objectives outlined in this research study.

- *Literature studies:* A literature study is a critical overview and is based on facts that have been discovered concerning a particular subject matter (Hofstee, 2006, p. 91). The current paper-based South African electoral system was investigated in detail. Furthermore, an investigation into the use of technology to conduct an election was explored. In addition to this, investigating the importance of security in such an electronic electoral process was also conducted. Additionally, this research study used existing, relevant literature, which included journal articles, conference papers, books, magazine and newspaper articles, online sources, published statistics, government records, electronic databases, theses and dissertations and various case studies. Online sources were used because of the absence of e-voting sources in South Africa.

- *Argumentation:* According to Metcalfe and Powell (2000) an "argument is a possible strategy, technique, method and research methodology particularly suited to IS research". The primary strategy in this research study will make use of argumentation. All conclusions made from the conducted literature study will be utilized to argue *evidentially* according to the principles of Mason (1996) and reason towards the need for alternative voting methods to improve the current electoral process in South Africa. In addition to arguing evidentially the researcher also argues *interpretively* or *narratively*.

- *Expert Review:* An expert review was conducted. Various experts were identified for feedback on the E-voting Process Model proposed in this research study. The experts were identified based on their knowledge and experience with regard to the South Africa electoral system or e-voting. Additionally, their willingness to participate in the expert review, their availability and ease of access by the researcher played an important role

in selecting them. A structured questionnaire was utilized to conduct the expert review.

Furthermore, the various sources used to collect data were triangulated, increasing the credibility and validity of the results in this research. The following section discusses the benefits and significance associated with this research study.

1.6 Benefits and Significance of the Study

Currently there is a lack of significant research with regard to e-voting in the South African context. As discussed in section 1.2 the current South African electoral process faces many potential challenges. This dissertation will address these challenges and look at technology as an alternative method to improve the current voting process in South Africa. Technology is used worldwide to make various electoral processes more efficient. South Africa can use conclusions and solutions from worldwide experiences concerning e-voting and use the knowledge to assist in preventing potential challenges in future. This study will propose a process model for e-voting within the South African context.

1.7 Delineations and Limitations

The research will focus on the current paper-based South African electoral process with e-voting as a potential alternative solution, and will not address any political issues that are associated with the current process.

There are various components associated with the South African electoral system, such as the Electoral Act of 1998, various Role Players, Awareness Campaigns and Infrastructure for example. This dissertation will not address all of these components. The focus of this research will only be on the technology element associated with the Infrastructure component as in Chapter 4.

E-voting has various benefits associated with it, however, with these benefits come increased security requirements. This research does acknowledge that security is one of the challenges associated with e-voting, as will be discussed in section 2.5 and 2.6, but it must be noted that the proposed process model does

not address security components such as, for example, security policies and protocols.

1.8 Ethical Considerations

For the purpose of this research study no ethical approval was required. The various participants in this research were voluntary and could withdraw at any time. The participants were ensured of their privacy (anonymity and confidentiality) throughout this research study.

1.9 Chapter Layout

The introduction chapter, **Chapter 1,** introduces the subject matter and the objectives of the dissertation. The chapter describes background information that contributes to define the problem area. In addition to this, the research methodology employed in this study is introduced.

Chapter 2 conducts an investigation into different e-voting systems worldwide. This chapter also examines the capabilities of the different e-voting technologies as well as the challenges associated with them. Furthermore, this chapter identifies the importance of information in an election and addresses the information security challenges facing any election. This chapter focuses on the various risks and challenges associated with e-voting technologies.

Chapter 3 introduces the South African democracy, including the background of the current electoral process in South Africa. An in-depth investigation is conducted on the current paper-based South African electoral process characteristics, including challenges associated with the process. In addition, the ICT status in the South African electoral process is discussed in detail.

Chapter 4 proposes a customized process model to improve the current South African electoral process. Consequently, it addresses various challenges and argues towards how technology can be used to improve the current process of voting in South Africa.

Chapter 5 discusses the research methodology followed in this dissertation. The research process is detailed, identifying the philosophy associated with this

research study. Additionally, the research approach, strategy, data collection methods, data analysis approach and triangulation are described in detail.

Chapter 6 discusses the results obtained from the expert review. The expert review permitted for valuable feedback from various identified experts. The results from the expert review are presented and discussed in detail in this chapter. The feedback was used to validate the proposed E-voting Process Model in this research study.

Chapter 7 concludes the dissertation and summarizes the accomplished results during the research process. This chapter also briefly discusses future research regarding the improvement of the current paper-based electoral process in South Africa.

Figure 1.1 is a graphical representation of the logical flow of the chapters in this dissertation.

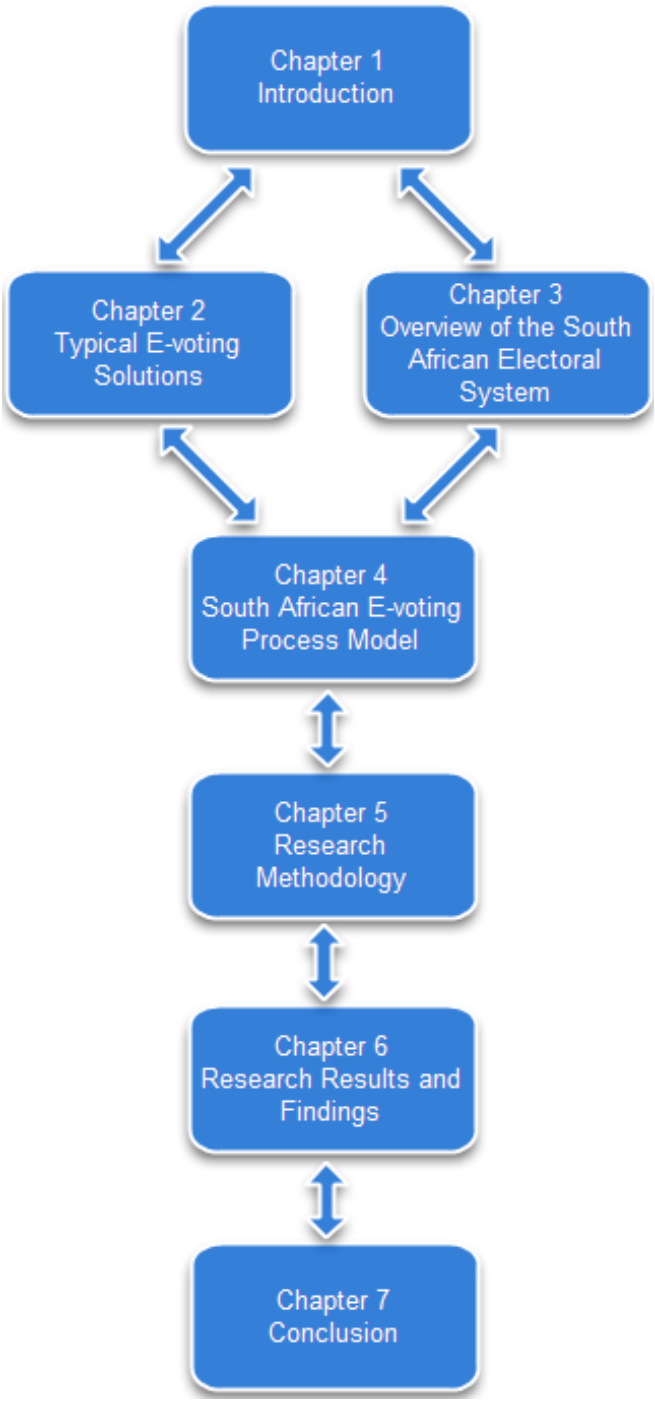
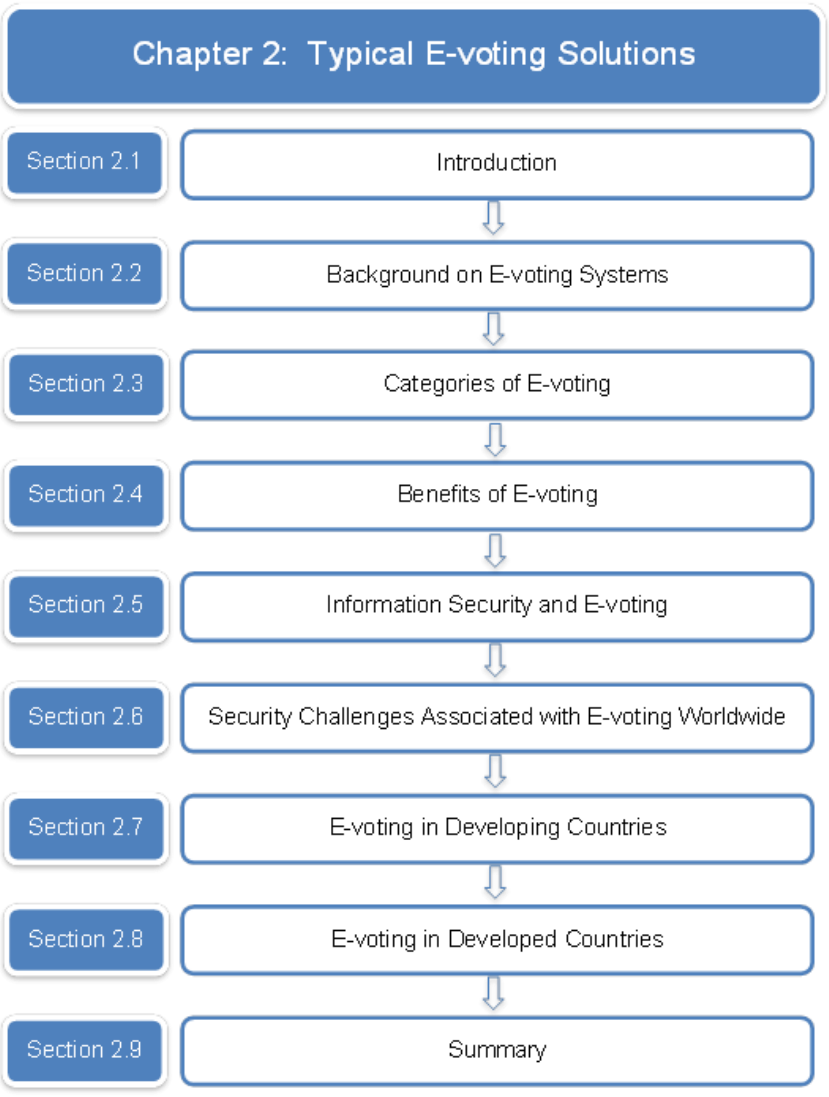


Figure 1.1: Chapter Layout

Chapter 2

Typical E-voting Solutions



2.1 Introduction

"Technology has always influenced and shaped the ways elections are held." - (Krimmer, Triessnig, & Volkamer, 2007)

Electronic voting (e-voting) refers to an election process where a country makes use of technology to facilitate an election. There are various criteria which play an important role in the success of implementing an e-voting system. A secure, transparent and reliable system is some of the characteristics required but are not limited to these which contribute to the success of an e-voting system. A reliable e-voting system will be a contributing factor in achieving a healthy democracy (Gritzalis, 2003). Democracy can be influenced negatively if an election does not function correctly. All participants, including voters, politicians and authorities need to trust the electoral system (Brändli & Braun, 2006).

Various e-voting systems have been utilized around the world. This chapter will discuss the various e-voting systems and consider different countries that have utilized e-voting as an alternative execution of an election. In addition, the benefits of e-voting systems will be detailed. E-voting systems and the benefits associated with them do, however, come with increased security requirements. According to Von Solms & Von Solms (2009) information is an asset and needs to be protected from threats. Therefore, the protection of election information is of utmost importance. The significance of information security in an election plays a vital role in achieving a free and fair election. This chapter will examine the importance of the confidentiality, integrity and availability of election information. In addition, the different risks associated with e-voting will be discussed in detail in this chapter.

2.2 Background on E-voting Systems

E-voting can be defined as making use of technology to cast a vote in an election process. According to Volkamer (2009) there must be an electronic copy of the vote stored in at least one point in the election process. Thus, the final result will be calculated utilizing the stored electronic votes (e-votes). An e-voting system has minimum requirements that need to be met that would contribute to confidence in such a method of voting.

According to Anane, Freeland, & Theodoropoulos (2007), the following are requirements that play a pivotal role in any electoral process:

- Only voters that meet the voting criteria are eligible to cast their vote;
- A voter may only cast a vote once;
- Every voter's vote must be confidential;
- No one must be able to make a copy of a voter's vote;
- The integrity of a voter's vote may not be compromised without being discovered and;
- An audit trail must be available to confirm that the voter's vote has been counted.

E-voting has a history of nearly half a century worldwide (Volkamer, 2009). Countries that have opted to implement e-voting as an election method are, for example, the United States of America (USA), Estonia, India and Brazil.

In addition, there are a number of other countries worldwide that are currently running pilot projects using e-voting. From this it can be seen that democracies around the world are looking at methods to improve their electoral systems.

E-voting has different characteristics from traditional paper ballot elections. The difference between traditional paper ballot elections and e-voting is shown in Table 2.1. The table takes into account all different e-voting systems for example online voting, optical scan and direct record electronic (DRE) voting devices. This section will discuss the differences between polling station paper-based elections and e-voting elections.

Polling Station Paper-based Elections	E-voting Elections
Easier to manipulate, small amendments to results can be made by any person with access; no expertise required	If hacked the results could be changed, but requires technical expertise to change results
Ballot forms look the same for all voters	Different ballot form layout and can accommodate different languages
Spoilt votes	Alleviate spoilt votes
Time consuming counting process	Faster and more efficient counting process
High volume of paper usage	Less paper usage and less transport energy
Less convenient for voters have to travel to polling station	More convenient for voters

Table 2.1: Differences between ballot paper elections and e-voting (Volkamer, 2009, p. 9; Thakur, 2010).

As depicted in Table 2.1, e-voting systems are more difficult to manipulate than a paper-based election. An attacker in an e-voting attack would need technical knowledge to complete an attack. Therefore, it is much more difficult to amend results when using an e-voting process. In contrast, in a paper-based election anyone that has access to the paper ballots could influence the results. Thus, small adjustments can be made to the results and could influence the final results.

The next identified difference is the ballot form layout, in which e-voting allows for different layouts. An example is that electronic ballots (e-ballots) can accommodate different languages. The voting interface could appear different depending on the device and software that is being used in an e-voting system. Paper-based ballots will not differ; every voter will have a similar ballot. Furthermore, e-voting alleviates spoilt ballots whereas a paper ballot approach could result in increased spoilt ballots (Volkamer, 2009).

The counting of ballot papers is a time consuming process, especially in a country such as India, for example, as they have a voting population of approximately 671 million registered voters (Thakur, 2010). In contrast, an e-voting counting process is faster and more efficient than a paper-based counting process.

When conducting a paper-based election a high volume of ballot papers is printed. As stated by Thakur (2010), the utilization of ballot papers is not seen as an environmentally friendly process. In contrast, making use of e-ballots reduces the amount of paper and the cost that is incurred by the logistical cost. As a result, this makes the utilization of e-ballots more environmentally friendly compared to paper-based elections. Furthermore, e-voting can also be more convenient for voters when compared to polling station paper-based elections. An example is when a voter makes use of online voting and he/she can vote from their home. This could potentially contribute to increase voter participation (Thakur, 2010).

According to Gritzalis (2003) there are three different kinds of e-voting. These include polling station voting, kiosk voting and Internet voting, also known as online or remote electronic voting. Volkamer (2009) recognized eight different categories of elections. The different categories will be discussed in more detail in section 2.3.

Volkamer (2009) not only identified the categories but also two different environments when referring to an e-voting process. This is known as e-voting in a *controlled environment* and e-voting in an *uncontrolled environment*. When voting in a *controlled environment* it allows the voter to cast his/her vote where the poll worker is responsible for the accuracy, confidentiality, integrity and privacy of the election process (Volkamer, 2009).

In contrast e-voting in an *uncontrolled environment* allows a voter to participate in an election, where there is no election official available. Therefore, there is no way to guarantee that the election process will be confidential, accurate, and private. The voter will be responsible for the confidentiality, integrity and privacy of the voting process, consequently being responsible for making sure the vote is accurate. The next section will discuss the various categories associated with e-voting.

2.3 Categories of E-voting

As mentioned in section 2.2, there are two environments e-voting can take place in, a *controlled environment* or an *uncontrolled environment.* These two different environments were discussed in detail in section 2.2.

	Controlled Environment	Uncontrolled Environment
Electronic Elections	Paper-Based Electronic Voting Systems	Paper-Based Electronic Voting Systems
	Stand-Alone Electronic Voting Machines in Polling Stations	Kiosk Electronic Voting Machines
	Networked Electronic Voting Machines in Polling Stations	Remote Electronic Voting

Table 2.2: Election categories. Adapted from Volkamer (Volkamer, 2009, p. 18).

Furthermore, Table 2.2 shows the different e-voting categories as stated by Volkamer (2009). The main purpose of this table is to illustrate which e-voting categories are included under a *controlled* and an *uncontrolled environment.* The various e-voting categories as can be seen in Table 2.2 will be discussed in the following sub-sections.

2.3.1 Paper-Based E-voting Systems

The first category of e-voting is that of paper-based e-voting. Paper-based e-voting uses paper ballots for voters to cast their votes. The paper ballots are scanned and counted electronically, therefore discarding manual counting of votes. Paper-based e-voting could be implemented in a *controlled* or *uncontrolled environment* as seen in Table 2.2. There are several systems used when it comes to paper-based e-voting, for example:

- Punch Card Voting Systems;
- Optical Scan Systems.

Some of these voting systems have been used in various states in the USA for example. The main benefit associated with a paper-based e-voting system is that votes could be audited or recounted if there are any inconsistencies. The two paper-based e-voting systems mentioned above will be discussed in detail in the following sub-sections.

2.3.1.1 Punch Card Voting System

A punch card voting system is a voting system that has been around for decades where the voter still has to go to a polling station to cast

his/her vote (Bellis, 2008). This method of voting system utilizes ballot forms where the voter uses a device to punch a hole next to the candidate/party of choice. The device used is normally a metal stylus device that makes the hole next to the political party or candidate of choice.

After the voter has cast his/her vote the ballot could be placed in a ballot box or counted electronically. The electronic tabulating process includes a device which reads the choice on the voting ballot; a computer vote-tabulating device (Bellis, 2008). The ballot form with the punched hole will be placed in a ballot box after voting (Jones, 2003). This method of voting takes place at a polling station, thus in a *controlled environment,* therefore, alleviating the risks associated with unauthorised access to electoral devices for example.

2.3.1.2 Optical Scan Voting System

Optical scan voting systems are also known as mark-sense systems. An optical scan voting system is employed at a polling station in a *controlled environment*. These voting systems make use of “dark logic”; this is used to read a voter’s ballot form by selecting the darkest mark on the ballot form as the voter’s choice. A standard paper ballot has a similar look to an optical mark-sense ballot form (Volkamer, 2009).

Optical scan technology has been used for decades not only for voting, but also in worldwide lottery systems (Bellis, 2008). A voter will cast his/her vote on a ballot form, where a political party or candidate is pre-printed with an empty rectangle, circle, oval or arrow next to it. The voter will make his/her selection by filling in the empty rectangle, circle, oval or arrow. After the voter has completed his/her vote the marked ballot form will be scanned by an optical scanning device. This allows for the votes to be tabulated electronically, thus alleviating the influence humans have in the counting process.

Furthermore, an optical scan voting system allows for the votes to be recounted manually if any discrepancies arise. Therefore, this method of voting provides an option to audit an optical scan voting system. This audit is referred to as a voter-verified paper ballot. This could play a significant role in contributing to confidence in an electoral system (Caarls, 2010). Another benefit associated with an optical scan voting system is its ability to function with batteries. In addition, the system could have an electrical cord and battery as backup to fully function. Section 2.8.2 will discuss the use of an optical scan voting system which has been used in various states in the USA.

The next sub-section will discuss other categories of e-voting systems which makes use of electronic ballots (e-ballots) instead of paper ballot forms.

2.3.2 Stand-Alone E-voting Machines in Polling Stations

Stand-alone e-voting takes place in a *controlled environment*, at a polling station as seen in Table 2.2. The benefit of such a system is that there is no connection to any network, thus, making it more secure from malicious attacks. The devices used are usually direct record electronic (DRE) voting machines with flat panel displays (Volkamer, 2009). DRE voting machines are one of the most recent additions in the development of e-voting systems (Bellis, 2008).

The ballot form displayed in a DRE voting system is known as an e-ballot and DRE voting machines can store different versions of e-ballots in a variety of languages. An e-ballot eliminates the use of paper ballots. Therefore, a DRE voting machine removes the cost associated with printed paper ballots, thus making an e-ballot environmentally friendly.

Buttons or touch screens are normally utilized as an input method. The DRE voting machine guides the voter through all the steps involved in an election. All e-votes that are completed by voters are stored on the voting

machine's internal storage. The DRE voting machine stores an e-vote at the same time as recording the e-vote (Caarls, 2010).

When vote tabulation takes place the results are normally stored on a removable memory device or another storage device. In addition to vote storage the results are printed too. The results would then be transmitted electronically to a central location where the final results are consolidated and the final results are reported. DRE voting machines do not provide a paper trail; therefore recounts cannot be done manually.

Two countries that have made use of the DRE voting machines are India and Brazil. These case studies will be discussed later in this chapter.

2.3.3 Networked E-voting Machines in Polling Stations

Networked e-voting takes place in a *controlled environment* as illustrated in Table 2.2, and is similar to stand-alone e-voting DRE voting machines which are usually utilized. However, the difference between the two methods is a network connection, as a networked e-voting machine makes use of the Internet or any other network connectivity. This allows for instant verification online to check if the voter is eligible to participate in the election. In addition, e-votes can be counted immediately at a central location because the results are transmitted over the network. This, however, increases the risks associated with e-voting. The various security risks associated with e-voting will be discussed in section 2.6.

2.3.4 Kiosk E-voting Machines

Kiosk e-voting machines are similar to an automated teller machine (ATM) which is employed by banking sectors worldwide. Kiosk e-voting machines are in an *uncontrolled environment* as seen in Table 2.2; therefore there is no method to ensure accuracy, integrity and privacy (Volkamer, 2009). The voting system's locations are normally dispersed across shopping centres, schools and some other central locations. This method of voting is similar to the networked electronic voting machines, as it allows e-votes to be stored and transferred instantly to a central location. DRE voting machines are utilized and touch screens or buttons are used as input devices as

mentioned in previous sections. As the DRE voting machines are connected to a network or the Internet, security risks such as malicious attacks could potentially increase. As mentioned in the previous section, e-voting security risks will be discussed in section 2.6.

2.3.5 Online Voting

Online voting, also known as Internet or remote e-voting is another type of e-voting and is similar to postal voting. For the purposes of this research the term online voting will be used. Postal voting allows a voter to participate in an election from anywhere in the world and usually occurs in advance except for Austria where postal voting is used on Election Day. In countries such as Germany postal voting is only used on request (Volkamer, 2009).

Further, postal voting takes place in an *uncontrolled environment* where no election official is responsible for the election process. Online voting has similar features associated with it. For example the voter could cast his/her vote from any location in the world. The difference between online voting and postal voting is that the online vote is registered instantly. Postal voting requires the use of paper ballots whereas online voting utilizes an e-ballot.

Online voting takes place in an *uncontrolled environment*, giving the voter the mobility to vote from any location of choice. Requirements for online voting would be an Internet connection, access to a computer and a browser that supports the application utilized to vote. The voter must be registered to be able to participate in an election. In addition, a voter would be authenticated online via various methods, for example using an ID card.

An example of a country using online voting is Estonia; they make use of the Estonian ID card as identification. Therefore, the voter would need access to a card reader to verify the Estonian ID card online (VVK, 2011). The Estonian voting process will be discussed in detail in section 2.8.1.

Online voting faces many challenges when it comes to security. One of the benefits that online voting has over postal voting is the fact that it happens instantly, thus the votes can be counted immediately.

Another benefit would be that people living abroad could also participate in an election without having to travel back to the country where the elections take place (ACE Projects, 2011). Further benefits associated with online voting will be discussed in detail in this chapter. In addition, the benefits associated with e-voting will also be discussed in the subsequent section.

2.4 Benefits of E-voting

According to Volkamer (2009) various authorities worldwide are starting to implement e-voting because of the various benefits associated with an election. There are a myriad of benefits that e-voting has to offer. These added benefits could contribute to achieve a free and fair election.

The first benefit that arises when discussing e-voting is that ultimately it can prove to be more cost effective. South Africa is an example of a country that still uses ballot papers when going to the polling station. The 2009 South African election had 55 543 000 ballot papers printed in full colour to allow every registered voter to vote. There was a total of 23.1 million people registered to participate in the 2009 South African elections. In addition, it was reported that 460 tonnes of ballot paper were used (IEC, 2010a). Therefore, not only would online voting be more cost effective but the carbon footprint would also be minimised. It also presents better access to information regarding the whole election process (Brown & Langenegger, 2011, p. 194).

Furthermore, e-voting also allows for more accurate results. The mitigation of spoilt votes is an advantage and contributes to achieving a more exact final result. In addition, the counting process of e-voting is much more efficient than for example counting ballot papers by hand (Frith, 2007). Consequently, this could allow for instant results after an election.

Another benefit is the mobility associated with e-voting, in particular online voting. As mentioned earlier online voting would allow expatriates to participate in an election. A country such as South Africa can benefit from online voting because of the vast number of South African citizens living abroad. The South African election in 2009 permitted people living abroad to participate in the national elections (IEC, 2009a). According to the 2009 election report 18 855 citizens living

abroad were registered to vote. It was calculated that only 9 857 citizens voted at 123 embassies worldwide in the 2009 election (IEC, 2010a). A possible reason for the lack of participation was that all citizens had to go to an embassy to participate in the elections. Thus, travelling cost could have hampered the participation of voters in the 2009 election (February & Misra-Dexter, 2010, p. 178; Swanepoel, Thomson, & van Niekerk, 2010). For that reason, to improve expatriate participation in an election, online voting can be of a huge benefit to an election process (Herbert, 2009).

Another advantage of e-voting is that, because of its adaptability, people with disabilities, ill health and the elderly can vote. An example would be a visually impaired voter could use a screen magnifier to enlarge the text. In addition, the e-ballot layout can also contribute to a more user-friendly experience. For example a voter could vote in his/her language of choice (Scytl, 2012).

This section discussed the benefits of e-voting. However, there are challenges associated with the implementation of such a voting process. According to literature, security has been identified as one of biggest challenges that face e-voting. Section 2.6 will discuss the various security challenges associated with the implementation of e-voting systems. The next section defines the information security requirements with regard to the confidentiality, integrity and availability in the context of e-voting.

2.5 Information Security and E-voting

Making use of technology when casting a vote can increase security challenges, for example, through exposure to internal, external and physical attacks. E-voting, especially online voting faces substantial security challenges that stem from infrastructure, software, hardware and protocols. An e-voting system makes use of computer systems to store, send and process information and, therefore, protecting the information against threats is extremely important. These threats include, but are not limited to, viruses, worms, hackers and social engineering which will be detailed in subsequent sections.

The process of protecting information from harm is known as Information Security. The main objective of information security is to protect the characteristics of

information; that is protecting the confidentiality, integrity and availability of the information. According to Abraham & Chengalur-Smith (2010) one needs to identify and classify threats with regards to information systems. The identification and classification can be seen as one of the cornerstones to safeguard information systems (Abraham & Chengalur-Smith, 2010). An e-voting system stores, sends and processes all election information such as the voter's personal details. These details include but are not limited to for example the votes cast.

Therefore, the protection of election information is of utmost importance. Ensuring the confidentiality, integrity and availability through the implementation of technical, physical en procedural controls can contribute to the success of an e-voting system (Frith, 2007).

2.5.1 Confidentiality

The confidentiality of information ensures that only authorized parties can access the information. In an e-voting system the purpose of confidentiality is to allow a voter to cast a vote secretly and anonymously, thus ensuring that the casting, transfer, reception, collection and tabulation of votes are private (Gritzalis, 2002).

2.5.2 Integrity

The integrity of information ensures that no unauthorized person or malicious software program has modified the data (Gritzalis, 2003). Any threat that can compromise the integrity of an e-voting system must be mitigated or fully eliminated. The ballot that is cast by the voter must be transferred to the tabulating system without any modification and must be accurate (Gritzalis, 2003). If the integrity of such a voting system can be achieved it will contribute to voters having confidence in the electoral system.

2.5.3 Availability

The availability of information must allow authorized individuals to be able to access the information when needed and restrict attempts by unauthorized individuals. E-voting systems need to be available for voters

to cast their vote when required to do so. An e-voting system should be protected from threats like denial of service attacks for example. If not, the system will be unavailable and can affect the right of a voter to cast his/her vote.

The next section will discuss the various security challenges that face e-voting systems. The section will detail the most well-known challenges but it is not limited to these security threats.

2.6 Security Challenges Associated with E-voting Worldwide

Frith (2007) stated that there is no voting system in history that has ever proven to be 100 percent perfect. In recent times, it has become much more difficult to secure information. Technology faces a huge increase in the number and sophistication of threats nowadays. As a result of the speed of attacks, faster detection of weaknesses and distribution of attacks, security cannot be overemphasized because of its importance in an e-voting system. To have a voting system that will convince the public that it is credible is of utmost importance to a country's democracy.

Exploring different e-voting systems worldwide; it has been concluded that there are many issues that need to be addressed because they can influence the desirability of such an electoral system. When implementing a new system a voter must have confidence in the new system. Therefore, careful consideration must be given which voting system to select. Some of e-voting's biggest threats with regards to security, are social engineering and attacks from malicious software, but are not limited to them (Mason, 2004).

These different security threats to an e-voting system will be discussed in detail in subsequent sections.

2.6.1 Social Engineering

"Social engineering uses influence and persuasion to deceive people by convincing them that the social engineer is someone he isn't, or by manipulation. As a result, the social engineer is able to take advantage of

people to obtain information with or without the use of technology." - (Mitnick & Simon, 2003)

Social engineering has been identified as one of the favourite methods to carry out electronic crimes (e-crimes) (Abraham & Chengalur-Smith, 2010). Therefore, it can be seen as a great risk with regards to an e-voting system, especially online voting. According to Mitnick & Simon (2003) no one will be able to stop a gifted social engineer from accessing corporate and government databases, even if the best encryption methods and firewalls are put into practice. An attacker will always find a route into a system and the most effective way is to take advantage of the weakest link – the human factor.

Social engineering uses the human factor to infiltrate systems despite any controls that have been implemented. Exploiting humans and their gullibility is so much simpler than trying to get access to a system that is secure. Many systems are automated today but there is no system that does not require a human to be involved; this might include maintenance or simply editing data (Thapar, 2007). Getting access to information through social engineering techniques is definitely one of the most effective methods without raising users' suspicions. According to Thapar (2007) there are two categories concerning social engineering namely human-based/non-technical deception and computer-based/technical deception. All techniques in social engineering belong to one of these two categories (Allen, 2007).

The difference between these two categories is when making use of human-based deception, an interpersonal relationship is formed as stated by Allen (2007). In addition, as mentioned in this section, humans are the weakest link with regards to social engineering (Abraham & Chengalur-Smith, 2010). Hackers will exploit this link by acting as a person with authority and making a phone call to the user portraying himself or herself as a manager. An example of such a scenario is phoning the help-desk and asking the employee to reset the "managers" username and password because he/she forgot it. This will give a hacker full access to the account

holder's credentials (Thapar, 2007). Thus, this is just one technique that could be utilized to exploit the so-called weak link – people. There are many different techniques to trick people into giving their important information to the attacker.

Computer-based deception makes use of technology to deceive the user (Allen, 2007). An example would be when a user is working with an application that is believed to be the true application. This application would require the user to enter some personal information like his/her username and password without being suspicious. Applications like this normally pop-up, and then after the user has provided the required data the hacker has access to confidential information (Thapar, 2007).

Social engineering has different technical and non-technical attack methods. These include the following:

- Phishing;
- Dumpster Diving;
- E-mail Infection;
- Pop-up Windows;
- Pre-texting, Impersonation;
- Spying & Eavesdropping;
- Technical Expert / Support Staff (Buetler, 2009; Thapar, 2007)

The above mentioned social engineering techniques could contribute to the failure of a political election if not managed properly. According to Rubin (2002), when voting in an election, many people are not able to follow basic steps, adding to confusion when voting. Therefore, this can be seen as a human vulnerability that a hacker can potentially take advantage of in an election.

When a voter takes part in an election using online voting, for example, a social engineer can easily spoof the election website. This can be done by sending an e-mail message containing a fake link to the spoofed election website. This will cause the voter to believe that they have accessed the correct election website without any suspicion that they have been misled.

The attacker can then use the voter's credentials to cast a vote for a party or candidate of his/her choice, therefore, stealing the vote (Rubin, 2002).

2.6.2 Domain Name Server Attack

Another serious security challenge facing an online election process is a domain name (DNS) server attack. The function of DNS is to map from an IP address (e.g.: 209.85.129.147) to a domain name (e.g.: www.google.com). An attack that is launched on Election Day against a DNS server could have an enormous impact on election participation. In addition the damage will not be limited to election participation - it will also affect the final results.

An example which is a known vulnerability of DNS is cache posing, this is a process which corrupts the Internet DNS table using a rogue address. This will route a request from an e-voter to a wrong web server which appears to be the legitimate election voting webpage. This gives an attacker the opportunity to act as a man in the middle, thus allowing the attacker to control the webpage and have the power to influence the whole voting process. This security challenge could influence the availability of the election system, thus influencing the outcome of the results.

2.6.3 Attacks from Malicious Software

Malicious software can be defined as software that compromises applications that are distributed onto computer systems to instigate damage to that system. This could cause the system not to fully function as required by the user.

Viruses, worms, Trojan horses and spyware are examples of malware. According to Schryden (2004) the damages that could be inflicted by malware are unlimited. In an election process these threats, if they materialize, could have an enormous impact on the final result. Therefore, it is vital to protect the confidentiality, integrity and availability of election information as mentioned in section 2.5. E-voting systems are just as vulnerable to malicious attacks as any other information technology system.

Section 2.2 outlined that a voting process can take place in a controlled and *uncontrolled environment.* An *uncontrolled environment* might face additional challenges when it comes to an election. Hosting an election in a *controlled environment* allows for increased control over the election process such as voting at a polling station. An example will demonstrate the importance of mitigating all security risks. When an attacker gets physical access to a DRE voting system he/she can configure the machine using malicious software. This can be done by removing the memory card within a few minutes without anyone noticing the attacker installed the malicious software. The end result will have serious consequences when it comes to an election.

Rivest (2001) states that current infrastructures of e-voting, especially online voting, could be exploited by malicious software. In an *uncontrolled environment* for example the Internet can be exposed to a flooding of Denial-of-Service (DoS) attacks. A DoS attack prevents a legitimate user from accessing the device or service required. An example of a DoS attack in an e-voting context would be disallowing the voter from accessing the election website. The reason for this is because the attacker would have flooded the target computer i.e. the election server with invalid requests. A well-known DoS attack is where the attacker uses a large number of computers to launch a joint attack on the target machine. This is known as a distributed-denial-of-service attack. In 2007, the Estonian Internet infrastructure was attacked using a distributed denial-of-service (DDoS) attack. These attacks lead to the unavailability of important services, such as online banking. Such an attack with regards to online voting could have an extremely negative impact on an election.

Another form of malicious software is viruses. Extensive defence mechanisms are required to protect against the vast range of different and complex viruses attacking networks and systems. Even with all these intrusion prevention mechanisms computer systems are still vulnerable to these threats. A virus can be defined as malicious software that could cause harm to a system in different ways (Sophos, 2009). This harm can be for example stealing data or taking control over a system. Viruses

normally replicate themselves onto other systems through the distribution of e-mails containing an infected attachment or simply by downloading files from the Internet. In addition to this, storage mediums are also a source to distribute viruses (Walker, 2006). A virus such as Chernobyl could potentially cause a lot of damage in an election context. The reason for this is that a virus such as Chernobyl has a trigger date connected to it. Further, the date of an election is normally known well in advance. Thus, this malicious software could be triggered on the Election Day. The Chernobyl virus caused damage by modifying the BIOS in computer systems and the result was that a computer system could not even boot. If a virus such as Chernobyl was executed on an election day many voters would not be able to vote and this could have a direct impact on the election results (Schryen, 2004).

A further type of malicious software is a Trojan horse. A Trojan horse pretends to be something it is not, intentionally misleading someone. Thus, this malicious program pretends to be something that is advantageous, but in fact it is the contrary. What distinguishes them from viruses and worms is that they do not re-replicate or infect computer files. A Trojan horse inserts malicious instructions or code into a program (Sophos, 2009). The malicious code inside the program can do a lot of harm to information systems. Trojan horses could assist attackers in committing serious cybercrimes and give them access to systems remotely. These crimes include fraud, theft of services, sabotage and espionage for example. Trojans can also be as destructive as viruses. Therefore, protecting the election information from Trojans cannot be overstated as mentioned by Rubin (2002).

