

**DESIGN AND IMPLEMENTATION OF AN ONLINE VOTING SYSTEM IN
SELECTED DEVELOPING COUNTRIES; A CASE OF THE REPUBLIC
OF UGANDA**

BY

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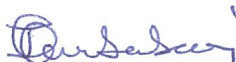
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**PROJECT REPORT SUBMITTED TO THE COLLEGE OF APPLIED SCIENCE AND
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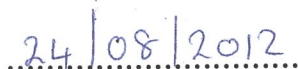
Declaration

We , **KEMBABAZI Jackline** and **Alfred OJAKOL**, do hereby declare that this project proposal is our original and has not been published and/or submitted for any other Degree award to any other institution before.



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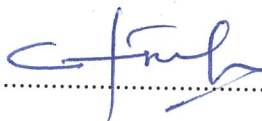
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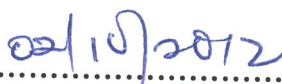
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Approval

This project proposal has been submitted for Examination with my approval as the University Supervisor.



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LIST OF ACRONYMS

ICT	Information Communication Technology
PC	Personal Computer
BBC	British Broadcasting Company
TCP/IP	Transmission Control Protocol/Internet Protocol
LAN	Local Area Network
USA	United States of America
LC	Local Council
EC	Electoral Commission
CAST	College of Applied Science and Technology
SQL	Structured Query Language

LIST OF FIGURES

0. Conceptual model for an online voting system.....	22
0.1. Entity Relationship diagram.....	32
1. A Gantt chart for time frame.....	33
2. Login interface.....	35
3. Voter's registration form.....	36
4. Polling form.....	36
5. Statistical vote's results chart.....	37
6. Home page of online voting system web site.....	39
7. Illustration of system conversion.....	44
8. Voter's Registration form.....	40
9. Voter's Login frame.....	40
10. Voter's account opening form.....	41
11. Polling frame.....	42
12. Candidates' frame.....	43
13. Online voting system database.....	56
14. Users' table.....	57
15. Voters' table.....	58
16. Voters' registration table.....	59
17. Poll menu table.....	60

Abstract

Potential voters face difficulty when registering to be legitimate voters, some of these difficulties includes: the long distances to be traveled for registration process, the long queues at the registration sites, the short time duration provided for registration, updating and viewing the voter register. In an effort to make the voter registration and voting process easier, this project report outlines the designing and implementation of the online voting system based on current literature on voter registration and voting process, web security and latest software application. The online voting system allows the voter to register online and ensure the existence of his/her name on the voter register. Furthermore, it allows the voter to cast his/her vote and check for election results updates.

Although the online voting system focused on the Uganda Electoral Commission (UEC), it is important to note that it can be implemented for other electoral commissions in other democratic countries worldwide. The online voting system was evaluated and validated in terms of usability and feasibility. The online voting system is both usable and feasible, though fixes are recommended to meet the limitations. Trends in the quantitative data and logical inference based on the context of the evaluation suggest that the online voting system might help the UEC to produce more accurate voting process.

TABLE OF CONTENTS

Declaration.....	II
Approval	III
Acknowledgements.....	IV
LIST OF ACRONYMS	V
LIST OF FIGURES	VI
Abstract.....	VII

CHAPTER ONE	4
INTRODUCTION	4
1.0 INTRODUCTION.....	4
1.1 BACKGROUND OF THE STUDY	4
1.2 STATEMENT OF THE PROBLEM	5
1.3 PURPOSE OF THE STUDY	6
1.4 MAIN OBJECTIVE	6
1.5 SPECIFIC OBJECTIVES	6
1.6 RESEARCH QUESTIONS	7
1.7 SCOPE	7
1.7.1 <i>Geographical scope</i>	7
1.7.2 <i>Content Scope</i>	7
1.7.3 <i>Time scope</i>	7
1.7.4 <i>Significance of the study</i>	7
CHAPTER TWO	9
LITERATURE REVIEW	9
2.0 INTRODUCTION.....	9
2.1 INFORMATION COMMUNICATION TECHNOLOGY (ICT).....	9
2.1.1 <i>Web site</i>	11
2.1.2 <i>Database</i>	11
2.1.3 <i>Network</i>	11
2.1.4 <i>Internet</i>	12
2.1.5 <i>Voting process management</i>	12
2.1.6 <i>Voters' registration</i>	12
2.1.7 <i>Communication</i>	12
2.1.7.1 <i>Communication via LAN</i>	12
2.1.7.2 <i>Communication via Internet</i>	13
2.1.8 <i>Votes casting, recording and counting</i>	13
2.2. VOTES REPORT	13
2.2.1 <i>ICT and Voting Process Management</i>	13
2.2.2 <i>Theoretical perspective</i>	15
2.2.3 <i>Related studies</i>	16
CHAPTER THREE.....	18
METHODOLOGY	18
3.0 INTRODUCTION.....	18
3.1 RESEARCH DESIGN.....	18
3.2 RESEARCH POPULATION	18

3.3	SAMPLE SIZE	18
3.4	SAMPLING PROCEDURES	19
3.5	RESEARCH INSTRUMENTS.....	19
3.5.1	<i>Questionnaires</i>	19
3.5.2	<i>Observation</i>	19
3.6	DATA GATHERING PROCEDURES.....	20
3.6.1	<i>Before the administration of the questionnaires</i>	20
3.6.2	<i>During the administration of the questionnaires</i>	20
3.6.3	<i>Ethical Considerations</i>	20
3.7.8	<i>Limitations of the Study</i>	21
CHAPTER FOUR		22
SYSTEM DESIGN AND IMPLEMENTATION.....		22
4.0	INTRODUCTION.....	22
4.1	OLD SYSTEM WEAKNESSES	22
4.2	EXPECTED VALUES OF THE NEW SYSTEM.....	22
4.3	SYSTEM REQUIREMENTS.....	22
4.3.2	<i>Functional requirements</i>	23
4.3.3	<i>System Development Methodology</i>	23
4.3.4	<i>System Development Tools</i>	23
4.3.5	<i>Function needs of the system</i>	23
4.4	SYSTEM DESIGN	24
4.4.1	<i>Logical Design</i>	24
4.4.2	<i>Entity Relationship Diagram</i>	24
4.4.3	<i>Data flow Diagram</i>	25
4.4.4	<i>Physical Design</i>	27
4.4.5	<i>Database Design</i>	27
4.4.6	<i>Login interfaces</i>	27
4.4.7	<i>Voters' registration form</i>	28
4.4.8	<i>Polling form</i>	28
4.4.9	<i>Statistical votes results chat</i>	29
4.5	SYSTEM DEVELOPMENT	29
4.5.1	<i>Introduction</i>	29
4.5.2	<i>System implementation</i>	29
4.5.2.1	<i>Registration</i>	30
4.5.2.2	<i>Creating an account</i>	30
4.5.2.3	<i>Login</i>	30
4.5.2.4	<i>Cast the vote</i>	30
4.5.2.5	<i>View the results</i>	30
4.6	COMPONENTS OF THE ONLINE VOTING SYSTEM.....	31

4.6.1 Online Voting System Home Page.....	31
4.6.2 Registration Form	31
4.6.3 Login Frame	32
4.6.4 Voter's account.....	33
4.6.5 Polling Frame.....	33
4.6.6 Candidates' Frame.....	35
4.6.7 Database.....	35
4.6.8 Findings.....	35
5. SYSTEM CONVERSION.....	36
CHAPTER FIVE	37
SUMMARY, EVALUATION, CONCLUSION, AND RECOMMENDATIONS	37
5.0 INTRODUCTION.....	37
5.1 SUMMARY	37
5.2 EVALUATION OF THE NEW SYSTEM.....	37
5.3 CONCLUSION	38
5.4 RECOMMENDATIONS	38
REFERENCES	39
APPENDICES.....	41
APPENDIX I	41
APPENDIX II	46
APPENDIX III.....	47
APPENDIX IV	48
APPENDIX V	49
APPENDIX VI	50
APPENDIX VII.....	51

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This study focuses on design and implementation of an online voting system for Uganda, managed by Electoral Commission that will facilitate Uganda citizens in the diaspora and in the country, to vote via Internet with a major focus on the overcoming of the election material and time costs and allow anyone who would like to cast his/her vote, to do so from where he/she is without going to line up at the polling stations. A good electoral process is one that ensures the preservation of the secret ballot, accuracy, privacy, integrity and proper tabulation of the voter's intent regardless of his or her physical condition, language of origin, or literacy ability. The election system must be sufficiently strong to withstand a variety of fraudulent behaviors, must be sufficiently transparent and comprehensible that voters and candidates can accept the results from an election. Indeed, free and fair elections are a component of all definitions of democracy. The online voting system will work in parallel with an existing one. The existing system is conducting election process in a traditional manner, where the voters have to go to line up at the polling stations. However, the new system will not replace completely the old one since the online voting system requires some computer knowledge to use it. Thus, the old system will be maintained to serve those who are ignorant in computer environment until when every Ugandan will be able to use a computerized system.

1.1 Background of the study

In a true democracy, elections are the basis for the nation's political health. Elections allow the populace to choose their representatives and express their preferences for how they want to be governed. Naturally, the integrity of the electoral process is fundamental to the integrity of democracy in any developing country like Uganda. Nowadays, the issues of combining voting with information technology can develop an online voting, which is voting on the internet without limiting people in the polling station but needs higher level of security. By using Information Technology, online voting system can cast and count votes with higher convenience and efficiency, even make the electoral procedures simple and reduce the mistake rate of ballot examination.

At the global level, electronic election started in the year 2000 for presidential election in United States of America. The aim was to increase participation, lower the costs of running elections and improve the accuracy of results. This briefing note looks at options for using new technologies in voting, focusing on the pros and cons of Internet voting and the implications of such a radical change in the way that elections are conducted, Jung-Ying Lai (2003).

In Africa, some countries still experience political and ethnic divisions, confirming that Africans do not trust the counting of votes which is carried out manually. So, the dynamic of elections should be changed from a traditional to an electronic one. So far, no African country has tried to implement an electronic voting, Kyanda S. (2004).

In Uganda, the voters suggest the concept of an online voting, by integrating Information Technology to satisfy the characteristic of election such as uniqueness, accuracy, completeness, verifiability, audibility, and privacy. This can also facilitate those in the Diaspora to vote from abroad via the Internet at the time of voting to exercise their right, Kyanda S. (2004).

This project intends to come up with an online voting system prototype that will facilitate any Ugandan citizen to enjoy the right of casting the vote from where he/she is via the Internet.

1.2 Statement of the problem

The Government of Uganda attaches great importance to the free and fair elections. It recognizes the fact that free and fair elections for all is a powerful tool for transformation of society, in a way that elections play a key role in achieving moral, intellectual, ideological, cultural, social development and prosperity for the people in the society as well as achieving national goals of unity, democracy, financial progress and security for all its citizens, (White Paper, 2001).

The government of Uganda, according to the White Paper, (2001), is fully conscious of the problems it is facing in its effort to cause rapid improvement of democratization. The quality of elections has been seriously eroded at all levels due to depredation of war, civil strives and the consequent financial decline during the last two decades. Ugandan citizens have experienced dictatorship problem, security was just a dream, people were demoralized and many of them have been killed during elections and others have been forced to take exile where some of them

are still outside the country and have no right to enjoy and participate in democratic exercise that is taking place in the country.

In Uganda, it has been proved that election malpractice and or fraud has become a threat to the democratization process. Furthermore, the corruption, loss of lives in election process, the delays in election materials and high costs of conducting elections in a traditional manner have become a burden for the country. Thus, IT has to be considered as a good solution for the above problems.

In the light of the above scenario, the prevailing problem which this study intends to solve, is the design and implementation of an online voting system which is the better solution for all Ugandans wherever they are, because in case Ugandans in Diaspora are deprived of their voting right, they may be a problem to the current regime by creating a strong opposition through which they hope to be treated like other Ugandan nationals. This system will handle such problem since it will be uploaded so that anyone can access it form the Internet wherever hi/she is located.

1.3 Purpose of the study

The purpose of this study is to design and implement a web based voting system that will facilitate Ugandan citizens abroad and in the country to vote via the Internet without going to line up at the polling stations.

1.4 Main Objective

The main objective of this study is to design and implement an online voting system that will facilitate Uganda citizens abroad and locally to vote via Internet in order to achieve a democratic goal.

1.5 Specific objectives

- 1) To investigate the existing voting system in Uganda
- 2) To analyze the requirements of the new voting system
- 3) To design a database to store the voters' identification and votes
- 4) To build a dynamic website that will serve as interface between the users(voters) and the voting system
- 5) To implement and test the web based voting system prototype to ensure that it is of expected quality

1.6 Research questions

- 1) Is it possible to design and implement an online voting system that will facilitate Uganda citizens abroad and locally to vote via Internet?
- 2) Is it possible to design a database to store the voters' identification, record, counting and display statistically vote results?
- 3) Is it possible to build a dynamic website that will serve as interface between the users (voters) and the voting system?

1.7 Scope

1.7.1 Geographical scope

The study will be conducted in five divisions of Kampala district (Kampala central, Kawempe, Makindye, Rubaga and Nakawa) .The investigation will look upon the voters, candidates and Electoral Commission staff as well.

1.7.2 Content Scope

The study will investigate the existing voting system in Uganda and analyze the requirements of the upcoming system.

1.7.3 Time scope

The study will cover the period of five months (May-September, 2012) as shown in Appendix II.

1.7.4 Significance of the study

The following disciplines will benefit from the findings of the study: The entire Uganda community in general and Diaspora in particular will recognize the role they have to play in Electronic ICT resources availability and their utilization in democratization exercise. Furthermore, the voters will get their full right of casting their votes from everywhere they are without queuing at the polling stations.

The government of Uganda will aim to achieve the good of good governance and democracy. Then, it will save costs in terms of money and time it usually use to purchase and ship the ballots; security will be sure and no cheating will be experienced since the voters will be voting in absolute secret and the system will be designed in a such way that no one will be given a gap for cheating.

The Uganda Electoral Commission will use the findings as empirical information to improve the modern way of voting, quality standard in terms of democracy in Uganda toward a free and fair election in countrywide and in Diaspora communities.

The future researchers will utilize the findings of this study to embark on a related study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter involves looking through earlier research documents and related literature with an aim of identifying a problem of concern such that no duplication of earlier research work was done. This was sourced by reviewing documented resources such as text books and online publications, related with the research topic.

2.1 Information Communication Technology (ICT)

In today's world, Information and Communication Technology (ICT) is rapidly growing and being widely used in different aspects of human life. According to Internet work stats (2010), 1.9 billion users have been using Internet by June 30, 2010. Since Internet is a main basis of ICT, these facts and One Man International Company Business Model 301 figures that show 448 percent increase from 2000 to 2010 in World Internet Users and Population Stats, indicate the growing role of ICT in human life, David F. (2000).

In the field of Politics, Information and Communication Technology (ICT) has emerged as E-voting and online voting. Computer scientists who have done work in, or are interested in, electronic voting all seem to agree on two things:

1. Internet voting does not meet the requirements for public elections
2. Currently widely-deployed voting systems need improvement, Charles W. (2000).

Voting on the Internet using everyday PC's offers only weak security, but its main disadvantages are in the areas of anonymity and protection against oppression and/or vote selling. It's such a truly bad idea that there seems to be no credible academic effort to deploy it at all. The USA Presidential elections of 2000 brought national attention to problems with current American methods of casting and counting votes in public elections. Most people believe that the current system should be changed; there is much disagreement on how such changes should be made, Jamie B. (2003).