The integrity of the voting system is of utmost importance and when an attacker can get access to a voting machine, the system's integrity will be jeopardised. The various security vulnerabilities discussed in this section are some of the biggest challenges facing e-voting. Rubin (2002) stated that security in elections is very important and the public must have confidence so that they can elect their government of choice. Any threat to the integrity of the election system must be dealt with vigilance and suspicion.

2.7 E-voting in Developing Countries

Countries with a low level of material well-being are classified as developing countries. Various definition of this term exists, but there is an absence of a single internationally-recognised definition (Nangue, 2011). Developing countries such as India and Brazil have also joined other countries to utilize technology in their election process (Thakur, 2010). These two countries face similar challenges that could hamper the implementation of technology in an election. Poverty, illiteracy, grid, digital divide and lack of ICT infrastructure are some of the challenges faced by developing countries.

According to the International Telecommunication Union (ITU) (2010), approximately 21 percent of people in developing countries have access to the Internet. In contrast, developed countries have an Internet connectivity rate of 71 percent among their citizens. In addition to not having Internet access, there is also a shortage of computer literacy in developing countries worldwide. Developing countries are improving their IT skills/literacy among citizens, but their literacy levels are still behind developed countries around the globe.

South Africa is acknowledged as a developing country (AMS, 2011). Furthermore, South Africa is also recognised as a newly industrialized country. Countries with more advanced economies than other developing nations, but which have not yet fully demonstrated the signs of a developed country, are grouped under the term newly industrialized countries. In addition, India and Brazil has also established themselves as newly industrialized countries (IMF, 2011).

As the focus of this research is South Africa, it is relevant to investigate e-voting in countries such as Brazil and India that face similar challenges to South Africa (Thakur, 2010). Brazil, India and South Africa have similar challenges facing them because of their status as developing countries. As mentioned earlier, some of the challenges include, but are not limited to grid challenges, poverty, illiteracy, election fraud and digital divide.

One of the above mentioned challenges is the off-grid challenge. Brazil and India display a mixed economy. According to Thakur (2010) South Africa has also been identified as a country with a mixed economy, thus various parts of South Africa,

Brazil and India has well-developed urban areas, but in contrast also have less developed areas.

Developing countries have high levels of illiteracy. In addition, poverty is also associated with developing countries. The ICT infrastructure associated with Brazil and India has been identified as mixed. Therefore, urban areas have a higher Internet, mobile and fixed line utilization rate, while rural areas show far lower connectivity levels. According to Thakur (2010), South Africa has been identified with a low literacy level and mixed connectivity. Therefore, digital division are associated with countries such as South Africa, India and Brazil.

Furthermore, Brazil, India and South Africa form part of the trilateral alliance called the India, Brazil and South African alliance (IBSA). As mentioned both Brazil and India make use of e-voting processes in their electoral system. Therefore, taking all the similarities in to account and their IBSA partnership, it might be a sufficient condition to leverage and investigate their e-voting experiences. As stated by Thakur (2010), Brazil and India can share their experiences, information and informed intelligence with regard to their e-voting experiences.

For that reason investigating electoral processes from countries such as Brazil and India, can contribute to formulate a process model which will depict a possible technological voting solution for South Africa. The following sub-section will discuss the various electoral processes from Brazil and India.

2.7.1 Brazil

Brazil is a country with a population of approximately 203 429 773 people (The World Factbook, 2011a). According to the World Fact book (2011a) Brazil's population figure is ranked fifth in the world in comparison with other countries, and approximately 120 million people participate in their elections (BBC News, 2008). In Brazil the Tribunal Superior Electoral (TSE) is responsible for the administration of the Brazilian electoral process.

Brazil was the first country with a large population with various challenges such as poverty, illiteracy, digital divide, off-grid problems and election fraud that executed a fully computerised election.

Brazilians experienced e-voting for the first time in October, 1996. This was at municipal level (Meza & Nelly, 2009). Soon after 1996 the general elections in 1998 also had various cities testing the new e-voting system. In the 2000 municipal elections all Brazilian citizens across the country could vote via the e-voting system (Avgerou, Ganzaroli, Poulymenakou, & Reinhard, 2007). The e-voting system utilized by Brazil is a direct record e-voting (DRE) system in a *controlled environment* at a polling station. Figure 2.1 illustrates what the Brazilian DRE voting system looks like.

Figure 2.1: Brazil electronic ballot box, 2006 model. Adapted from Superior Electoral Court (TSE, n.d.).

There are various benefits associated with the Brazilian DRE voting system. One of the benefits is that the system allows for rapid vote tabulation. Therefore, results are available to the public within hours after voting.

Another benefit associated with the DRE voting system is its internal battery support. When a power failure occurs, the DRE voting system switches over to use its internal battery. In addition, the DRE voting system can also be connected to an automotive battery to fully operate. This can potentially address power failure challenges in an election.

Since the 2008 elections the TSE in Brazil has started to implement a new version of the DRE voting system in certain parts of the country. The new

version of the e-voting system integrates biometric technology to increase security. According to the People Daily (2010), Brazil expects to have all their DRE systems using biometric technology by 2018. The new biometrical e-voting system will be storing a voter's fingerprint, photo and some personal information. This will improve the credibility of the DRE system.

The next few paragraphs will discuss the Brazilian method of voting and the focus will be on the DRE voting system that was utilized in most parts of Brazil during the 2008 elections. This section will not discuss the DRE biometrical voting machine that is utilized in certain areas in Brazil since the 2008 elections. The DRE biometrical voting machine is still in a pilot study phase, therefore for the purpose of this research the information available were not sufficient enough.

The Brazilian DRE voting machine which was utilized in the 2008 election has various characteristics associated with it, for example, it is an interface that is easy to use, straightforward and secure (TSE, n.d.). The DRE voting system has a liquid crystal screen (LCD) with a numerical keypad that allows the voter to cast his/her vote as illustrated in Figure 2.1.

In addition, one of the major benefits of the DRE voting system is the braille coding that has been incorporated onto the numerical keypad. This affords blind people the opportunity to participate in the Brazilian elections. There are also headphones available for a disabled person when voting. The voting process is made very simple because of the large number of illiterate voters in Brazil. According to statistics there is an estimate of 30 percent of the Brazilian population who are illiterate (Avgerou et al., 2007).

In Brazil voters must be registered to be able to participate in an election. When a voter registers he/she will receive a voting card that will be used as an identification method on Election Day. Citizens who are 18 years and older must participate in the election. Certain people are exempted from the mandatory voting process, which include people younger than 18 years and older than 70 years (Caarls, 2010). Furthermore, it is optional for illiterate Brazilians to participate in an election.

The first step for a voter at the election polling station will require the voter to prove his/her eligibility to participate in the election. This is done by typing the voter's vote identification number into the voter identification terminal as illustrated in Figure 2.1. The e-voting machine stores a list of registered voters on the storage medium of the e-voting machine. The voter's vote identification number is compared to a list of registered voters (Chaum, Jakobsson, & Rivest, 2010, p. 131). If the voter is eligible he/she will go to the secure voting booth. The voter makes use of a numerical keypad to choose his/her candidate of choice. A picture of the candidate is displayed with an identifying number next to the candidate. After the voter has made his/her selection there are two buttons available: a green button and an orange button. The green button is the confirmation button and the orange button is there to correct the voter's choice. In addition to the two keys there is a white key which is used to cast a blank vote (Froehner & Ryan, 2010). After the voter has voted there is a confirmation that he/she has voted. A feature that is not included in the Brazilian DRE voting system is a paper audit trail. This can be seen as one of the drawbacks associated with a DRE voting system as mentioned in section 2.3.2.

As mentioned, the tabulation process of votes happens rapidly and is one of the benefits associated with the Brazilian voting system. A double encrypted format is utilized to save the election data on a disk. The voter's identification is not stored on these disks. Thus, the confidentiality of the vote is protected. In addition, the encryption also helps to protect the integrity of the election data and alleviates the chance of election data being tampered with (Avgerou et al., 2007). After polling stations close on a general election day the encrypted data on the disks is transported to the local electoral committee. The data is read and then transmitted to the Regional Electoral Court of the Federal District (BBC News, 2008).

Finally, Avgerou et al. (2007) concluded that prior to the 2008 elections, Brazilian citizens showed a high level of trust in the electronic election process. In contrast, security concerns have been raised among technology experts and political scientists. As stated by Froehner and Ryan (2010) various countries have not implemented e-voting because of the

suspicion of electronic fraud. Brazil, however, took this opportunity to include technology into their voting process which was well received and helped in mitigating election fraud. (Froehner & Ryan, 2010).

Another developing country that has used e-voting with great success is India. The subsequent section will discuss the Indian electoral system in detail.

2.7.2 India

India has the world's second largest population with an estimate of 1 189 172 906 people (The World Factbook, 2011c). It is seen as one of the largest democracies in the world. India has received numerous accolades for conducting free and fair elections on such a large scale (Indian.gov.in, 2009). India faces various challenges such as poverty and illiteracy which has the potential to contribute to decreased voter participation in an election. In 2009, India held its general election which elects its Prime Minister and takes place every five years. There were approximately 714 million eligible voters that were registered to vote (BBC News, 2009b). The election process in India takes place over one month because of the large population that is eligible to vote. Therefore, India has turned to technology to simplify the voting process (Singh, 2004).

India's technology evolution started as early as November 1998 (ECI, 2009). They started utilizing electronic voting machines (EVM) to reduce irregularities such as election fraud. Additionally, e-voting reduced the logistical facets associated with the Indian voting process. In India's 2004 election, EVMs were utilized at every polling station countrywide for the first time. The 2009 Indian election had 828 804 polling stations which used 1 368 430 EVMs (BBC News, 2009b).

As stated in section 2.4 e-voting has various benefits but in contrast there are also some challenges. According to the Indian Chief Election Commissioner, Navin B. Chawla (2010), the Indian EVMs that are utilized in elections are very successful. In contrast, researchers have proved that the Indian EVM is not tamper-proof (Gonggrijp, et al., 2010). Therefore, India

has been running pilot projects to incorporate the voter verifiable paper audit trail into their EVMs. A paper trail is a paper backup of every vote cast in an election. This would increase the credibility of India's EVM system that has been criticised previously (Tewari, 2011).

The EVM has been very successful and it can be attributed to its simple design, ease of use and reliability (Gonggrijp, et al., 2010). One of the advantages of the Indian EVM is that there is no network connectivity. This enhances security as it minimizes the risks of remote attacks via networks, such as malicious software attacks. Another benefit is that the EVM can run on battery power, eliminating the need for a power supply. This is a very important feature especially in a country such as India that faces power supply challenges (Sengupta, 2007).

The EVM consists of two interlinked units; the ballot unit and the control unit as shown in Figure 2.2.

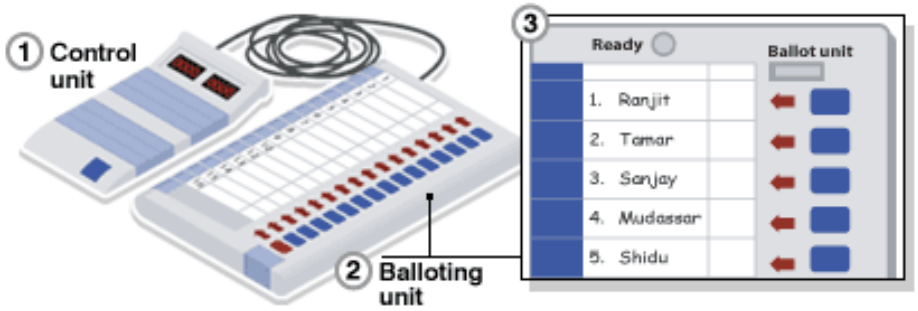


Figure 2.2: India's Electronic Voting Machine (Beary, 2004).

The ballot unit is used by the voter to make his/her choice. The control unit stores all the functions and data of the EVM. The software which controls the unit uses a non-volatile microchip; this ensures the data is burnt on the chip and no one can alter the chip. To enhance security, dynamic coding is used to protect data being transmitted from the ballot unit to the control unit (Gonggrijp, et al., 2010). Another feature associated with the EVM is that it records the exact time and date when a key was pressed on the machine, which is achieved through the real-time clock and date stamping feature. The control unit also displays the results of the total number of votes cast.

In addition, a major benefit is that the EVM can detect physical tampering, thus increasing security (Gonggrijp, et al., 2010).

The voting process in India does require that all participating voters are registered on the voters roll. The Election Committee of India oversees the whole voting process. The elections in India have become simple and fair because of the introduction of the photo electoral roll with photo identity cards for identification. The election photo identity card (EPIC) is required by a voter to qualify to participate.

There are different stages involved when going to the polling station in the Indian election (ECI, 2006). These stages will be explained in detail as follows:

- The first step entails that the voter goes to a polling station where the 1st officer will confirm that the voter is eligible to participate in the election. The voter is identified by his/her electoral photo identity card (EPIC). This officer is responsible for the electoral roll;
- The 2nd polling officer is responsible for marking every eligible voter's left forefinger with indelible ink. This is to prevent a voter from casting a vote twice. The officer will record the serial number of the voter in the electoral roll. The register must then be signed by the voter. If for any reason the voter is not able to sign the electoral roll he/she will have to provide a thumb print;
- The voter will then receive a signed slip from the 2nd polling officer that will be recorded in the register of voters and in the election roll;
- The signed slip will be given to the 3rd polling officer; he is in charge of activating the ballot and guiding the voter to the voting booth (ECI, 2006).

The voting procedure inside the voting booth consists of the following steps:

- Inside the voting booth the voter will make his/her choice by pressing the blue button next to the name or symbol of the candidate of choice, this is on the ballot unit;
- A red lamp will shine next to the choice of the voter;

- In addition to that, there will be a beep sound indicating the voter has cast his/her vote (ECI, 2006).

The above mentioned steps summarise the whole voting process in India. The voting process in India has been criticized by various authorities worldwide. However, as stated earlier India has held numerous elections which have been successful. The main benefit associated with the Indian e-voting system is the fact that it is easy to use. It allows every citizen the opportunity to participate in the Indian election. This includes, for example, people that are illiterate as mentioned earlier. Therefore, the Indian voting system could be seen as contributing to a democratic India.

2.8 E-voting in Developed Countries

Developed countries usually face fewer challenges than developing countries (Thakur, 2010). Estonia, Austria, Switzerland and the USA are all considered developed countries. In developed countries Internet access and computer literacy are at a much higher percentage than developing countries. Developed countries usually have comprehensive access to Internet in rural and urban areas (Thakur, 2010). Estonia, for example, is a world leader when it comes to technology and the Internet plays a pivotal role in the everyday functioning of Estonia. The implementation of e-voting in Estonia has been very successful (Kalvet, 2009).

The following section will examine the Estonian voting process in detail.

2.8.1 Estonia

Estonia is a European country with a population of approximately 1 282 963 citizens (The World Factbook, 2011b). Estonia actively uses the Internet to ensure “efficient and client-friendly” interaction with the Estonian government. According to Hall & Maaten (2008), using technology can contribute to achieving a better society and allowing citizens to actively participate to promote the democratic process. In Estonia the Internet is “almost as vital as water” because citizens use this for Internet banking, casting their vote in an election, filing their taxes and other online transactions (Landler & Markoff, 2007). According to the Estonia

OSCHE/ODIHR (2011) election assessment report an estimate of 68 percent of households have Internet access. In addition 88 percent of the population utilizes the Internet. This can be seen as a contributing factor to the success of electronic services in Estonia, especially online voting.

Estonia was the first country that hosted online voting in an election successfully (Caarls, 2010). Estonia has had five successful elections using online voting since October, 2005. The most recent election took place in March 2011. There are various methods that are utilized in Estonia when a voter wants to participate in an election. Online voting offers an extra voting channel. The other method of voting is similar to South Africa, going to a polling station on Election Day to cast a vote. Estonia makes use of paper ballots when going to the polling station to vote. This research will focus on investigating the online voting method utilized by Estonia.

There are various challenges facing e-voting, as discussed in previous sections in this chapter. In contrast to these challenges there are various benefits that make online voting an attractive method of voting. Estonia has implemented this method of voting with great success. Online voting participation has increased from the first time in 2005 (Caarls, 2010). Therefore, it could be concluded that the Estonian voting audience has developed confidence in the voting method. In addition, according to a survey that was done after the 2007 elections, one out of ten people that participated in the 2007 elections would not have voted if online voting was not available to them (Hall & Maaten, 2008). This presents a voting method that could increase voter participation in future.

Online voting in Estonia takes place a few days before the actual Election date. Security is one of the main concerns facing e-voting and therefore, Estonia has introduced the Estonian ID-card to provide confidentiality by authenticating the voter using the ID-card (ID.ee, 2007). In addition to the Estonian ID-card there is another method of identification – the mobile-ID. This method of identification was utilized for the first time in the 2011 election with success.

The Estonian ID-card is issued to all citizens by the Citizenship and Migration Bureau of the Police and Border Guard Board. The Estonian ID-card has security features such as two unique pin numbers. It has two certificates associated with it. The purpose of these certificates is for authentication and a digital signature. The ID-card has personal information attached to it. This information on the front side of the ID-card is the name of the card holder, personal code of card holder, birth, sex, citizenship, residence permit details, card number and card expiration date. The back side of the card has the card holder's place of birth, the issuing date and the card and holder data in machine-readable format. To utilize the Estonian ID-card in an election the voter has to have access to a computer with an Internet connection. In addition, the operating systems that are supported are Microsoft Windows, Mac OS X and Linux. The voter should also have a chip card reader that would be utilized in the voting process. The card reader is used to read the information on the ID-card. The software utilized for the Estonian ID-card is available online for downloading (ID.ee, 2007). As an alternative to using the Estonian ID-card for voting, the voter could instead use the new identification method, the mobile-ID (VVK, 2011).

The mobile-ID is used by Estonians to identify them online. It requires a SIM card that has been activated for the mobile-ID service. This is done at a mobile operator where a service agreement is made between an Estonian citizen and the operator. The benefit that arises from using the mobile-ID identification method is that the voter does not require a chip card reader, thus making the process of identification more convenient. The mobile-ID is similar to the ID-card and has two pin numbers associated with it. In addition, the voter has a mobile-ID certificate associated with it to make the authentication process more secure. When utilizing the mobile-ID the voter still requires a computer with Internet access to participate in an election (VVK, 2011).

The steps that are involved in online voting happen in advance, normally from the 10th day until the 4th day prior to Election Day. The online voting

steps are explained in detail as stated by the official Estonian election website (VVK, 2011).

Stages of online voting if **mobile-ID** is used:

- Voter accesses the National Electoral Committee's online voting website;
- Voter downloads the voter application;
- Voter enters his/her mobile number;
- Voter enters mobile-ID Pin 1 for identification (control code was sent via SMS to his/her mobile phone);
- Candidate list shall be displayed;
- Voter selects his/her candidate of choice;
- Voter provides a digital signature to confirm his/her choice by entering the mobile-ID PIN2 code (control code was sent via SMS to his/her mobile phone);
- The voter receives an on-screen notification that his/her vote has been accepted (VVK, 2011).

Stages of online voting by means of **ID card**:

- Voter uses a card reader to insert his/her ID card into;
- Voter accesses the National Electoral Committee's online voting website;
- Voter downloads the voter application;
- Voter enters PIN1 code to identify himself/herself;
- Candidate list shall be displayed;
- Voter selects his/her candidate of choice;
- Voter confirms his/her choice by digital signature and entering the PIN2 code;
- The voter receives an on-screen notification that his/her vote has been accepted (VVK, 2011).

The above mentioned steps detailed the online voting process in Estonia. One benefit of this system is that a voter can change his/her vote as many

times as he/she wishes. When a voter changes his/her vote only the last vote will be counted thus complying with the election legislation; one vote per voter. An advantage of such a system is the prevention of illegal influences; this allows the voter to cast a new vote when the person that influenced them has left. Another advantage is that when the e-voting system is compromised, for example if it is hacked, then the voter can still cast a vote by going to a polling station using a ballot paper. When the votes are tabulated the last legal vote of a voter would be counted as mentioned previously (VVK, 2010). The e-votes are counted on the Election Day with the ballot paper votes. Thus, online voting takes place in advance but not the tabulation of the e-votes.

Ensuring the confidentiality (secrecy) of a vote in the online voting system, Estonia uses the double envelope scheme as illustrated in Figure 2.3 (VVK, 2011). This is a similar concept to postal voting used in various other countries. First, the voter's choice will be encrypted using a voting application (i.e. voter seals the choice into an inner blank envelope) and the voter digitally signs (i.e. places the inner envelope into an outer envelope with the voter's details on it) the vote. The encrypted, signed votes are accumulated to a central site for confirming that only one vote has been cast and counted per voter (VVK, 2007).

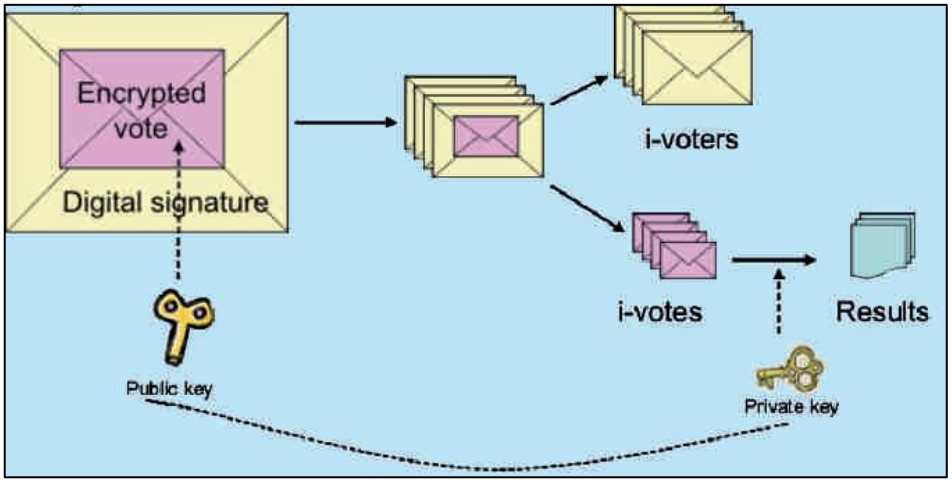


Figure 2.3: Double-envelope secrecy scheme (Internet Voting in Estonia, 2007).

Before the counting takes place, the personal data contained in the digital signature (outer envelope) is removed and anonymous encrypted votes (inner envelopes) are submitted into the ballot box to be counted. A public key cryptography which makes use of a private and public key is used in the "double envelope" scheme. A vote can only be decrypted using the private key of the corresponding public key used to encrypt the data. The National Electoral committee is responsible for the safeguarding of the private keys, and opening the encrypted Internet vote on the Election Day (VVK, 2007). The use of the public key infrastructure is a prerequisite in Estonia together with digital signatures and the authentication process. This plays a pivotal role in the protection of the secrecy of a voter's vote. Thus, increasing confidence in the election process and contributing to achieving a free and fair voting process. According to Hall and Maaten (2008) technology worldwide has influenced the way elections are held and therefore, one would see the wide dispersion of technology utilization globally in the future.

In addition to Estonia, various states in the USA implemented e-voting systems in their electoral processes. This research will look at paper-based optical scan voting machines which have been implemented across numerous states in the USA. The Election System and Software (ES&S) electoral system utilized in various counties across USA states will be discussed in detail in section 2.8.2.

2.8.2 United States of America (USA)

The USA is known as one of the world's most influential and technologically advanced countries globally (EconomyWatch, 2010). Their population is estimated at approximately 313 232 044 people (The World Factbook, 2011e). The country is divided into fifty states and one district. According to the World Factbook (2011e) this is the third largest population in the world. The USA is another example of a developed country which opted to incorporate technology into its electoral system. The first implementation of e-voting systems in the USA was almost a half a century ago and has continued to evolve (Bellis, 2008).

Various electoral systems have been utilized in different counties within various states in the USA. According to statistics most states across the USA opted to implement paper-based optical scan voting systems (Pew Center of the States, 2008b). This was followed by the implementation of DRE voting systems. Each county in various states or districts in the USA is allowed to implement its own choice of voting system. Figure 2.4 illustrates the percentage of e-voting systems used in the 2008 general election across the USA.

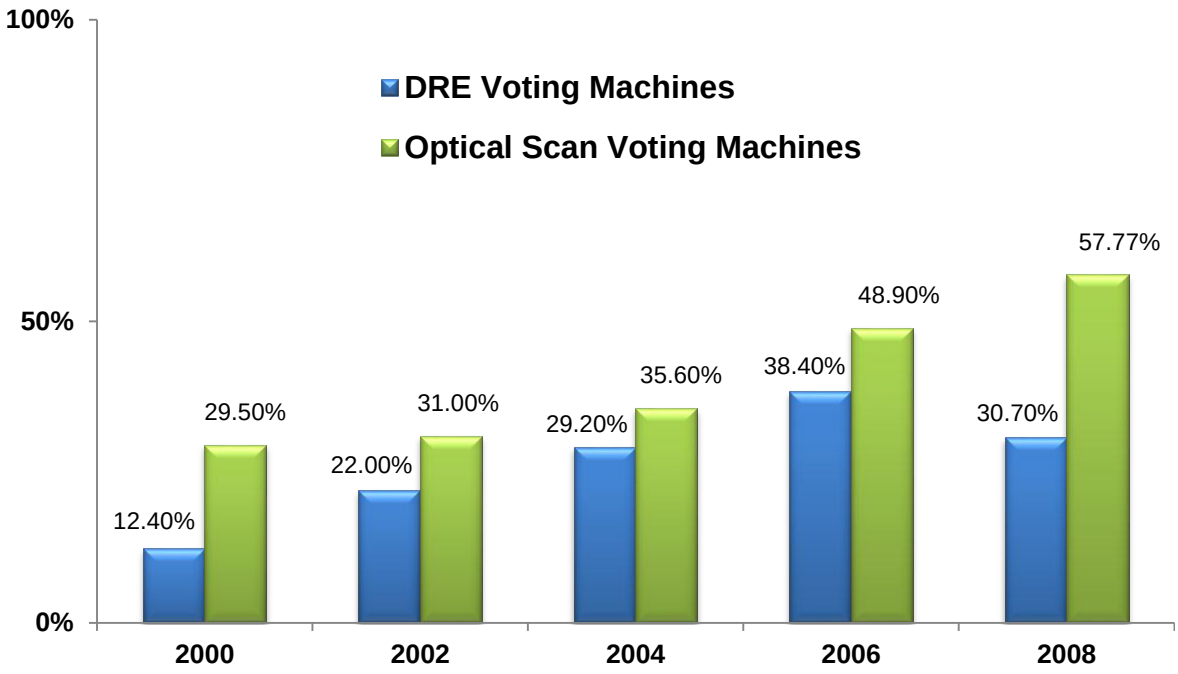


Figure 2.4: Voting systems in 2008. Adapted from Election Preview 2008 (Pew Center of the States, 2008b).

As depicted in Figure 2.4 paper-based optical scan voting systems have predominantly been utilized in the 2008 general election. There was a decrease in the utilization of DRE voting systems in the USA since the 2006 elections as illustrated in Figure 2.4 (Pew Center of the States, 2008b).

Paper-based optical scan voting systems at a polling station offer various benefits. As mentioned in section 2.3.1.2, one of the benefits associated with an optical scan voting system is the provision of an audit trail. Another benefit is the mitigation of security risks because an optical scan polling station voting process takes place in a *controlled environment*. These

benefits could potentially be the reason for the increased implementation in the 2008 general election in the USA, but are not limited to them, (Pew Center of the States, 2008a). The following are some advantages which could contribute to the success of an optical scan voting system.

- The same ballot papers are used by all voters;
- Voters understand ballot papers easier;
- Voters can verify paper ballots;
- Optical scan voting systems allow voters to correct their mistakes;
- Optical scan voting systems can be audited;
- In the event that an optical scan voting systems fails, a voter can continue to vote;
- Optical scan voting systems theoretically prevent invalid votes (NCVOTER, n.d.).

The above mentioned benefits could be a few of the reasons why a large number of USA counties decided to implement paper-based optical scan voting systems.

This section will focus on the paper-based optical scan polling station voting process which has been widely used across the USA. Optical scan voting systems are manufactured by different companies across the world. For the purpose of this research the focus will be on the process associated with the Election System and Software (ES&S) DS200 optical scan voting system.

An example of the ES&S DS200 which utilizes digital scan technology is illustrated in Figure 2.5. The ES&S DS200 has various characteristics associated with it. For example, it provides an LCD touch screen with a user-friendly design. The LCD provides feedback to a voter if, for example, the voter has completed the vote casting process. In addition, the system has an integrated thermal printer and is also flexible and efficient (ES&S, n.d.). The ES&S DS200 stores the votes on internal memory which is transferred to a central location when voting has been completed.

Figure 2.5: ES&S DS200 optical scan voting system
(ES&S, n.d.)

The voting process associated with the ES&S DS200 optical scan voting system which has been used across the USA is as follows:

- The voter receives his/her ballot paper from an election official after registration;
- The voter casts his/her vote by marking the oval/rectangle/arrow next to the candidate's name with the marking-device provided;
- The voter feeds his/her ballot paper into the optical scan voting system to cast his/her vote;
- The optical scan voting system will notify the voter if the voter has over-voted by choosing more than one candidate;
- If the voter has over-voted he/she presses the return button and asks the election official for a new ballot paper;
- If the voter has not over-voted and he/she is satisfied with the vote the voter must press the accept button to cast his/her vote (Chan & Tarantola, 2010).

The above mentioned steps are the vote casting process associated with an ES&S DS200 optical scan voting system.

The ES&S DS200 optical scan voting system provides compatibility with an additional device; this is known as the AutoMARK Voter Assist Terminal.

According to ES&S the AutoMARK Voter Assist Terminal supports various voting system models which make voting more efficient and easier to use (ES&S, n.d.). Therefore, it is not limited to the ES&S DS200 optical scan voting system.

The AutoMARK Voter Assist Terminal allows people with a disability or someone with specials needs the opportunity to participate in an election. These voters can cast their secret vote independently and in privacy. The paper ballots utilized with the ES&S optical scan voting systems are similar for all voters. Thus, disabled and special needs voters utilize the same ballot as any other voter.

Some of the features associated with the AutoMARK Voter Assist Terminal are headphone support which accommodates blind and severely vision impaired voters. Another feature is the sip/puff tube which allows people that are unable to use their hands for example to participate in an election. There is also the option to increase the size of text on the LCD display which is integrated in the AutoMARK Voter Assist Terminal. This would improve the voting experience for someone that has limited vision.

The voting steps associated with the AutoMARK Voter Assist Terminal are similar to the ES&S DS200. As stated in this section the AutoMARK Voter Assist Terminal is used when a voter is disabled or has special needs.

This AutoMARK Voter Assist Terminal does not count votes; it is an added feature to an optical scan voting system. Therefore, the ES&S DS200 optical scan voting system would store the votes cast by the AutoMARK Voter Assist Terminal. The vote tabulation process associated with an optical scan voting system requires that the votes stored on the internal memory be transmitted to a central location where the final tabulation takes place at the end of the Election Day (Corley, n.d.). Thus all votes are counted electronically. In addition, the paper ballots used by voters to cast their votes serve as a paper trail. Therefore, a paper-based optical scan voting system can contribute to voter confidence. Another feature associated with ES&S voting systems is the option for custom made solutions, thus providing an option to improve e-voting systems.

Optical scan voting systems, as mentioned in this section, have various benefits associated with them. The USA has been implementing these e-voting systems in various states with great success. In contrast there have been incidents where the utilization of e-voting systems in the USA have been questioned; especially the security aspects of e-voting. Section 2.6 discussed the various security challenges associated with e-voting systems worldwide.

2.9 Summary

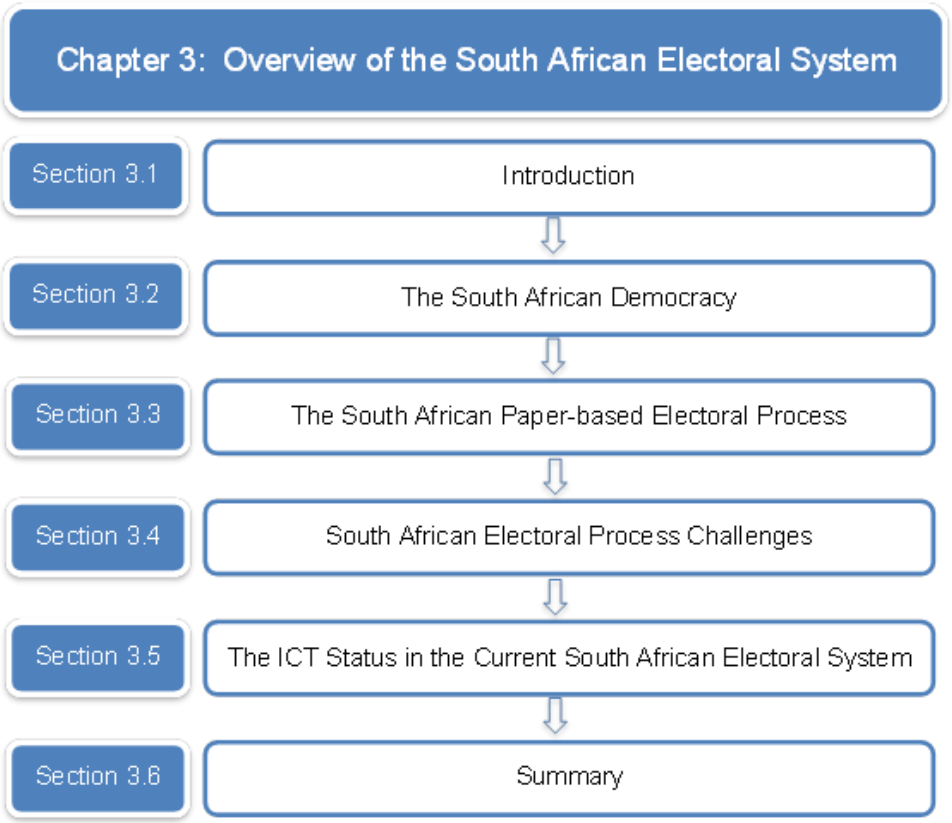
E-voting has been implemented in various countries including developed and developing countries. As seen in this chapter there are various benefits associated with e-voting such as cost saving, accurate results, improved counting time and multiple language support. In addition, there are also different vulnerabilities that threaten the security of votes, which could hinder the voters' confidence in a country's democracy. Protecting the confidentiality and integrity of the votes cast in an election, and ensuring the availability of the elections systems, should be of utmost importance in ensuring a free and fair election in any country.

This chapter contained a brief background discussion with regards to e-voting. The various categories associated with e-voting were investigated. In addition to the various categories, their different capabilities were identified and discussed in detail. Furthermore, several developed and developing countries which opted to employ e-voting systems were discussed in detail. This chapter also provided an overview of the various challenges associated with e-voting. The conclusions drawn from these different e-voting systems from different countries will be used to develop a proposed solution for South Africa.

The following chapter will discuss the South African electoral system in detail with a brief background on the South African democracy. This entails all characteristics associated with South African electoral system. In addition, the role that Information and Communication Technology (ICT) plays in the current electoral system will be investigated extensively.

Chapter 3

Overview of the South African Electoral System



3.1 Introduction

"Elections are the core element of democracy as a society's way to make decisions". – (Krimmer, Triessnig, & Volkamer, 2007)

Periodic elections are a core element of democracies worldwide (United Nations, n.d.). The first democratic election in South Africa took place in 1994 (Mostert, 2004). The 1994 election allowed every South African to participate, which

differed from past experiences where only a select group of South African citizens could actively participate in elections (Mostert, 2004). South Africa has experienced four successful national elections, which have contributed to South Africa's fledgling democracy (IEC, 2010a).

The Independent Electoral Commission (IEC) is a permanent body, established in 1997, responsible for the whole voting process in South Africa. This includes pre-electoral, electoral and post-electoral processes. The IEC's vision is:

"To strengthen constitutional democracy through the delivery of free and fair elections in which every voter is able to record his or her informed choice".

Therefore, everyone should have the opportunity to participate and have confidence in the electoral process in South Africa (IEC, 2010c).

The current South African electoral process arguably faces many challenges. Addressing these challenges is of the utmost importance to maintain trust in the electoral process. Without trust in the electoral process, South Africans may not be able to receive the benefits associated with a true democratic country. Addressing the challenges facing the current paper-based process will contribute toward having a more reliable electoral process.

This chapter investigates the current electoral process in South Africa. All the known characteristics and challenges associated with the current paper-based electoral process are detailed in subsequent sections. Additionally, the role that Information and Communication Technology (ICT) plays in the current electoral process is also addressed in this chapter.

3.2 The South African Democracy

The South African Government legally recognized equal rights for all South African citizens in December 1993 (Athiemoolam, 2003). This gave each person the opportunity to participate in elections. South Africa's first democratic election took place between 26 and 29 April 1994. According to international observers the election was free and fair, therefore contributing to achieving democracy in South Africa (Álvarez-Rivera, 2010).

After South Africa's first democratic election, the South African Government introduced the Constitution, which is the law of the country and no other law is superior to the Constitution. The Constitution is known as the "birth certificate" of the new democratic South Africa and is seen as one of the finest Constitutions worldwide (Ebrahim, 2011). Section 19 of the second chapter of the Constitution explains the Bill of Rights. According to the Bill of Rights, every citizen has the right to a "free, fair and regular election". This corresponds to the IEC's vision statement as mentioned in section 3.1 (IEC, 2010c).

Before the introduction of the South African Constitution in 1996, a temporary electoral commission was responsible for the first democratic election. Since the introduction of the Constitution, the IEC has been managing South African elections. The Electoral Act 73 of 1998 is governed by the Constitution which forms part of the South African democracy. In addition, the current electoral system depends mostly on the Electoral Act 73 of 1998 (Thakur, 2010).

The IEC has obligations and duties that need to be met to achieve free and fair elections as stated by the South African Constitution and Electoral Act 73 of 1998. Section 190 of the South African Constitution details the following obligations:

- Manage elections of national, provincial and municipal legislative bodies;
- Ensure that those elections are free and fair;
- Declare the results of those elections;
- Compile and maintain a voters' roll (South African Government Information, 1996).

The Electoral Act 73 of 1998 section 5 outlines the duties of the IEC as follow:

- Compile and maintain a register of parties;
- Undertake and promote research into electoral matters;
- Develop and promote the development of electoral expertise and technology in all spheres of government;
- Continuously review electoral laws and proposed electoral laws, and make recommendations;
- Awareness Campaigns to promote voter education;

- Declare the results of elections for national, provincial and municipal legislative bodies within seven days;
- Appoint appropriate public administrations in any sphere of government to conduct elections when necessary.

Therefore, as can be seen, the IEC has various obligations and duties that must be met to achieve their vision and mission. Trust and confidence in the electoral process is of utmost importance.

Further, trust and confidence in the electoral process is promoted by the IEC meeting their obligations and duties (Mfeketo, 2011). The following section will detail the current South African paper-based electoral process characteristics.

3.3 The South African Paper-Based Electoral Process

The South African electoral process makes use of a secret vote using paper ballots as a medium to cast a vote, which is also known as the "Australian ballot". The first states in Australia which introduced the secret ballot were South Australia and Victoria in 1856. As a result, the secret ballot was referred to as the "Australian ballot" (Britannica, 2011).

The South Africa electoral process uses a proportional representation system that takes place every five years for national and provincial elections (Álvarez-Rivera, 2010). In an electoral process that makes use of proportional representation, a political party list is implemented at national and provincial level. This allows the voter to make his/her selection by marking the ballot paper with an '✘' next to the political party. As a result, a percentage of seats will be allocated to a political party based on the number of votes received during the specific election. Another characteristic is that a voter can only vote for a political party of choice, not a specific individual.

The South African elections have to conform to certain laws and regulations (IEC, 2010b). The Constitution in South Africa is seen as the highest law and is superior to any other law. The Electoral Act 73 of 1998 regulates elections on national, provincial and municipal levels in South Africa. Therefore, all elections must conform to these laws.

Further, according to the Electoral Act 73 of 1998, when a South African citizen wants to participate in an election he/she must have a valid South African identification document. In addition to this a voter has to be 18 years or older to be eligible to cast a vote. Chapter two of the Electoral Act indicates that every voter has to be registered, and thus listed on the National Common Voters' Roll, before elections take place (Department of Home Affairs, 1998).

The National Common Voters' Roll is a document that contains the details of all registered South African voters and includes information concerning the voter. There are more than 23 million registered voters' names on the National Common Voters Roll (IEC, 2009b). According to the IEC the purpose of such a document is to help prevent fraud with regards to an election.

As mentioned earlier, a national election is held every 5 years in South Africa. The President of the Republic of South Africa announces the date of the election well in advance. Elections in South Africa take place for one day where polling stations are open from 7am to 9pm and voting participation must take place during these allocated hours. There are exceptions where voters are allowed to vote beforehand if they are not able to travel to their designated polling station. The voter then casts his/her vote in advance. This is known as a "special vote" according to the Electoral Act. A voter qualifies to cast a "special vote" if the voter:

- Has a physical infirmity or disability, or is pregnant;
- Is absent from the Republic on Government Service;
- Is an election officer or security services member on duty during elections;
- Is a South African citizen temporarily absent from the Republic for purposes of a holiday, business trip, attendance at a tertiary institution, an educational visit or participation in an international sports event (Department of Home Affairs, 1998).

Since the 2009 elections, in addition to the criteria stipulated in the Electoral Act, citizens living abroad also qualify to cast a "special vote". This decision was made during a Court ruling on 12 March 2009 (IEC, 2009a).

Permitting the use of "special votes" in an election offers everyone the opportunity to participate in the South African election. The various steps associated with the

South African voting process (in accordance with the Electoral Act 73 of 1998) will be discussed in detail in the following section.

3.3.1 South African Voting Process

The South African voting process has various steps associated with it. The following section describes every step associated with the voting process in South Africa. Figure 3.1 illustrates a *process model*, illustrating the different steps involved when participating in South African elections on and before Election Day.

According to Olivier (2004, p. 45) a *model* captures "the essential aspects of a system or *process*, while it ignores the nonessential aspects." Therefore, *models* are uncomplicated, thus easy to understand. Additionally, a *model* can be easily manipulated compared to reality. To illustrate a *process* such as the South African voting process, a *model* can be used that will describe what the *process* will entail. Thus, a *model* depicts "how things must/should/could be done in contrast to the *process* itself which is really what happens" as stated by Rolland (1998). Therefore, it could be argued that Figure 3.1 is a *process model* that illustrates all the relevant steps associated with the South African voting process.

In addition, the various Role Players are also illustrated in Figure 3.1, such as Presiding Officer, Deputy Presiding Officer and Party Agent. The Electoral Act 73 of 1998 identifies the roles of various Role Players. The various Role Players play an important part in the success of the South African electoral process (Department of Home Affairs, 1998; IEC, 2010a). This process as illustrated in Figure 3.1, applies to every election that takes place in South Africa (Department of Home Affairs, 1998).

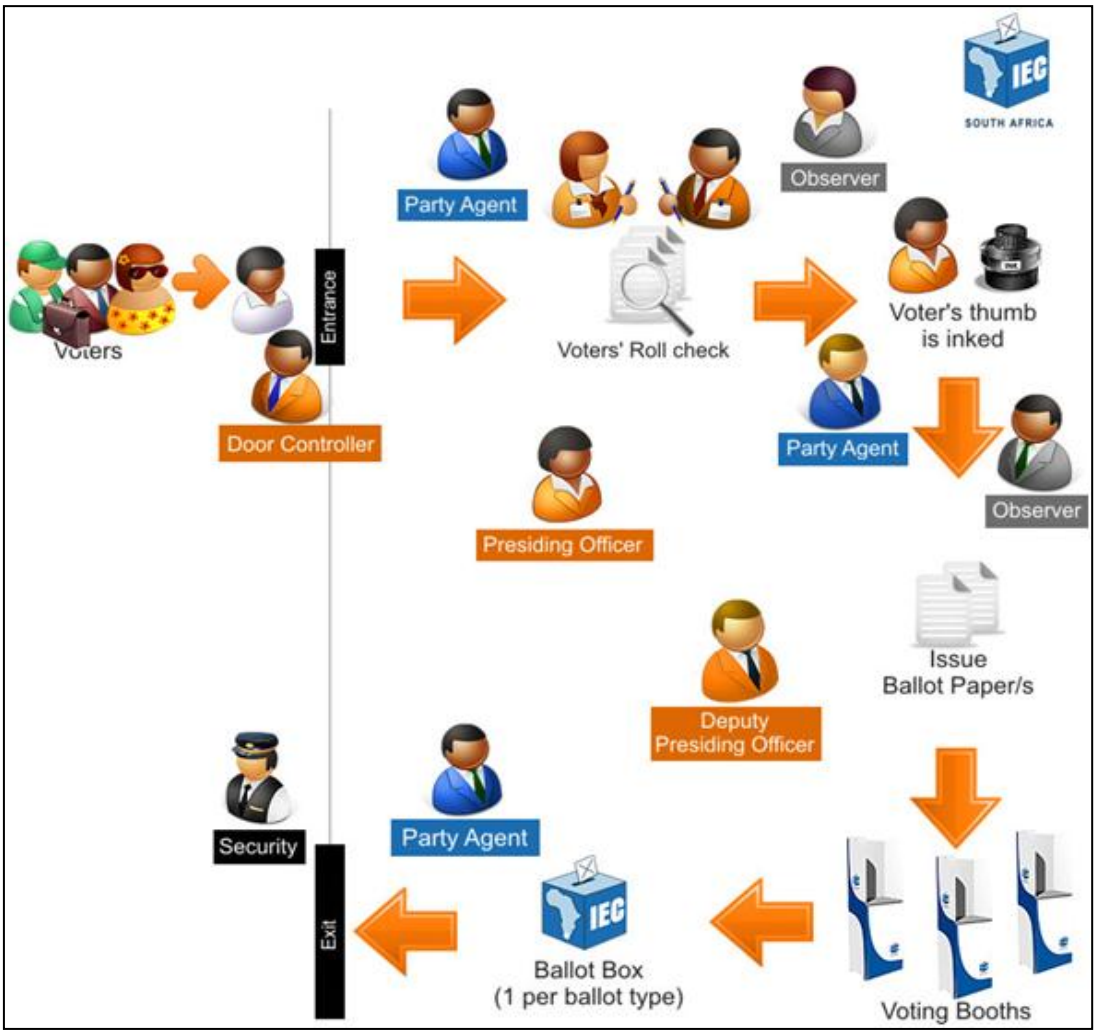


Figure 3.1: South African Voting Process (IEC, 2011)

In South Africa according to the Electoral Act 73 of 1998, it is compulsory for a voter to be registered to be able to participate in any election. Therefore, if a voter is registered, he/she will be able to participate in any South African election (Department of Home Affairs, 1998).

The first step associated with the South African elections requires the voter to travel to the urban and rural area designated polling station. As illustrated in Figure 3.1, the voter must queue at the entrance of the polling station. Whilst the voter is queuing to access the polling station, his/her South African identification document will be checked by an IEC official to confirm that the voter is registered (IEC, 2011). Any person who is disabled, infirm, pregnant or elderly would be given priority to cast his/her vote.

The second step is for the voter's identification document to be checked by an official at the entrance of the polling station using a zip-zip controller device that scans the barcode of the identification document. In addition, the voter's hands would be checked to verify that he/she has not voted already. This is done by checking for any indelible ink markings on the voter's hands. When it has been confirmed that the voter has not participated yet, the election official would verify that the voter is on the voters' roll by checking the voter's identification document. This is done by using a device called a zip-zip controller as mentioned, which has the entire voters' roll loaded on it and can be used to verify whether the voter is on the voters' roll. When there is confirmation that the voter is on the voters' roll the voter will receive a slip with a sequence/queue number on it.

The third step in the voting process is for the voter to hand his/her sequence/queue slip to the voters' roll officer. The officer will again check the voters' roll to identify the voter and then draw a line through the voter's name. This will ensure that a voter will not be able to cast a vote a second time (IEC, 2009c).

The voter will then proceed to the next table to complete the fourth step. This step entails that the voter's left thumb be marked with indelible ink (Department of Home Affairs, 1998). This ink mark would be made on the cuticle and nail of the thumb. The reason for the indelible ink is to prevent a voter from casting a vote more than once. If for some reason the voter does not have a left thumb the election official can make a mark somewhere else. Utilizing indelible ink ensures that the voter will not be able to remove the ink for a period of time (IEC, 2009c).

The next step in the voting process allows the voter to receive two ballot papers to cast his/her vote. The first ballot paper is for the National Assembly and the second is for the Provincial Legislature. The layout of the South African ballot paper is illustrated in Figure 3.2. Additionally, the national and provincial ballot papers have a similar layout.

Figure 3.2: South African Ballot Paper
(Politicsweb, 2009b)

The national and provincial ballot papers have the following characteristics (IEC, 2009c):

- Each Political Party with its full name;
- The abbreviated name of each Political Party;
- A logo and symbol that represents each Political Party;
- Each party leader's photograph in colour;
- A blank space for the voter to make his/her mark next to the Political Party of choice;
- Each ballot paper will have an IEC official stamp (IEC, 2009c).

After the voter has received the ballot papers, he/she would proceed to the fifth step, that includes stepping inside the secure empty voting booth as stated in the Electoral Act section 38 (6a). The voter would then cast his/her vote marking the ballot paper with an '✗' next to his/her party of choice.

The final step in the voting process is for the voter to fold the ballot papers so that the vote will not be visible to anyone. This contributes to the confidentiality of the vote and to a free and fair electoral process where only the voter knows who he/she voted for. After an election official has confirmed there is a stamp on the back of the ballot papers, the voter places the paper ballots in the correct ballot boxes.

According to the Electoral Report 2009 (2010a), the IEC has made provision for South African voters that are widely spread among deep-rural areas. The IEC makes use of mobile voting stations. These mobile voting stations travel on pre-determined routes and stop at pre-determined points. These allocated routes have specific times associated with them, which are advertised publically (IEC, 2010a).

After voting has been completed on Election Day the ballot papers are manually counted by election counting officers at the polling stations. "Special votes" which were cast in advance are kept at a secure location until Election Day when they are counted with all other votes cast.

After all the votes are manually counted by election counting officers, result slips are printed out. These result slips are transported to the office of the municipal electoral officer by the presiding officer or an area manager. At the municipal election office the results displayed on the result slips are captured, audited and scanned by the municipal electoral officer. All the results are captured by data capturers twice to make sure the information is correct. All the results that were captured and scanned at the municipal election office are electronically transmitted to the IEC's headquarters.

The final results are made public at the IEC's headquarters. This completes the counting process associated with the South African electoral process, and concludes the whole South African paper-based voting process when going to a polling station.

The electoral system in South Africa has been utilized in four national elections to date. According to the IEC, these elections could be seen as successful (BBC News, 2012). However, there have been many challenges associated with South African elections (Sapa, 2009b).

The next section will discuss the various challenges associated with the current paper-based South African electoral process.

3.4 South African Electoral Process Challenges

The IEC has a vision to give everyone the opportunity to participate in elections. Even so, according to a report from the World Economic Forum (2010), voter participation has decreased by 10 percent worldwide across democracies in the last decade.

Further, as stated in section 3.3, there were numerous successful national and provincial elections held by the IEC, however, not without some challenges. Various challenges encountered in the national and provincial elections are represented in Table 3.1:

Electoral Process Challenges	References
Election fraud occurred through previously marked ballot papers and ballot boxes going missing	(Daniel & Southall , 2010, p. 158), (Kersting N. , 2009), (Sapa, 2009b), (Mafirakurewa, 2009),
Cost of voting and registration challenges for expatriate voters	(Le Roux, 2009) ,(Qantas, 2012), (Travelmath, 2010), (Dilip & Plaza, 2011)
Lack of confidence and trust in the South African electoral process. Voter participation decreasing.	(IDASA, 2008), (Kersting N. , 2009)
Logistical challenges which included ballot paper shortages, long queues and barcoded identification document shortages were experienced in various elections	(Sapa, 2009b), (February & Misra-Dexter, 2010, p. 178), (Khosa & Muthien, 2000)
The current South African electoral process is challenging for the high number of illiterate adult citizens	(Botes, 2010) , (World Bank, 2010)
Vote coercion where voters are being influenced who to vote for	(Sapa, 2009a), (Bam, 2008)
Spoilt ballots	(IEC, 2009b), (Mtyala, 2011)
Many South African are not able to commute to polling stations as a result of poverty amongst other factors	(February & Misra-Dexter, 2010, p. 178) ,(Swanepoel, Thomson, & van Niekerk, 2010), (Thakur, 2010)
Various challenges face disabled voters when participating in an election	(Mpumlwana , 2011), (SAHRC, 2002), (Xingwana , 2011), (Van Zyl, 2009)

Table 3.1: South African Electoral Process Challenges

The following sub-section discusses the above mentioned challenges that could be a contributing factor to the decreasing voter participation in South Africa.

As can be seen in Table 3.2, voter participation has decreased in South Africa in the last 10 years (IEC, 2009b; StatsOnline, 2010a).

The results in Table 3.2 were based on statistics gathered from the IEC and Stats SA (StatsOnline, 2010a). The total percentage of the population that voted in South Africa in each year was calculated by dividing the total votes cast with the population in South Africa in the same year.

Year	Population in South Africa	# of registered voters	Total % of population that voted	Total votes cast
1994	40.42 million	22.70 million	48.31%	19.53 million
1999	43.05 million	18.12 million	37.70%	16.22 million
2004	46.60 million	20.67 million	34.04%	15.86 million
2009	49.32 million	23.18 million	36.33%	17.91 million

Table 3.2: South African Voter Participation (IEC, 2009b; StatsOnline, 2010a)

South African citizens living abroad were allowed to participate in the 2009 elections as a result of the decision made by the Constitutional Court, as mentioned in section 3.3 (IEC, 2009a). There are approximately two million South African citizens living abroad and, as such, they can still contribute to democracy (Mbola, 2009).

However, there are a few challenges associated with expatriates' voter participation. The Constitutional Court Ruling in 2009 stipulated that citizens living abroad have to vote at a polling station located at a South African embassy, High Commission or Consulate (Mbola, 2009). This could possibly require many potential voters to travel great distances to vote. For example, a South African citizen living in Brisbane, Australia, has to travel to the South African embassy in Canberra, Australia, to participate in elections. The distance for travelling from Brisbane to Canberra is approximately 1209km by road and 935km via a flight (Travelmath, 2010). The cost involved in travelling in a country such as Australia is expensive because of the distances between cities. According to the Qantas Airline website the cost of an airline ticket would be approximately $600 AUD (Qantas, 2012).

As mentioned previously, another challenge associated with expatriate voting is that a voter has to be registered before being eligible to participate in elections (IEC, 2009a). Therefore, if a voter is living abroad during an election and has not been previously registered on the National Common Voters' Roll for an election, he/she will not be able to cast a vote in that election (Le Roux, 2009). This could result in decreasing voter participation in future elections.

Another challenge in the South African electoral process is the trust and confidence in the South African electoral process. According to a survey that was done in 2008 by Citizen Surveys concerning the secrecy of the ballot, 6 out of10 citizens have confidence in the secrecy of the ballot paper. Therefore, only 58 percent of the representative sample group of 2400 citizens expressed their confidence (IDASA, 2008).

In addition to the result of the survey, there have been reports of a voter casting a vote twice (Ebersohn, 2009). The Electoral Act 73 of 1998 (section 38) states that a voter is only allowed to vote once in an election. An example such as this, could contribute to citizens having reservations about the trustworthiness of the current South African electoral process (Ebersohn, 2009).

Further criticism regarding ballot paper shortages across South Africa in the 2009 election was expressed by political representatives (BBC News, 2009a). At various polling stations, citizens were allowed to cast their votes, even though they were not registered at that particular polling station. This contributed to a high number of voters voting at polling stations to which they were not allocated, thus contributing to unavailability of ballot papers (Basson, Rossouw, & SAPA, 2009).

Another problem that came to light was that some ballot boxes were too full because of the high voter turnout in certain parts of the country. Additionally, long queues were also experienced (Sapa, 2009b). Furthermore, another logistical challenge is the lack of bar-coded identification documents among voters; this is especially a challenge in deep rural areas (February & Misra-Dexter, 2010, p. 178).

The 2009 elections had various criminal challenges such as election fraud for example (Sapa, 2009b). An electoral fraud activity such as ballot papers that were previously marked can hamper the confidence in the electoral process. This was experienced in the 2009 election where previously marked voting ballots were found in sealed envelopes (Mafirakurewa, 2009). There were also reports of ballot boxes that disappeared from different polling stations (Sapa, 2009b).

In addition to the above-mentioned issues, South Africa faces various other challenges concerning the voting process. A possible challenge in the

paper-based electoral process is that South Africa has a large number of illiterate adults (World Bank, 2010). Data indicates that there are approximately 4.7 million totally illiterate adults (Botes, 2010). This statistic represents adults that have never attended school. Being able to comprehend the ballot paper can be a challenging task for illiterate people.

A further challenge in the 2009 election was that there were reports of coercion. Coercion is when a voter's vote is bought or the voter could have been forced to vote for a specific candidate. Therefore, it is not a true reflection of what the voter's choice would have been if not under pressure (Van Acker, 2004). Coercion was mostly experienced by voters that were illiterate and elderly in 2009. An example was when an elderly voter was told by a party volunteer where to make her cross (Sapa, 2009a).

Further, South African elections have experienced a number of spoilt ballots since the 1994 elections (Mtyala, 2011). The Electoral Institute of South Africa (EISA) also recognized in the 2004 elections that some of the ballot papers were not clear and contributed to some misunderstanding amongst voters, which could have played a part in the 1,58 percent of ballots that were spoilt (EISA, 2004). According to IEC statistics, in the 2009 election there were 239 237 spoilt votes nationally and 223 462 spoilt votes provincially. In addition to this South Africa has 11 official languages, and this can contribute to some uncertainty when casting a vote if the ballot paper is not in your own language (ITU, 2010).

Another factor that contributes to the electoral process challenges is poverty (February & Misra-Dexter, 2010, p. 178). South Africa has an unemployment rate of 25.3 percent. Therefore, there are approximately 4.3 million unemployed people between the ages of 15 and 64 and many people living in poverty (StatsOnline, 2010b). Transport from rural areas to designated polling stations for voters could be expensive and this could hamper voter participation (February & Misra-Dexter, 2010, p. 178).

South Africans with disabilities can also face some difficulties when participating in elections, depending on their disability (Mpumlwana , 2011; SAHRC, 2002; Xingwana , 2011). An example would be when a blind or partially sighted voter wants to cast a vote - he/she would need some assistance. The 2009 election

saw the introduction of a new Braille template called “Betty the Braille” (Mabandu, 2009). This made some provision for people who were blind and partially sighted to vote in secret, which resulted in the confidentiality of the vote cast. The ballot paper is inserted into the template where the voter reads the name and number of the political party in braille. Further, a line of elevated dots continues to a box where the voter must makes his/her ‘✕’.

This new addition to the electoral process was met with great enthusiasm among the blind and the partially sighted. However, there was a shortage of Braille templates at various polling stations according to the South African National Council for the Blind (Van Zyl, 2009). In a few polling stations that did have the Braille template, the IEC officials had no knowledge concerning the use of the Braille template. In addition to this some of the ballot papers did not fit into the template provided by the IEC. This influenced the “new” voting experience by not allowing blind and partially sighted citizens to vote without assistance. A number of blind and partially sighted voters also felt that the template should be improved in future to provide for a better voter experience (Van Zyl, 2009).

As detailed in the above section, there are challenges that face the current South African electoral process. These challenges could hinder the motivation of South African citizens to participate in elections.

As shown in Chapter 2, various countries have been investigating different methods of voting to improve their electoral process and South Africa should investigate the experiences of these countries regarding electoral process improvements. Technology, or ICT, has been implemented worldwide to improve electoral processes (ACE Projects, 2010). Therefore, it could be argued that ICT should play a significant role in meeting the challenges in the South African electoral process.

3.5 The ICT Status in the Current South Africa Electoral System

The current South African electoral process as explained in this chapter, 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 electoral process (Mawson & McConnachie, 2011). In addition, the Vice-President

of South Africa, Kgalema Motlanthe (2009) at the announcement of the final result in the 2009 national and provincial elections, stated that South Africa should consider the implementation of e-voting in future elections.

Therefore, looking to e-voting experiences worldwide could provide valuable information when considering an e-voting system for South Africa. This information could help South Africa in developing an e-voting system which could address the challenges encountered by the current paper-based electoral process.

The current South African paper-based electoral process has various technological facets associated with it. As stated in the 2009 election report, ICT played a fundamental role in the whole election process. Hence, the utilization of different technologies permitted the IEC to deliver good services on all levels (IEC, 2010a).

Various services were available to voters in the 2009 national elections, for instance a voter could check his/her registration details online on the IEC's official website. Besides checking the voter's status online, he/she could send a text message using a mobile phone. This allowed voters to receive relevant information with regard to their registration status.

The IEC also made use of various systems to assist them in the management of the overall electoral process. Examples of the applications and systems used by the IEC in the 2009 election are illustrated in Table 3.3.

Election Applications and Systems	Description of the Applications and Systems
Voting stations operation system (VSO)	User can view the exact location of a polling stations and its boundaries
Voter registration scanners	Voter's identification document is scanned and voters are added to voters roll
Logistics information system (LIS)	Materials requirements planning tool i.e. to determine the amount of stationary, ballot boxes and ballots
Electoral staff system (ESS)	Manages the recruitment process including payment process.
Candidate nomination system (CNS)	Management of nomination candidates list and political party list
Special votes application request system (SVRS)	Capturing data from expatriate voters and verification of expatriate voters on the voters' roll
Voter participation application	Zip-zip controller device stores the voter participation application which contains voters' roll to identify registered voters
National and provincial election result system (NPE)	Captures results, results scanning module, results slip generation, issue logging module

Table 3.3: IEC's applications and systems used in 2009 elections (IEC, 2010a)

In addition to the applications and systems illustrated in Table 3.3, the IEC's technology infrastructure was implemented in the 2009 election. A large number of desktop computers, computer servers, and desktop scanners were employed in the 2009 election. Furthermore, the network infrastructure was well maintained. According to the 2009 election report, the IEC's network (WAN and LAN) infrastructure was 100 percent stable during data capturing (IEC, 2010a). Therefore, it could be argued that opting to implement technology in the vote casting and counting phase could potentially be done with success.

In addition to the IEC's utilization of technology, various Political Parties used ICT extensively in their 2009 election campaigns (Nielsen, 2009). These parties made use of different platforms to host their election campaigns in the 2009 general elections. The platforms included traditional media sources such as television, radio, newspapers and text messages as well as technology.

The Internet was widely utilized in the 2009 election and included the usage of social media websites, for example Facebook, Twitter and YouTube. Social media usage has increased significantly in recent times. There are approximately 4.4 million Facebook users in South Africa (MyBroadband, 2011). This increase in social media usage could be as a result of the increased usage of the Internet by South Africans.

South Africa's Internet penetration rate is approximately 13.9 percent and it is estimated that Internet growth will double by the year 2014 (Internet World Stats, 2011).

Another area of technology that is experiencing growth in South Africa is mobile phone Internet usage (World Wide Worx, 2011a). 39 percent of urban South Africans use the Internet on their mobile phones. In addition, of the people living in rural areas approximately 27 percent use the Internet on their mobile phones. This study was conducted by World Wide Worx and First National Bank which represented 20 million South Africans, who were 16 years and older. The research excluded "deep rural" mobile users (Nicholson, 2011).

However, Internet usage in South Africa is not limited to accessing social media websites, e-mail and web browsing. South Africans also make use of the Internet for online transactions. This includes online banking and shopping. South Africans have spent more than R2-billion on online retail in 2010 (World Wide Worx, 2011b). This was a growth of approximately 30 percent from 2009. In addition, 71.59 percent of Internet users in South Africa make use of online banking. (Muller, 2011). Thus, it could be argued that South Africans' confidence in online transactions is growing and more South Africans are using computers and mobile technology.

Furthermore, technology has also been used extensively by the Department of Home Affairs. The South African Home Affairs National Identification System (HANIS) database is an initiative that was started by the Department of Home Affairs in 1993. This database replaced the legacy paper system containing fingerprints with the leading-edge digital database storing fingerprints of South African citizens (NEC, 2008).

The details of every South African citizen who has a South African identification document, are stored on the HANIS database. The details include, for example, name, surname, photograph and fingerprint.

An example where the HANIS system will be utilized to mitigate fraud is in the South African banking sector (SouthAfrica.info, 2010b). The South African Banking Risk Information Centre (SABRIC) and the Department of Home Affairs are in the process of implementing this project. The utilization of the database will allow South African banks to verify the identity of clients in real-time.

As stated in section 3.4, the South African electoral process has various challenges associated with it. One of the objectives of this research is to see how technology could potentially improve the South African electoral process. This section has discussed various uses of technology in the current paper-based electoral process and shown how the utilization of technology has improved various processes in the electoral system. Therefore, looking at incorporating technology into the vote casting and counting process could potentially improve the current electoral process.

3.6 Summary

South Africa has held four successful national elections since the first democratic election in 1994. Even though the electoral process in South Africa has seen some improvements since the first democratic elections in 1994, there are still numerous challenges facing the current paper-based electoral process in South Africa.

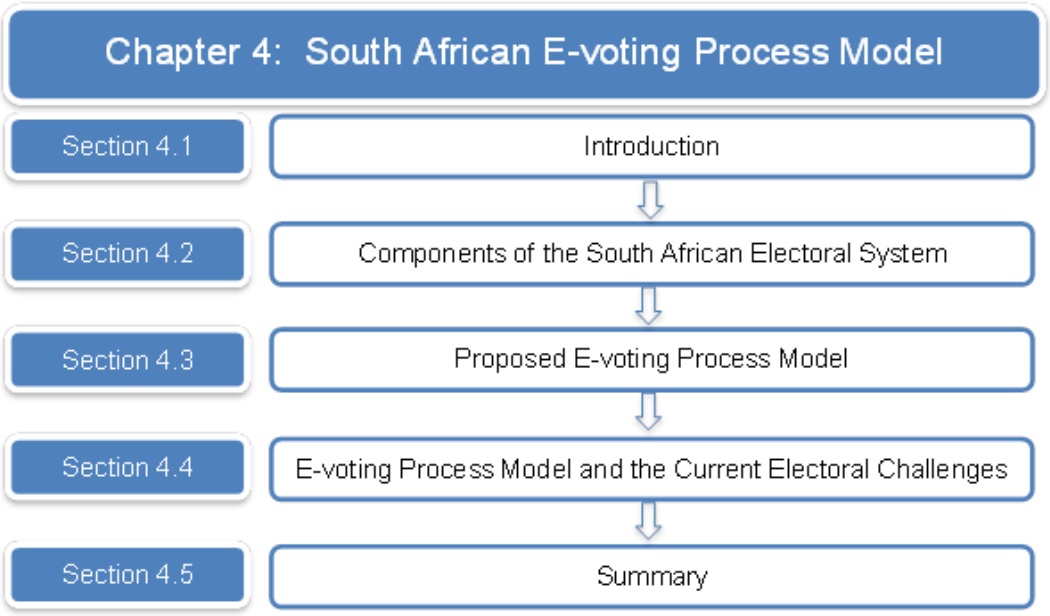
This chapter investigated the current electoral process in South Africa and its characteristics. This included discussing the various challenges faced by the current paper-based electoral process. In Chapter 2, various electoral processes in various countries and their capabilities were investigated. The previous chapter discussed various e-voting systems.

Therefore, the conclusions drawn from these different countries that use e-voting in their elections will be used to develop a proposed solution for South Africa, which will be discussed in the next chapter. All relevant components associated with the South African electoral process will also be detailed. This proposed

solution will entail a process model depicting the “new” voting process for South Africa, and which will address a few of the challenges outlined in this chapter. As mentioned, technology has been used for different processes in previous South African elections. Therefore, looking at implementing technology in the vote casting and counting process could potentially improve the current electoral process in South Africa. The next chapter will discuss in detail the proposed process model which makes use of technology when casting and counting votes.

Chapter 4

South African E-voting Process Model



4.1 Introduction

"I believe that if you show people the problems and you show people the solutions they will be moved to act". - (Gates, 2005)

An electoral process is of extreme importance to the success of an election. Countries around the globe make use of various voting processes to conduct their elections. Each voting method has various benefits, as well as challenges, associated with them.

A country such as South Africa has its own unique challenges, as outlined in section 3.4, which could hamper an electoral process. Therefore, looking at alternative voting processes to improve the current electoral process in South Africa is one of the goals of this chapter. The evolution of voting worldwide has

seen the integration of technology into various electoral processes globally. This is known as e-voting.

This chapter discusses the various components associated with the South African electoral system. Furthermore, the role each component plays in the electoral system is detailed in this chapter.

The primary objective of this research is to develop a process model which will potentially address the various identified challenges in the South African electoral process. The proposed process model makes use of an e-voting process that includes two different voting processes. The different steps associated with the two proposed voting options will be discussed in detail in this chapter.

4.2 Components of the South African Electoral System

The South African electoral system comprises various components. These components which are detailed in the Electoral Act 73 of 1998 and from the IEC, are graphically represented in Figure 4.1 (Electoral Act 73 of 1998, 1998; IEC, 2011). To put the South African Electoral System Component Model in context, this section will discuss each component included in this model (as seen in Figure 4.1) and what role each component plays in the electoral system.

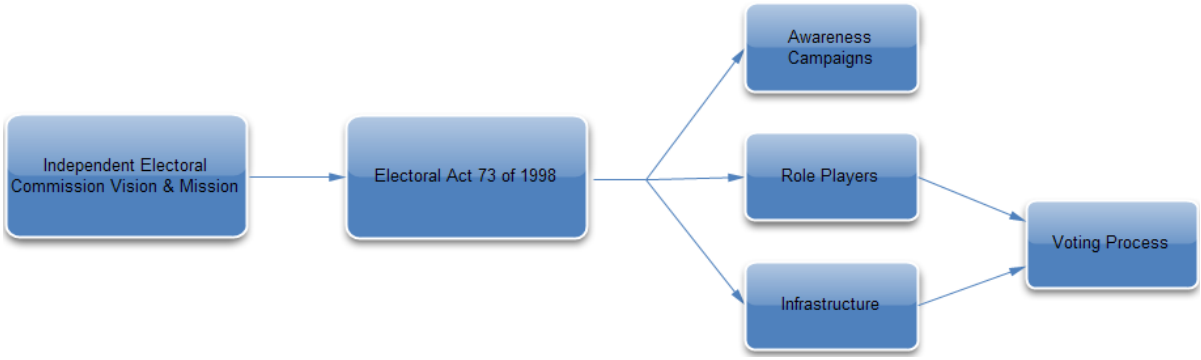


Figure 4.1: South African Electoral System Component Model

The first component illustrated in Figure 4.1, is the IEC's Vision and Mission.

4.2.1 Independent Electoral Commission Vision and Mission

The IEC, as mentioned in section 3.2, plays a pivotal role in the electoral system. This body is responsible for the management of the electoral process. The main goal of the IEC is to achieve a free and fair election; thereby allowing every South African to participate in elections and allowing them to make their own choice when casting a vote. All other components illustrated in Figure 4.1, contribute to the IEC's Vision and Mission as stated in section 3.2.

4.2.2 Electoral Act 73 of 1998

The second component is the Electoral Act 73 of 1998, which is the legal framework supporting the IEC in achieving their goals as mentioned in section 3.2. The legal framework regulates elections of the National Assembly, the provincial legislatures and municipal councils. The Electoral Act 73 of 1998 plays a vital role in elections and details all pre-electoral, electoral and post-electoral events as stated in section 3.1. For the purpose of this research the legal aspects of the electoral system will not be investigated but would need to be addressed when integrating technology into the vote casting and counting process to ensure legal compliance.

4.2.3 Awareness Campaigns

Awareness Campaigns could be seen as another important component in the South African electoral system as stated in section 3.2. This component addresses various factors that contribute to the success of an election. Awareness Campaigns could include, for example, relevant information about elections and educating voters on various electoral processes as mentioned in section 3.2. This component would need to be addressed when looking at incorporating technology into the electoral process and educating users on how to use the new e-voting system. However, it should be noted that an in-depth discussion on Awareness Campaigns is outside the scope of this research.

4.2.4 Role Players

The next component depicted in Figure 4.1 is the Role Players. Role Players include, but are not limited to, political parties, election officials and voters as stated in section 3.3.1. The incorporation of technology into the voting process would have an impact on the various Role Players. However, discussing the impact of the incorporation of technology on each Role Player is beyond the scope of this research.

4.2.5 Infrastructure

In addition to the Role Players component, Infrastructure also plays a crucial role in the electoral system in South Africa. The Infrastructure component has various elements associated with it such as the ICT, operational and architectural infrastructures are associated with the Infrastructure component. This research addresses the technological component within the ICT Infrastructure by integrating technology into the vote casting and counting process as stated. The proposed E-voting Process Model discusses in detail the utilization of technology in the electoral process for South Africa.

As discussed in section 3.5, technology has been utilized in various communication processes in previous elections, such as certain election applications and systems. Furthermore, technology has been employed on Election Day to authenticate voters before voting. This was done by using a zip-zip controller device. As mentioned in section 3.3.1, the zip-zip controller device has the National Common Voters' Roll stored on it to verify voters. In addition, the registration and counting process also makes use of technology to store the relevant election information. However, there has been no implementation of technology in the vote casting and counting process. The proposed E-voting Process Model will address the Infrastructure component of Figure 4.1.

As mentioned in section 3.5, there is some presence of technology in the South African electoral process. The proposed E-voting Process Model, depicted later in this chapter, will discuss in detail the two selected voting processes that will be

associated with the South African electoral process. The model will outline all necessary technological elements that would play a fundamental role in the Infrastructure component. Section 4.3 and 4.4, will discuss in detail the proposed E-voting Process Model for South Africa.