Other researchers have done work in electronic voting; while they may not explicitly mention voting from remote poll sites, their work is nonetheless relevant to any effort at designing or implementing a remote poll site voting system. Lorrie C. (2002) could be classified, like the Caltech researchers, as a cautious optimist. She acknowledges the problems inherent in each kind of voting apparatus, but doesn't make an overt recommendation on her site for one technology over the rest.

Mercuri, R. (2002) invented the Mercuri method for electronic voting. A critical component of this method is very similar to the Caltech proposal: a voting machine must produce human-readable hardcopy paper results, which can be verified by the voter before the vote is cast, and manually recounted later if necessary.

David, C. (2002) presents a very interesting scheme, Available at <http://www.vreceipt.com/article.pdf>), whereby voters could get receipts for their votes. This receipt would allow them to know if their votes were included in the final tally or not, and to prove that they voted without revealing any information about how they voted. The security of this scheme depends on visual cryptography developed by Naor and Shamir, and on voters randomly choosing one of two pieces of paper.

Dr. Michael, S.(2002) provides a sharp counterpoint to Mercuri's view. He is less afraid of the catastrophic failures and sweeping fraud made possible by imperfections in electronic voting machines actually occurring in a real election. Shamos is also much less impressed with paper ballots than is Mercuri. He places a great deal of faith in decentralization to make fraud difficult to commit and easy to detect.

According to Reding V. (2008), ICT has increasingly been identified as a major contributor to the process of business development and improvement and it has been identified that ICT is responsible for around half of productivity growth in modern economies. It drives improved efficiency and better services and products across the entirety of the private and the public sectors.

According to BBC, (2005), the use of ICT has affected every aspect of business, transforming not only the way that business is conducted but also creating new business sectors and jobs. The

creation of companies like Google and e-Bay which did not exist 10 years ago, was only made possible by advances in ICT and the changes that this has created in the way that people behave (currently Google is valued at 44£billion).

According to Ronamald T. & William C. (2003), Information Technology refers to as a system that is both simple and complete and electronic hardware devices and informal (word-of-mouth) communication chain net or computer based information system that use hardware and software, Net Internet and other communication networks that transform data resources into an endless variety of information products.

2.1.1 Web site

A website is a set of related web pages containing content (media) such as text, image, video, audio, etc. A website is hosted on at least one web server, accessible via a network such as the Internet or a private local area network through an Internet address known as a Uniform Resource Locator, Ronamald T & William C.B. (2003).

2.1.2 Database

Widom J. (2001) defines a database as a collection of data, organized for access and modification preserved over a long period.

According to C.J.Date (1990), a database is a computerized record keeping system; that is, it is a computerized system whose overall purpose is to maintain information and to make that information available on demand.

2.1.3 Network

Andrew S. Tanenbaum (2002) defines a network as an interconnected collection of autonomous computers and other communication devices that are able to share resources and exchange the information.

According to Glenn Berg (1998), a network is a set of interconnected systems with something to share. The shared resource can be data, a printer, a fax modem, or service such as a database or an e-mail system. The individual systems must be connected through a pathway (called a transmission media) that is used to transmit the resource or service between the computers. All the systems on the pathway must follow a set of common communication rules for data to arrive at its intended destination and for the sending and receiving systems to understand each other.

2.1.4 Internet

According to Layman L. (2001), Internet is a network of networks. Internet is basically a collection of computers that span the entire globe and connected by satellites, cables, routers and switches etc. Communication between these computers is by a protocol called Transmission Control protocol / Internet Protocol (TCP/IP). Using one Computer on the Internet, you can access another computer on the Internet to obtain data such as Pages, Videos, Audios, and applications, also over the same Internet one can place a phone call.

To logon to the Internet, a Personal Computer (PC) must have a Browser application program running on it. Browsers include Internet Explorer, Mozilla Firefox, Google chrome, Netscape navigator, etc. Documents, files, movies, audio files and any other Internet data can be stored on a certain Computer over the Internet and each bearing a special Uniform Resource Locator (URL) address specifying the computer on which this information is residing and the path to this file on the computer where it is found.

2.1.5 Voting process management

Online voting process management like any other Information system refers to as an organized combination of people, hard wares, Soft wares, communication networks and data resources that collects, transforms, stores and disseminates information in an organization.

2.1.6 Voters' registration

Internet voting goes a step further in the sense that it implies electronic registration, culling and counting of votes cast from different locations. It typically allows voters to use a more genetic technology such as the Internet, to register or cast their votes from any preferred place be it from the home, from the office or even from an Internet cafe while traveling abroad, Norbert Kersting (2004).

2.1.7 Communication

2.1.7.1 Communication via LAN

A LAN (Local Area Network) supplies networking capability to a group of computers in close proximity to each other such as in an office building, a school, or a home. A LAN is useful for sharing resources like files, printers, games or other applications, Bradley Mitchell (2010).

2.1.7.2 Communication via Internet

According to Jay Dax Designs (2000), Internet is a great alternative to the conventional methods of communication. Using Internet you can: send an e-mail, send a fax by e-mail, receive fax by e-mail, chat to an individual, send and receive instant messages, chat to a group, talk by voice (Internet telephony), video conferencing, register for voting, cast votes, and display votes report. In e-voting, Internet is used for online voters' registration, online vote casting and online election results updates checking. Furthermore, the voters can interact with EC staff by sending and receiving messages via the Internet.

2.1.8 Votes casting, recording and counting

Voting by polling machine simply refers to the use of any electronic apparatus to record and count votes in a fixed public place. This may be a specialized voting machine in a voting booth or a standalone personal computer (PC) specially installed for this purpose in a voting kiosk. Polling machines may be specially helpful for a reliable, objective, efficient and expeditious counting of votes and may also offer some possibilities for electronic verification (for example verification of whether the user is indeed entitled to vote and whether the vote is cast correctly).

2.2. Votes report

In a web based voting management system, the elections results are displayed on the electoral commission web site for the public to see. The election results can also be sent to the voters e-mail addresses or by sms via voters' cell phones. The results will be shown at the end of election exercise.

2.2.1 ICT and Voting Process Management

E-voting has been used in Europe, for legally binding elections, since at least 1982, Niemoller, D. K. (2004). Its use is still not widespread, though interest has increased. The Netherlands was a very early adopter, and it was almost a decade later (1991) that Belgium started experimenting with e-voting. Just a few years later, in the mid-nineties, France did the same. By the early 2000's, experiments or pilots had been run in the United Kingdom, Italy, Spain and the Republic of Ireland, among others, Benoit, D. K. (2004).

In the absence of controversy, surveys of voter attitudes usually reflect satisfaction and trust. When concerns are raised by experts and in the media, however, public opinion can change

dramatically. For example: in Ireland in 2003 a survey by Amarach Consulting found that a majority of Irish citizens were in favor of the introduction of e-voting.

This instinctive trust of e-voting systems also appears to exist amongst officials. When government representatives speak about e-voting it tends to be in very positive terms. Their statements emphasize the benefits of e-voting; the largest obstacle, from their point of view, is usually gaining the voters' trust. The idea that the system in question might not deserve such trust is given little or no attention, except where it overlaps with "allaying public concern" about the security of the system. Two prime examples of this are the web pages for the voting systems of the Irish Government and the Swiss state of Geneva.

In reality, implementing e-voting is not so simple. According to Mercuri, R. (2000), identified one of the most significant obstacles – the conflict between the requirements for secrecy and accuracy. Serious problems also arise from the way in which voting systems are currently developed. To knowledge there is still no voting system that has been treated as safety-critical in its development and deployment. The components of the systems are, in general, proprietary. These and other factors have combined to create serious issues in legally binding elections.

Examples of worrying incidents in real elections in the US have been gathered by the Verified Voting Foundation's Election Incident Reporting System.