4.3 Proposed E-voting Process Model

The South African electoral process currently makes use of pen and paper, with a manual counting process. There are numerous challenges facing the current South African electoral process which were highlighted in section 3.4. Looking at alternative methods that could potentially address these challenges could be of great benefit to the democratic process in South Africa. However, the proposed voting process will not aim to resolve all the challenges in the current South African electoral process.

In Chapter 2 various e-voting processes from countries around the world were discussed in detail. The various case studies were investigated and these worldwide experiences concerning e-voting were utilized to contribute to the proposed E-voting Process Model, as will be discussed in this chapter.

As stated in section 3.1, the current paper-based electoral process has been used in numerous elections in South Africa. Therefore, implementing a new electoral process which has similar characteristics to the current electoral process could improve confidence among voters with regard to the introduction of technology. Additionally, such a process could contribute to the acceptance of a new voting process and voters might comprehend the voting process more easily.

As such this research will propose an E-voting Process Model which will potentially address some of the challenges facing the current South African electoral process. Section 3.3.1 described the *process model* associated with the current electoral process. In addition, a *process model* was defined in section 3.3.1. Thus, for the purpose of this research study a *process model* will depict two e-voting processes, which illustrate the relevant steps associated with the South African electoral process.

The proposed E-voting Process Model would have to accommodate all South Africans with the different requirements. South Africa is a diverse country with

different characteristics. There are people who are illiterate, literate, disabled, wealthy, and poor for example. Therefore, the proposed E-voting Process Model must provide an electoral process which will accommodate all groups of people.

For that reason two e-voting processes have been chosen for the proposed E-voting Process Model, based on case studies worldwide as discussed in Chapter 2. A voter will have an opportunity to select one of the two methods to vote in the South African electoral process; optical scan polling station voting or online voting. Both of these voting processes will utilize the HANIS database as described in section 3.5.

It can be argued that not all South Africans have the opportunity to participate in elections. South Africans are required to be registered when participating in an election as stated in section 3.3.1. The National Common Voters' Roll stores all the relevant information with regards to registered voters. The utilization of the voters' roll ensures that only citizens who are registered are eligible to participate in South African elections. Section 3.3 also showed there are more than 23 million voters on the National Common Voters' Roll. As seen in Table 3.2, the South African population in 2009 was calculated to be approximately 49 million people. Hence, based on the figures in Table 3.2, only 47 percent of the total population in South Africa is eligible to participate in South African elections.

To address the lack of registered voters, the proposed voting process will remove the utilization of the National Common Voters' Roll. The National Common Voters' Roll will be replaced by utilizing the HANIS database as described in section 3.5.

All the required details currently necessary for a voter to participate in an election are already stored on this database. Therefore, it could be argued that the HANIS database could be of great benefit to the authentication and identification of voters in an electoral process.

The characteristics and steps associated with the different e-voting processes will be discussed in detail in the following sub-sections. Option A will be discussed in detail in section 4.3.1, followed by Option B, which when combined, represent the E-voting Process Model.

4.3.1 Optical Scan Polling Station Voting Process

In section 2.3.1.2 and 2.8.2, an optical scan polling station voting process was discussed in detail, together with the benefits thereof. The reason for incorporating optical scan voting technology into the South African electoral process is because it shares similar characteristics to the current electoral process. However, the optical scan polling station voting process electronically counts the votes, thereby eliminating the manual counting process. Even though the manual counting process is eliminated, one of the main benefits of an optical scan polling station voting process is the fact that it provides an audit trail as stated in section 2.3.1.2. Thus, using an optical scan polling station voting process with an audit trail will provide the IEC with the option to recount votes manually if there is any discrepancy with the e-voting process. This could potentially increase trust and confidence in the optical scan polling station voting process. The goal is to make use of this method of voting and to address some of the challenges faced by the current electoral process which will be highlighted in section 4.4.

The current electoral process in South Africa, as detailed in section 3.3.1, is simple and straightforward. In addition, it also accommodates people who are illiterate and disabled for example. The ballot paper used in current elections has a simple layout which accommodates different groups of people such as uneducated people. In section 3.3.1, the characteristics of the South African ballot paper were discussed in detail. One of the characteristics which contribute to the simplicity of the ballot paper is the use of a logo and symbol which represent each Political Party. In addition, there are full colour pictures of the leaders of each participating Political Party, making it easier for illiterate voters to participate in an election.

An additional benefit to the simple layout of the ballot paper is that it also provides a template for blind people to use when voting. Section 3.4, discussed the template known as “Betty the Braille”.

As mentioned in section 3.3, the current ballot paper layout has been used with great success in previous elections in South Africa. Therefore, it can

be argued that it would be beneficial for a similar ballot layout to be used for the proposed optical scan polling station voting process.

An optical scan polling station voting process takes place in a controlled environment as stated in section 2.3.1.2. Thus, having an election in a controlled environment allows election officials to prevent unauthorized people from accessing and tampering with electoral materials or equipment. There have been various fraudulent incidents during several previous South African elections as detailed in section 3.4. Ballots that were already marked and ballot boxes that disappeared from polling stations are just some of the fraudulent events that were experienced in the 2009 election. One of the goals of the proposed optical scan polling station voting process is to mitigate electoral fraud when counting votes. An optical scan polling station voting process, as described in section 2.3.1.2, eliminates human interaction when counting votes. Therefore, theoretically, it could mitigate fraud that is associated with manual vote counting.

Further, as the protection of election information is of utmost importance, unauthorized access could have a great impact on the results of an election if tampered with. In Option A of the proposed E-voting Process Model, election officials would still be in control. The only process the election officials will not be involved with is the vote counting process which will become automated through technology.

The counting process will be done instantaneously. When polling stations close for voters at the end of the Election Day, all the election data will be transferred over a secure network connection to the IEC's headquarters for the final counting process. As seen in section 3.3.1, this is similar to the current electoral process where captured results are transmitted to the IEC's headquarters.

Election data will be stored electronically on the internal memory of the optical scan voting machines. All data will be encrypted on the storage device to protect against any security threats.

In section 2.6, security threats and how they could threaten the security of election information was discussed in detail. Table 2.1 highlighted that technical expertise is required for someone to manipulate an e-voting system. However, a paper-based electoral process, such as the current South African process, would be easier to manipulate. No expert knowledge would be required to manipulate the process as stated in Table 2.1.

Figure 4.2 illustrates the first channel of voting in the proposed E-voting Process Model which would be the optical scan polling station voting process – Option A. Therefore, Option A in the proposed E-voting Process Model illustrates the various steps that are associated with the voting process.

Figure 4.2: Option A: Optical Scan Polling Station Voting Process

The *first step* as seen in Figure 4.2, associated with the voting process requires the voter to go to a polling station to participate in an election.

Similar to the current paper-based voting process in South Africa, voters would be assigned to a specific polling station as mentioned in section 3.3. Instead of each voter registering to vote, the IEC will make use of the HANIS database as described in the previous section. The database will be utilized to assign each South African to a polling station.

In the current paper-based process South Africans can verify their voter registration details online or by sending a text message using their mobile phone as stated in section 3.5. This confirmation process allows the voter to verify his/her eligibility to participate in an election and to which polling station the voter is allocated. Similarly with the proposed process, voters would be able to confirm their registration details such as address and their polling station using the IEC's website. Furthermore, a voter could also confirm his/her details sending a text message using his/her identification number as a reference.

The *second step* associated with the voting process, requires an election official to identify and authenticate the voter. A computer system with barcode scanning and fingerprint scanning features would be utilized in this step. This replaces the zip-zip controller device and voters' roll as described in section 3.3.1. An election official would scan the voter's green barcoded identification document. In addition, the voter's fingerprint will be read using a fingerprint reader. This information will be used and compared to the HANIS database to verify the voter's details in real-time similar to South African banks as mentioned in section 3.5.

This combination of using biometrics and the green barcoded identification document of a voter could potentially mitigate fraud. This method of identification and authentication would also allow a voter only to vote once, therefore, adhering to the Electoral Act 73 of 1998. In addition, indelible ink will not be used in the voting process as previously used in South African elections for the prevention of fraud. As mentioned in section 2.7.1, Brazil is currently busy with pilot projects where biometrics is being included in their e-voting electoral process, for the prevention of fraud. Therefore,

South Africa can implement this method of identification and authentication, thus, learning from experience from other countries such as Brazil.

The *third step* in the proposed voting process, if the voter is eligible to vote, would be to collect an election ballot paper. The ballot paper layout would be similar to the current layout as mentioned earlier in this section. This is because South African voters are familiar with the layout. It has a simple layout to accommodate people who are illiterate. Blind or partially sighted voters would receive a Braille template. The current paper-based voting process made use of this braille template as described in section 3.4. In addition, an extra feature, similar to the DRE process in Brazil and optical scan polling station voting process in the USA, would be the usage of headphones for blind people as discussed in section 2.7.1 and 2.8.2. A voter who is blind would be able to hear if his/her vote was accepted or declined.

The *fourth step* associated with Option A, as can be seen in Figure 4.2, would be for an election official to escort the voter to a private voting booth. The voter would, in secret, make an '✘' next to his/her candidate of choice on the election ballot. The main difference between the current paper-based electoral process and the proposed optical scan polling station voting process is highlighted in this step. After the ballot paper has been marked the voter would feed the ballot paper into the optical scan voting machine.

In the current electoral process one of the challenges which arose was spoilt ballot papers. Section 3.4., revealed that the 2009 election in South Africa had 239 237 spoilt ballots votes nationally and 223 462 provincially. However, with the utilization of optical scan technology it can be argued that spoilt ballot papers could be alleviated. The optical scan polling station voting process will read the marked data on the ballot paper and would then verify that the ballot paper was marked correctly or incorrectly. If, for example, the ballot paper was marked incorrectly the LCD screen on the optical scan voting machine will display a red '✘' with a message stating "invalid vote". If the ballot paper was marked correctly the message on the

LCD display will display a “vote accepted” message with a correct mark ‘✓’. The ‘✗’ and ‘✓’ symbols are used for illiterate people to understand the status of the vote.

After the voter has completed his/her vote and the vote was accepted he/she will proceed to the next step. The optical scan voting machine will reset itself for the next voter to cast his/her vote. This step is necessary because a free and fair election allows a voter’s vote to be confidential. Therefore, not a single person should be able to tell who a voter voted for in an election.

The *fifth and final step* associated with Option A requires the voter to place his/her ballot paper in the ballot box. This is similar to the current paper-based voting process used in South Africa which was discussed in section 3.3.1. The difference is that the votes would only be counted manually if there are any discrepancies with the optical scan vote counting process. This provides a paper trail for voters and allows the process to be audited. This could contribute to improving the confidence in such a process among voters. The DRE system used in India has been under scrutiny because of the absence of a paper trail which could be audited as mentioned in section 2.7.2. Therefore, implementing an optical scan polling station voting process compared to a DRE system eliminates that challenge and could improve voter confidence in an electoral process that utlizes technology.

Another characteristic similar to the current South African electoral process, associated with the optical scan polling station voting process, is that mobile voting. Section 3.3.1 states that South Africa uses mobile voting in rural areas in the current electoral process. The proposed optical scan polling station voting process would be able to function without electrical power. This is similar to the optical scan polling station voting process mentioned in section 2.7.2, which could fully function on battery power. Therefore, rural South Africans who are not able to travel to polling stations could be included to vote in elections when using an optical scan voting process. This would be accomplished where election officials would travel

to the rural areas with a mobile voting station, which includes the optical scan voting device that operates on battery power as mentioned.

South Africa has been challenged with ballot paper fraud in previous elections as stated in section 3.4. It could be argued that technology could improve the process of voting and possibly alleviate certain areas of fraud associated with the current voting process. The purpose for implementing Option A is because it removes the need for the manual count of ballot papers thereby, eliminating the need for people to count votes and alleviating vote counting errors. This completes the steps associated with Option A in the proposed E-voting Process Model.

In addition to using an optical scan polling station voting process in the proposed E-voting Process Model an extra channel of voting is recommended. Online voting would serve as an additional method of voting in the proposed E-voting Process Model. The next sub-section will describe the online voting process in detail and how it could address challenges facing the current South African electoral process.

4.3.2 Online Voting Process

Every South African citizen should have an opportunity to participate in the elections as mentioned in section 3.4. One of the goals of the proposed voting process would be to allow all South Africans the opportunity to take part in the elections. The proposed electoral process presents two different methods of voting as highlighted in section 4.3. Option A was explained in detail in the previous sub-section. This sub-section will discuss the second channel of voting, Option B as illustrated in Figure 4.3.

Option B describes an online voting process for South Africa. As mentioned in section 4.2 different e-voting systems were investigated worldwide. Section 2.8.1 discussed in detail the Estonian online voting process and its success. South Africans would utilize online voting in a similar process as the Estonian online voting process.

The greatest benefit associated with online voting is that it allows a voter to cast a vote from anywhere in the world in an uncontrolled environment as

stated in section 2.3.5 and 2.4. Utilizing online voting would allow citizens living abroad the opportunity to participate in the South African elections. In addition, it could improve voter participation because it may provide voters with a more convenient way of voting if one can vote from home. A voter would not be required to go to a polling station and stand in a queue. Therefore, online voting would not be limited to people living abroad; it would be available to all South Africans who have access to the Internet. Option B is shown in Figure 4.3.

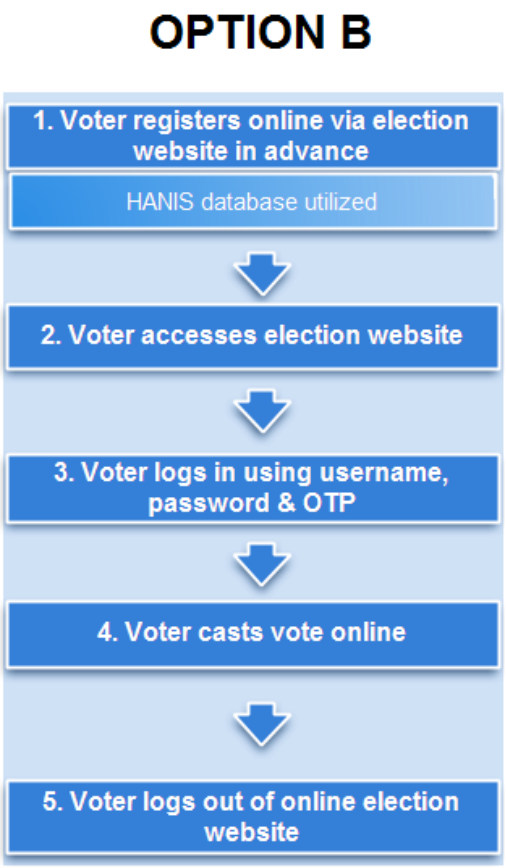


Figure 4.3: Option B: Online Voting Process

As explained in section 1.2, South African expatriates are allowed to participate in South African elections after the court ruling in 2009. The drawback associated with expatriate voting is the requirement that a voter must go to a South African embassy to participate in an election as stated in section 3.4. This could have been a contributing factor for the lack of expatriate voter participation in the 2009 election.

Another challenge is that a voter is required to be registered on the National Common Voters' Roll as mentioned in section 3.4. The National Common Voters' Roll was implemented after the 1994 elections by the IEC. Therefore, people who left the country before the 1999 election would not be on the National Common Voters' Roll. It could be argued that implementing an extra channel of voting such as online voting could contribute to improve voter participation. In addition, using the HANIS database as mentioned in section 3.5. would also include people who were not registered after the 1994 election in South Africa. Another feature that would be associated with Option B is that a voter would be allowed to register and vote in his/her own language.

The online voting process, Option B as illustrated in Figure 4.3, will be described in detail with all the steps associated with the process.

The *first step* as seen in Figure 4.3, associated with the voting process requires a voter to register online on the official IEC website. The voter would be able to select his/her own language to register and cast their vote after registration. As mentioned in section 3.4, South Africa has eleven official languages, thus by using online voting it could give voters the opportunity to use their own language, which would make the process more user-friendly.

The HANIS database would also be used in Option B to authenticate and identify the voter in real-time. Therefore, the National Common Voters' Roll will not be used. The reason for registration is to make online voting more secure and allow the voter access to the online voting website when required to vote.

The registration process would be compulsory if a voter wants to participate in the South African election online. In addition, the voter would need to register at least 11 days prior to the official Election Day. This is because online voting would take place from the 10^{th} to the 4^{th} day before the official Election Day. This is similar to the Estonian online voting process as discussed in section 2.8.1.

The registration process would require the voter to provide personal information, for example name, surname, identification number, username, password and mobile. This would be a similar process to online banking registration in South Africa. After registration the voter would receive a one-time pin (OTP) to confirm his/her registration. An OTP is a password which gets generated once. Additionally, an OTP can only be used once, which makes it more secure (Smart Technology Solutions, 2006). The OTP will be sent to the voter's mobile number that was provided when he/she registered online. The voter would have to confirm his/her details using the OTP to make the registration more secure. This completes the registration process.

The *second step* associated with Option B, would take place between the 10th and 4th day before the official Election Day. This would ensure that each voter's vote would only be counted once. This step requires that the voter must access the official secure election website which is the official IEC's website. Section 2.6.3 explained that voting in an uncontrolled environment increases security risks, such as viruses and Trojans. Therefore, extra protection measures must be made available to protect the credentials of the voter and the election information. As mentioned in section 2.5, the protection of election information is of utmost importance to any electoral process. Therefore, the website would implement extra security measures such as an online anti-virus and spyware scanning application. Additionally, the IEC's website should make use of security protocols to ensure a secure connection between the official election website and the voter's computer. The details of the various security features that would be utilized to guarantee a secure online electoral process are outside the scope of this research.

The *third step* associated with Option B, requires that the voter would need to log in with his/her username, password and identification document number. These details would be utilized to verify that the voter is registered to vote online. The voter would receive the first random generated OTP via his/her mobile number that was registered to confirm the voter's identity. This would contribute to make the process of voting more secure. After the

voter has entered all the required details, including the OTP, he/she would continue to the following step.

The *fourth step* associated with Option B, is the actual vote casting step. The voter would see a similar ballot layout to the current ballot used in the paper-based voting process in South Africa as illustrated in Figure 3.2. The e-ballot would allow a voter to vote in his/her own language as stated previously. In addition, section 3.4 detailed challenges associated with the current paper-based ballot, such as spoilt ballots. Online voting could address some of these challenges, as will be discussed in Section 4.4.

Additionally, as mentioned in section 2.4, the carbon footprint associated with an e-ballot is considerably reduced compared to a paper ballot. Therefore, e-ballots are much more environmentally friendly. As seen in section 2.4, another benefit is that online voting could also be more cost-effective in the long run.

After the voter has selected his/her candidate of choice he/she will receive a second OTP. This pin is required for the voter to submit his/her selection. This second pin is to increase security and to prevent unauthorised people from voting. Similar to the Estonian online voting process, as discussed in section 2.8.1, a South African voter could also recast his/her vote if required to do so within the allocated time for voters to cast their votes. This could potentially mitigate the influence from other people, thereby mitigating vote coercion which was mentioned as a challenge in section 3.4.

A voter, however, will not be able to amend his/her vote if the time allocated to online voting has expired. Therefore, the voter would not be able to vote at a polling station. The Estonian election process allows a voter to amend his/her vote on Election Day. The voter could amend his/her vote at a polling station on Election Day as stated in section 2.8.1. All the voter's previous votes will be automatically cancelled. Therefore, only the last vote cast will be counted in the Estonian election process, as mentioned in section 2.8.1. This will not be possible in the South African online voting process. The reason for not allowing citizens to amend their votes on the official Election Day would be to contribute to less confusion. A South

African voter would only be able to vote by using one of the two options proposed in the E-voting Process Model.

The *fifth and final step* associated with Option B, would require the voter to log out of the online voting website. There would be extra security measures in place which is similar to online banking to protect the voter. This entails that a voter would need to complete the voting process within an allocated time, for example five minutes. If the voter forgets to log out this extra feature would take effect after five minutes. Therefore, this safeguard would protect the voter's credentials from unauthorised access. This completes the voting process associated with Option B in the proposed E-voting Process Model.

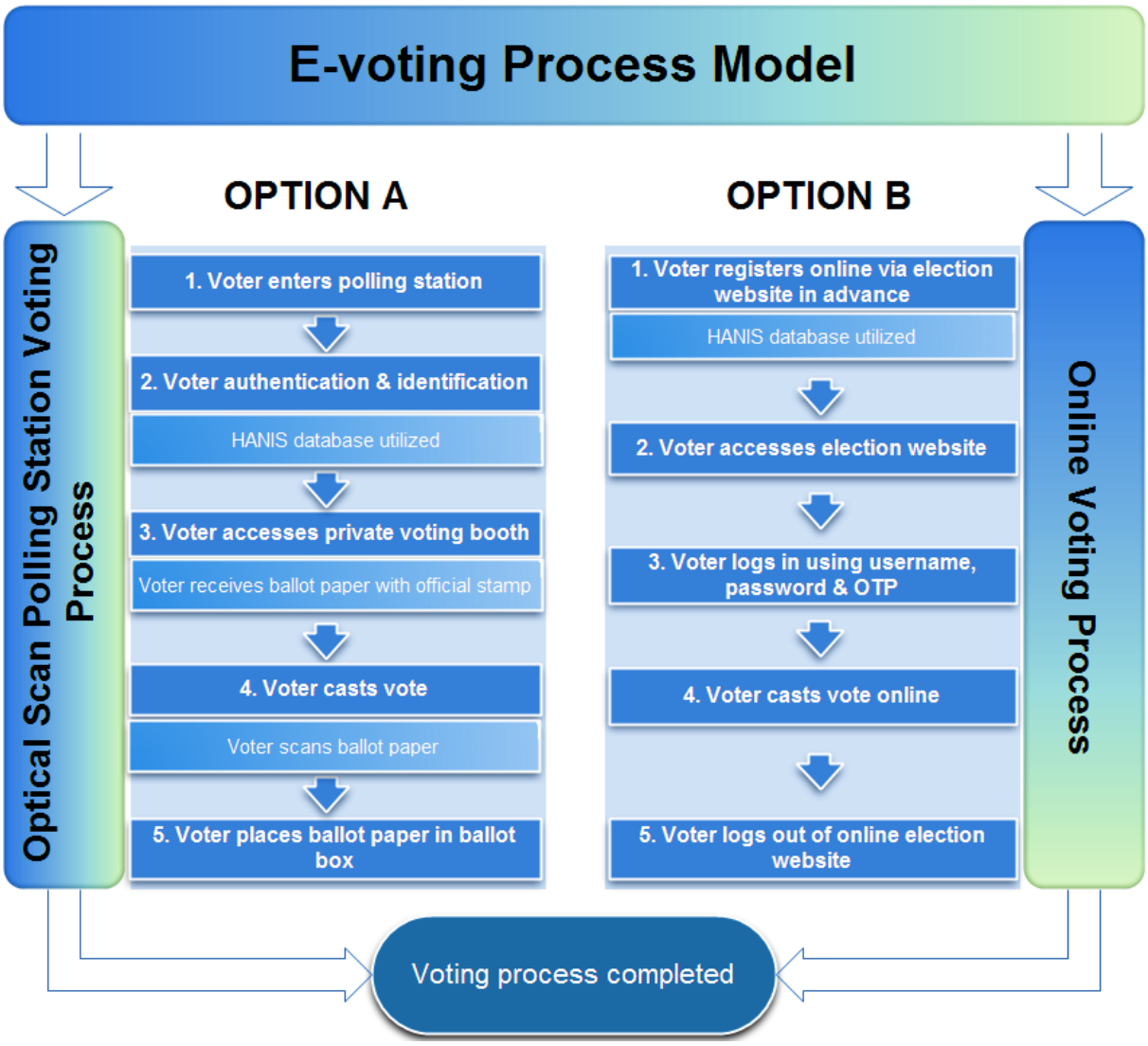


Figure 4.4: E-voting Process Model for South Africa

In section 4.3, the E-voting Process Model outlined two options proposed for the South African electoral process. Section 4.3.1 and 4.3.2 detailed the various steps associated with Option A in the E-voting Process Model. Furthermore, in this section the various steps associated with Option B in the E-voting Process Model were discussed in details. As stated in section 4.3 these two options – optical scan polling station voting and online voting combined - represent the E-voting Process Model as illustrated in Figure 4.4. The following section will discuss the proposed E-voting Process Model and how the model could address the challenges mentioned in Chapter 3.

4.4 E-voting Process Model and the Current Electoral Challenges

Previous chapters have articulated the important role an electoral process plays in a democratic process. The primary objective of this research is to develop a process model detailing how e-voting could address the challenges faced by the current electoral process. Figure 4.4 is a graphical representation of the proposed E-voting Process Model for South Africa which entails the two electoral processes, namely optical scan polling station voting process and online voting process.

The proposed E-voting Process Model was developed to address some of the challenges that are faced by the current paper-based voting process to potentially improve the current electoral process in South Africa. These challenges and how they are addressed will be highlighted in this section. However, this model is not intended to serve as a solution for every challenge faced by the current electoral process.

The proposed E-voting Process Model illustrated in Figure 4.4 comprises of two voting options for South Africa. Option A outlines the process associated with an optical scan polling station voting process. Option B outlines the process associated with an online voting process. These two different methods of voting represent an E-voting Process Model for South Africa.

Section 4.3.1 and 4.3.2 discussed in detail the different steps associated with the proposed E-voting Process Model and how it could potentially address the various challenges facing South Africa. The challenges listed below were discussed in section 3.4 and this section will highlight how the proposed E-voting Process

Model could address these challenges. The challenges being addressed by the proposed E-voting Process Model are as follows:

- *Election fraud occurred through previously marked ballot papers and ballot boxes going missing.*

  Election fraud was exposed where ballot papers were already marked, and ballot boxes disappeared in previous elections in South Africa. The proposed E-voting Process Model addresses the challenge of ballot papers being marked before the official elections take place. When a ballot paper is already marked, the optical scan device will not count the ballot paper again.

  In addition, scanning of a voter's identification document and fingerprint will remove the opportunity for a voter to cast his/her vote more than once. The HANIS database as mentioned in section 3.5 and 4.3 will be used to verify a voter in real-time. Additionally, Option B in Figure 4.4 makes use of e-ballots; thus, a voter would only be able to mark one ballot.

- *Logistical challenges, which included ballot paper shortages and long queues:*

  The logistical challenges associated with the current electoral system as mentioned in section 3.4 will also be addressed by the proposed E-voting Process Model. When a voter uses Option B to vote, there will be no queue and no ballot paper shortages because e-ballots are being used. When voting online the voter will be able to choose his/her own language when casting an e-vote which will make the process more user-friendly. In addition, online voting is environmentally friendly and more cost effective as mentioned in section 2.2.

- *Vote coercion where voters are being influenced who to vote for:*

  The proposed E-voting Process Model addresses vote coercion when a voter casts his/her vote using Option B. The online voting process as described in section 4.3.2 allows the voter to cast the vote well in advance, thus allowing the voter to change his/her vote if needed. The final vote cast

will be counted electronically. This could potentially mitigate the influence from other people when participating in an election.

- *Lack of confidence and trust in the South African electoral process:*

  The lack of confidence and trust associated with the current electoral system, as mentioned in section 3.4, could also be addressed by the proposed E-voting Process Model. The various elements that contribute to the lack of confidence and trust, such as election fraud, could be addressed by the E-voting Process Model as discussed earlier in this section.

- *Spoilt votes:*

  The proposed E-voting Process Model will also eliminate spoilt ballots; which is another challenge associated with the current electoral process as mentioned is section 3.4. A voter's vote will not be counted if the vote is not correct, for example when a voter over-votes. If the vote is incorrect, the voter will be requested to recast his/her vote.

- *Various challenges face disabled voters when participating in an election:*

  Another challenge that will be addressed by the proposed E-voting Process Model is disabled voters such as blind and partially sighted people. The current system uses a template called "Betty the Braille" for blind and partially sighted voters as mentioned in section 3.4. This will also be used in the proposed E-voting Process Model. Additionally, as mentioned in section 4.3.1, voters will also have the opportunity to make use of headphones to tell the voter if his/her vote is correct or incorrect when using Option A to vote. This will contribute to making their vote independent. When voting online, the election website would accommodate people who are visually impaired. An example would be that the font of the ballot can be made larger for visually impaired voters. This is just one of the features which could be implemented to assist visually impaired voters. In addition, a physically disabled voter with Internet access would not have to travel to a polling station, which could make voting more convenient for them.

- *The current South African electoral process is challenging for the high number of illiterate adult citizens:*

  The proposed E-voting Process Model will potentially make the voting process easier. The reason is that the process model uses a simple layout of the ballot – similar to the current South African ballot paper as mentioned in section 4.3. Therefore, a simple layout allows a smaller amount of difficulty for illiterate voters to cast a vote.

- *Many South Africans are not able to commute to polling stations as a result of poverty and unemployment.*

  A large number of South Africans are unemployed and live in poverty as stated in section 3.4. Participating in an election could be costly for them. Travelling from a rural area to their designated polling station could be too expensive for a voter who does not have the funds. As mentioned in section 3.3.1, the current South African electoral process makes use of mobile voting station in deep-rural areas. Therefore, the proposed E-voting Process Model must provide the same or better service to voters' i.e. mobile voting stations. Furthermore, in section 4.3.1, Option A in the proposed E-voting Process Model does not need electricity to operate; it can run on batteries. Section 2.3.1.2 highlighted this as a benefit for an optical scan voting device. Therefore, it could be possible for the IEC to travel to these rural areas allowing voters to participate in an election using Option A.

- *Cost of voting for expatriate voters and registration challenges:*

  As discussed in section 4.3.2 the proposed E-voting Process Model could be seen as a great benefit for expatriate voters who want to participate in the South African election. Online voting will contribute to reduce costs associated with voting participation for a voter. For example, an expatriate voter would not have to travel to an embassy to participate in the South African elections, thus, reducing the cost associated with voting as mentioned in section 3.4. Online voting will be more convenient for voters

because they do not have to go to a polling station to cast a vote and stand in a queue.

Furthermore, the proposed E-voting Process Model eliminates the need to be registered on the voters' roll, as in the current South African electoral process. As stated in section 4.3 the voters' roll will be replaced by the HANIS database. This will allow expatriates who have not registered after the 1994 election to participate in South African elections. In addition, this is not limited to expatriate voters; citizens living in South Africa who are not on the voters' roll could also participate in elections, because the proposed E-voting Process Model makes use of the HANIS database in real-time.

The proposed E-voting Process Model as illustrated in Figure 4.4 aims to ensure that every South African has the opportunity to participate in an election. Therefore, it can be argued that the combination of voting processes proposed in the E-voting Process Model would achieve this by making two voting options available to voters. Those voters who do not have Internet access would be able to vote using Option A. Furthermore, those voters who are not able to travel to polling stations would be able to vote using Option B. This could improve voter participation in South African elections and could potentially address the previously mentioned challenges.

4.5 Summary

An electoral process is of great importance to the success of an election. The South African electoral system has various components associated with it. This chapter detailed the various components associated with the South Africa electoral system and the role each component plays. There are numerous challenges associated with the current South African electoral process.

This chapter proposed a process model to address the various challenges associated with the electoral process. The proposed E-voting Process Model incorporates technology into the South African electoral process. In Chapter 2 various countries around the world, which utilize technology known as e-voting, were investigated. The conclusions drawn from the examination of the electoral processes of these countries, contributed to develop the proposed E-voting

Process Model for the South African electoral process. This contributed to achieve the primary objective, which is to develop a process model demonstrating how e-voting can address challenges in the current South African electoral system.

There are two voting options associated with the proposed E-voting Process Model as discussed in this chapter. This includes an optical scan polling station voting process and an online voting process. The various steps associated with the proposed E-voting Process Model were also discussed in detail. Additionally, this chapter detailed how the E-voting Process Model would address the various challenges of the South Africa electoral system.

The following chapter will discuss the research methodology followed in this research study. The research methodology contributed to achieving all the objectives outlined in this research study.

Chapter 5

Research Methodology

5.1 Introduction

“”Knowledge does not start from perceptions or observations or the collection of data or facts; it starts, rather, from problems”. - (Popper, 1996, p. 65)

The main aim of this chapter is to discuss the research methodology associated with this research study. This chapter will briefly discuss the purpose of this research. The different paradigms and the research strategy are also discussed in detail. Furthermore, this chapter discusses the various ways in which data was collected and analysed. Argumentative methods were identified and utilized which contributed to achieving the primary objective of this research. The different methods of argumentation are defined and briefly discussed. Additionally, an expert review was conducted to obtain feedback on the proposed E-voting Process Model in this research. The expert review was conducted using a structured questionnaire with closed questions with the various experts. The validity of the research results in this dissertation was increased by using data triangulation.

The following sections will discuss in detail the various elements associated with the research process.

5.2 The Purpose of the Research and Research Objectives

Chapter 1 outlined the primary and secondary research questions and objectives for this dissertation. The main goal associated with this research is to develop a process model that addresses various challenges faced by the current paper-based electoral system in South Africa. The proposed E-voting Process Model incorporates the use of technology, known as e-voting, into the South African electoral system. In addition, it should be noted that the proposed E-voting Process Model aims to improve the current paper-based system and will not provide a solution to address all the challenges of the current system. A process model was defined in section 3.3.1.

The primary and secondary research questions associated with this research are:

Primary Research Question: **How can an e-voting process model be used to address challenges in the current paper-based electoral process?**

Research Question 1: What are the challenges facing the current South African electoral process?

Research Question 2: How is ICT currently being used to support the election process in countries worldwide?

Research Question 3: How can ICT enhance the South African electoral process?

Research Question 4: What are the different e-voting technologies and their capabilities?

Research Question 5: What are the security challenges facing e-voting?

To answer the above research questions in this study, various research methods were used. The following section will discuss in detail the research process that contributed to achieve all the objectives outlined in section 1.4. The various objectives will be highlighted in a later section.

5.3 Research Process

There are various definitions associated with the term research. According to the Oxford online dictionary (2010b), research is defined as "the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions."

Saunders, Lewis and Thornhill (2009) define research as "something that people undertake in order to find out things in a systematic way, thereby increasing their knowledge." In addition to the various definitions linked to the term research, Olivier (2004, p. 2) states that there are three approaches for conducting research:

- A researcher collects information on a relevant topic, where other researchers may have already discovered pieces of information but no contribution has been made into a single coherent body of knowledge;
- A researcher provides a solution to a problem where no solution has been proposed;
- A researcher finds a better solution for a problem that has a solution already associated with it.

This research is identified as using relevant information with regards to the subject matter. Therefore, all conclusions made were compiled into a single coherent body of knowledge. Additionally, a solution was provided that has not been previously proposed. Thus, the researcher proposes a new solution.

The proposed solution entailed a *process model* which depicted two electoral processes as discussed in Chapter 4. According to Olivier (2004) a model does not include insignificant characteristics of a process; therefore it only encapsulates the important characteristics of a process. Therefore, the *process model* represented the two electoral processes that included all facets that are significant to the proposed solution for voting in South Africa.

5.3.1 Research Philosophy

Gilner and Morgan (2000) define a paradigm as a "way of thinking about and conducting research. It's not strictly a methodology, but more a philosophy that guides how research is to be conducted." There are two main paradigms or philosophies associated with research, namely *positivistic* and *phenomenological (or interprevist)* (Collis & Hussey, 2003, p. 47). These two main paradigms are seen as two extremes of the continuum.

Positivist assume that the reality is objective. According to the *positivistic* paradigm a researcher and the research instrument acts independantly. Furthermore, it is believe that data collection should be conducted objectively such as using experiments for example. Through being objective interpretative bias is lessened. *Positivism* is often refered to as quantitative (Collis & Hussey, 2003).

A quantitative approach is said to be objective and can be seen as a process to test a hypothesis. According to Kothari (2008, p. 3) quantitative research is concerned with quantity. Therefore, the phenomena can be expressed in terms of quantity or measured in numbers. This theory is based upon variables and evaluated by analysis of numerical data. Thus, the data can be analysed by comparing statistical procedures to the hypothesis to provide the effectiveness and truth about the specific

research. Research is known to fall into one of these paradigms; or a research study can make use of both paradigms which is known as a mixed method. Tashakkori and Teddlie (1998, p. ix) defined mixed methods as the combination of "qualitative and quantitative approaches in the methodology of a study".

In contrast, on the other side of the continuum is the *phenomenological (or interprevist)* paradigm. According to the *interprevist* a researcher and the reality are inseperable. Therefore, the researcher involves himself, while data is collected and analysed. Research findings in a *interprevist* paradigm is argued to be subjective because humans have different experiences in society. *Interprevism* is often refered to as qualitative (Collis & Hussey, 2003).

Creswell (2009, p. 232) defined a qualitative study as "a means of exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures; collecting data in the participants setting; analysing the data inductively; building from particulars to general themes; and making interpretations of the meaning of the data."

In addition, the goal of qualitative research is to answer questions about a certain occurrence or subject matter under investigation from the participant's viewpoint. Olivier (2004, p. 112) states that qualitative research cannot be quantified in the same manner as quantitative data. Qualitative research is said to be more subjective, thus, the phenomena is different for each person, and it changes over time.

The research in this dissertation is primarily based on a qualitative approach as described in Creswell (2009) and Olivier (2004). In addition, there are some quantitative elements associated with the expert review in this research study.

5.4 Research Approach

There are two primary research approaches that are associated with research (Trochim, 2006). These are known as a deductive research approach and an

inductive research approach. Figure 5.1 illustrates the two research approaches as identified by Trochim (2006).

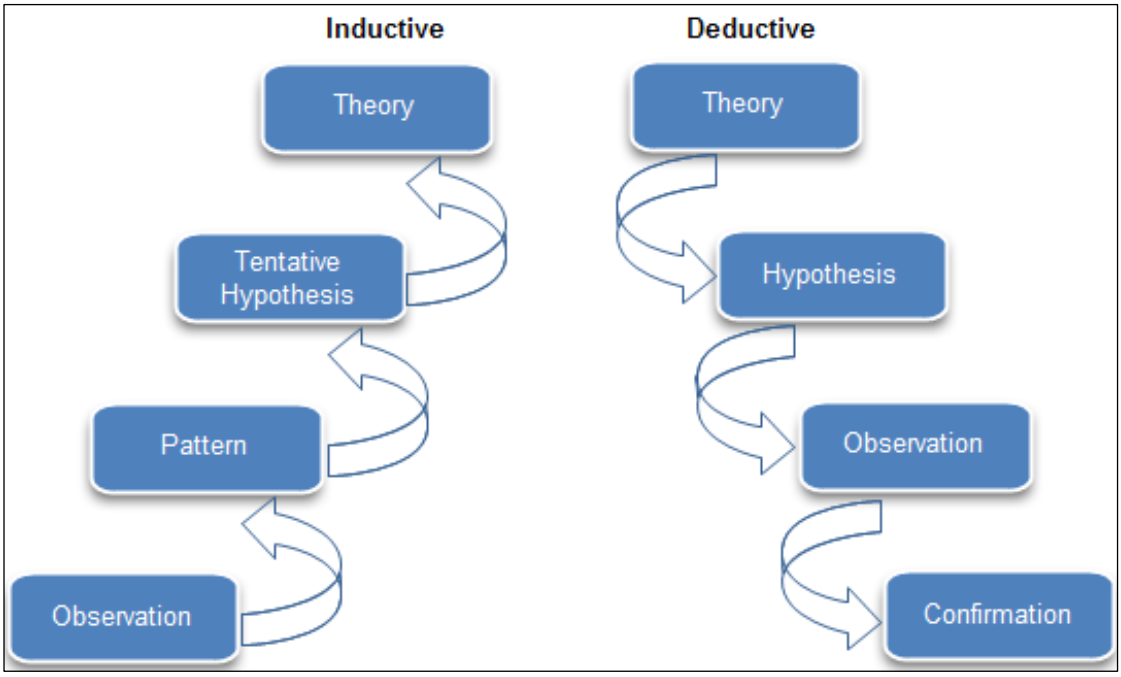


Figure 5.1: Inductive and Deductive Approach. Adapted from (Trochim, 2006)

According to Trochim (2006), deductive reasoning works from general to specific. The researcher develops a theory and hypothesis which are tested by empirical observations. In contrast, inductive reasoning works from specific observations to general facts. Thus, the researcher gathers data where a theory would be developed as a result of the data analysis.

The approach taken in this research is based on deductive reasoning. This study started with a theory where secondary data was gathered. Various identified themes were analysed which contributed to the proposed E-voting Process Model (hypothesis). The validation of the proposed process model was conducted through an expert review.

The next section will discuss the research strategy associated with this research study.

5.5 Research Strategy

A research strategy according to Saunders et al. (2007, p. 610) is “a general plan of how the researcher goes about answering the set of research questions you have set.” There are various strategies associated with quantitative and qualitative research. These include a survey, experiment, a case study and grounded theory, for example.

According to Metcalfe and Powell (2000) an “argument is a possible strategy, technique, method and research methodology particularly suited to IS research”. Therefore, the main strategy used in this research study is argumentation. Mason (1996, pp. 176-177) identified different methods of argumentation. In this research evidential and interpretative argumentation was used.

Evidential argumentation is when the researcher can make an argument because he/she is capable of showing the relevant evidence. According to Mason (1996, pp. 176-177) “if this is your argument, you will be concerned to demonstrate that you have marshalled and assembled your evidence carefully and appropriately. You will need to be clear about the basis on which you suppose your data constitutes evidence". In this research, evidential argumentation has been used extensively by compiling relevant evidence from literature. The evidence has been rigorously gathered and structured. In addition to arguing evidentially the researcher also argues *interpretively* or *narratively*.

As stated by Mason (1996) when a researcher argues *interpretively* or *narratively*, he/she can make the argument because the researcher can show the audience that his/her interpretation or narrative is meaningful or reasonable. The researcher will be concerned to show that his/her interpretation is sensitive, appropriately nuanced, and valid. In this research *interpretative* arguments have been used to show that evidence is reasonable and suitably nuanced. This research interpretatively presented the secondary data to support the proposed E-voting Process Model. Feedback from experts was obtained using an expert review. The primary data obtained from the experts was interpreted in a concise narrative manner to verify the validity of the process model in this research.

To summarize, evidential arguments were used wherever sufficient facts were found. In cases where the researcher had to interpret other sources and present arguments that show those sources supported the researcher's claims interpretative argumentation techniques were used. In other words, care was taken to base arguments on proven facts (the findings of past research) or where the findings stemmed from primary data; care was taken to try to convince the reader of the validity of the researcher's interpretation of the data.

5.6 Data Collection Methods

Various data collection techniques and procedures were utilized throughout this dissertation. This section will discuss in detail the different techniques and procedures utilized. Collecting data consists primarily of two groups of data, namely primary data collection and secondary data collection methods.

According to Kothari (2008) primary data collection is when data is collected "afresh and for the first time". In contrast, secondary data is data that has already been collected by other researchers regarding the subject matter.

The main source of data was the utilization of secondary data for this research study. This research study used existing, relevant literature, which included journal articles, conference papers, books, magazine articles, newspaper articles, online sources, published statistics, government records, electronic databases, thesis and dissertations and various case studies. Online sources were used because of the absence of e-voting sources in South Africa.

According to Hofstee (2006, p. 91) a literature study is a critical overview and is based on facts that have been discovered before concerning a particular subject matter. The researcher critically analysed secondary data, which led to the problem statement in this dissertation as stated below:

The current paper-based electoral system does not sufficiently address the unique needs of the South African democratic society.

Furthermore, the researcher examined secondary data using various case studies from countries worldwide. Case studies make use of qualitative research where

multiple bounded systems and a bounded case over a period of time are examined when doing case study research (Creswell, 2007, p. 73).

In Chapter 2, the researcher examined four different case studies with regards to the implementation of an e-voting system in the electoral process. These case studies included countries such as Brazil, India, Estonia and the USA. Brazil and India were identified because these developing countries face similar challenges to South Africa. In addition, developed countries such as Estonia and the USA were also identified because of their history of e-voting utilization. The Estonian e-voting system was examined because of its successful application of online voting since 2005.

Furthermore, the USA was examined because they make use of various forms of e-voting systems. These different case studies contributed to achieve various objectives in this research.

The primary and secondary objectives were outlined in section 1.4, and were achieved by making use of argumentation as described by Mason (Mason, 1996). This contributed to the development of the proposed E-voting Process Model in this dissertation.

The primary objective is stated below. Additionally, to achieve the primary objective a number of secondary objectives have been defined and achieved in various chapters.

The primary objective of this research project is to develop a process model demonstrating how e-voting can address challenges in the current South African electoral process.

Three of the secondary objectives are achieved in Chapter 2. The objectives as mentioned below are achieved by investigating the various case studies and critically analysing various literature sources; as mentioned in this chapter.

- To identify and evaluate e-voting technologies and their capabilities;
- To define the information security requirements with regard to the confidentiality, integrity and availability in the context of e-voting;
- To identify and evaluate e-voting technologies and their capabilities;

In Chapter 3, two of the secondary objectives as mentioned below are achieved in this research study.

- To investigate the current South African electoral process challenges and characteristics;
- To evaluate the applicability of ICT in the South African electoral process;

Additionally, in Chapter 4, one of the secondary objectives as mentioned below is achieved in this research study. It must be noted that Chapter 3 as mentioned helped to achieve this secondary objective.

- To evaluate the applicability of ICT in the South African electoral process.

Achieving the secondary objectives in this study contributed to achieve the primary objective outlined in this dissertation, as mentioned previously. All the secondary data which was identified and examined is used to argue towards the proposed solution in Chapter 4; the E-voting Process Model.

5.6.1 Expert Review

According to the Oxford online dictionary (2010a) an expert is defined as “a person who is very knowledgeable about or skilful in a particular area”. In addition, the Oxford online dictionary (2010c) defines a review as “a formal assessment of something with the intention of instituting change if necessary”. For the purpose of this research an expert is a person knowledgeable about workings of the South African electoral process.

In section 4.3, two e-voting processes were identified and it was argued how the two voting processes could be used in the South African electoral process to address various challenges. Therefore, various experts were identified for feedback on the E-voting Process Model proposed in this research study. Primary data was collected through the expert review. The technique utilized to get feedback from various experts with regard to the proposed E-voting Process Model was a structured questionnaire.

The experts were identified based on their knowledge and experience with regards to the South African electoral process or e-voting. Additionally, their willingness to participate in the expert review, their availability and

ease of access to the researcher played an important role in selecting them. Furthermore, the researcher contacted the IEC to participate in the expert review, but their participation was withdrawn because of their unavailability during the time the expert review was conducted, in the research study. Therefore, the study had to rely on purposeful sampling and made use of various available participants who met the criteria as experts.

As stated the experts were provided with a structured questionnaire which had closed-ended questions associated with it. Furthermore, the expert review was utilized to verify the validity of the proposed E-voting Process Model in Chapter 4, using triangulation. The expert selection process will be discussed in detail in section 5.6.1.1.

A questionnaire is another widespread data collection method. Sanders (1995) defines a questionnaire as a "data-gathering instruments used to obtain factual data, opinions and attitudes in such a way that the respondents and the data-gatherer need not come into contact with each other". According to Hofstee (2006, p. 132), a questionnaire is a form of structured interviewing. There are various advantages and disadvantages associated with a questionnaire.

Some of the advantages highlighted by Hofstee (2006, p. 133) are, for example, reduced economical cost associated with a questionnaire, feedback may be rapid from a large group of participants, the participants can be geographically dispersed, results obtained are generally easier to analyse and it offers participants anonymity, thus protecting their personal credentials.

In contrast, the disadvantages can include a lack of direct interaction between the participants and the researcher; a researcher cannot deviate from the questionnaire structure, thus preventing him/her to obtain more details from the participants and it can be time-consuming.

Furthermore, questionnaires have two general forms associated with it as stated by Kothari (2008, p. 101), namely a structured or unstructured questionnaire. Structured questionnaires have definitive, concrete and

predetermined questions. Therefore, all participants receive exactly the same set of questions and answers. In contrast, when the above mentioned structured characteristics are not present, it is known as an unstructured questionnaire.

There are various ways of conducting a questionnaire. Examples include postal, telephone, electronic and personally administered methods.

For the purpose of this research study a structured questionnaire was utilized to receive feedback from the various identified experts. The measure used was a five-point Likert scale technique with closed questions, therefore restricting the participant to select one of the available answers.

The participants received the questionnaires via e-mail or the researcher personally administered it. Two of the participants (expert 1 and 3) received the questionnaire via e-mail because of their physical location. The experts could contact the researcher if there were any queries with regard to the questionnaire. All relevant information was included in the e-mail sent to the participants (expert 1 and 3). Two participants (expert 2 and 4) were consulted in person. An introductory to the questionnaire was conducted with the experts, who claimed to be knowledgeable with regards to the electoral process. The researcher thoroughly discussed in detail the questionnaire with the participants (expert 2 and 4). Thereafter, the experts completed the questionnaire and returned it in their own time. Furthermore, the expert review provided a method to verify the validity of the proposed E-voting Process Model.

5.6.1.1 Expert Selection

The goal of this research study is to develop an E-voting Process Model demonstrating how e-voting can address challenges in the current South African electoral process as mentioned in section 1.4. As stated in section 5.6.1 various participants were identified who participated in an expert review. According to Nielsen (2005) when using evaluators in a research study, three to five experts are seen as sufficient enough for an expert review. The method used was a

structured questionnaire with closed questions, as discussed in detail in section 5.6.1.

The selection of the participants as experts was based on a set of criteria that had to be met. The researcher identified various criteria because there was no set of criteria available. The most important criteria that were identified to select participants as experts, were their knowledge with regard to the current South African electoral system and technology. Appendix A illustrates the questionnaire background questions posed to the selected participants. These included:

- The number of years' experience in the South African elections;
- The participant's role in the South African elections;
- The participant's technology exposure;
- The participant's knowledge with regards to the South African electoral system; and
- The participant's confidence level towards answering questions with regards to the current South African electoral system and the use of technology in the current system.

In the South African electoral system there are various Role Players, as discussed in section 4.2.4. Therefore, the researcher identified experts based on the role he/she plays in the electoral system. In addition, the number of years' experience also contributed to identifying experts. To qualify as an expert the participant had to be involved either as an IEC member, political party representative, electoral official or an academic researcher in the field of e-voting with regard to the South African electoral system. A South African voter did not qualify as an expert, because as stated, various criteria had to be met in terms of knowledge with regard to the South African electoral system and technological exposure.

Furthermore, technological exposure played an important role with regard to the selection of experts. The proposed E-voting Process

Model makes use of technology in the vote casting and counting process as discussed in Chapter 4. For that reason the participants required technological knowledge. However, the participant did not require in-depth technical knowledge but had to be exposed to technology as a user.

5.6.1.2 Expert Questionnaire

The second component associated with the expert review was two identified categories that were associated with the questionnaire. These categories were identified as Section B: Electoral System and Section C: Proposed E-voting System. The main goal associated with the two categories was to establish the experts' opinions towards the current South African electoral system and the process model proposed in this research study.

Section B, questions 7 to 12, investigated the expert's opinions towards the South African electoral system as illustrated in Appendix B and below.

- Do you think the current manual paper-based electoral system in South Africa is reliable?
- Do you think the current manual paper-based electoral system in South Africa could be improved?
- Do you think the Information and Communication Technology currently being used in the South African electoral system is utilized with success?
- Do you think the National Common Voters' Roll used in the South African electoral system is accurate?
- Integrating technology into the vote cast process could improve the current manual paper-based system in South Africa?
- Integrating technology into the counting process could improve the current manual paper-based system in South Africa?

Additionally, another goal associated with the questionnaire was to establish what the various experts' opinions were with regard to the role technology could play in the improvement of the current South African electoral system, i.e. the improvement of the vote casting and counting process. The questionnaire was used to determine whether the experts agreed that technology could potentially improve the current electoral system in South Africa.

In Section C, questions 13 to 16 investigated the expert's opinions towards the process model proposed in this research study, as illustrated in Appendix B and below.

- Do you think the proposed e-voting system could potentially improve the current manual paper-based South African electoral system?
- Do you think the proposed e-voting system would be accepted by South African voters?
- Does the proposed e-voting system offer more South Africans the opportunity to participate in South African elections compared to the current paper-based election?
- Do you think the proposed e-voting system could contribute to a freer and fairer election in South Africa?

In Chapter 4, an E-voting Process Model was proposed as the solution for this research study. Therefore, questions 13 – 16, were identified to establish if the experts felt that the Proposed E-voting Process Model could potentially improve the current South African electoral process. In addition, questions 13 – 16, allowed for extra feedback on the proposed process model in this research.

The results associated with the questionnaire were presented and analysed in Chapter 6. The following section will discuss the data analysis approach associated with this research study.

5.7 Data Analysis Approach

Data analysis and interpretation play an important role in a research project. There are different techniques that could be utilized in the analysis and interpretation of research data, namely qualitative analysis and quantitative analysis (Collis & Hussey, 2003).

In this dissertation, the data analysis approach was primarily qualitative, but contained some quantitative elements specifically in the validation phase of the research.

An initial study was done examining the concepts of e-voting and the South African electoral system and its challenges fairly broadly. Based on this initial study, a paper was prepared and presented at the *1st International ICST Conference on e-Infrastructure and e-Services for developing countries: Maputo, Mozambique, 3 - 4 December 2009*, titled *E-voting: A South African Perspective.* The paper is attached as Appendix D. Feedback leading from this paper contributed to theme analysis based on the paper and feedback from peers. Furthermore, Boyatzis (1998) stated that thematic analysis in its simplest form is a categorizing strategy for qualitative data.

As stated primary and secondary data collection methods were utilized throughout this research study. Firstly, a detailed literature review was conducted were several important inter-related emerging themes and categories were identified using theme analysis. These specific thematic areas were examined in detail and are as follows:

- The South African electoral process;
- Electoral processes worldwide;
- ICT utilization in a South African context;
- E-voting technologies; and
- Information Security.

Following the theme analysis various participants were identified as experts as mentioned in section 5.6.1. The participants were provided with a questionnaire detailing the major identified themes and were requested to give feedback on the specific themes and categories. The expert review contributed to the validation of

the themes and categories. The analysis of the results was done, as will be discussed in Chapter 6.

5.8 Triangulation

Triangulation is defined by Merriam (2002, p. 31) as a technique to use when a researcher wants to confirm the validity or credibility of the research findings. This is done by using multiple sources of data, investigators or data collection methods.

In this research, various sources of data were utilized, which included primary and secondary data. Secondary data was compiled from various documentation sources, which were used to argue evidentially and interpretively/narratively towards the proposed E-voting Process Model. In addition, primary data was collected by conducting an expert review, which gained valuable feedback on the proposed E-voting Process Model in this research. The various sources used to collect data were triangulated, increasing the credibility and validity of the results in this research.

5.9 Summary

This chapter discussed the research methodology used during this dissertation. Figure 5.2 illustrates the research process that was followed throughout this research study.

The two primary research paradigms were briefly discussed, and the researcher identified this research as being predominantly qualitative research.

However, some quantitative elements were used in this study during the validation of the process model. An extensive literature study was conducted by the researcher which contributed to gathering all the relevant information to identify the problem and propose a solution in this research study.

The secondary data was utilized, which included various sources that contributed to argue towards the proposed E-voting Process Model in this dissertation. Different argumentation methods were described and used during this research. Furthermore, primary data was collected from an expert review. Various experts were identified and a structured questionnaire with closed questions was sent to them to gain valuable feedback on the proposed E-voting Process Model.

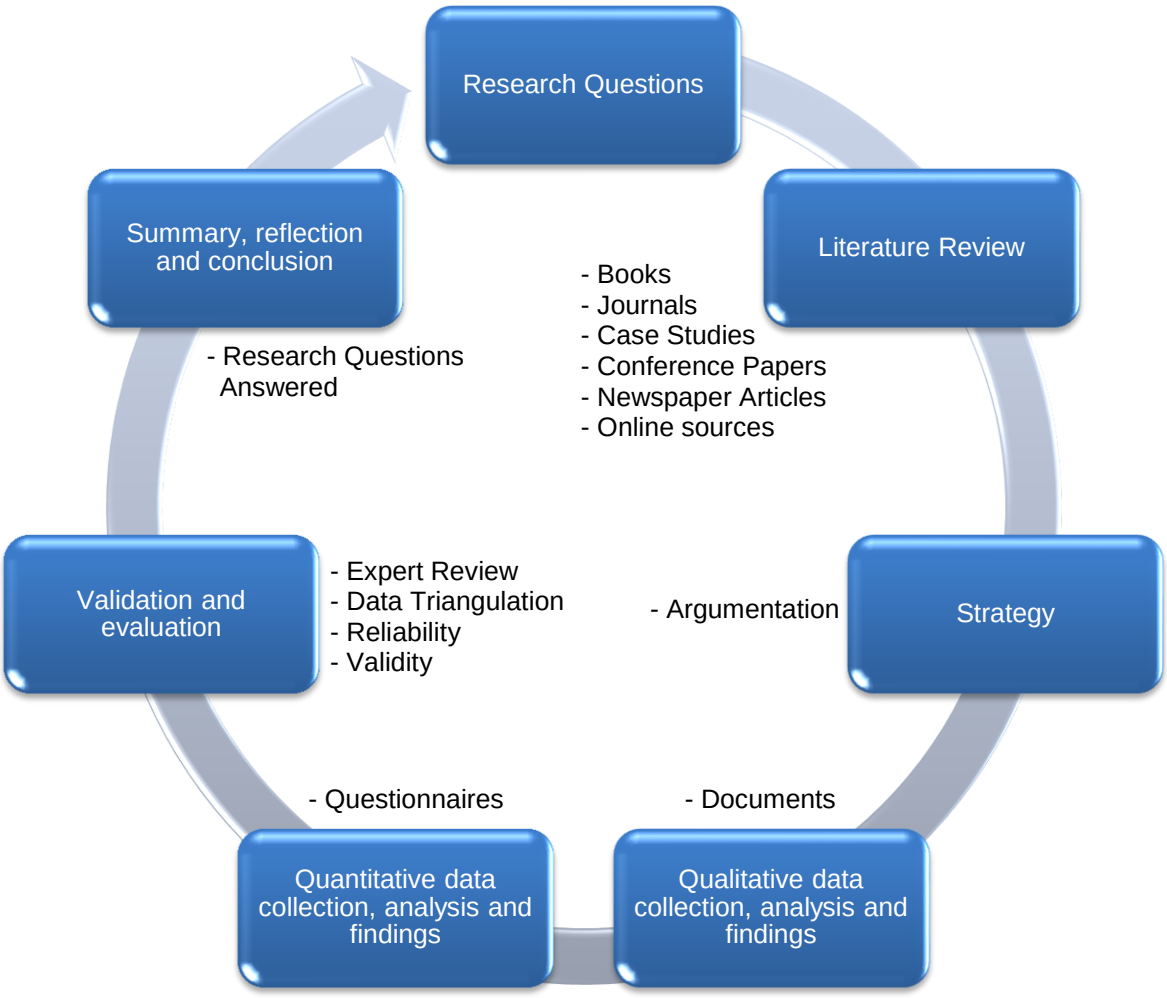


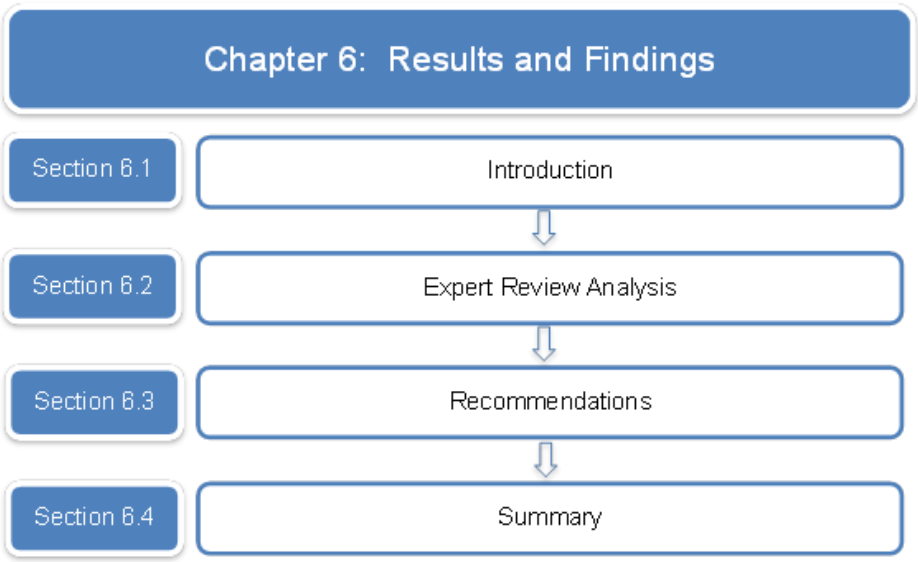
Figure 5.2: Research Process

In addition, this chapter detailed the data analysis approach which was followed. Further, the validity and/or credibility of this research were established by using data triangulation.

This chapter served to demonstrate the rigour of the research conducted during this study. The chapter also provided insight into the reasons for choosing specific methodologies and/or approaches used in the study. The next chapter will discuss the results validation of this research study.

Chapter 6

Research Results and Findings



6.1 Introduction

"Not everything that can be counted counts, and not everything that counts can be counted." – Albert Einstein

The research methodology used in this research study was discussed in detail in the previous chapter. The goal of this research is to recommend an E-voting Process Model for the electoral process in South Africa. The proposed E-voting Process Model was discussed in detail in Chapter 4. In addition, the validation of the proposed E-voting Process Model was conducted through an expert review. Experts were identified based on their knowledge with regard to the South African electoral process and e-voting. A structured questionnaire with closed questions was sent to various experts to obtain feedback on the proposed E-voting Process Model.

In this chapter, the results obtained from the conducted expert review will be discussed in detail. After all the various questions have been analysed and discussed, recommendations to improve the proposed E-voting Process Model for the South African electoral process will be discussed.

6.2 Expert Review Analysis

The data analysis process was described in detail in section 5.7. As stated various themes and categories arose from literature. Additionally, a questionnaire comprising of these themes and categories was sent to various experts for feedback.

The expert review was conducted with various identified participants based on their knowledge with regard to the South African electoral process and e-voting. As stated in section 5.6.1, purposeful sampling was utilized. The IEC was included in the expert review but had to withdraw because of their unavailability during the time expert review was conducted by the researcher, thus contributing to a smaller sample size.

Four participants were identified with the required expertise. For this research study, the participants' personal details will be kept confidential. Thus, the participants will be referred to as expert (n). There are three sections associated with the expert review in this chapter.

The first section focuses on the biographical information of the various expert reviewers. This contributed to motivating their status as participants. The second section focuses on the South African electoral process, and the third section focuses on the proposed E-voting Process Model. Furthermore, the third section required the expert reviewers to provide a reason for their answers to the questions posed in Appendix B. In addition, the participants were also allowed to add extra comments at the end of the questionnaire. Appendix A presents an expert review cover letter and a summary of the research study. The questions associated with the expert review are shown in Appendix B.

The questionnaire was delivered to the experts either personally, or by using e-mail. Two of the participants received the questionnaire in person, while the other two participants received the questionnaire using e-mail as a communication

method. The reason for delivering two of the questionnaires by e-mail was because of the physical location of the various participants.

The structured questionnaire with closed questions used a five-point Likert scale ranging from *strongly agree, agree; neither disagree nor agree, disagree* to *strongly disagree*. The experts' answers to the various questions posed in the questionnaire will be discussed in detail in the following sub-sections.

6.2.1 Section A: Biographical Information

The previous section highlighted that four participants were identified as experts. The participants received a questionnaire to obtain feedback regarding this research study. One of the criteria used to identify participants was their experience in the current electoral process in South Africa. In addition, their exposure to technology also played an important part in identifying them as participants. As stated, technology plays an important role in this research study, thus selecting the various participants as experts required that they have sufficient experience with technology.

As shown by the answers in Appendix C, all the selected participants had four years or more experience in the current South African electoral process. Based on Appendix C, three of the four participants (Expert 2, Expert 3 and Expert 4) are political representatives, therefore, identifying them as having sufficient knowledge about the South African electoral process. Further, one of the participants (Expert 1) is an academic researcher.

According to Appendix C, all 4 participants have been adequately exposed to technology. Thus it can be argued that the selected participants have the necessary knowledge to be regarded as experts with regard to the subject matter. Furthermore, Section 6.2.2 will further motivate the participants' knowledge about the current electoral process in South Africa, and their confidence level associated with answering questions about technology.

6.2.2 Section B: Electoral System

This section will elaborate on the expertise of the chosen participants. The section will specifically justify the experts' fitness to answer questions related to the current electoral process and technology as can be seen in Table 6.1, 6.2 and 6.3. As mentioned in Section 6.2 a five-point Likert scale was used in the structured questionnaire as can be seen in Section B and C in Appendix B.

Q4: Do you rate yourself as knowledgeable with regard to the South African electoral system?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree	×	×	×	
Agree				×
Neither Agree nor Disagree				
Disagree				
Strongly Disagree				

Table 6.1: Results from Section B: Question 4

Table 6.1 shows that three out of the four participants (Expert 1, Expert 2 and Expert 3) rate themselves as knowledgeable with regard to the South African electoral system. Furthermore, one participant (Expert 4) agreed that he/she is knowledgeable in the South African electoral system as shown in Table 6.1. Therefore, it can be concluded that the participants have adequate knowledge about the South African electoral system.

Q5: Are you confident in your ability to answer questions about the election process in South Africa?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree	×	×	×	×
Agree				
Neither Agree nor Disagree				
Disagree				
Strongly Disagree				

Table 6.2: Results from Section B: Question 5

In addition, Table 6.2 illustrates that all four of the participants are also confident in their ability to answer questions about the election process in South Africa. Therefore, it could be argued that the selected participants have the necessary experience to answer all the questions regarding this research study.

Q6: Are you confident in your ability to answer questions about the use of technology in the South African electoral system?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree	×	×	×	
Agree				×
Neither Agree nor Disagree				
Disagree				
Strongly Disagree				

Table 6.3: Results from Section B: Question 6

As mentioned in Chapter 1, the primary goal of this research is *to develop a process model demonstrating how e-voting can address problems in the current South African electoral process.* The proposed E-voting Process Model, discussed in Chapter 4, makes extensive use of technology in the South African electoral process. Therefore, the chosen participants must have sufficient knowledge about using technology in electoral processes to answer various questions associated with the experts' review.

As seen in Table 6.3 the selected participants confirm their confidence with regard to their ability to answer questions about using technology in the South African electoral process. As shown in Table 6.3, three out of the four participants (Expert 1, Expert 2, and Expert 3) strongly agreed that they are confident in their ability to answer questions about the use of technology in the South African electoral system. In addition, Table 6.3 shows that one participant (Expert 4) agreed that he/she is confident in answering questions regarding technology in the South African electoral system. Therefore, it can be concluded that all four of the participants are confident in their ability to answer questions about using technology in the South African electoral system.

Q7: Do you think the current manual paper-based electoral system in South Africa is reliable?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree	×			
Agree			×	×
Neither Agree nor Disagree				
Disagree		×		
Strongly Disagree				

Table 6.4: Results from Section B: Question 7

The participants were questioned regarding their views on the status of the current electoral process. As can be seen in Table 6.4, various answers were given with regard to the reliability of the current manual paper-based electoral system in South Africa.

According to Table 6.4, one out of four participants (Expert 1) strongly agreed that it is reliable. While two out of the four participants (Expert 3 and Expert 4) simply agreed that the electoral system is reliable. In contrast, one participant (Expert 2) disagreed about the reliability of the current manual paper-based electoral system in South Africa as shown in Table 6.4.

Q8: Do you think the current manual paper-based electoral system could be improved?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree		×		×
Agree				
Neither Agree nor Disagree	×		×	
Disagree				
Strongly Disagree				

Table 6.5: Results from Section B: Question 8

Table 6.5 questioned participants about their views on the improvement of the current electoral system in South Africa. Two out of the four participants (Expert 2 and Expert 4) strongly agreed that improvements could be made to the current South African electoral system. However, a further two out of four participants neither agreed nor disagreed with this question.

Q9: Do you think the Information and Communication Technology currently being used in the South African electoral system is utilized with succes?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree	×			
Agree			×	×
Neither Agree nor Disagree				
Disagree		×		
Strongly Disagree				

Table 6.6: Results from Section B: Question 9

Furthermore, the current electoral system in South Africa makes use of some technological elements in elections, as described in Chapter 3. As shown in Table 6.6, one out of the four participants (Expert 1) strongly agreed that the ICT utilization in the South African electoral system is accurate. A further two out of the four participants (Expert 3 and Expert 4) agreed with the question in Table 6.6. However, one out of the four participants (Expert 2) disagreed that the current utilization of ICT in the South African electoral system is accurate.

Q10: Do you think the national common voters' roll used in the South African electoral system is accurate?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree	×			
Agree				×
Neither Agree nor Disagree		×	×	
Disagree				
Strongly Disagree				

Table 6.7: Results from Section B: Question 10

The South African electoral system requires voters to be registered to be able to participate in South African elections, as described in Chapter 3. Additionally, voters who are registered are listed on the National Common Voters' Roll, which comprises of all the registered voter's details. Table 6.7 indicates that one out of the four participants (Expert 1) strongly agreed with the accuracy of the National Common Voters' Roll in South Africa. A further, one of the participants (Expert 4) agreed that the National Common Voters' Roll can be seen as accurate. Conversely, there were two out of four participants (Expert 2 and Expert 3) that neither agreed nor disagreed that the National Common Voters' Roll is accurate.

Q11: Integrating technology into the vote cast process could improve the current manual paper-based electoral system in South Africa?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree		×		×
Agree	×		×	
Neither Agree nor Disagree				
Disagree				
Strongly Disagree				

Table 6.8: Results from Section B: Question 11

As mentioned previously, one of the goals of this research is to incorporate technology into the South African electoral process, i.e. the vote casting and counting processes. As shown in Table 6.8 there were two out of the four participants (Expert 2 and Expert 4) who strongly agreed that incorporating technology into the vote cast process could improve the current manual paper-based electoral system in South Africa. A further two participants (Expert 1 and Expert 3) agreed that the incorporation of technology into the vote casting process could improve the current manual paper-based electoral system in South Africa. Therefore, according to the responses from the participants as seen in Table 6.8, there is an overall agreement that integrating technology into the vote casting process could lead to an improvement of the vote cast process in South Africa.

Q12: Integrating technology into the counting process could improve the current manual paper-based electoral system in South Africa?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree		×		×
Agree	×		×	
Neither Agree nor Disagree				
Disagree				
Strongly Disagree				

Table 6.9: Results from Section B: Question 12

Table 6.9 shows the participants' answers to Question 12. Two out of four participants (Expert 2 and Expert 4) strongly agreed that incorporating technology into the counting process could improve the current South African electoral system.

Additionally, the other two participants (Expert 1 and Expert 3) agreed that incorporating technology into the counting process could improve the current South African paper-based electoral system. Thus it could be concluded all four of the participants felt that the incorporation of technology into the counting process could improve the current South African electoral system.

In this section, an inquiry into the expertise of the identified participants, and their opinions regarding the current paper-based system used in South

Africa, was conducted. In addition, the questions assimilated the opinions of the experts on the utilization of technology in various electoral processes.

The next section will discuss Section C in Appendix B. Additionally, the next section includes questions about the proposed E-voting Process Model, the development of which is the primary objective of this research.

6.2.3 Section C: Proposed E-voting System

The questions in this section relate to the proposed E-voting Process Model in this research study. Similar to Section 6.2.2, a five-point Likert scale method was used. In addition, the participants were asked to provide reasons for their answers in Section C in Appendix B.

Q13: Do you think the proposed e-voting system could potentially improve the current manual paper-based South African electoral system?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree		×		×
Agree				
Neither Agree nor Disagree	×			
Disagree			×	
Strongly Disagree				

Table 6.10: Results from Section C: Question 13

The selected participants had various viewpoints about the question in Table 6.10. The Table shows that two out of four participants (Expert 2 and Expert 4) strongly agreed that the proposed E-voting Process Model could improve the current electoral process in South Africa. Supporting comments by Expert 4 for strongly agreeing, was that the proposed E-voting Process Model minimizes the human factor, which is related to many of the challenges discussed in Chapter 3. One out of four participants (Expert 1) indicated that they neither agreed nor disagreed with the question. Motivating comments from Expert 1 was that there is no compelling reason to use e-voting since South Africa has other pressing priorities which need attention.

In contrast, one out of the four participants (Expert 3) disagreed with the idea that the proposed E-voting Process Model could potentially improve the current South African electoral process. Expert 3 supported the answer

by saying that there are concerns that the mechanism for monitoring a ballot from issue to counting is lost. This expert clearly felt the transparency of the vote could be negatively affected; however, transparency and confidentiality always have a trade-off. It should be noted that any e-voting process used should be open for scrutiny, thus the process followed by e-voting should be auditable.

Q14: Do you think proposed e-voting system would be accepted by South African voters?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree				
Agree			×	
Neither Agree nor Disagree	×	×		×
Disagree				
Strongly Disagree				

Table 6.11: Results from Section C: Question 14

Table 6.11 showed that three out of four participants (Expert 1, Expert 2 and Expert 4) did not disagree or agree on whether the South African voters would accept the implementation of the proposed E-voting Process Model in the electoral process. Expert 1 expressed concerns, because there are various political players who have already stated that they are against an e-voting system. Thus, this could potentially hamper the acceptance of the proposed E-voting Process Model.

Additionally, Expert 2 indicated that South Africa has a large number of illiterate people that might not accept an e-voting process such as the proposed E-voting Process Model. In contrast, Expert 2 did indicate there will be South Africans who might accept the model.

In addition, Expert 4 stated the following reason for being neutral with regard to answering the question in Table 6.11. There are a large number of South Africans who are not “technological literate”. In contrast, Expert 4 did indicate that South Africans’ literacy abilities are increasing.