This study attempts to address the challenges faced by Uganda and other developing countries in the use of e-voting by proposing a strategy aimed at reducing the setup and operational costs for election process, increasing the potential for sustainability and creating an environment that will encourage the development of the ICT infrastructure.

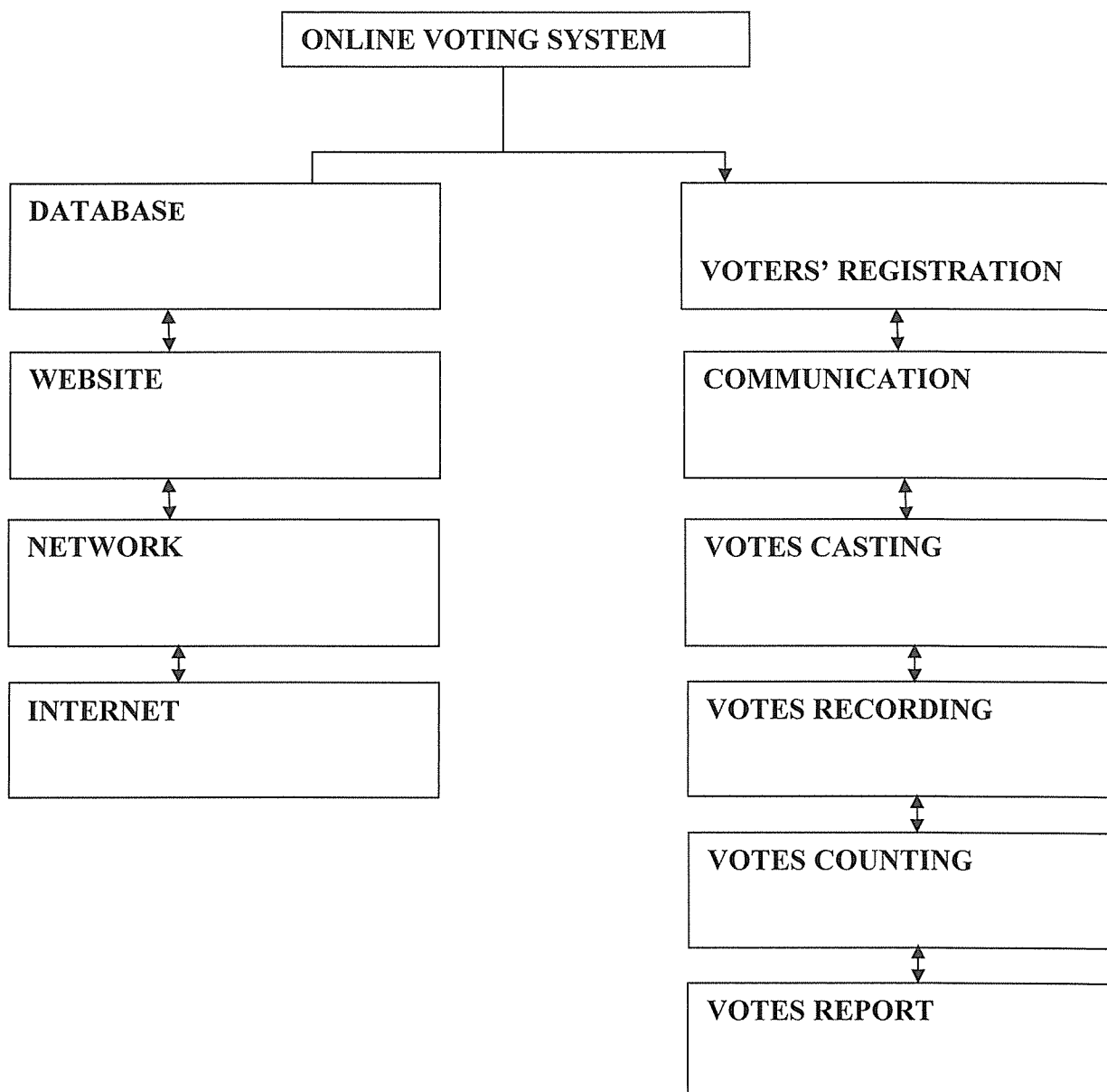


Fig.0 Conceptual Model for an online voting system.

Source: Morgan and Harnns (1986)

2.2.2 Theoretical perspective

This study is based on the open systems model which looks at an organization as a complex living organism which interacts with its environment. The organization is depicted as distinct and

separate from its external environment but with permeable and often ill-defined boundaries. It is a purposeful entity producing output which it exchanges with stake holders in its external environment in return for resources and support and so is dependent upon its environment.

In this study, our web based voting system will be an open system that will allow the system administrator to upgrade it when need be. Its components such as Database, web site, networks and internet will be independent so that in case of any upgrading task performed on a particular component will not affect the other. However, all these components will be interacting and work as a single system.

2.2.3 Related studies

ICT and Voting Process Management

Fujioka et al. (1992) pioneered the verifiability in e-voting protocols by forcing voters to involve more than one round. Voter has to participate in the counting stage by checking that his vote is listed correctly in the tallying list, and then sending a part of the vote in order to complete voting. In this protocol, verifiability is defined as “No one can falsify the result of the voting”.

Later, Sako et al. (1995) introduces the concept of universal verifiability to emphasize the importance of auditing of overall election by categorizing the verifiability as individual variability and universal verifiability.

Further e-voting studies apply this categorization. Sako et al. defines individual and universal verifiability respectively as “A sender can verify whether or not his message has reached its destination, but cannot determine if this is true for the other voters” and “In the course of the protocol the participants broadcast information that allows any voter or interested third party to at a later time verify that the election was performed properly”.

Cranor et al. (1997) makes the definition of universal verifiability narrow by limiting it as just counting the votes and defines verifiability as “Anyone can independently verify that all votes have been counted correctly”. Most of the later studies use this definition since it is much more specific and measurable.

He et al. (He 1998) and Riera et al. (Riera 1998) give a variant of the aforementioned definitions for verifiability. He et al. handles verifiability as “Every voter can make sure that his vote has been taken into account in the final tabulation”; and Riera et al. handles verifiability as “A system is verifiable if voters can independently verify that their votes have been counted correctly”.

Karlof et al. (2005) combines the verifiability definition without distinguishing universal or individual as follows: “Verifiably cast-as-intended means each voter should be able to verify his ballot accurately represents the vote he cast. Verifiably counted-as-cast means everyone should be able to verify that the final tally is an accurate count of the ballots.”

It is obvious that all the above studies left a knowledge gap in their researches. No one of the above authors talked about web based or online / Internet voting, where by a voter can cast his/her vote from anywhere he/she is without going to line up at the polling station. Therefore, this study intends to assess an existing voting system and integration of ICT in voting process in Uganda. Furthermore; the study will design and implement an online voting system for Uganda Electoral Commission that will facilitate Uganda citizens abroad and in the country to vote via Internet without going to line up at the polling stations.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter includes items like research design, research population, sample size, sampling procedures, research instruments, data gathering procedures, data analysis, system development methodology and tools and project plan schedule.

3.1 Research Design

The research design is the strategy used in the research to identify and isolate the most appropriate design for a study. This research used the descriptive correlation survey and expost-factor designs. It described the characteristic of respondents, and the relationship between the ICT and Voting Process Management. It was expost-factor because the researcher got the facts as they already existed in the field. It was a survey because it involved a big sample.

In data gathering both quantitative and qualitative approaches were considered. Both primary and secondly data were gathered. Primary data are responses retrieved from respondents whereas secondly data are from documents, report literature and related publications.

3.2 Research Population

The target population included a total number of one hundred sixty four (164) senior, middle, and lower staffs of Uganda's Electoral commission which is up to now operating in a traditional way. This is because; the three categories of staff are able to give complete and concrete information that can be used to determine requirements for the system under investigation. The research also targeted Electoral commission agents and voters in order to augment the information gathered from the target institution.