Further, one out of the four participants (Expert 3) agreed that the proposed E-voting Process Model would be accepted by South African voters. Expert 3’s motivation for agreeing to the question in Table 6.11 is that South Africans will accept the proposed E-voting Process Model because it

provides them with the option not to stand in queues. Consequently, this would contribute to making the process more convenient as discussed in Chapter 4.

Q15: Does the proposed e-voting system offer more South Africans the opportunity to participate in South African elections compared to the current paper-based election?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree		×		
Agree				×
Neither Agree nor Disagree	×			
Disagree			×	
Strongly Disagree				

Table 6.12: Results from Section C: Question 15

In Table 6.12, one participant (Expert 2) gave a positive feedback, strongly agreeing that the proposed E-voting Process Model offers more South Africans the opportunity to participate in South African elections compared to the current paper-based election.

In addition, one participant (Expert 4) agreed with the question in Table 6.12. Expert 4 was confident and stated that expatriates will also have the opportunity to participate in an election when using online voting in the E-voting Process Model. As mentioned in Chapter 4, this is one of the benefits associated with online voting.

Furthermore, another one of the participants (Expert 1) neither agreed nor disagreed that the proposed E-voting Process Model will offer more South Africans the opportunity to participate in the South African elections compared to the current South African election. The supporting comments from Expert 1 stated that there are various challenges such as technical and grid challenges, which could be an obstacle to allow more South Africans to vote when using the proposed E-voting Process Model.

In contrast, there was one participant (Expert 3) that disagreed that the proposed E-voting Process Model could offer more South Africans the opportunity to vote. The expert's motivation for the answer in Table 6.12 was that the current law in South Africa requires a voter to be registered. As stated in Chapter 4, this is one of the components which would need to

be addressed if an E-voting Process Model would be implemented. In addition, as detailed in Chapter 4, the legal component associated with the South African electoral process is outside the scope of this research study.

Q16: Do you think proposed e-voting system could contribute to a freer and fairer election in South Africa?	Expert 1	Expert 2	Expert 3	Expert 4
Strongly Agree		×		×
Agree				
Neither Agree nor Disagree				
Disagree	×		×	
Strongly Disagree				

Table 6.13: Results from Section C: Question 16

Table 6.13 presented the final question on the proposed E-voting Process Model. According to the results of this question, two out of the four participants (Expert 2 and Expert 4) strongly agreed that the proposed E-voting Process Model could contribute to a freer and fairer election in South Africa. The reason provided by Expert 2 is that the proposed E-voting Process Model could potentially rule out fraud and corruption in the vote casting and counting process. Expert 4 strongly agreed because there would be less intimidation and the proposed E-voting Process Model will contribute to the confidentiality of the voting process.

In contrast, two out of four participants (Expert 1 and Expert 3) disagreed that the proposed E-voting Process Model could contribute to a freer and fairer election in South African. The supporting comments associated with Expert 1 was that South Africa has a large population which would need education before there will be a “buy-in” on the proposed E-voting Process Model. Furthermore, Expert 3 expressed concerns about the proposed E-voting Process Model because it could potentially increase corruption.

In this section, the expert review contributed valuable feedback from the various identified participants. The feedback from the experts will be discussed in the next section with possible recommendations.

6.3 Recommendations

In the previous sections, the feedback from various experts was discussed in detail. This section will use the feedback results from the various experts and will motivate why the proposed E-voting Process Model could be beneficial to the current South African electoral process.

This research identified various challenges associated with the current electoral process in Chapter 3. Therefore, looking at alternative methods, such as incorporating technology into the vote casting and counting process, could potentially improve the electoral process in South Africa. All the experts indicated that they felt that incorporating technology into the vote cast and counting process could potentially improve the current electoral process in South Africa. Therefore, proposing a model such as the E-voting Process Model could be the foundation for future research to improve the current electoral process.

The E-voting Process Model was discussed in detail in Chapter 4. There were different opinions on the process model amongst the experts, as can be seen in Table 6.10. The transparency of the proposed E-voting Process Model was questioned. However, the E-voting Process Model does provide transparency. As stated in Chapter 4, the model proposes two options to vote – an optical scan polling station process or an online voting process. When the voter makes use of the optical scan polling station process option, there is an audit trail, therefore making the process transparent. The mechanism for monitoring the ballot from issue to counting is not lost. This is similar to the current electoral process as stated in Chapter 4. In addition, when utilizing the online voting process the proposed E-voting Process does not provide an audit trail; therefore, it is proposed that future research does address this facet of the online voting process.

Additionally, one of the experts felt that opting to implement an E-voting Process Model should not be one of the main concerns in South Africa. According to the experts there are other pressing priorities facing the country. However, as stated in Chapter 1, an electoral process plays a pivotal role in any democracy worldwide. Therefore, it could be argued that an electoral process is just as important as any other pressing priority. Having a free and fair system and allowing everyone the

opportunity to participate in an election is one of the objectives outlined by the Universal Declaration of Human Rights, as stated in Chapter 2.

Furthermore, one of the experts pointed out that the model could potentially minimize the human factor. As mentioned in Chapter 3, there are various challenges that face the electoral system, such as election fraud. Through implementing the proposed E-voting Process Model, election fraud, such as eliminating ballot forms being counted twice, could potentially be mitigated.

In addition, three of the experts were neutral about the potential acceptance by South African citizens of the E-voting Process Model as can be seen in Table 6.11. Certain concerns were identified such as the negativity towards e-voting among various political players. A further concern was the technological illiteracy levels of South Africans. However, as stated in Chapter 4, the E-voting Process Model proposes similar characteristics to the current South Africa electoral process. Therefore, those voters who are technologically illiterate would still have the option to vote at a polling station. When going to a polling station to vote the process will be very similar to the current process as discussed in Chapter 4, which could contribute to acceptance of this model by voters because of their familiarity with a similar electoral process, namely the current electoral process.

Furthermore, as can be seen in Table 6.11, one of the experts was positive that the E-voting Process Model would be accepted. The experts identified one of the benefits associated with the E-voting Process Model as discussed in Chapter 4. The benefit is that voters would potentially accept the E-voting Process Model because it provides the opportunity for them not to have to stand in a queue, which contributes to making the E-voting Process Model more convenient compared with the current electoral process.

As can be seen in Table 6.12, one of the experts disagreed that the proposed E-voting Process Model could potentially offer more South Africans the opportunity to participate in South African elections. The experts highlighted that the current South African law requires voters to register and be listed on the National Common Voters' Roll as stated in Chapter 3. As explained in Chapter 4, the National Common Voters' Roll will not be used in the proposed E-voting Process Model. Instead, of using the National Common Voters' Roll the HANIS database

will be utilized. The HANIS database stores every South African's detail as mentioned in Chapter 4. Thus, all necessary information of voters is stored on the HANIS database. Therefore, there is no need for voters to register when using the proposed E-voting Process. The database would be used to verify a voter's eligibility to vote through scanning his/her identification document and fingerprint as discussed in Chapter 4. Therefore, it could be argued that the utilization of the HANIS database is beneficial for authentication and identification of voters in the South African electoral process. As indicated in Chapter 4, this research is not addressing any legal component; however, it is acknowledged that the South African electoral law would have to be amended to incorporate the proposed E-voting Process Model and its use of HANIS.

Furthermore, another hindrance to the current electoral process highlighted by the experts is grid challenges. The proposed E-voting Process Model does address grid challenges with the implementation of an optical scan voting device which can function without electrical power. Therefore, as stated in Chapter 4, election officials would be able to travel to rural areas where electricity might be an issue, with a "mobile voting station", which includes the optical scan voting device. As a result, the proposed E-voting Process Model does address these grid challenges.

Furthermore, there are various technical challenges associated with e-voting, such as security, but the challenges are not limited to that. As stated in Chapter 1, security challenges are acknowledged as one of the challenges associated with e-voting, but it is not the focus of this research study. Therefore, the proposed E-voting Process Model did not address security challenges as mentioned in Chapter 1. In addition, the focus of this research was on the South African electoral process as stated in Chapter 1.

Additionally, one of the experts identified that the proposed E-voting Process Model could provide expatriates the opportunity to participate in the South African electoral process. The E-voting Process Model provides voters with an option to cast their vote online as discussed in Chapter 4. Therefore, an expatriate would have the opportunity to participate from any location worldwide if the voter has Internet access. Online voting, though, is not only limited to expatriates, it includes

every eligible South African voter. Therefore, it can be argued that this is one of the most important benefits associated with the proposed E-voting Process Model.

As can be seen in Table 6.13, two experts disagreed that the proposed E-voting Process Model could contribute to a freer and fairer election in South Africa. The experts highlighted that South Africans need education before there will be a "buy-in" on the proposed E-voting Process Model. In addition, corruption could also potentially increase as stated by the experts. The proposed E-voting Process Model, as stated in Chapter 4, incorporates an optical scan polling station voting process because it shares similar characteristics to the current electoral process in South Africa. Consequently, it does address the challenge of uneducated voters by having a simple ballot paper layout, thus making it easier for uneducated people to vote. The proposed E-voting Process Model uses an optical scan polling station voting process because there are minimal changes when compared to the current electoral process in South Africa.

Furthermore, the experts highlighted that the proposed E-voting Process Model could increase corruption. As discussed in Chapter 3, the current electoral process has various challenges such as election fraud. The proposed E-voting Process Model addresses fraud by making use of the HANIS database as discussed in Chapter 4. The HANIS database could potentially mitigate fraud, as a fingerprint would be required and voters would not be able to vote more than once. As discussed in Chapter 4, the South African banking sector is utilizing the HANIS database to mitigate fraud. Therefore, it could be argued that the proposed E-voting Process Model is addressing corruption through the implementation of the HANIS database and biometrics as discussed in Chapter 4.

There were, however, two experts who felt that the proposed E-voting Process Model could potentially contribute to a freer and fairer election because the model eliminates election fraud and corruption. Additionally, the experts highlighted that the proposed E-voting Process Model will contribute to confidentiality and less intimidation. Therefore, these two experts strongly agreed that the proposed E-voting Process Model could potentially contribute to a freer and fairer election.

Even though the experts provided much feedback, they made no recommendations to change the proposed E-voting Process Model. There were

various components associated with this model that were questioned. As a result, this section addressed the proposed E-voting Process Model components that were questioned by the experts.

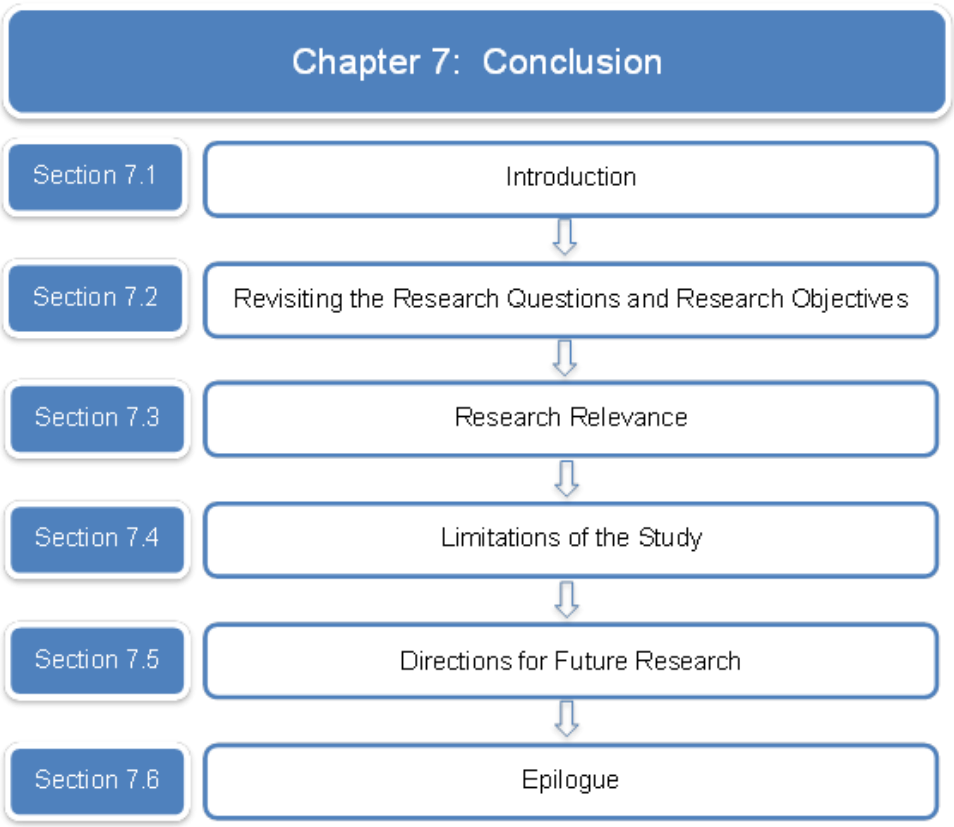
6.4 Summary

In this chapter, the primary data obtained from the expert review was presented. The feedback results from the expert review were analysed and discussed in detail. The various experts all agreed that incorporating technology into the vote casting and counting process could potentially improve the current South African electoral process. The proposed E-voting Process Model incorporated technology into the vote casting and counting process. As a result, the primary objective in this research was achieved through the proposed E-voting Process Model and was validated through an expert review.

In addition, there were several components of the proposed model that were questioned by the various experts. Therefore, this chapter addressed the feedback results from the experts and argued how the proposed E-voting Process Model could potentially address these. The next chapter will conclude this research study.

Chapter 7

Conclusion



7.1 Introduction

"It always seems impossible until it's done" – Nelson Mandela

This research dissertation investigated the South African electoral process. Various challenges were identified which contributed to the research problem. The primary objective of this research dissertation was to propose an improvement to the current electoral process in South Africa with the focus on the vote casting and counting process.

Consequently, this dissertation proposed that incorporating technology into the vote casting and counting process could potentially address the various challenges identified in this research. Furthermore, this research investigated the role played by ICT in various electoral processes worldwide. This contributed to the development of the E-voting Process Model for the South African electoral process.

This chapter will highlight the various objectives identified in Chapter 1. Additionally, the majority of this chapter will evaluate whether the research objectives have been achieved as envisioned at the beginning of this research dissertation. Following this, the chapter will conclude with some suggestions for future research.

7.2 Revisiting the Research Questions and Research Objectives

The primary objective of this dissertation was to ***develop a process model demonstrating how e-voting can address challenges in the current South African electoral process*** as stated in section 1.4. To achieve this primary objective, a number of secondary objectives were addressed. The remainder of this section will address the five secondary objectives, which were identified in Chapter 1 and will conclude with a discussion of the primary objective.

Research objective: *To investigate the current South African electoral process challenges and characteristics;*

This *secondary objective* was achieved in Chapter 3. An extensive literature review was conducted to achieve this objective. Chapter 3 discussed the South African democracy which included the background of the current electoral process in South Africa. An in-depth investigation was conducted on the current paper-based South African electoral process characteristics, which included identifying the various challenges associated with the South African electoral process.

The identified challenges contributed to argue towards the need for improving the current South African electoral process. Thus, by identifying the challenges facing the South African electoral process and the need to improve the current electoral process in South Africa, a paper entitled: *E-voting: A South African Perspective* was presented at the *1st International ICST Conference on e-Infrastructure and*

e-Services for developing countries: Maputo, Mozambique, 3 - 4 December 2009. The paper is attached as Appendix D.

Therefore, achieving the first *secondary objective* contributed to answer the first secondary research question as stated in Chapter 1, section 1.3, namely "*what are the challenges facing the current South African electoral process?"*

Research objective: *To investigate the use of ICT in current electoral processes in countries worldwide;*

This *secondary objective* was achieved by means of an extensive literature review of various case studies. Chapter 2 looked at different countries worldwide, which incorporated technology into their electoral processes known as e-voting. This achieved this secondary objective and therefore answered the second research question as stated in Chapter 1, section 1.3, namely *"how is ICT currently being used to support the election process in countries worldwide?"*

Research objective: *To evaluate the applicability of ICT in the South African electoral process;*

This *secondary objective* was achieved in Chapters 3 and 4. The current ICT status of the South African electoral process was evaluated in detail through an extensive literature review in Chapter 3. Chapter 3 investigated the different technological facets associated with the current South African electoral process and how the IEC is using ICT in the South African elections. Additionally, the various election applications and systems were identified and discussed.

Furthermore, Chapter 4 discussed in detail how ICT could be incorporated into the South African electoral process. In addition, Chapter 4 discussed the benefits associated with incorporating technology into the current electoral process to improve it. This achieved this secondary objective and thus answered the third research question as stated in Chapter 1, section 1.3, namely "*how can ICT enhance the South African electoral process?"*

Research objective: *To identify and evaluate e-voting technologies and their capabilities;*

Furthermore, this research objective was achieved in Chapter 2. This objective was achieved by conducting an in-depth literature study. In Chapter 2, various countries worldwide were identified that use e-voting in their electoral processes. Further, Chapter 2 investigated numerous developed and developing countries, which opted to implement e-voting in their general elections with success.

In addition, different e-voting systems were identified and discussed in detail. The numerous benefits e-voting offers were discussed in detail, which contributed to argue towards incorporating technology into the South African vote casting and counting process. Therefore, achieving this objective contributed to answer the fourth secondary research question as stated in Chapter 1, section 1.3, namely *"what are the different e-voting systems and their capabilities?"*

Research objective: *To define the information security requirements with regard to the confidentiality, integrity and availability in the context of e-voting.*

The final objective in this dissertation was achieved in Chapter 2, through an extensive literature review. As stated in Chapter 2 using technology in an election could increase security challenges. This research identified the importance of information in an election. Chapter 2 discussed in detail the importance of the confidentiality, integrity and availability of information. Furthermore, the various risks and security challenges associated with e-voting systems were identified and discussed in detail. Therefore, achieving this objective contributed to answer the fifth secondary research question as stated in Chapter 1, section 1.3, namely *"what are the security challenges facing e-voting?"*

In addition to these secondary objectives, the primary objective, to *develop a process model demonstrating how e-voting can address challenges in the current South African electoral process* was met through the development of the E-voting Process Model for South Africa in Chapter 4. This answered the primary research question of this dissertation, namely, "*how can an e-voting process model be used to address challenges in the current paper-based electoral process?"*

7.3 Research Relevance

This study, due to the challenges faced by the current paper-based electoral system in South Africa, proposed an E-voting Process Model. The proposed

E-voting Process Model has two voting processes associated with it – optical scan polling station voting and online voting. The two different options allow South African voters to participate in elections, thereby, giving all South Africans the option to select their method of voting. In addition, the proposed E-voting Process Model addresses various identified challenges facing the current paper-based electoral system. Challenges such as ballot paper fraud, spoilt ballots, logistical challenges, vote coercion, lack of confidence and trust in the electoral process, disabled and illiterate voters, travel challenges and expatriate registration and voting challenges were addressed by the proposed E-voting Process Model for South Africa in this research study.

For that reason, it could be argued that there are numerous benefits associated with the process model. Finally, the proposed E-voting Process Model could be the foundations for future research to improve the current South African electoral process.

7.4 Limitations of the Study

A number of obstacles were encountered during this research study. Firstly, there was a lack of literature with regards to e-voting in a South African context. It must be noted that access to peer-reviewed academic papers and published books on e-voting specific to South Africa was limited. However, global organizations such as the United Nations Development Programme (UNDP), International Foundation of Electoral Systems (IFES) and Carter Institute have shown a growing interest towards e-voting. In addition, a lack of access to documents, conference and journal papers to the problem area was also experienced during the duration of this research study. Therefore, the researcher examined various countries around the world, which face similar challenges to South Africa, but was not limited to them.

Secondly, no prototype of the proposed E-voting Process Model was developed and implemented. In addition, the IEC declined a request to implement a questionnaire on Election Day, which took place on 18 May 2011. The researcher wanted to investigate how South African voters felt about the current South African paper-based electoral system and their feelings towards the utilization of technology in the electoral process. As mentioned above the IEC declined a

closed-ended questionnaire as by law, according to them, no event or activity can take places in conjunction with any election process in South Africa. The Electoral Act of 73 of 1998 does confirm that no activity or event can take place in conjunction with any electoral process, therefore limiting the collection of primary data in this research study.

In addition, the researcher also contacted the IEC to participate in the expert review as stated in section 5.6.1. Their participation was withdrawn because of their unavailability during the time the expert review was conducted in the research study.

Therefore, future research could attempt to get feedback from South African voters by implementing a questionnaire with regards to their feelings about the current South African paper-based electoral system and their feelings towards the utilization of technology in the electoral process. Additionally, a prototype could be developed and implemented with regards to the E-voting Process Model proposed in this research study.

7.5 Directions for Future Research

This research study may be regarded as foundational research on which further research may be built. The research dissertation proposed using an E-voting Process Model for the South African electoral process. The model addressed various challenges and proposed two voting methods as described in Chapter 4, namely an optical scan polling station voting process and an online voting process. This model was constructed looking at various e-voting processes worldwide. There are, however, certain aspects that can be addressed in future research. This section will outline the areas for future research.

Confidence and trust in an electoral system play an important role in contributing to a successful election. As stated in Chapter 2, e-voting has various benefits associated with it, but comes with increased security requirements. Therefore, future research should address the security requirements for each voting process associated with the proposed E-voting Process Model for South Africa, i.e. an optical scan polling station voting process and an online voting process. This

research study identified various security risks associated with e-voting but an in-depth investigation was outside the scope of this research study.

Furthermore, an audit trail plays an important role in an election environment. An audit trail could contribute to voters having confidence in the electoral process that their vote has been cast correctly. In addition, this could prevent potential fraud or malfunction, which increases the credibility of an e-voting system. The proposed E-voting Process Model does provide an audit trail when using the optical scan polling station voting process. In contrast, the online voting process does not provide a voter the opportunity of an audit trail. Therefore, future research should address the feature of audit trails when implementing an online voting process. This could contribute to increased voter confidence when opting to use an online voting process when participating in an election.

Finally, there was no E-voting Process Model prototype developed and implemented throughout this research study. Therefore, future research could potentially look at the development and implementation of the proposed E-voting Process Model for South Africa.

7.6 Epilogue

Elections play an important role in democracies worldwide. South Africa has held various successful elections as stated by the IEC. However, this research has identified a number of challenges facing the current paper-based electoral process in South Africa. In addition, these challenges could potentially contribute to reduced voter participation in an election. Therefore, this research investigated the use of technology in electoral processes, known as e-voting, in countries worldwide. As a result, this research looked at e-voting as an option to improve the current paper-based South African electoral process.

The primary objective of this research was to develop a process model which made use of technology in the vote casting and counting process. Two e-voting processes were used in the process model namely an optical scan polling station voting process and an online voting process. The E-voting Process Model was discussed in detail and argued how it could address the various challenges facing the current South African electoral process. The validity of the E-voting Process

Model was achieved by conducting an expert review with various knowledgeable participants.

Furthermore, the proposed E-voting Process Model contributes to achieve the IEC's vision:

"To strengthen constitutional democracy through the delivery of free and fair elections in which every voter is able to record his or her informed choice".

Therefore, everyone could have the opportunity to participate in elections using one of the proposed options in the E-voting Process Model.

References

Abraham, S., & Chengalur-Smith, I. (2010). An overview of social engineering malware: Trends, tactics, and implications. *Technology in Society , 32* (3), 183-196.

ACE Projects. (2010). *Countries with e-voting projects*. Retrieved November 5, 2010, from ACE Electoral Knowledge Network: http://aceproject.org/ace-en/focus/e-voting/countries

ACE Projects. (2011, February 3). *Internet Voting.* Retrieved February 3, 2011, from ACE Electoral Knowledge Network: http://aceproject.org/ace-en/topics/et/eth/eth02/eth02b/eth02b4/?searchterm=internet%20voting

Allen, M. (2007, January 18). *Social Engineering: A Means To Violate A Computer System.* Retrieved March 25, 2011, from SANS: http://www.sans.org/reading_room/whitepapers/engineering/social-engineering-means-violate-computer-system_529

Álvarez-Rivera, M. (2010, August 24). *Election Resources on the Internet: The Republic of South Africa Electoral System.* Retrieved August 24, 2010, from http://electionresources.org/za/system/

AMS. (2011). *Developing Countries List*. Retrieved July 12, 2011, from American Mathematical Society: http://www.ams.org/membership/individual/types/mem-develop

Anane, R., Freeland, R., & Theodoropoulos, G. (2007). e-Voting Requirements and Implementation. *In Proceedings of CEC/EEE'2007*, (pp. 382-392).

Athiemoolam, L. (2003). *South Africa's Peaceful Transition to Democracy: Nine Years of Peace in a Trouble World.* Retrieved February 23, 2010, from http://www.zsn.uni-oldenburg.de/download/Logan_Japan_Conference.pdf

Avgerou, C., Ganzaroli, A., Poulymenakou, A., & Reinhard, N. (2007). ICT and Citizens' trust in government : lessons from electronic voting in Brazil. *Proceedings of IFIP Working Group 9.4 conference*, (pp. 1-13). San Paolo, Brazil.

Bam, B. N. (2008). Eternal vigilance and the value of Peace and Political Tolerance in advancing Democracy. *South Africa Peace Indaba Summit.* Durban.

Basson, A., Rossouw, M., & SAPA. (2009, April 22). *First election results out*. Retrieved January 5, 2012, from Mail & Guardian Online: http://mg.co.za/article/2009-04-22-iec-polling-stations-close-despite-anc-push-for-extension

Baudrillard, J. (1987). Cool Memories.

BBC News. (2008, October 1). *How Brazil has put an 'e' in vote*. Retrieved June 20, 2011, from http://news.bbc.co.uk/2/hi/7644751.stm

BBC News. (2009a, April 22). *Huge turnout in South Africa poll*. Retrieved September 15, 2010, from http://news.bbc.co.uk/2/hi/africa/8012567.stm

BBC News. (2009b, March 30). *Indian election in numbers*. Retrieved June 28, 2011, from http://news.bbc.co.uk/2/hi/south_asia/7972675.stm

BBC News. (2012, January 6). *South Africa profile*. Retrieved January 6, 2012, from http://www.bbc.co.uk/news/world-africa-14094760

Beary, H. (2004, February 27). *Gearing up for India's electronic election*. Retrieved June 28, 2011, from BBC News: http://news.bbc.co.uk/2/hi/south_asia/3493474.stm

Bellis, M. (2008). *The History of Voting Machines*. Retrieved June 20, 2011, from http://inventors.about.com/library/weekly/aa111300b.htm

Botes, A. (2010, May 26). Retrieved September 27, 2010, from South African Government Information: http://www.info.gov.za/speech/DynamicAction?pageid=461&sid=10830&tid=10847

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development.* Thousand Oaks, London, & New Delhi: SAGE Publications.

Brändli, D., & Braun, N. (2006). *Swiss E-Voting Pilot Projects: Evaluation, Situation Analysis and How to Proceed.* Retrieved March 14, 2011, from http://www.e-voting.cc/static/evoting/files/braun_braendli_swiss_e-voting_27-36.pdf

Britannica. (2011). *Australian ballot*. Retrieved November 25, 2011, from Encyclopædia Britannica: http://www.britannica.com/EBchecked/topic/43932/Australian-ballot

Brown, L., & Langenegger, J. A. (2011). Practicing Texas Politics. Boston, USA: Wadsworth Publishing Company.

Buetler, I. (2009, June 9). *Social Engineering Test Cases.* Retrieved March 25, 2011, from Compass Security AG: http://www.csnc.ch/misc/files/publications/Social_Engineering_V2.0.pdf

Caarls, S. (2010). *E-voting Handbook.* Council of Europe.

Caarls, S. (2010). *The use of technologies in electoral systems.* Retrieved July 12, 2011, from Aswatna: http://www.aswatna-eg.net/assets/files/Technology%20and%20Elections.pdf

Chan, C., & Tarantola, A. (2010, November 2). *How to Vote: A Guide to Every Voting Machine in America*. Retrieved July 14, 2011, from Gizmodo: http://gizmodo.com/5670162/how-to-vote-a-guide-to-every-voting-machine-in-america#AutoMARK

Chaum, D., Jakobsson, M., & Rivest, R. L. (2010). *Towards Trustworthy Elections: New Directions in Electronic Voting.* Springer-Verlag Berlin and Heidelberg.

Collis, J., & Hussey, R. (2003). *Business research. A practical guide for undergraduate and postgraduate students* (2nd ed.). Palgrave Macmillan.

Corley, B. E. (n.d.). *Optical Scan Voting System*. Retrieved September 5, 2011, from Supervisor of Elections Pasco County: http://www.pascovotes.com/optscan.asp

Creswell, J. W. (2007). *Qualitative Inquiry and Research Design Choosing Among Five Approaches* (2nd ed.). SAGE Publications.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed.). SAGE Publications Ltd.

Daniel, J., & Southall , R. (2010). *Zunami!: The 2009 South African Elections.* Jacana Media.

Department of Home Affairs. (1998). *Electoral Act 73 of 1998*. Retrieved October 30, 2011, from http://www.dha.gov.za/PDF/Acts/Electoral%20Act%2073%20of%201998.pdf

Ebersohn, K. (2009, April 23). *Volksblad.* Retrieved Septermber 14, 2010, from http://jv.news24.com/Die_Volksblad/Nuus/0,,5-83_2505642,00.html

Ebrahim, H. (2011, May). *The South African Constitution: Birth Certificate of a Nation.* Retrieved November 2011, 23, from UNMIS: http://unmis.unmissions.org/Portals/UNMIS/Constitution-making%20Symposium/2011-05_Ebrahim_South%20Africa.pdf

ECI. (2006). *A Guide for Voters.* Retrieved June 30, 2011, from Election Commission of India: http://eci.nic.in/eci_main/ECI_voters_guideline_2006.pdf

ECI. (2009). *Electronic Voting Machines*. Retrieved June 28, 2011, from Election Commission of India: http://www.eci.nic.in/eci_main1/evm.aspx

EconomyWatch. (2010, June 30). *US Economy*. Retrieved January 5, 2012, from http://www.economywatch.com/world_economy/usa/?page=full

EISA. (2004). *Election observer mission report.* Retrieved June 2010, from Electoral Institute of Southern Africa: http://www.eisa.org.za/PDF/sa04eomr.pdf

ES&S. (n.d.). *ES&S AutoMARK(i) Voter Assist Terminal.* Retrieved July 14, 2011, from Election Systems and Software: http://www.essvote.com/HTML/products/automark.html

ES&S. (n.d.). *ES&S DS200(i)™ Precinct Scanner & Tabulator*. Retrieved August 16, 2011, from Election Systems and Software: http://www.essvote.com/HTML/docs/ESS_DS200%28i%29_V6_10-09.pdf

February, J., & Misra-Dexter, N. (2010). *Testing Democracy - Which Way is South Africa Going?* The Institute for Democracy in South Africa.

Frith, D. (2007). E-voting security: hope or hype? *Network Security , 2007* (11), 14-16.

Froehner, J., & Ryan, M. P. (2010, April 13). *Profiles in Information Technology: Brazil.* Retrieved June 22, 2011, from George Washington University: http://www.law.gwu.edu/Academics/research_centers/ciec/Documents/profiles/Profiles%20in%20Information%20Technology%20-%20Brazil.pdf

Gates, B. (2005, July 4). Retrieved July 28, 2011, from BBC News: http://news.bbc.co.uk/2/hi/technology/4648003.stm

Gliner , J. A., & Morgan, G. A. (2000). *Research Methods in Applied Settings: An Integrated Approach to Design and Analysis.* Routledge Academic.

Gonggrijp, R., Halderman, A., Kankipati, A., Prasad, H., Sakhamuri, S., Wolchok, S., et al. (2010). Security Analysis of India's Electronic Voting Machines. *Proceedings of the 17th ACM Conference on Computer and Communications Security (CCS'10).* New York, USA.

Gritzalis, D. A. (2002). Principles and requirements for a secure e-voting system. *Computers & Security , 21* (6), 539-556.

Gritzalis, D. A. (2003). *Secure Electronic Voting.* United States of America: Kluwer Academic Publishers.

Hall, T., & Maaten, E. (2008). Improving the Transparency of Remote E-voting: The Estonian Experience. *3rd International Conference on Electronic Voting 2008*, (pp. 31-43). Bregenz, Austria.

Herbert, D. (2009, January 12). *Online Voting Closer Than Imagined*. Retrieved January 4, 2012, from National Journal Live: http://www.nationaljournal.com/njonline/no_20090107_7892.php

Hofstee, E. (2006). *Constructing a Good Dissertation: A Practical Guide to Finishing a Masters, MBA or PhD on Schedule.* Johannesburg, South Africa: EPE.

ID.ee. (2007, November 2). *Estonian ID Card.* Retrieved June 28, 2011, from http://www.id.ee/11019

IDASA. (2008). *Concern about Ballot Secrecy.* Retrieved September 14, 2010, from http://www.idasa.org/our_products/resources/output/afrobarometer_citizens_concerns/?pid=afrobarometer

IDEA. (2010). *Electoral System Design: the New International IDEA Handbook.* Retrieved March 4, 2010, from The International Institute for Democracy and Electoral Assistance: http://www.idea.int/publications/esd/upload/ESD_Handb_low.pdf

IEC. (2009a, March 12). *Court Ruling.* Retrieved November 2011, 23, from Independent Electoral Commission: http://www.elections.org.za/content/DynamicDocs.aspx?id=416&BreadCrumbId=416&LeftMenuId=251&name=home

IEC. (2010a). *Election Report: 2009 National and Provincial Elections.* Retrieved February 16, 2011, from Independent Electoral Commission: http://www.elections.org.za/content/Dynamic.aspx?id=1344&name=Elections&LeftMenuId=100&BreadCrumbId=220

IEC. (2010b). *Laws and regulations*. Retrieved October 3, 2010, from Independent Electoral Commission: http://www.elections.org.za/content/DynamicDocs.aspx?id=292&BreadCrumbId=292&LeftMenuId=251&name=home

IEC. (2009b). *National and Provincial Elections Results*. Retrieved October 4, 2010, from Independent Electoral Commission: http://www.elections.org.za/content/Pages/LGE_NPE_Reports/Reports.aspx?lEEtypeID=1&id=1426&name=Elections

IEC. (2011). *The voting process*. Retrieved February 2, 2011, from Independent Electoral Commission: http://www.elections.org.za/content/Dynamic.aspx?id=575&name=Elections&LeftMenuId=100&BreadCrumbId=220&ekmensel=14ae2c49_100_252_btnlink

IEC. (2010c). *Vision, Mission and Values*. Retrieved August 24, 2010, from Independent Electoral Commission: http://www.elections.org.za/content/Dynamic.aspx?id=1326&LeftMenuId=79&name=About%20Us&BreadCrumbId=212

IEC. (2009c). *Voter education.* Retrieved November 23, 2011, from IEC: http://www.elections.org.za/content/DynamicDocs.aspx?id=414&BreadCrumbId=414&LeftMenuId=251&name=home

IMF. (2011, April). *International Monetary Fund.* Retrieved 2012, from World Economic and Financial Surveys: http://www.imf.org/external/pubs/ft/weo/2011/01/pdf/text.pdf

Indian.gov.in. (2009). *General Elections, 2009*. Retrieved January 5, 2012, from http://india.gov.in/spotlight/spotlight_archive.php?id=39

Internet World Stats. (2011, March 31). *Internet Usage Statistics for Africa*. Retrieved June 14, 2011, from http://www.internetworldstats.com/stats1.htm

ITU. (2010). *The World in 2010.* Retrieved February 21, 2011, from International Telecommunication Union: www.itu.int/ITU-D/ict/material/FactsFigures2010.pdf

Jones, D. W. (2003). The Evaluation of Voting Technology. In D. A. Gritzalis, *Secure Electronic Voting* (pp. 3-16). Kluwer Academic Publishers.

Kalvet, T. (2009). Management of Technology: The Case of e-Voting in Estonia. *2009 International Conference on Computer Technology and Development*, (pp. 512-515). Kota Kinabalu, Malaysia.

Kersting, N. (2006). Electoral Reform in Southern Africa: Voter Turnout, Electoral Rules and Infrastructure. *Journal of African Elections , 6* (1), 134-151.

Kersting, N. (2009). Voting Behaviour in the 2009 South African Election. *Africa Spectrum , 44* (2), 125-133.

Khosa, M. M., & Muthien, Y. G. (2000). Election Management in South Africa: an Evalutation of the 1999 Election. *International IDEA Conference - Towards Sustainable Democratic Institutions in Southern Africa*, (p. 105). Gaborone.

Kothari, C. R. (2008). *Research Methodology: Methods and Techniques* (2nd ed.). New Delhi: New Age International Publishers.

Krimmer, R., Triessnig, S., & Volkamer, M. (2007). *The Development of Remote E-Voting around the World: A Review of Roads and Directions.* Retrieved March 14, 2011, from E-voting.cc: http://www.e-voting.cc/static/evoting/files/VOTE-ID-2007.pdf

Landler, M., & Markoff, J. (2007). *Digital Fears Emerge After Data Siege in Estonia*. Retrieved June 26, 2011, from The New York Times: http://www.nytimes.com/2007/05/29/technology/29estonia.html

Le Roux, 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.