3.3 Sample size

As a number of population is big, a sample from the target population was taken. The Sloven's formula was used to determine the minimum sample size.

$$n = \frac{N}{1 + Na^2} = \frac{164}{1 + 164(0.05^2)} = 116$$

Where n = sample size, N = population and $\alpha = 0.05^2$ level of significance. From the population of 164 administrative staff, the researcher selected a minimum sample of 116.

3.4 Sampling Procedures

The purposive sampling were utilized to select the respondents based on these criteria:

1. Male or female respondents in any of the LC1 from five divisions in Kampala District.
2. EC staff and Agents with experience under ICT discipline ranging from one year and above.

From the list of qualified respondents chosen based on the inclusion criteria, the random sampling were used to finally select the respondents with consideration of the minimum sample size.

3.5 Research Instruments.

The research instruments included interview, questionnaires and observation. Interview can give information about policies, procedures and the prevailing situation in the organization. Some information may not be got from other methods, therefore we used interview. Interview can be approached by looking at different levels. Top management and lower cadre's levels. Interview may be structured or unstructured. Structured interviews include only questions you have planned and written out in advance. By sticking with this script, you can ask a number of people identical questions and compare their answers. In the other hand, unstructured interviews also include questions prepared in advance, but you can vary from the line of questions and pursue other subjects if it seems productive.

3.5.1 Questionnaires

Questionnaires are set of documents with questions that are sent out to respondents. Questionnaires are useful for getting information from large group of people when you cannot get around to interview everyone. Questionnaires may also yield more information if respondents can be anonymous. In addition, this tool is convenient, is inexpensive, and yields a lot of data.

3.5.2 Observation

Observation technique was used by the researchers to monitor obvious items of the system without applying interview or questionnaires methods. These led to the best conclusion of the whole situation within the Electoral Commission. Through observation, the researchers saw how

voters interact with EC agents (during by election exercises), how time of voting was not enough and how people in diasporas had no right of voting; etc. The observation was conducted secretly by the researchers as participant observers in order to get more insights by experiencing the conflicts and responsibilities of the people they were working with. We avoided making people to know that they were being observed, because they might falsify their behavior in some way.

3.6 Data Gathering Procedures

3.6.1 Before the administration of the questionnaires

1. An introduction letter was obtained from the College of Applied Science and Technology (CAST) for the researcher to solicit approval to conduct the study from respective administrative entities.
2. When approved, the researchers secured a list of the qualified respondents from the research areas' authorities in charge and selected through random sampling from this list to arrive at the minimum sample size (116 respondents).
3. The respondents were explained about the study and were requested to sign the informed Consent Form.
4. We reproduced more than enough questionnaires for distribution.
5. We selected research assistants who assisted in the data collection; briefed and oriented them in order to be consistent in administering the questionnaires.

3.6.2 During the administration of the questionnaires

1. The respondents were requested to answer completely and not to leave any part of the questionnaires unanswered.
2. The researchers and assistants emphasized retrieval of the questionnaires within five days from the date of distribution.
3. On retrieval, all returned questionnaires were checked if all were answered.

3.6.3 Ethical Considerations

To ensure confidentiality of the information provided by the respondents and to ascertain the practice of ethics in this study, the following activities were implemented by the researchers:

1. The respondents were coded instead of reflecting the names.
2. We solicit permission through a written request to the concerned officials of the administration entities included in the study.

3. We request the respondents to sign in the Informed Consent Form
4. We present the findings in a generalized manner.

3.7.8 Limitations of the Study

In view of the following threats to validity, the researchers claimed an allowable 5% margin of errors. Measures were also indicated in order to minimize if not to eradicate the threats to the validity of the findings of this study.

Extraneous variables which were beyond the researchers' control such as respondents' honesty, personal biases and uncontrolled setting of the study.

Instrumentation: The research instruments on ICT resources availability and utilization were not standardized. Therefore a validity and reliability test was done to produce a credible measurement of the research variables.

Testing: The use of research assistants could bring about inconsistency in the administration of the questionnaires in terms of time of administration, understanding of the items in the questionnaires and explanations given to the respondents. To minimize this threat, the research assistants were oriented and briefed on the procedures to be done in data collection.

CHAPTER FOUR

SYSTEM DESIGN AND IMPLEMENTATION

4.0 Introduction

This chapter explains the logical design, physical design developed by the researcher, entity relationship diagram, data flow diagram, the new design system, data input and findings from questionnaires and observation. The new system is designed to meet the needs of Electoral Commission as far as voters' registration and election results report are concerned. It is also designed to ensure accurate voters' record keeping and provide better services to voters. It will be expected to overcome the shortfalls associated with the current voting system that uses traditional manual methods to operate.

4.1 Old system weaknesses

The existing system uses traditional manual methods to operate. Voters line up at the polling station to be able to cast their votes. Sometimes; some voters do not go for vote because they do not like queuing. During votes counting, there is vote rigging due to the lack of secure system to control any kind of fraud. Ugandans in Diaspora do not have right to exercise their voting right because it is very hard for them to come for voting in the country

4.2 Expected values of the new system

In the light of the above system weaknesses, the researcher intends to design and implement an online voting system that is expected to improve efficiency in conducting the voting processes, hence saving time and money. Further, it has to ensure the preservation of the secret ballot, accuracy, privacy, integrity and proper tabulation of the voter's intent regardless of his or her voting right, and political preferences.

4.3 System requirements

4.3.1 User requirements

This involved the project developer identifying and analyzing the end-users' needs. Users describe the people who would use the system and these mainly were the EC staff and agents, voters, and other authorized persons. Requirements were what the intended users were required of the system that is, what requirement could be met for them to perform effectively.

4.3.2 Functional requirements

Functional requirements are statements of services the system should provide, how the system should react to a particular inputs and how the system should behave in a particular situation. In some cases, the functional requirements may also explicitly state what the system should not do.

4.3.3 System Development Methodology

The system was developed using the system development life cycle. During the planning phase, the researchers identified the scope and the boundary of the system and planned the development strategy and goals. In the analysis phase, the researchers studied and analyzed the problem, causes and effects of the new system and also analyzed the requirements that had to be fulfilled for the new system to be successful. The researchers then designed the new system and developed a prototype .In the implementation stage, the prototype was put in use and tested.

4.3.4 System Development Tools

This involved a collection of programs, routines and subroutines that facilitated programming and operation of the system, but also included documentation and operational procedures.A content management system “Joomla 1.5.26” was used to develop a system’s website and user interfaces. MYSQL server used to build a powerful database to store the information and handle the large number of voters. This is because MYSQL can be used in distributed computing, in a networked environment. The application operates on Windows7 ultimate and Windows server 2008 operating systems. This is because windows operating system is user friendly and widely used in many organizations. Windows Internet Explorer 8 was used as a web browser.Other requirements included RAM for Windows (2 GB), disk space at least 160 GB, printer, monitor. A dual core processor with at least 3GHZ was used to enable faster computation and allowed further investigations of new components into the application and run it.

4.3.5 Function needs of the system

The function needs of the system included online voters’ registration, vote casting, counting, storing and report.

4.4 System Design

System design is specification or construction of a technical, computer based solution for the business requirements identified in a system analysis. Whereas system analysis emphasizes the business problem, system design focuses on the technical or implementation concerns of the system. It is driven by the technical concerns of the system designer. System design is looked at from the three perspectives: Logical design, Physical design and Database design.

4.4.1 Logical Design

Logical design (logical models) depict what a system is or what a system must do but not how the system will be implemented. They are implementation independent that is they depict the system independent of any technical implementation.

Logical design is concerned with the conversion of logical records structures of a data model supported by a database management system identifying entities and their matching attributes and the relationship types determining the attributes domain. It involves the use of entity relations diagrams.

4.4.2 Entity Relationship Diagram

An entity relationship model is part of system development methodology that provides an understanding of the logical data requirement of a system independently of the systems' organization and process. It also reflects a static view of the relationship between different entities

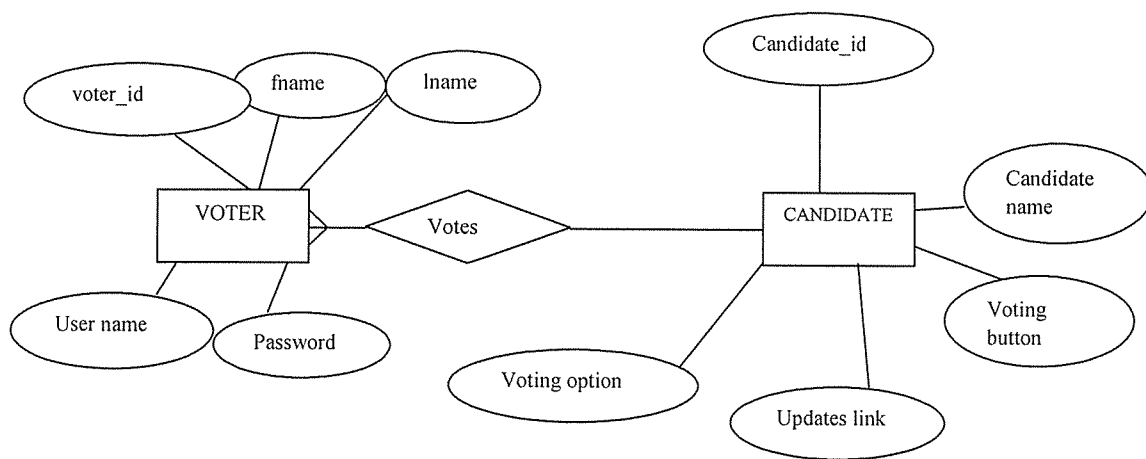


Figure 0. Entity Relation Diagram

From the above diagram, one candidate can be voted by many voters. From the above diagram the relationship between the voter table and candidate table is many to one.

4.4.3 Data flow Diagram

Data flow diagram is a tool that depicts the flow of data through a system and the work of processing performed by the system (Jeffrey and Whitten, 2001). It can also be described as a graphical modeling technique that models the sources and destination of data inputs and outputs and the data maintained by the information system. It's a graphic design that shows both how data flows to, from and within an information system and various processes that transforms the data.

The above flow chart shows how the voter interacts with the online voting system. When a voter casts the vote to the candidate the system enters the vote into the database and it displays the updated results.

4.4.4 Physical Design

Physical design (physical models) show how not only what a system is nor does, but also how the system is physically and technically implemented. They are implementation dependent because they reflect technology choices and limitations of those technology choices.

4.4.5 Database Design

Database design was the process of producing a detailed data model of the database. This logical data model contained all the needed logical and physical design choices and physical storage parameters needed to generate a design in a contents management system (Joomla), which was then used to create the database. Database design was the process of translating logical data models into physical database schemas. Data models are the standard way to show the complete picture of the data used and stored by the system. The designer used a Contents Management System (Joomla 1.5.26) and Wamp server 2.0 to come up with data model.

The design of the Online Voting System has been tailored to fulfill the objectives of the project. Section 4.1.4 looks at the design of the interface, section 4.1.5 looks at the Voters 'Registration form, 4.1.6 looks at Polling form, section 4.1.7 looks at Statistical votes results and 4.1.8 looks at Results updates form.

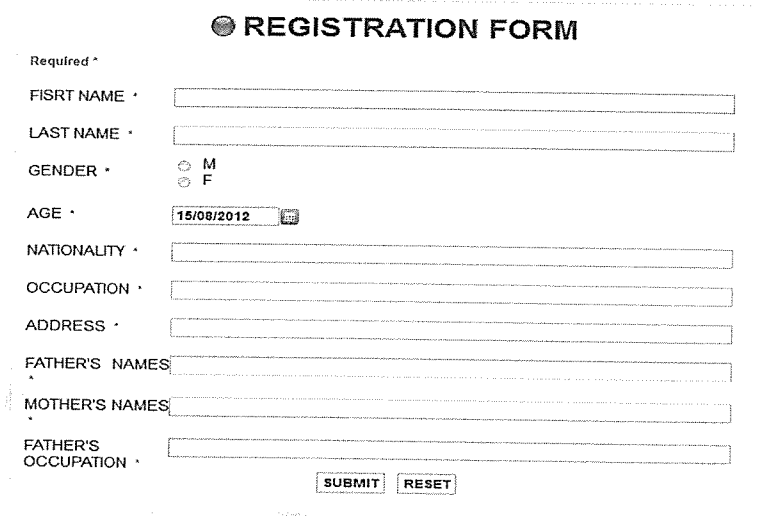
4.4.6 Login interfaces

A screenshot of a web application's login interface. At the top, the word "LOGIN" is displayed in a bold, sans-serif font. Below it, there are two input fields: "Username" and "Password", each with a small icon to its right. Under the password field is a "Remember Me" checkbox. Below these fields is a "Login" button. At the bottom of the interface, there are four links: "Forgot your password?", "Forgot your username?", and "Create an account".

Figure 2 shows Login interfaces

This is where the only registered voter has the right to login and view either the polling menu for voting or to view the election results.

4.4.7 Voters' registration form



The screenshot shows a web form titled "REGISTRATION FORM" with a "Required *" label. The form contains the following fields: "FIRST NAME" (text input), "LAST NAME" (text input), "GENDER" (radio buttons for "M" and "F"), "AGE" (text input with "15/08/2012" and a calendar icon), "NATIONALITY" (text input), "OCCUPATION" (text input), "ADDRESS" (text input), "FATHER'S NAME" (text input), "MOTHER'S NAME" (text input), and "FATHER'S OCCUPATION" (text input). At the bottom right are "SUBMIT" and "RESET" buttons.

Figure 3 shows voter's registration form

In order to get right for voting or viewing the election results updates, the voter has to fill the following form to get registered with the Online Voting System.

4.4.8 Polling form



The screenshot shows a web form titled "Cast Your Vote Now". It lists six candidates, each with a radio button for voting: "BESIGYE W. KIFEFE", "Y. K. MUSEVENI", "ABED BWANIKA", "BETTY NAMISANGO", "BIDANDI SSALI", and "KEN LUKYAMUZI". Below the list are "Vote" and "View details" links.

Figure 4 shows polling form

This is where the candidates' names appear with the option of voting by selecting the name of the candidate of your choice. To vote, you select a radio button behind the candidate's name. The polling frame is entitled "Cast your vote now".

4.4.9 Statistical votes results chat

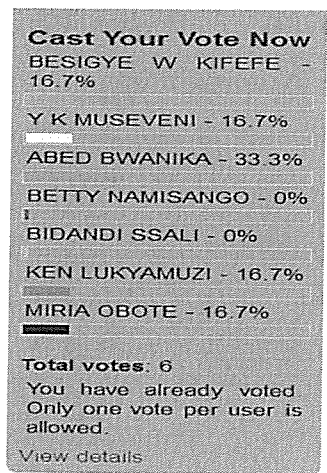


Figure 5 shows statistical vote's results chart

This is where the updated statistical election results will automatically appear after casting a vote, showing the name of candidates, the number of people that have voted so far and the number, percentage and graphical representation of the votes each candidate has got.

4.5 System Development

4.5.1 Introduction

This contains program testing, project implementation, user interfaces and system conversion. System implementation entails the construction of the new system and delivery of that system into production. Prior to system implementation, it's necessary to carry out training since it enables users to gain maximum benefits from the new system. Managers should learn that the system is capable of functioning to the benefits of the organization. Operators need training in how to interact with the new system.