Lohumi, R. (2010, June 13). *EVMs India's technological wonder: CEC*. Retrieved June 20, 2011, from The Tribune: http://www.tribuneindia.com/2010/20100614/himachal.htm#1

Mabandu, P. (2009, April 26). *Feeling the vote.* Retrieved September 28, 2010, from Mail & Guardian Online: http://www.mg.co.za/article/2009-04-26-feeling-the-vote

Mafirakurewa, M. (2009, April 22). *Marked ballot papers found*. Retrieved September 27, 2010, from Africa News: http://www.africanews.com/site/SA_Marked_ballot_papers_discovered/list_messages/24430

Mason, J. (1996). *Qualitative researching.* SAGE Publications.

Mason, S. (2004). Is there a future for Internet voting? *Computer Fraud & Security , 2004* (3), 6-13.

Mawson, N., & McConnachie, K. (2011, May 13). *IEC ponders e-votes* . Retrieved May 13, 2011, from ITWeb: http://www.itweb.co.za/index.php?option=com_content&view=article&id=43634:iec-ponders-evotes&catid=89

Mbola, B. (2009). *South Africans abroad win right to vote*. Retrieved February 3, 2010, from SouthAfrica.info: http://www.southafrica.info/abroad/expats-voting.htm

Merriam, S. B. (2002). *Qualitative research in practice: examples for discussion and analysis.* Jossey-Bass.

Metcalfe, M., & Powell, L. (2000). *Revisiting the Argumentative Methodology.* Retrieved October 30, 2011, from University of South Australia: http://www.unisa.edu.au/irg/documents/argue_acis.pdf

Meza, M., & Nelly, S. (2009). *A model for direct recording electronic voting systems, MIT dissertation, University of Pretoria.* Retrieved June 20, 2011, from http://upetd.up.ac.za/thesis/available/etd-01072010-181121/

Mfeketo, N. (2011, October 13). *Speech by Deputy Speaker of the National Assembly, Hon. Nomaindia Mfeketo*. Retrieved January 5, 2012, from Parliament of the Republic of South Africa: http://www.parliament.gov.za/live/content.php?Item_ID=1737

Mitnick, K., & Simon, W. L. (2003). *The Art of Deception: Controlling the Human Element of Security.* New York, NY, USA: John Wiley & Sons, Inc.

Mostert, J. (2004). Diffusing information for democracy: an insight of the South African Parliament. *Library Management , 25* (1/2), 28-38.

Mpumlwana , T. (2011, May). *Democracy doesn't discriminate against disabled*. Retrieved January 5, 2012, from City Press: http://www.citypress.co.za/Columnists/Democracy-doesnt-discriminate-against-disabled-20110507

Mtyala, Q. (2011, May 24). *People don't know how to vote*. Retrieved 5 January 5, 2012, from Independent Online: http://www.iol.co.za/news/south-africa/western-cape/people-don-t-know-how-to-vote-1.1073034?ot=inmsa.ArticlePrintPageLayout.ot

Muller, R. (2011, June 28). *What South Africans do online*. Retrieved June 29, 2011, from My Broadband: http://mybroadband.co.za/news/internet/26873-what-south-africans-do-online.html

MyBroadband. (2011, September 16). *Facebook demographics in South Africa*. Retrieved September 16, 2011, from My Broadband: http://mybroadband.co.za/news/internet/34072-facebook-demographics-in-south-africa.html

Nangue, C. R. (2011). *Guidelines for the successful integration of ICT in schools in Cameroon.* Nelson Mandela Metropolitan University.

NCVOTER. (n.d.). *Advantages of Paper Ballot and Optical Scan (PBOS) Systems*. Retrieved August 20, 2011, from http://www.ncvoter.net/downloads/AdvantagesDisadvantagesOpScan.pdf

NEC. (2008). *NEC AFIS created the world's largest civilian fingerprint identification database for HANIS*. Retrieved August 16, 2011, from www.nec.com/global/cases/sa/pdf/catalogue.pdf

Nicholson, D. R. (2011). Mobile Technologies - Information on the Move … or Stuck in a Groove? - A South African Perspective. *Library and Information Science Research Electronic Journal , 21* (2).

Nielsen, M. M. (2009, April 20). *Technology use in the 2009 South African elections*. Retrieved February 4, 2010, from Pan European eParticipation Network: http://pep-net.eu/blog/2009/04/20/technology-use-in-the-2009-south-african-elections/

Nielson, J. (2005). *How to conduct a heuristic evaluation*. Retrieved from Useit.com: http://www.useit.com/papers/heuristic/heuristic_evaluation.html

Olivier, M. S. (2004). *Information Technology Research.* Pretoria, South Africa: Van Schaik Publishers.

OSCE. (2011, May 16). *Estonia OSCE/ODIHR Election Assessment Mission Report.* Retrieved June 22, 2011, from Organization for Security and Co-operation in Europe: http://www.osce.org/odihr/77557

Oxford Dictionaries. (2010a, April). *Expert*. Retrieved October 30, 2011, from http://oxforddictionaries.com/definition/expert

Oxford Dictionaries. (2010b, April). *Research*. Retrieved October 28, 2011, from http://oxforddictionaries.com/definition/research

Oxford Dictionaries. (2010c, April). *Review*. Retrieved October 30, 2011, from http://oxforddictionaries.com/definition/review

Pew Center of the States. (2008a, February). *Back to Paper: A Case Study*. Retrieved January 5, 2012, from http://www.pewcenteronthestates.org/uploadedFiles/EB21Brief.pdf

Pew Center of the States. (2008b, October 20). *Election Preview 2008.* Retrieved August 9, 2011, from http://www.pewcenteronthestates.org/uploadedFiles/Election%20Preview%20FINAL.pdf

Politicsweb. (2009b, March 31). *The National ballot paper*. Retrieved November 26, 2011, from http://www.politicsweb.co.za/politicsweb/view/politicsweb/en/page71656?oid=123491&sn=Detail

Popper, K. R. (1996). *In Search of a Better World: Lectures and Essays from Thirty Years.* London: Routledge.

Qantas. (2012, January 7). *Perth to Canberra*. Retrieved January 7, 2012, from http://book.qantas.com.au/pl/QFOnline/wds/OverrideServlet

Reynolds, A., & Steenbergen, M. (2006). How the world votes: The political consequences of ballot design, innovation and manipulation. *Electoral Studies , 25* (4), 570-598.

Rivest, R. L. (2001). Electronic voting. *Financial Cryptography , 2339*, 243-268.

Rolland, C. (1998). A comprehensive view of process engineering. In *Advanced Information Systems Engineering. Lecture Notes in Computer Science* (Vol. 1413, pp. 1-24). Springer Berlin / Heidelberg.

Rubin, A. (2002). Security Considerations for Remote Electronic Voting. *Communications of the ACM. Volume 45, Issue 12* , 39-44.

SAHRC. (2002, November). *Towards a barrier-free society.* Retrieved January 5, 2012, from South African Government Online: http://www.info.gov.za/view/DownloadFileAction?id=70265

Sanders, M. (1995). A Useful Format for Questionnaires and Tests used in Educational Research. *Proceedings of the 3rd annual meeting of the South African Association for Research in Mathematics and Science Education* (pp. 712-725). Cape Town: SAARMSE.

Sapa. (2009a, April 22). *ANC told people who to vote for.* Retrieved September 30, 2010, from News24: http://www.news24.com/Elections/News/ANC-told-people-who-to-vote-for-20100625

Sapa. (2009b, April 22). *Voting stations overwhelmed by high turnout*. Retrieved September 15, 2010, from polity.org.za: http://www.polity.org.za/article/voting-stations-overwhelmed-by-high-turnout-2009-04-22

Saunders, M., Lewis, P., & Thornhill, A. (2007). *Research Methods for Business Students* (4th ed.). Financial Times Press.

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research Methods for Business Students* (5th ed.). Financial Times Press.

Schryen, G. (2004). How security problems can compromise remote internet voting systems. In A. Prosser , & R. Krimmer (Ed.), *1nd International Workshop on Electronic* (pp. 121-131). Bregenz, Austria: Gesellschaft fur Informatik E.V.

Scytl. (2012). *Enfranchising voters through new voting channels.* Retrieved January 4, 2012, from http://www.scytl.com/en/remote-e-voting-s-5.html

Sengupta, S. (2007, May 17). *In the new India, the old problem with electricity*. Retrieved June 2011, 2011, from The New York Times: http://www.nytimes.com/2007/05/17/world/asia/17iht-india.1.5753757.html

Singh, V. (2004, May). *Electronic Voting Eases India Elections*. Retrieved January 5, 2012, from IEEE Spectrum: http://spectrum.ieee.org/computing/software/electronic-voting-eases-india-elections

Smart Technology Solutions. (2006). A smart answer to online fraud. *Card Technology Today , 18* (5), 10-11.

Sophos. (2009). *Threatsaurus the a-z of computer and data security threats.* Retrieved June 8, 2011, from Sophos Group: http://www.sophos.com/medialibrary/PDFs/marketing%20material/sophosthreatsaurusazen.pdf

South African Government Information. (1996). *Constitution of the Republic of South Africa.* Retrieved February 10, 2010, from http://www.info.gov.za/documents/constitution/1996/index.htm

SouthAfrica.info. (2006, November). *Education in South Africa*. Retrieved March 5, 2010, from http://www.southafrica.info/about/education/education.htm

SouthAfrica.info. (2010a). *Independent Electoral Commission.* Retrieved March 5, 2010, from http://www.southafrica.info/about/democracy/iec.htm

SouthAfrica.info. (2010b, March 17). *SA banks to use fingerprint verification*. Retrieved August 16, 2011, from http://www.southafrica.info/services/consumer/banking-170310.htm

StatsOnline. (2010a). *Mid-year population estimates.* Retrieved September 13, 2010, from Statistics South Africa: http://www.statssa.gov.za/publications/statspastfuture.asp?PPN=P0302&SCH=4696

StatsOnline. (2010b, July 27). *Quarterly Labour Force Survey.* Retrieved September 28, 2010, from Statistics South Africa: http://www.statssa.gov.za/keyindicators/QLFS/Press/Q2_2010_Press_Statement.pdf

Swanepoel, E., Thomson, K.-L., & van Niekerk, J. (2010). E-Voting: A South African Perspective. In *E-Infrastructures and E-Services on Developing Countries* (pp. 70-77). Springer Berlin Heidelberg.

Tashakkori, A., & Teddlie, C. (1998). *Mixed Methodology: Combining Qualitative and Quantitative Approaches.* Thousand Oaks, CA: SAGE.

Tewari, R. (2011, June 21). *Election Commission tests a paper trail for electronic voting*. Retrieved June 28, 2011, from Livemint and The Wall Street Journal: http://connect.in.com/bharatiya-janata-party/article-election-commission-tests-a-paper-trail-for-electronic-voting-35755-2a0cb6e24f520b7d113eb80870de046cb5ec3184.html

Thakur, S. (2010, December 1). Electronic voting - the cross-national experience. *Unpublished report* . Independent Electoral Commission.

Thapar, A. (2007, June 12). *Social Engineering - An Attack Vector Most Intricate to Tackle!* Retrieved March 23, 2011, from InfoSec Writers: http://www.infosecwriters.com/text_resources/pdf/Social_Engineering_AThapar.pdf

The World Factbook. (2011a). *Brazil: Central Intelligence Agency*. Retrieved June 20, 2011, from https://www.cia.gov/library/publications/the-world-factbook/geos/br.html

The World Factbook. (2011b). *Estonia: Central Intelligence Agency*. Retrieved June 26, 2011, from https://www.cia.gov/library/publications/the-world-factbook/geos/en.html

The World Factbook. (2011c). *India: Central Intelligence Agency.* Retrieved June 28, 2011, from https://www.cia.gov/library/publications/the-world-factbook/geos/in.html

The World Factbook. (2011e). *USA: Central Intelligence Agency*. Retrieved July 13, 2011, from https://www.cia.gov/library/publications/the-world-factbook/geos/us.html

Travelmath. (2010, September 14). *The driving distance from Brisbane to Canberra.* Retrieved September 14, 2010, from http://www.travelmath.com/driving-distance/from/Brisbane,+Australia/to/Canberra,+Australia

Trochim, W. (2006, October 20). *Research Methods Knowledge Base*. Retrieved November 19, 2011, from http://www.socialresearchmethods.net/kb/dedind.php

TSE. (n.d.). *Computerization*. Retrieved June 2011, 2011, from Superior Electoral Court: http://www.tse.jus.br/internet/ingles/historia_eleicoes/maquina_votar.htm

TSE. (n.d.). *Security in Electronic Voting System*. Retrieved June 22, 2011, from Superior Electoral Court: http://www.tse.jus.br/internet/ingles/voto_eletronico/conhecendo_ue.htm

United Nations. (n.d.). *Democracy and the United Nations*. Retrieved August 31, 2010, from http://www.un.org/en/events/democracyday/demohr.shtml

Van Acker, B. (2004). *E-voting.cc.* Retrieved November 3, 2010, from http://www.e-voting.cc/stories/1275718/

Van Zyl, L. (2009). *How effective was the IEC's braille template?* Retrieved September 29, 2010, from South African National Council for the Blind: https://medusa.cybersmart.co.za/sancb/press.asp

Vecchiatto, P. (2009, April 28). *Electronic voting for next elections?* Retrieved February 2011, from ITWeb: http://www.itweb.co.za/index.php?option=com_content&view=article&id=22263:electronic-voting-for-next-elections

Volkamer, M. (2009). *Evaluation of Electronic Voting.* Germany: Springer.

Von Solms, R., & Von Solms, S. H. (2009). *Information Security Governance.* Springer.

VVK. (2010). *E-voting system.* Retrieved June 28, 2011, from Vabariigi Valimiskomisjon: http://www.vvk.ee/public/dok/Yldkirjeldus-eng.pdf

VVK. (2007). *Internet Voting.* Retrieved June 28, 2011, from Vabariigi Valimiskomisjon: http://www.vvk.ee/public/dok/Internet_Voting_in_Estonia.pdf

VVK. (2011, February 3). *Internet Voting in Estonia*. Retrieved February 3, 2011, from Vabariigi Valimiskomisjon: http://www.vvk.ee/voting-methods-in-estonia/engindex

Walker, A. (2006). *Absolute Beginner"s Guide to Security, Spam, Syware & Viruses.* United States of America: Que Publishing.

World Bank. (2010). *South Africa Independent Electoral Commission*. Retrieved February 25, 2010, from The World Bank: http://go.worldbank.org/PVOKXOPRL0

World Economic Forum. (2010, January 29). *Rethinking e-governance.* Retrieved September 13, 2010, from http://www.qatar-conferences.com/economic/world/gri_institutions.pdf

World Wide Worx. (2011a, February 3). *Mobility 2011*. Retrieved June 6, 2011, from http://www.worldwideworx.com/2011/02/03/sa-cellphone-users-embrace-internet/

World Wide Worx. (2011b, May 12). *Online sales accelerate in SA*. Retrieved June 8, 2011, from http://www.worldwideworx.com/2011/05/12/online-sales-accelerate-in-sa/

Xingwana , L. (2011, June 7). *Budget Vote 2011/12 speech by the Minister for Women, Children and People with Disabilities*. Retrieved January 5, 2012, from South African Government Information: http://www.info.gov.za/speech/DynamicAction?pageid=461&sid=18926&tid=34677

Xinhua. (2010, October 5). *Brazil to fully use biometric identification in elections by 2018*. Retrieved June 20, 2011, from People's Daily Online: http://english.peopledaily.com.cn/90001/90777/90852/7157485.html

Appendix A:

Expert Review Cover Letter and Research Summary

• PO Box 77000 • Nelson Mandela Metropolitan University
• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University
for tomorrow

Summerstrand North Campus
School of ICT
S20520190@live.nmmu.ac.za
Kerry-Lynn.Thomson@nmmu.ac.za
Darelle.vanGreunen@nmmu.ac.za

Dear (*Expert*),

The primary objective of this exercise is to gain feedback from experts with insightful knowledge about the South African electoral system. This will provide additional research rigour for the proposal of, and argument towards, a proposed Hybrid E-voting Process Model for South Africa.

What follows is a short research summary of the proposed solution for South Africa to help you familiarize yourself with the research that has been conducted. In Appendix A the proposed process model which is the primary objective of this research is provided.

The structured interview will include all relevant questions required by the researcher to achieve the objective with regards to the expert review.

It will be appreciated if you could read through the summary provided and provide your feedback and comments when interviewed by the researcher.

Thank you for your cooperation and feedback which is greatly appreciated.

Kind regards,
Eraneé Swanepoel

MTech IT Student
Nelson Mandela Metropolitan University

Research Summary: A Model for E-voting in Developing Countries: A South African Perspective

1. Prologue

An electoral process is of extreme importance to the success of an election. Countries around the globe make use of various voting methods to conduct their elections. These different voting methods have various benefits associated with them, but in contrast, there are also challenges that could make it less desirable. A country such as South Africa has its own unique challenges which could hamper an election process. Therefore, looking at alternative voting methods to improve the current electoral system in South Africa is one of the objectives of this research. The evolution of voting worldwide has seen the integration of technology into various electoral processes globally. This is known as electronic voting (e-voting). E-voting can be defined as making use of technology to cast a vote in an election process. There must be an electronic copy of the vote stored in, at least, one point in the election process. Thus the final result will be calculated utilizing the stored electronic vote (e-vote).

There are several methods of e-voting, this includes:

- Punch card voting systems;
- Optical scan voting systems;
- Stand-alone e-voting systems (DRE machines)
- Networked e-voting systems (DRE machines)
- Kiosk e-voting systems;
- Online voting.

Countries such as India, Brazil, Estonia and the USA are just some of the countries which opted to incorporate technology into their voting processes.

The primary objective of this research was to develop a process model which will demonstrate how e-voting could improve the current South African electoral system by addressing the various challenges. The proposed process model makes use of a hybrid voting process. The hybrid voting process includes two different voting processes. The different steps associated with the two proposed voting options will be detailed in this document. The scope of this research focussed on the voting process. This research does not address any political issues associated with the South African electoral system.

2. Proposed Solution

The South African electoral system makes use of pen and paper with a manual tabulating process. There are numerous challenges facing the current South African electoral system. Therefore, looking at alternative methods that could potentially address these challenges could be of great benefit to the democratic process in South Africa. This research investigated the feasibility of incorporating technology into the current electoral system which is known as e-voting. The researcher's goal is to improve the current South African electoral system. Thus, the proposed hybrid voting system will not resolve all the challenges presented by the current South African electoral system. The investigation into different e-voting systems worldwide contributed to the proposed hybrid voting system for South Africa. There are various requirements which play a pivotal role in any electoral system which contributes to confidence in an election. These requirements need to be accomplished in any electoral system and are as follows:

- Only eligible voters are able to vote;
- No voter is permitted to vote more than once;
- No one should be able to determine the value of anyone else's vote;
- No one can duplicate a vote;
- No one can alter another person's vote without being detected;
- Voters can verify that their vote has been counted.

The IEC has been responsible for the whole voting process in South Africa. Achieving a free and fair election is of extreme importance to the IEC. One of the challenges associated with the current South African electoral system is that it requires voters to be registered when participating in an election. The national common voters' roll stores all the relevant

information with regards to registered voters. This requirement is outlined in the Electoral Act 73 of 1998. According to the IEC the reason for the voters' roll is for the prevention of electoral fraud.

The researcher argues that not all South Africans have the opportunity to participate in elections. The utilization of the voters' roll only allows citizens that are registered, eligible to participate in South African elections. There are more than 23 million voters on the national common voters' roll. The South African population in 2009 was calculated to be approximately 49 million people. Hence, only 47 percent of the total population in South Africa is eligible to participate in South African elections.

To address the lack of registered voters, the proposed hybrid voting system will remove the utilization of the national common voters' roll. The national common voters' roll will be replaced by utilizing the South African Home Affairs National Identification System (HANIS). The HANIS database is an initiative that was started by the Department of Home Affairs in 1993. This database replaced the legacy paper system containing fingerprints with the leading-edge digital database storing fingerprints of South African citizens. The details of every South African citizen that has a South African identification document are stored on the HANIS database. The details include name, surname, photo and fingerprint for example. All the required details for a voter to participate in an election are stored on this database. Therefore, the HANIS database could be utilized instead of the national common voters' roll.

An example where the HANIS system will be utilized to mitigate fraud is in the South African banking sector. The South African Banking Risk Information Centre (SABRIC) and the Department of Home Affairs is in the process of implementing this project. The utilization of the database will allow South African banks to verify the identity of clients in real-time. Therefore, it could be argued that the HANIS database could be of great benefit to the authentication and identification of voters in an election process.

One of South Africa's biggest challenges is illiteracy. A large percentage of South Africans cannot read and write. In addition, a large portion of the South African population is also computer illiterate. Therefore, the researcher argues that at least one of the options recommended by the proposed electoral system must have similar characteristics to the current South African electoral system.

The current paper-based electoral system has been used in numerous elections in South Africa. Therefore, implementing a "new" electoral system which shares similar characteristics to the current electoral system could improve confidence among voters. Additionally, such a system could contribute to speed up the adoption of a "new" voting system and it would be easier to understand by voters.

The proposed solution would have to accommodate all South Africans with the different requirements. South Africa is a diverse country with different characteristics. There are people who are illiterate, literate, disabled, wealthy, and poor for example. Therefore, the proposed solution must provide a voting system which will accommodate all groups of people.

For that reason the proposed hybrid voting system will have two voting methods associated with it. Appendix A illustrates the proposed process model for South Africa. The voter will have an opportunity to select one of the two methods to vote; optical scan voting or online voting. There are different features associated with these two voting methods. Additionally both of these voting methods will utilize the HANIS database. The characteristics and steps associated with the different voting methods will be discussed in detail.

3. Option A: Optical Scan Voting System

An optical scan voting system is the first proposed method of voting for South Africa. There are various benefits associated with an optical scan voting system. The reason for incorporating optical scan voting technology into the South African electoral process is because it would share similar characteristics to the current electoral system. The main benefit of an optical scan voting system is the fact that it provides an audit trail. The objective to make use of this method of voting is to address some of the challenges faced by the current electoral system.

Option A in Appendix A, illustrates the first channel of voting which would be the optical scan voting system. Therefore, option A in the process model illustrates the various steps that are associated with the voting process.

The current voting process in South Africa is simple and straightforward. In addition, it also accommodates people that are illiterate and disabled for example. The ballot form used in current elections has a simple layout which accommodates different disadvantaged groups of people. One of the characteristics which contribute to the simplicity of the ballot paper is the use of a logo and symbol which represent each political party. In addition, there are full colour pictures of the leaders of each participating political party, therefore, making it easier for disadvantaged voters to participate in an election.

An additional benefit to the simple layout of the ballot paper is that it also provides a template for blind people to use when voting which is known as Betty the Braille.

As mentioned, the current ballot paper layout has been used with great success in previous elections in South Africa. Therefore, the researcher argues that it is essential to use a similar ballot form layout as was utilized in the national election in 2009 for the proposed optical scan voting system.

There have been various fraudulent incidents during several previous South African elections. This included ballots that were already marked and ballot boxes that disappeared from polling stations. These are just some of the fraudulent events that were experienced in the 2009 election and previous ones. One of the objectives of the proposed optical scan voting system is too mitigate electoral fraud when counting votes. An optical scan voting system eliminates human interaction when counting votes. Therefore, it could theoretically mitigate fraud that is associated with manual vote counting. The researcher mentioned a few challenges that were experienced in previous elections in South Africa. In the comprehensive research document these challenges and more are discussed in detail.

The voting process associated with the optical scan voting system will be discussed in detail. Each step that is included in the proposed voting process will be explained and how it could improve the South African voting process.

Optical scan voting takes place in a controlled environment. When voting in a controlled environment it allows the voter to cast his/her vote where the poll worker is responsible for the accuracy, confidentiality, integrity and privacy of the election process. Thus, having an election in a controlled environment allows election officials to prevent unauthorized people from having access to and tamper with electoral materials or equipment. Election information is of utmost importance. Hence, unauthorized access could have a great impact on the results of an election if tampered with. Therefore, election officials would still be in control of the whole process of voting in option A, illustrated in Appendix A. The only process the elections officials will not be involved with is the vote counting process which will be technologized. The counting process will be done instantaneously. Election data will be stored electronically on the internal memory of the optical scan voting system. All data will be encrypted on the storage device to protect against any security threats.

When the polling stations close for voters at the end of the Election Day, all the election data will be transferred, over a secure network connection to the IEC's headquarters, for the final count process. This is similar to the current electoral system where captured results are transmitted to the IEC's headquarters.

The **first step** associated with option A, requires the voter to go to a polling station to participate in an election. Similar to the current paper-based voting system in South African citizens would be assigned to a specific polling station. The IEC will make use of the HANIS database as described in the previous section. The database will be utilized to assign each South African to a polling station.

In the current paper-based system South Africans can verify their voter registration details online or by sending a text message using their mobile phone. This confirmation process allows the voter to verify his/her eligibility to participate in an election. In addition, the polling station associated with the voter is also specified. Similarly with the proposed system, voters would be able to confirm their registration details such as address and their polling station using the IEC's website. Furthermore, a voter could also confirm their details sending a text message using his/her identification number as a reference. If there are any problems associated with the voter's details, for example an incorrect address, the voter would have to update his/her information on the HANIS system. This can be done at the Department of Home Affairs.

The **second step** associated with option A, requires an election official to identify and authenticate the voter. A computer system with barcode scanning and fingerprint scanning features would be utilized in this step. This replaces the zip-zip controller device and voters' roll which has been used in current South African elections. An election official would scan the voter's green barcoded identification document. In addition, the voter's fingerprint will be read using a fingerprint reader. This information will be used and compared to the HANIS database to verify the voter's details.

This combination of using biometrics and the green barcoded identification document of a voter could potentially mitigate fraud. This would prevent a voter from participating in an election twice as been experienced in previous elections in South Africa. In addition, indelible ink will not be used in the voting process as previously used in elections for the prevention of fraud.

The **third step** in the proposed voting process, if the voter is eligible to vote, would be to collect an election ballot paper. The ballot paper layout would be similar to the current layout as mentioned. This is because South African voters are familiar with the layout. It has a simple layout to accommodate people that are illiterate. Disabled voters such as a blind person would receive a braille template. The current paper-based voting process made use of Betty the Braille template in

the 2009 national elections. Similarly this template would be utilized in the proposed optical scan voting system. This would contribute to a free and fair election.

The **fourth step** associated with option A, as illustrated in Appendix A would be for an election official to escort the voter to a private voting booth. The voter would in secret make an '×' next to his/her candidate of choice on the election ballot. The main difference between the ballot-paper voting process currently and the proposed optical scan voting system would be experienced in this step. After the ballot paper has been marked the voter would feed the ballot paper into the optical scan voting system which has a liquid crystal display (LCD) screen.

In the current election process one of the problems which arose were spoilt ballot papers. The 2009 election in South Africa had 239 237 spoilt ballots votes nationally and 223 462 provincially. Thus, the researcher argues with the utilization of optical scan technology spoilt ballot papers could be alleviated in the South Africa elections. The optical scan voting system will read the marked data on the ballot paper and would then verify that the ballot paper was marked correctly or incorrectly. If for example the ballot paper was marked incorrectly the LCD screen on the optical scan voting machine will display a red '×' with a message stating "invalid vote". If the ballot paper was marked correctly the message on the LCD display will display a "vote accepted" message with a correct mark '✓'. The '×' and '✓' symbols are used for illiterate people to understand the status of the vote. An extra feature similar to the DRE system in Brazil and optical scan voting systems in the USA would be the usage of headphones for blind people. A voter that is blind would be able to hear if his/her vote was accepted or declined. If the vote was declined, the voter would have to re-cast his/her vote. An election official would supply the voter with a new ballot paper. The voter will then have to recast his/her vote.

After the voter has completed his/her vote and the vote was accepted he/she will proceed to the next step. The optical scan voting machine will reset itself for the next voter to cast his/her vote. This step is necessary because a free and fair election allow a voter's vote to be confidential. Therefore, not a single person should be able to tell who a voter voted for in an election.

The **final and fifth step** associated with Option A, requires the voter to place his/her ballot paper in the ballot box. This is a similar step as in the current paper-based voting process used in South Africa. The difference is that the votes would only be counted manually if there are any discrepancies with the optical scan vote counting process. This provides a paper trail for voters and allows the system to be audited. This could contribute to improve confidence in such a system among voters. The DRE system used in India has been under scrutiny because of the absence of a paper trail which could be audited. Therefore, implementing an optical scan voting system eliminates that challenge and could improve voter confidence in an electoral system.

Another benefit associated with the optical scan voting system is that people in rural areas would also be able to vote. The proposed optical scan voting system would be able to function without electrical power. This is similar to the DRE and optical scan voting systems used by Brazil, India and USA - which could fully function on battery power. Thus, this will allow people in rural South Africa, who do not have Internet access, transport or monetary funds also to vote in the elections. The IEC could travel with mobile voting stations to these rural groups.

South Africa has been challenged with ballot paper fraud in previous elections. Therefore, the researcher argues that technology could improve the process of voting and possibly alleviate certain areas of fraud associated with the current voting system. The main objective of implementing option A is because it removes the need for the manual count of ballot papers. Therefore, eliminating the need for people to count votes. Thus, alleviating vote counting errors. This concludes the steps associated with option A in the proposed hybrid voting system.

In addition to using optical scan voting in the proposed hybrid voting system an extra channel of voting is recommended. Online voting would serve as an **additional** method of voting in the proposed system. The next section will describe the online voting process in detail and how it could address current challenges facing the current South African electoral system.

4. Option B: Online Voting System

Every South African citizen should have an opportunity to participate in their elections as mentioned previously. One of the objectives of the proposed hybrid voting system would be to allow all South Africans the opportunity to take part in their elections. The proposed hybrid voting system presents two different methods of voting as mentioned. Option A with its steps was explained in detail in the previous section. This section will discuss the second channel of voting option B as illustrated in Appendix A – online voting.

Option B describes an online voting process for South Africa. Online voting takes place in an uncontrolled environment, where there is no election official available. Therefore, there is no way to guarantee that the election process will be

confidential, accurate, and private. The voter will be responsible for the confidentiality, integrity and privacy of the voting process, consequently being responsible for making sure the vote is accurate. As mentioned there are different e-voting systems and they were investigated worldwide for the purpose of this research. Estonia is a country which has utilized online voting with great success. The proposed online voting system would allow South Africans to utilize online voting in a similar way as the Estonian online voting process. There would be small differences between the Estonian and South African voting process.

The greatest benefit associated with online voting is that it allows a voter to cast a vote from anywhere in the world in an uncontrolled environment. The researcher argues that utilizing online voting would allow citizens that live abroad the opportunity to participate in the South African elections. In addition, it could improve voter participation because it may provide voters with a more convenient way of voting if one can vote from home. A voter would not be required to go to a polling station and stand in a queue. Thus, online voting would not be limited to people living abroad it would be available to all South Africans which have access to the Internet.

South African expatriates were allowed to participate in South African elections after the court ruling in 2009. The drawback associated with expatriate voting is the requirement that a voter must go to a South African embassy to participate in an election. This could have been a contributing factor for the lack of expatriate voter participation in the 2009 election. Another stumbling block is that a voter is required to be registered on the national common voters' roll. The national common voters' roll was implemented after the 1994 elections by the IEC. Therefore, people that left the country before the 1999 election would not be on the national common voters' roll. The researcher argues implementing an extra channel of voting such as online voting could contribute to improve voter participation. In addition, using the HANIS database would also include people that were not registered after the 1994 election in South Africa.

Another feature that would be associated with option B is that a voter would be allowed to register and vote in his/her own language. As mentioned the HANIS database would be used to confirm voter details. In addition, the election website would also accommodate people that are disabled, for example someone that is visually impaired.

The online voting process, option B as illustrated in Appendix A, will be described in detail with all the steps associated with the process.

The **first step** associated with option B, requires a voter to register online on the official IEC website. The voter would be able to select his/her own language to register and cast their vote after registration. South Africa is a country that has eleven official languages, thus, giving voters the opportunity to use their own language would make the process more user-friendly.

The HANIS database would also be used in option B to authenticate and identify the voter. Therefore, the national common voters' roll will not be used as in the current voting process in South Africa. The reason for registration is to make online voting more secure and allow the voter access to the online voting system website, when required to vote.

The registration process would be compulsory if a voter wants to participate in the South African election online. The voter would need to register well in advance if selecting this channel of voting. Therefore, a voter would need to register at least 11 days before the official Election Day. The reason for this is because online voting would take place from the 10^{th} to the 4^{th} day before the official Election Day.

The registration process would require the voter to provide personal information for example name, surname, identification number, username, password and mobile number for example. This would be a similar process as online banking registration in South Africa. After registration the voter would receive a one-time pin (OTP) to confirm his/her registration. An OTP is a password which gets generated once. Additionally, an OTP can only be used once, this makes it more secure. The OTP will be sent to the voter's mobile number that was provided when he/she registered online. The voter would have to confirm his/her details with using the OTP. This would make registration more secure. This completes the registration process.

The **second step** associated with option B, would take places between the 10^{th} and 4^{th} day before the official Election Day. This would ensure that each voter's vote would only be counted once. This step requires that the voter must access the official secure election website, which is the official IEC's website. The website would implement extra security measures such as an online anti-virus and spyware scanning application. Voting in an uncontrolled environment could increase security risks for example viruses and Trojans. Therefore, extra protection measures must be made available to protect the credential of the voter and the election information. The protection of election information is of utmost importance to any election process.

Additionally, the IEC's website will make use of security protocols to ensure a secure connection between the official election website and the voter's computer. The details of the various security features that would be utilized to guarantee a secure online election process is outside the scope of this research.

The **third step** associated with option B, requires that the voter would need to log in with his/her username, password and identification document number. These details would be utilized to verify that the voter is registered to vote online. The voter would receive the first random generated OTP via his/her mobile number that were registered to confirm the voter's identity. This would contribute to make the process of voting more secure. After the voter has entered all the required details including the OTP he/she would continue to the following step.

The **fourth step** associated with option B, is the actual vote casting step. The voter would see a similar ballot layout as the current ballot used in the paper-based voting system in South Africa. The electronic ballot (e-ballot) would allow a voter to vote in his/her own language as stated previously. Online voting could address some various challenges. For example spoilt ballots would be something of the past. The carbon footprint associated with an e-ballot is also considerably reduced compared to a paper ballot. Therefore, e-ballots are much more environmentally friendly. Another benefit is that online voting could also be more cost effective in the long run.

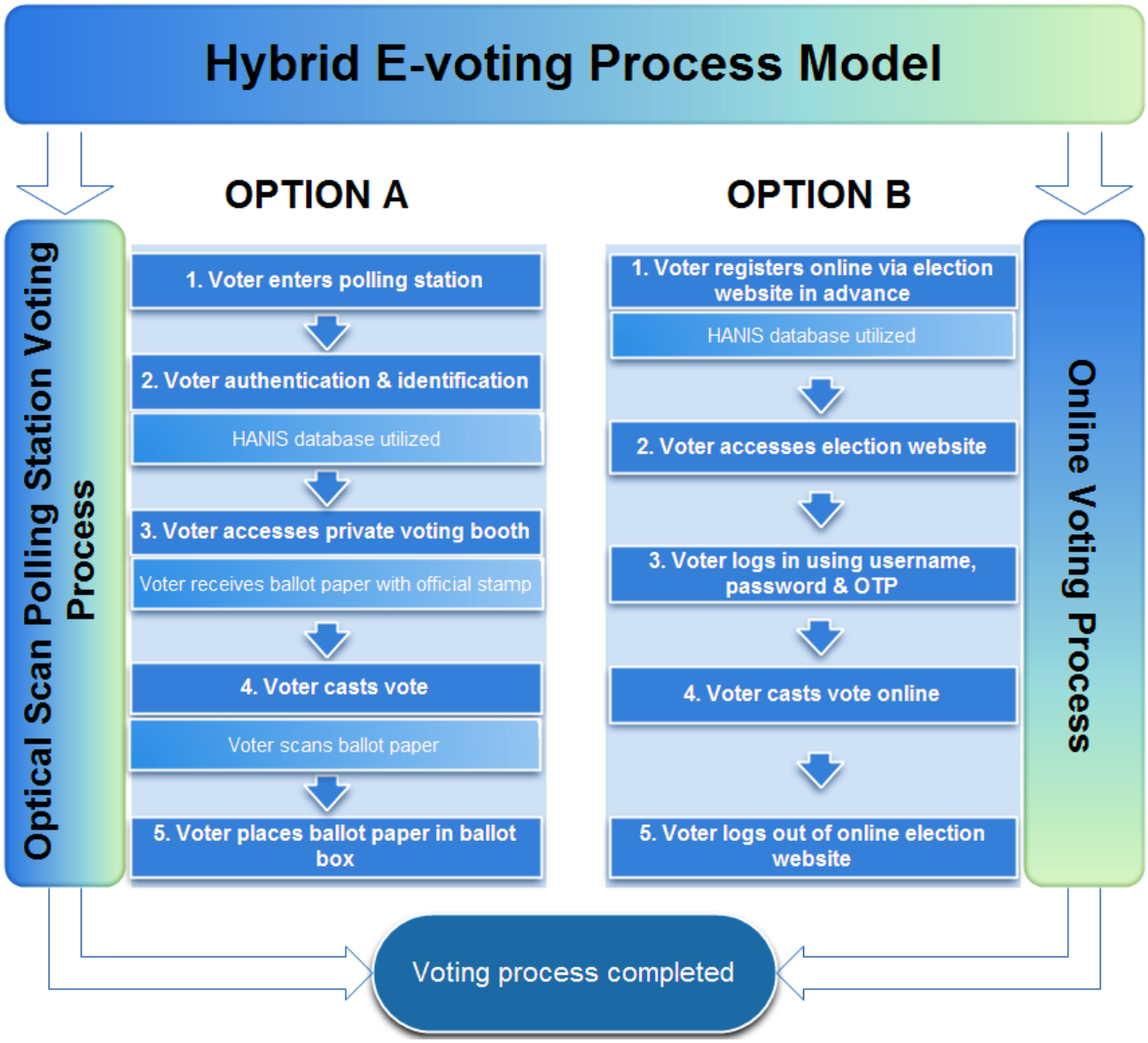
After the voter has selected his/her candidate of choice he/she will receive a second OTP. This pin is required for the voter to submit his/her selection. This second pin is to increase security and to prevent unauthorised people from voting. Similar to the Estonian online voting process a South African voter could also recast his/her vote if required to do so within the allocated time for voters to cast their votes. This could potentially mitigate the influence from other people, therefore, mitigating vote coercion.

A voter will not be able to amend his/her vote if the time allocated for online voting has expired. Thus, the voter would not be able to vote at a polling station. The Estonian online voting process allows a voter to amend his/her vote on Election Day too. This will not be possible in the South African online voting process. The reason for not allowing citizens to vote online on the official Election Day would contribute to less confusion. The IEC would not have to have new facilities for online voting such as computers with Internet access at polling stations too. In addition, having the optical scan voting system and online voting on the same day could confuse voters. Thus, the researcher proposes that this option could be investigated in future and be implemented similar to the Estonian election process.

The **final and fifth step** associated with option B, would require the voter to log out of the online voting website. There are extra security measures in place which is similar to online banking to protect the voter. This entails that a voter would need to complete the voting process within an allocated time, for example, five minutes. If the voter forgets to log out this extra feature would take effect after five minutes. Therefore, this safeguard would protect the voter's credentials from unauthorised access. This completes the voting process that is associated with option B as illustrated in Appendix A. Additionally, the counting process is done electronically therefore; no human interaction is required to count votes such as with the current paper-based electoral system.

This concludes the explanation of the proposed hybrid voting system for South Africa and the primary objective associated with this research.

Appendix A: Proposed Hybrid Voting System for South Africa



Appendix B:

Expert Review Questionnaire

• PO Box 77000 • Nelson Mandela Metropolitan University
• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University
for tomorrow

NMMU Research:
Structured Interview

This research structured interview is in support of fulfilling the Masters Research study:

A Model for E-voting in Developing Countries: A South African Perspective

Eraneé Swanepoel
School of Information and Communication Technology
Nelson Mandela Metropolitan University

2011

Supervisors:

Dr Kerry-Lynn Thomson
Tel: +27 41 504 3408
Mobile: +27 8460 29551
Email: Kerry-Lynn.Thomson@nmmu.ac.za

Prof Darelle van Greunen
Tel: +27 41 5042090
Mobile: +27 8256 42356
Email: Darelle.vanGreunen@nmmu.ac.za

Before You Begin To Answer

Important information to note before proceeding to participate in the structured interview

A. About the study

The current manual paper-based electoral system in South Africa faces various challenges. This research aims at developing a process model to improve the South African electoral system. The research addresses the various drawbacks and looks at technology as an alternative method to improve the current voting system in South Africa. The primary objective of this research is to develop a process model that comprises of two different voting methods which would contribute to the proposed solution.

B. Your participation in the study

The primary objective of this exercise is to gain feedback from experts with insightful knowledge about the South African electoral system in order to provide additional research rigour for the proposal of, and argument towards, a proposed e-voting electoral system for South Africa.

The structured interview should not take more than **30** minutes of your time to complete.

C. Confidentiality and publication of information

The information you provide will be treated with strict confidentiality. It is possible that anonymised summarized results will be used for publication in research conferences and journals. Any personal references to you will be made anonymous. You are requested to sign the “research participant’s permission” form in the next section to confirm your willingness to participate and that you understand that your information will be treated in confidence. A copy of this form will be given to you for your own record.

Research Participant's Permission

Signature to confirm participation in research study

I, **Eraneé Swanepoel** hereby state that I will not use the information provided in this structured interview for any other purpose other than the stated purpose, that being for use during analysis and discussion of findings in the study. I will respect the information with strict confidentially and anonymity.

_____ _____

Signature Date

I _____ hereby voluntarily give my permission to participate in this research study as explained to me by the researcher, Eraneé Swanepoel. The nature, objective, confidentiality and publication of information have been explained to me and I understand them.

_____ _____

Signature of Participant Date

For any queries, please contact Eraneé Swanepoel at:

S20520190@live.nmmu.ac.za

Mobile number: 084 981 6100

Procedure for Completing The Structured Interview

Instructions for completing the structured interview

The following guidelines will assist you in answering the questions to follow:

- It is important that you complete all the questions with sincere honesty. If you feel uncomfortable in answering a particular question you are welcome to indicate this.

- Your answers should accurately reflect your views. This will help provide a credible view with regards to the proposed solution in this research.

- The structured interview consists of three sections.

    - Section A: **Background information**
    - Section B: **Electoral system**
    - Section C: **Proposed e-voting system**

Section A: Background Information

Please draw a cross (X) in the box next to the appropriate answer – multiple answers can be selected.

1) How long have you been involved with the South African election process?	
a) 1 – 3 years	
b) 4 – 6 years	
c) 7 – 10 years	
d) 10 or more years	
e) Not directly involved	

2) Roles in South African election?	
a) Electoral official	
b) Voter	
c) Political party representative	
d) IEC Member	
e) Researcher	
f) Other (*Please specify*)	

3) Technology exposure?	
a) Mobile phone (iPhone, BlackBerry) Specify model:	
b) Personal Computer (PC)	
c) Laptop	
d) Tablet	

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

4. Do you rate yourself as knowledgeable with regards to the South African electoral system?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

5. Are you confident in your ability to answer questions about the election process in South Africa?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

6. Are you confident in your ability to answer questions about the use of technology in the South African electoral system?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

Section B: Electoral System

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

7. Do you think the current manual paper-based electoral system in South Africa is reliable?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

8. Do you think the current manual paper-based electoral system could be improved?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

9. Do you think the Information and Communication Technology currently being used in the South African electoral system is utilized with success?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

10. Do you think the national common voters' roll used in the South African electoral system is accurate?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

11. Integrating technology into the vote cast process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

12. Integrating technology into the counting process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

Section C: Proposed Hybrid E-voting Process Model

Please refer to the attached document to answer the following questions. Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box?

13. Do you think the proposed Hybrid E-voting Process Model could potentially improve the current manual paper-based South African electoral system?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

Please provide a reason for your answer in Question 13.

14. Do you think the proposed Hybrid E-voting Process Model would be accepted by South African voters?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

Please provide a reason for your answer in Question 14.

15. Does the proposed Hybrid E-voting Process Model offer more South Africans the opportunity to participate in South African elections compared to the current paper-based election?

.

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

Please provide a reason for your answer in Question 15.

16. Do you think the proposed Hybrid E-voting Process Model could contribute to a freer and fairer election in South Africa?

Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

Please provide a reason for your answer in Question 16.

_____

_____

_____

Additional Comments

Please share any further comments that will help the researcher to improve the proposed Hybrid E-voting Process Model for South Africa.

Thank you for your time and invaluable participation

Appendix C:

Expert Review Questionnaire Raw Data

Expert 1:

Questionnaire Feedback

Section A: Background Information

Please draw a cross (X) in the box next to the appropriate answer – multiple answers can be selected.

1) How long have you been involved with the South African election process?	
a) 1 – 3 years	
b) 4 – 6 years	x
c) 7 – 10 years	
d) 10 or more years	
e) Not directly involved	

2) Roles in South African election?	
a) Electoral official	
b) Voter	
c) Political party representative	
d) IEC Member	
e) Researcher	x
f) Other (*Please specify*)	

3) Technology exposure?	
a) Mobile phone (iPhone, BlackBerry) Specify model:	x
b) Personal Computer (PC)	x
c) Laptop	x
d) Tablet	x

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

4. Do you rate yourself as knowledgeable with regards to the South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
x				

5. Are you confident in your ability to answer questions about the election process in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
x				

6. Are you confident in your ability to answer questions about the use of technology in the South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
x				

Section B: Electoral System

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

7. Do you think the current manual paper-based electoral system in South Africa is reliable?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
x				

8. Do you think the current manual paper-based electoral system could be improved?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		x		

9. Do you think the Information and Communication Technology currently being used in the South African electoral system is utilized with success?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
x				

10. Do you think the national common voters' roll used in the South African electoral system is accurate?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
x				

11. Integrating technology into the vote cast process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	x			

12. Integrating technology into the counting process could improve the current manual paper-based electoral system in South Africa? Same as 11

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	x			

Section C: Proposed E-voting System

Please refer to the attached document to answer the following questions. Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box?

13. Do you think the proposed e-voting system could potentially improve the current manual paper-based South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		x		

Please provide a reason for your answer in Question 13.

There is no compelling reason to use e-voting and we have other pressing priorities

14. Do you think the proposed e-voting system would be accepted by South African voters?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		x		

Please provide a reason for your answer in Question 14.

No, it is already a political hot potatoe with the ANCYL against it, and some sectors of the ANC considering it.

15. Does the proposed e-voting system offer more South Africans the opportunity to participate in South African elections compared to the current paper-based election?

.

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		x		

Please provide a reason for your answer in Question 15.

This technology introduces grid and technical challenges

16. Do you think the proposed e-voting system could contribute to a freer and fairer election in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
			x	

Please provide a reason for your answer in Question 16.

This is my answer for now and the immediate future. We need to educate 50 million people before we can get a buy-in on the technology. There is no evidence of election related intimidation, booth capturing or chain voting

Additional Comments

Please share any further comments that will help the researcher to improve the proposed e-voting system for South Africa.
e-voting is a long process. It requires a transparent adoption decision, a transparent technology choice decision, and a transparent trial, and then ... a transparent pilot before the process even starts.

Right now, research such as this provides the IEC and others important pointers as to what where and how we should proceed.
I neither believe nor disbelieve in e-voting – I love that we can reuse and defer to the electorate ...
But houses, health, infrastructure, mass unemployment... e-voting. Which is a priority?

Thank you for your time and invaluable participation

Expert 2:

Questionnaire Feedback

Section A: Background Information

Please draw a cross (X) in the box next to the appropriate answer – multiple answers can be selected.

1) How long have you been involved with the South African election process?	
a) 1 – 3 years	
b) 4 – 6 years	
c) 7 – 10 years	X
d) 10 or more years	
e) Not directly involved	

2) Roles in South African election?	
a) Electoral official	
b) Voter	
c) Political party representative	X
d) IEC Member	
e) Researcher	
f) Other (*Please specify*)	

3) Technology exposure?	
a) Mobile phone (iPhone, BlackBerry) Specify model: BlackBerry	X
b) Personal Computer (PC)	X
c) Laptop	X
d) Tablet	

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

4. Do you rate yourself as knowledgeable with regards to the South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

5. Are you confident in your ability to answer questions about the election process in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

6. Are you confident in your ability to answer questions about the use of technology in the South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

Section B: Electoral System

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

7. Do you think the current manual paper-based electoral system in South Africa is reliable?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
			X	

8. Do you think the current manual paper-based electoral system could be improved?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

9. Do you think the Information and Communication Technology currently being used in the South African electoral system is utilized with success?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
			X	

10. Do you think the national common voters' roll used in the South African electoral system is accurate?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		X		

11. Integrating technology into the vote cast process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

12. Integrating technology into the counting process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree

Section C: Proposed E-voting System

Please refer to the attached document to answer the following questions. Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box?

13. Do you think the proposed e-voting system could potentially improve the current manual paper-based South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

Please provide a reason for your answer in Question 13.

14. Do you think the proposed e-voting system would be accepted by South African voters?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		X		

Please provide a reason for your answer in Question 14.

Many Illiterate people.

15. Does the proposed e-voting system offer more South Africans the opportunity to participate in South African elections compared to the current paper-based election?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

Please provide a reason for your answer in Question 15.

16. Do you think the proposed e-voting system could contribute to a freer and fairer election in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

Please provide a reason for your answer in Question 16.

Could potentially rule out fraud and corruption with regards to vote-cast.

Additional Comments

Please share any further comments that will help the researcher to improve the proposed e-voting system for South Africa.

Thank you for your time and invaluable participation

Expert 3:

Questionnaire Feedback

Confidential Research: Structured Interview

Section A: Background Information

Please draw a cross (X) in the box next to the appropriate answer – multiple answers can be selected.

(1) How long have you been involved with the South African election process?	
a) 1 – 3 years	
b) 4 – 6 years	
c) 7 – 10 years	
d) 10 or more years	✓
e) Not directly involved	

(2) Roles in South African election	
a) Electoral official	
b) Voter	
c) Political party representative	✓
d) IEC Member	
e) Researcher	
f) Other (*Please specify*)	

(3) Technology exposure	
a) Mobile phone (iPhone, BlackBerry) Specify model: BlackBerry Bold	✓
b) Personal Computer (PC)	✓
c) Laptop	✓
d) Tablet	

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

4. Do you rate yourself as knowledgeable with regards to the South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
✓				

5. Are you confident in your ability to answer questions about the election process in South Africa?

Strongly Agree ✓	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree

6. Are you confident in your ability to answer questions about the use of technology in the South African electoral system?

Strongly Agree ✓	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree

Confidential Research: Structured Interview

Section B: Electoral System

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

7. Do you think the current manual paper-based electoral system in South Africa is reliable?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	✓			

8. Do you think the current manual paper-based electoral system could be improved?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		✓		

9. Do you think the Information and Communication Technology currently being used in the South African electoral system is utilized with success?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	✓			

10. Do you think the national common voters' roll used in the South African electoral system is accurate?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		✓		

11. Integrating technology into the vote cast process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	✓*			

I.E. IF SO FAR AS THE COUNTING PART OF IT IS CONCERNED

12. Integrating technology into the counting process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree ✓	Neither Disagree or Agree	Disagree	Strongly Disagree

Confidential Research: Structured Interview

Section C: Proposed E-voting System

Please refer to the attached document to answer the following questions. Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box?

13. Do you think the proposed e-voting system could potentially improve the current manual paper-based South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
			X	

Please provide a reason for your answer in Question 13.

THE MECHANISM FOR MONITORING A BALLOT FROM ISSUE TO COUNTING IS LOST

14. Do you think the proposed e-voting system would be accepted by South African voters?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	✓			

Please provide a reason for your answer in Question 14.

VOTERS WOULD ACCEPT ANY MEANS TO MAKE QUEUES SHORTER

15. Does the proposed e-voting system offer more South Africans the opportunity to participate in South African elections compared to the current paper-based election?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
			X	

Please provide a reason for your answer in Question 15.

THE LAW REQUIRES A VOTER TO REGISTER TO VOTE IN PERSON WITH THE IEC

Confidential Research: Structured Interview

16. Do you think the proposed e-voting system could contribute to a freer and fairer election in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
			X	

Please provide a reason for your answer in Question 16.

I THINK IT PROVIDES OPPORTUNITIES FOR CORRUPTION

Confidential Research: Structured Interview

Additional Comments

Please share any further comments that will help the researcher to improve the proposed e-voting system for South Africa.

PLEASE ENLIGHTEN ME AS TO HOW A POLITICAL PARTY CAN MONITOR A VOTER AND ENSURE THAT:

A. THAT PERSON'S VOTE IS NOT CHANGED OUT OF SIGHT OF A PARTY AGENT

B. THAT CORRUPTION IS POSSIBLE WITH COMPLICIT OFFICIALS WORKING WITH THE RULING PARTY TO ALLOCATE VOTES TO THEMSELVES AND IT WOULD BE EXTRAORDINARILY DIFFICULT TO DETECT AND PROVE

Confidential Research: Structured Interview

Thank you for your time and invaluable participation

Expert 4:

Questionnaire Feedback

Section A: Background Information

Please draw a cross (X) in the box next to the appropriate answer – multiple answers can be selected.

1) How long have you been involved with the South African election process?	
a) 1 – 3 years	
b) 4 – 6 years	
c) 7 – 10 years	
d) 10 or more years	X
e) Not directly involved	

2) Roles in South African election	
a) Electoral official	
b) Voter	X
c) Political party representative	X
d) IEC Member	
e) Researcher	
f) Other (*Please specify*) Political Candidate	X

3) Technology exposure?	
a) Mobile phone (iPhone, BlackBerry) Specify model: BlackBerry	X
b) Personal Computer (PC)	X
c) Laptop	X
d) Tablet	

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

4. Do you rate yourself as knowledgeable with regards to the South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	X			

5. Are you confident in your ability to answer questions about the election process in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

6. Are you confident in your ability to answer questions about the use of technology in the South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	X			

Section B: Electoral System

Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box.

7. Do you think the current manual paper-based electoral system in South Africa is reliable?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	X			

8. Do you think the current manual paper-based electoral system could be improved?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

9. Do you think the Information and Communication Technology currently being used in the South African electoral system is utilized with success?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	X			

10. Do you think the national common voters' roll used in the South African electoral system is accurate?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	X			

11. Integrating technology into the vote cast process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

12. Integrating technology into the counting process could improve the current manual paper-based electoral system in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

Section C: Proposed E-voting System

Please refer to the attached document to answer the following questions. Please rate how strongly you agree or disagree with each of the following questions by placing a check mark in the appropriate box?

13. Do you think the proposed e-voting system could potentially improve the current manual paper-based South African electoral system?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

Please provide a reason for your answer in Question 13.
Elimination of 2/3/4/5th persons in process. Vote only accountable.

14. Do you think the proposed e-voting system would be accepted by South African voters?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
		X		

Please provide a reason for your answer in Question 14.
Big portion of residents not "technological literate" – do not trust technology/computers.

15. Does the proposed e-voting system offer more South Africans the opportunity to participate in South African elections compared to the current paper-based election?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
	X.			

Please provide a reason for your answer in Question 15.
All S A. overseas/outside RSA borders will be able to participate.

16. Do you think the proposed e-voting system could contribute to a freer and fairer election in South Africa?

Strongly Agree	Agree	Neither Disagree or Agree	Disagree	Strongly Disagree
X				

Please provide a reason for your answer in Question 16.

Intimidation / Privacy / Confidentiality

Additional Comments

Please share any further comments that will help the researcher to improve the proposed e-voting system for South Africa.

Thank you for your time and invaluable participation

Appendix D:

Paper Presented and Published

E-voting: A South African Perspective

E. Swanepoel, K. Thomson, J.F. van Niekerk

School of ICT, Nelson Mandela Metropolitan University

Abstract. The South African democracy, despite being worthy of admiration, is in its infancy. As such its electoral processes still needs to be nurtured and protected. Since 1994 there has been four national elections. All of these have been declared "free and fair" by the Independent Electoral Commission. However, there has been some problems and growing pains. This paper firstly discusses the current electoral system in South Africa. It then examines E-voting systems and discusses the feasibility of such a voting system for use in the South African context.

1 Introduction

"The victory of democracy in South Africa is the common achievement of all humanity." [Mandela(2005)].

Democracy is one of South Africa's biggest achievements. Fifteen years ago, for the first time, all South Africans had the right to cast their vote. This included people of all cultures. Since 1994 South Africa has had four national elections considered to be "free and fair" by the Independent Electoral Commission (IEC) of South Africa.

However, elections are not by default "free and fair". It is the responsibility of the IEC to ensure the continued integrity of the South African electoral system. The "fairness" of an election is determined by a combination of factors, including people, processes and the system itself. Occasionally this system comes under attack from unscrupulous individuals. For example, in the 2009 election marked national and provincial ballot papers were found sealed in envelopes in KwaZulu-Natal before the elections actually took place [News24(2009)]. It would be naive to assume that similar attempts at influencing the vote would not occur in future elections. The process of voting in South Africa is questioned by some, how "free and fair" is the final result? [Ebersohn(2009)]. Not everyone in South Africa can experience democracy and receive the benefits from such a system. For example citizens visiting foreign countries, people with disabilities, and people with transport problems in rural areas do not necessarily have easy access to polling stations. There have also been reported cases of multiple votes being cast [Ebersohn(2009)]. This paper will examine the South African election system and discuss the viability of E-voting in South Africa as a way to improve the overall efficiency of the system, and to reduce the risk of future attacks on the integrity of the system.

2 Background on the South African Electoral System

Microsoft Encarta Encyclopedia Online defines democracy as "the free and equal right of every person to participate in a system of government often practiced by electing representatives of the people by the majority of the people." [Encarta(2009)].

In December 1993, the South African government permitted equal rights to all South African citizens [Athiemoolam(2003)]. South Africa's first fully democratic election was held between 26 and 29 April 1994. The Independent Electoral Commission (IEC), which included international observers, declared that South Africa had a free and fair election [lvarez Rivera(2006)]. Looking at South African history, having such efficient transition to democracy can be seen as a miracle. This event captured the attention of people all around the world [Athiemoolam(2003)].

After the first democratic election the government prescribed a constitution which has been called the "birth certificate" of a new South Africa. Chapter One of the constitution guarantees democracy in South Africa; every South African citizen over the age of 18 has the right to vote in the South African elections [Republic of South Africa(1996)]. This corresponds to the vision statement of the Independent Electoral Commission stating that South Africa should have a "free and fair" election giving every voter the opportunity to vote for his/her chosen parties [IEC(2004)]. The IEC has been responsible for the implementation of the electoral system for the elections in South Africa since the first democratic election in 1994.

The South African parliamentary election takes place every five years with elections held under an electoral system of proportional representation. A proportional system uses a political party list at provincial and national levels. The political party will be allocated a number of seats in direct proportion to the number of votes received in the election. The voter can only vote for a party not an individual of choice. To ensure a "free and fair" election the electoral commission of South Africa oversees the election process [IEC(2004)].

The IEC is a permanent body established in terms of the Electoral Commission Act of 1996. It is independent from government, but reports to Parliament. The IEC promotes democracy in South Africa and must ensure a "free and fair" election at all levels of government - national, provincial and local. This is accomplished through:

- Dividing South Africa into voting districts, this ensures equal access to polling stations and avoids problems associated with overcrowding;
- Arranging the logistics of the election. This includes Information Technology systems, staffing, management of conflicts and the education of voters;
- Registering eligible voters onto a voters roll;
- Ensuring the efficiency of running the voting process; and
- Counting, verifying and announcing the final results of elections [IEC(2004)].

As can be seen from this list of tasks the IEC is responsible for overseeing the whole election process and contributing to a "free and fair" election.

3 Electoral System Characteristics

In South Africa, since 1999 eligible voters had to register to cast a vote in elections. The 1999 election saw 18 172 751 voters register in 14 650 voting districts. In 2004, 20 674 926 voters registered in 16 966 voting districts and in 2009, 23 181 997 voters registered in 19 705 voting districts. Prior to the current voting process, voters were allowed to cast their vote without having to be on a voter's roll. The current process in South Africa allows the voter to cast a vote on a ballot paper using a pencil selecting a political party [IEC(2004)].

The cost of the physical ballot paper is the first identified characteristic. In the 2004 election 56 million ballot papers were printed in colour with the 11 official languages on the ballot papers. As per the EISA research report no. 12, the total cost of the 2004 election was R790 million - that is R50.59 per national vote. The 1999 election cost R713.5 million or R44.65 per national vote; and 1994 cost R960 million or R49.15 per national vote [Piper(2005)].

A possible drawback to the South Africa system is that there are a large number of illiterate adults. Statistics show that 24 % of adults in South Africa over the age of 15 are illiterate. The number of languages in South Africa can contribute to further problems when voters go to the polling stations. Casting a vote using a ballot form might sound simple for educated people, but for illiterate people this can be a challenging task [SouthAfrica.info(2006)]).

In addition, the Electoral Institute of South Africa recognized in the 2004 elections that some of the ballot papers were not clear and contributed to some confusion amongst voters which could have played a part in the 1,58 % spoilt ballots. In the 2009 election there were 239,237 spoilt ballots nationally and 223,462 provincially [IEC(2004)].

Another concern is confidence in the ballot form. According to a survey done by Citizen Surveys in October and November 2008, South African citizens were concerned that the secrecy of their ballot form could be compromised. A sample was conducted on 2400 South Africans revealing that 58 % had confidence in the secrecy of their ballot form (Concern about Ballot Secrecy, online). In a report delivered by the Electoral Institute of South Africa, the 2009 election showed that a large number of the election officials did not have a clear understanding of the counting process which lead to delays. They observed that some of the polling stations used one ballot box for both ballots; the national assembly and provincial legislatures. Also the seals on some ballot boxes were not applied using the correct procedures [EIS(2009)].

A further contributing drawback is the fact that poverty is one of South Africa's biggest challenges, 50 % of the population live in underprivileged conditions [wor(2009)]. Transport from rural areas to polling stations can decrease voting registration and participation. People may not have the necessary funds to travel to an election polling station, which can be the reason for voter turnout decreasing in the South African elections. In 1994, 84 % of eligible voters cast their vote. In the 1999 election that figure declined to 63 % and in 2004, the election had a 61 % turnout [Kersting(June 2007)].

People with disabilities can face some disadvantages when it comes to casting votes, depending on their disability. In South Africa there are approximately 4 million people with disabilities according to the Council for Scientific and Industrial Research. As an example; when a blind person, or some one else with a disability, has to rely on assistance when casting his/her vote by making use of the presiding officer at the voting station; the integrity of the vote might be influenced [IEC(2009a)].

A large percentage of South African citizens live abroad and were eligible to take part in the 2009 election. The Constitutional Court delivered this decision on 12 March 2009 allowing South Africans living abroad to vote in the 2009 elections [IEC(2009b)]. This is good for democracy in South Africa, but can lead to challenges such as voters having problems accessing an embassy to register and cast their vote.

South Africans should not only be able to vote, but should also have a system that can be trusted. The protection of information in an election is very important; therefore this information needs to be protected from threats [Von Solms and Von Solms(2008)]. The risks that threaten the confidentiality, integrity and availability of information must be mitigated or fully eliminated. This will contribute to having a "free and fair" election where voters will have confidence in their country's electoral system.

A possible solution to eliminate some of these challenges facing the electoral system in South Africa is making use of technology; the implementation of an electronic voting system.

4 Background on Electronic Voting Systems

Electronic voting is the use of electronic means to cast a vote and is also know as E-voting. Since 1960 electronic systems have been used in certain states in America and more recently remote electronic voting has been used in countries like Estonia, Switzerland and others. E-voting is meant to complement traditional voting methods. There are different types of E-voting methods, including punch cards, optical scan voting systems, direct recording electronic voting systems (DRE systems), Web-based voting systems, ballots and voting via telephone [Bellis(Undated)][Gritzalis(2002)].

4.1 Punch Card Voting Systems

Punch cards is a voting system that has been around for decades where the voter still has to go to a polling station to cast his/her vote. This method of voting makes use of a small clipboard-sized device with a card where the voter's choice is recorded on. The card slides into the device and uses a metal or stylus device to make a hole next to the political party or candidate of his/her choice. The ballot will then be tabulated with a card counter at the polling station or at a central location using card readers. There are two well known versions of this voting system i.e. votomatic vote recorder and the datavote vote recorder [Bellis(Undated)][Gritzalis(2002)].

4.2 Direct Record Voting Systems

Direct record electronic voting systems are also known as a DRE voting system. DRE systems are the electronic version of the older mechanical lever system. They are similar because both systems don't use ballot papers to record a vote on. The DRE voting machines have touch screens or make use of keyboards to cast a vote electronically. The DRE machine has a monitor that guides the voter through all the steps involved in an election. All the votes that have been made by voters are stored on the voting machines. Storage methods used are for example memory cartridges, diskettes or smart cards. DRE systems are one of the most recent additions in the development of E-voting systems i.e. using technology to cast a vote in an election [Bellis(Undated)][Gritzalis(2002)]. DRE voting systems could have many advantages in a South African context. For example; the use of such systems could help to address the problems associated with having eleven official languages, or, by paying attention to usability concerns, a DRE could also be customized to alleviate problems experienced by disabled voters. These, and many other possible advantages, could make DRE voting systems a viable option in future.

4.3 Optical Scan Voting Systems

An optical scan voting system makes use of "dark magic logic"; this is used to read a voter's ballot form by selecting the darkest mark on the form as the choice of vote. The voter will cast a vote on a ballot form, where the political party or candidate is pre-printed with an empty rectangle, circle, oval or arrow next to it. Selecting a political party or candidate of choice is done by filling in the empty rectangle, circle, oval or arrow. The voter will then feed this ballot form into a computer tabulating system to be counted. The ballot form can also be placed in a ballot box where it will be counted by electoral staff. Making use of the optical-scan machines at the polling station will give you confidence that your vote was counted immediately. Optical scan technology has been used for decades not only for voting, but also implemented in worldwide lottery systems [Bellis(Undated)][Gritzalis(2002)].

4.4 Internet Voting System

Internet-, or Web-based voting systems, is another electronic method of voting referred to as remote electronic voting. Remote electronic voting requires that the voter has access to an Internet connection. Some countries for example Austria, Canada, Switzerland and others are involved in running pilot projects for implementing a remote electronic system in their election. Estonia became the first country to use remote electronic voting in their elections. In Estonia a voter needs to have an electronic identification card. The voting process consists of the following; first the voter inserts the identification card into a card reader, a webpage opens where the voter will cast his/her vote. The voter will need to enter a PIN for verification and a server checks the credentials of the voter. The

server will also verify that the voter is eligible to cast his/her vote. After verification a list of the candidates appears and the voter can make his/her choice, this will be encrypted. A second PIN is required to confirm the selection using a digital signature. Security in a remote electronic system is very important for an election. Making use of the Internet gives a voter the opportunity to cast their vote from anywhere in the world giving everyone the opportunity to participate [Estonia Today(2009)].

5 Electronic Voting Characteristics

E-voting enables new methods of polling, which facilitates the comfort of voters, increases the opportunity to participate and the mobility of voters. This would be particularly beneficial for those citizens who live abroad, have transport problems or are disabled and consequently limited in terms of mobility. E-voting can be beneficial for voter turnout; potentially everyone would be able to take part in the election and easier election participation would be possible. Groups of people that will benefit would be, for example, young people that are increasingly using the Internet and older people that have mobility problems. Citizens living overseas will also have the ability to vote as access to the Internet is available worldwide [Brändli and Braun(2006)].

The current South African electoral system has some drawbacks and introducing E-voting could possibly help improve the system. E-voting can help with the reduction of ballot paper and employment cost in an election and contribute to reducing environmental effects by reducing paper consumption. The counting process and result tabulation when using E-voting will much faster. Initially, the E-voting system may be more costly to implement. However, the high cost of printing ballot papers would be eliminated. Therefore in the long term, once fully implemented, E-voting could prove to be more financially viable. In addition to these cost savings, issues such as ballot box shortages that occurred in the 2009 election will be something of the past.

With approximately 1.5 million South Africans living abroad the use of Internet voting will give the opportunity to expats to cast their vote from anywhere in the world. This is not only beneficial to expats but disabled people would benefit from this too. Disabled individuals could make use of headphones, Braille keypads and so forth to cast their votes and they can vote within the comfort of their own home. This will allow them to vote independently, no human aide needed and contribute to the integrity of the vote.

Another benefit would be that the voter can change his/her vote if needed before polling station closure. Addressing the useability of such an E-voting system would be very important. South Africa has a large number of people that are illiterate; this can be one of the biggest challenges when it comes to E-voting in South African. An E-voting system can be developed with a graphical user interface making it user friendly. This will make it possible for illiterate people to understand and be able to cast a vote. Another added feature when using E-voting is that it can accommodate multiple languages thus giving every voter

access in their own language. With South Africa having 11 official languages this contributes to improving the useability of such a system.

However, with these added benefits, come increased security requirements. It is vital that the confidentiality, integrity and availability of election information must be protected to ensure the public's confidence. This is also one of the challenges facing the use of such an E-voting system. The worse-case scenario can have a devastating effect on an election. Protecting information is a challenge because of all the risks that technology faces. Examples are viruses, hackers, physical tampering, spoofing and so forth [Rubin(2002)]. Protecting a user's anonymity is very important for such an electronic system. The voter needs to know that their vote is confidential. By achieving this, confidence in such an electoral system will increase. Everyone involved in an election, including the voter, politicians and authorities need to trust the system [Brändli and Braun(2006)].

6 Conclusion

This paper has shown that there are still problems in the electoral system currently being used in South Africa. Many of these problems could conceivably be alleviated through the implementation of a comprehensive E-voting system. However, despite the possible benefits of such a system, one could also argue that South Africa is not yet ready for such a system. Apart from infrastructure questions, which should be investigated in future studies, one should also ask whether or not the South African public is ready for such a change. South Africans have only recently started to trust and make use of online services, such as, online banking, online gambling, buying airline tickets, paying accounts, filing tax returns, etc. Without public confidence, E-voting would not work. It would thus be imperative to comprehensively address the security concerns, which include issues of human confidence, before such a system is considered for South Africa. It could be argued that initial attempts should focus on using a combination of traditional and E-voting systems.

It should, however, be clear that a lot more research is needed before the question: "Is South Africa ready for E-voting?", can be answered. Future research will focus on addressing this question.

References

[EIS(2009)] Interim statement: Eisa observer mission to the 2009 south african national & provincial elections. Internet, 2009.

[IEC(2009a)] Voting questions and answers. Internet, 2009a.

[IEC(2004)] Report on the national and provincial elections. Technical report, Independent Electoral Commission, 2004.

[wor(2009)] World bank: South africa - country brief. Internet, 2009.

[Athiemoolam(2003)] L. Athiemoolam. South africa's peaceful transition to democracy: Nine years of peace in a trouble world. *Peace as a Global Language Conference II, Seisen University, Tokyo, Sept. 27-28, 2003. URL http://www.zsn.uni-oldenburg.de/download/Logan_Japan_Conference.pdf. Retrieved on 29 March 2009*, 2003.

[Bellis(Undated)] M Bellis. The history of voting machines. *[WWW document]. URL http://inventors.about.com/library/weekly/aa111300b.htm. Retrieved on 3 March 2009.*, Undated.

[Brändli and Braun(2006)] D. Brändli and N. Braun. Swiss e-voting pilot projects: Evaluation, situation analysis and how to proceed. *URL* $http://www.e\text{-}voting.cc/static/evoting/files/braun_braendli_swiss_e - voting_27 - 36.pdf. Retrievedon3March2009, 2006.$

[Ebersohn(2009)] K. Ebersohn. Bloemfonteinse vrou kry dit reg om twee keer te stem. Internet, 2009.

[Encarta(2009)] Encarta. Democracy. Internet, 2009.

[Estonia Today(2009)] Estonia Today. Estonia e-voting system. Internet, 2009.

[Gritzalis(2002)] D Gritzalis. *Secure Electronic Voting.* Springer, 2002.

[IEC(2009b)] IEC. Constitutional court ruling on overseas voting. *[WWW document]. URL http://www.elections.org.za/news.asp?press=0Opt=Data=Recnum=21. Retrieved on 13 March 2009.*, 2009b.

[Kersting(June 2007)] N. Kersting. Electoral reform in southern africa: voter turnout, electoral rules and infrastructure. *Journal of African Elections*, 6(1):134–151, June 2007.

[lvarez Rivera(2006)] M. lvarez Rivera. The republic of south africa electoral system. *[WWW document]. URL http://www.electionresources.org/za/system/. Retrieved on 29 March 2009.*, 2006.

[Mandela(2005)] N. Mandela. *Long Walk to Freedom.* Abascus., 2005.

[News24(2009)] News24. Marked ballot papers found. Internet, 2009.

[Piper(2005)] L. Piper. *South Africa's 2004 Election: The Quest for Democratic Consolidation.* South Africa: EISA., 2005.

[Republic of South Africa(1996)] Republic of South Africa. Constitutional court of south africa. *[WWW document]. URL http://www.constitutionalcourt.org.za/site/theconstitution/whatisaconstitution.htm. Retrieved on 29 March 2009.*, 1996.

[Rubin(2002)] A. Rubin. Security considerations for remote electronic voting. *Communications of the ACM*, 45(12):39–44, 2002.

[SouthAfrica.info(2006)] SouthAfrica.info. Education in south africa. Internet, 2006.

[Von Solms and Von Solms(2008)] R. Von Solms and B. Von Solms. *Information Sec urity Governance.* Springer., 2008.