4.5.2 System implementation.

To implement the system acquiring the installation of requirements e.g. hardware and software was needed. Planning analysis and project writing was done. The System was designed and users were trained on how to use the online voting system. System testing and review was also done to ensure that it was performing as it was designed to perform. It was reviewed to ensure that it has met the objectives The System was then implemented and a report was written. This scheme contains five main stages namely:

1. Registration
2. Creating an account
3. Login
4. Cast the vote
5. View the results

4.5.2.1 Registration

In order to get right for voting or viewing the election results updates, the voter has to fill the registration form to get registered with the Online Voting System.

4.5.2.2 Creating an account

In order to get the full right of login for voting or viewing the election results, each voter has to be with an account with the system. This is where you are authenticated to enable you vote once your details are identified. A voter's account is created by filling the appropriate form.

4.5.2.3 Login

This is where the only registered voter has the right to login and view either the polling menu for voting or to view the election results. The login form prompts the voter to enter the online voting system.

4.5.2.4 Cast the vote

After the voter has registered and logged in, a list of candidates appears. This where the candidates' names appear with the option of voting by selecting the name of the candidate of your choice. To vote, you select a radio button behind the candidate's name. The poling frame is entitled "Cast your vote now".

4.5.2.5 View the results

After casting a vote the updated statistical election results will automatically appear, showing the name of candidates, the number of people that have voted so far and the number, percentage and graphical representation of the votes each candidate has got.

4.6 Components of the Online Voting System

4.6.1 Online Voting System Home Page

This is the welcome screen for voters. It shows information about the Electoral Commission. The voters read carefully the information from this Home Page before they login for voting or viewing the election results updates.

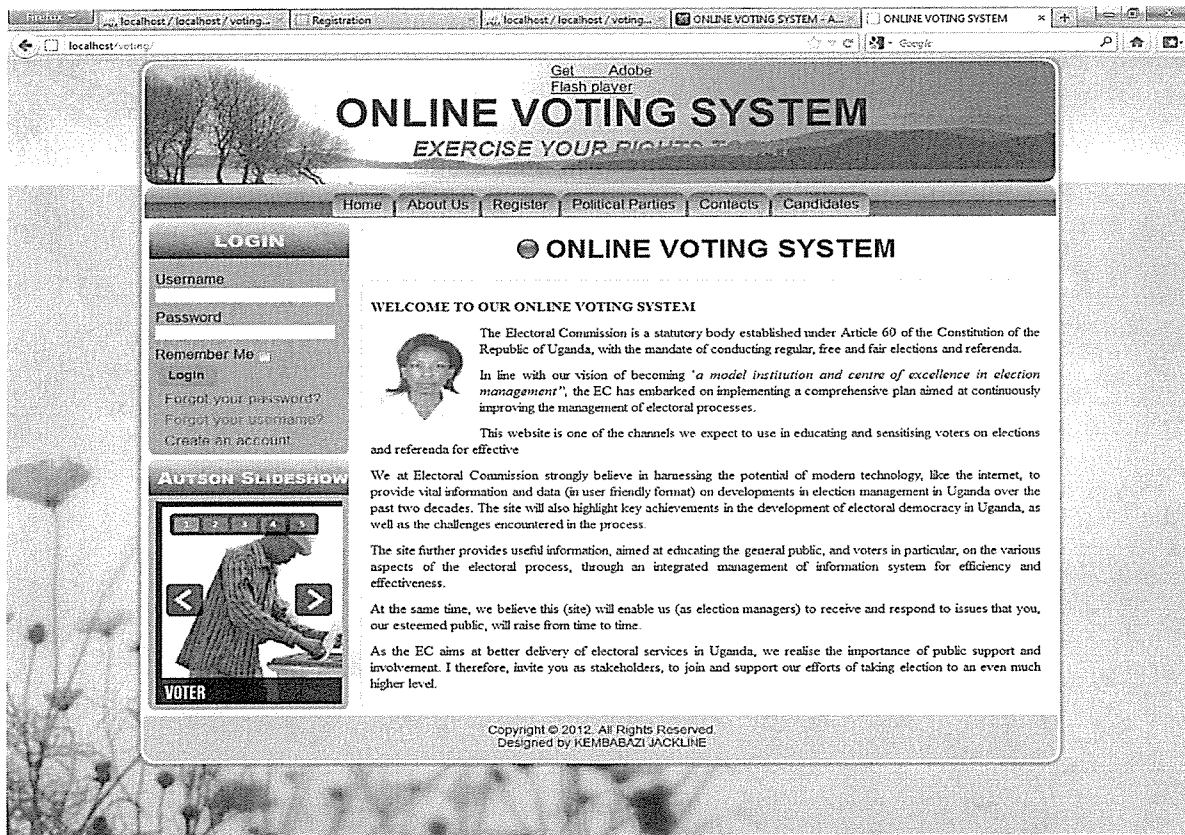


Figure 6 shows the home page of online voting system web site

4.6.2 Registration Form

In order to get right for voting or viewing the election results updates, the voter has to fill the following form to get registered with the Online Voting System.

Figure 7 shows voter's registration form

4.6.3 Login Frame

This is where the only registered voter has the right to login and view either the polling menu for voting or to view the election results.

Figure 8 shows voter's login frame

4.6.4 Voter's account

In order to get the full right of login for voting or viewing the election results, each voter has to be with an account with the system. This is where you are authenticated to enable you vote once your details are identified. A voter's account is created by filling the form below:

The screenshot shows a web browser window displaying the 'ONLINE VOTING SYSTEM' registration page. The page has a header with the system name and a navigation menu. The main content area is divided into a 'LOGIN' section on the left and a 'REGISTRATION' section on the right. The 'REGISTRATION' section contains a form with fields for Name, Username, E-mail, Password, and Verify Password. A 'Register' button is located below the form. The footer includes copyright information for 2012 and the designer's name, KEMBABAZI JACKLINE.

Get Adobe Flash player

ONLINE VOTING SYSTEM

EXERCISE YOUR RIGHTS TO VOTE

Home About Us Register Political Parties Contacts Candidates

LOGIN

Username:

Password:

Remember Me ☐

Login

Forgot your password?

Forgot your username?

Create an account

REGISTRATION

Name:

Username:

E-mail:

Password:

Verify Password:

Fields marked with an asterisk (*) are required.

Register

AUTSON SLIDESHOW

1 2 3 4 5

< >

VOTER

Copyright © 2012. All Rights Reserved
Designed by KEMBABAZI JACKLINE

http://localhost/voting/index.php?option=com_user&view=register

Figure 9 shows voter's account opening form

4.6.5 Polling Frame

This is where the candidates' names appear with the option of voting by selecting the name of the candidate of your choice. To vote, you select a radio button behind the candidate's name. The polling frame is entitled "Cast your vote now".

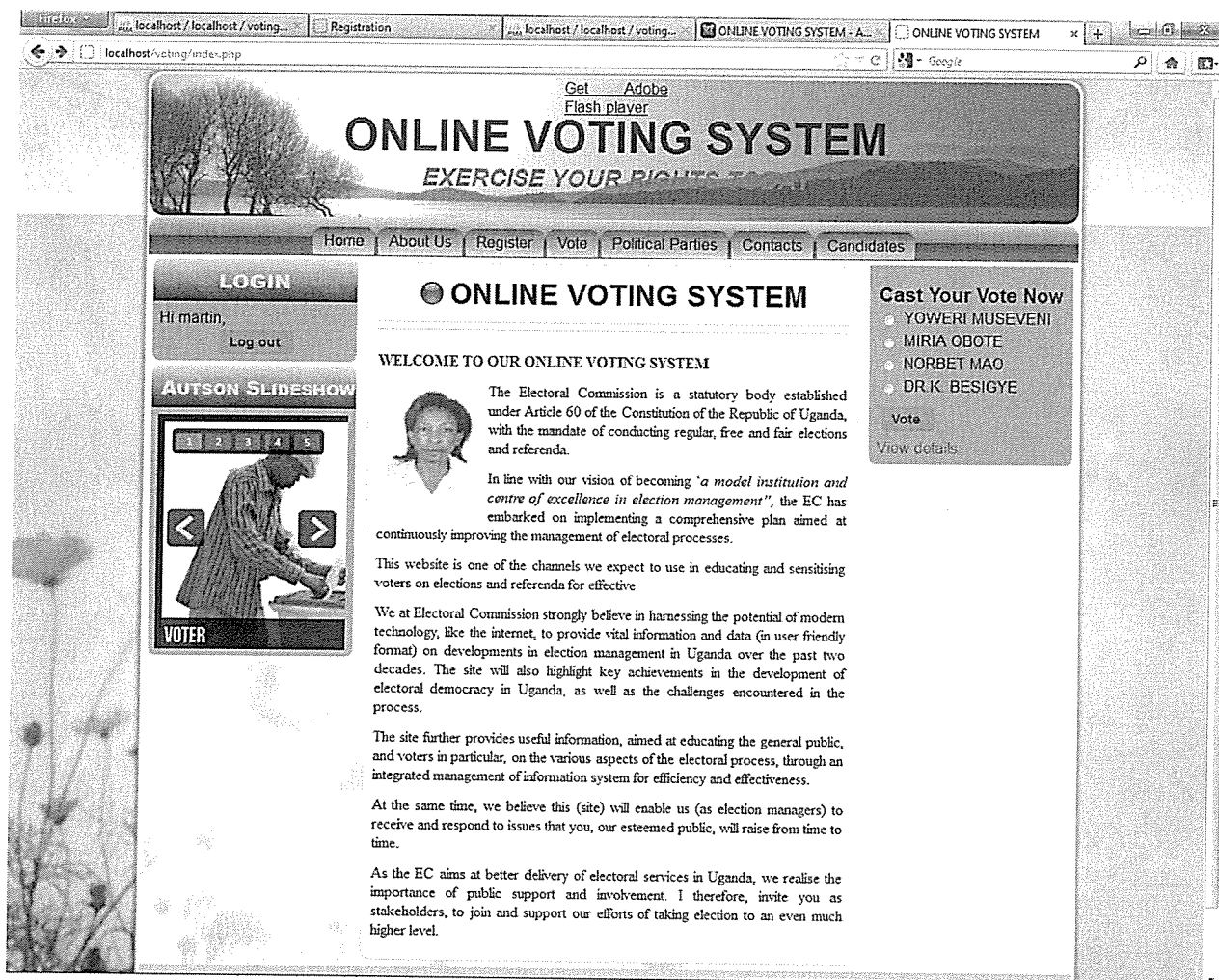


Figure 10 shows polling frame

4.6.6 Candidates' Frame

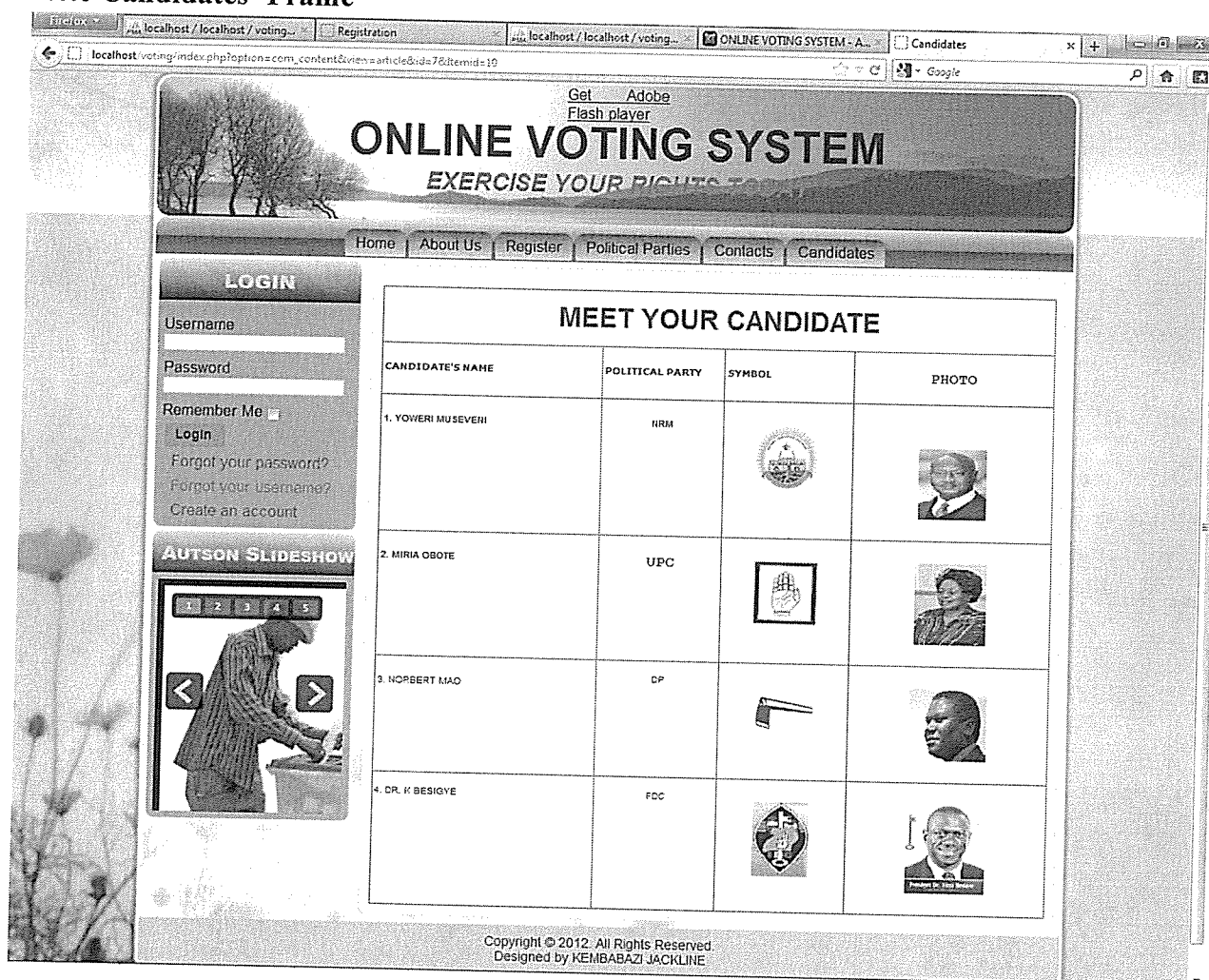


Fig 11 shows the candidates frame

4.6.7 Database

The database stores the users and voters' identification, candidates' identification and votes. The database for this project was created by the use of Joomla 1.5.26 and wamp server 2.0. The database and some tables' figures are shown in the appendices.

4.6.8 Findings

The research undertaken under the defined aim and objectives of this project gave the following findings:

- Security has been for a long time a major concern for computing systems and more so with the advent of the distributed networked system. Viruses, worms and hackers have

given the greatest challenge to the system security personnel as they strive to cover all loopholes into their systems.

- Authentication is also of the big challenge since one person may register for more than once using different names in this system prototype. During the system real life implementation, the finger print control system will be thought about.
- The preservation of the secret ballot, accuracy, privacy, integrity and proper tabulation of the voter's intent were given a great value in this system's design. The voter casts his/her vote secretly, no one can change the votes, no one can vote more than once and a voter as long as he/she is registered with the system has a right to come, login and review the election updates as the voting process is going on.
- The polling exercise is scheduled in a way that the beginning and the end of the voting process is specified so, anyone who comes before or after the appropriate time will not be allowed to vote.

5. System conversion

System conversion which is also called system change over, takes place upon the approval of the system testing. The parallel method of conversion from the current system to the new system was selected as the most appropriate for the current scenario.

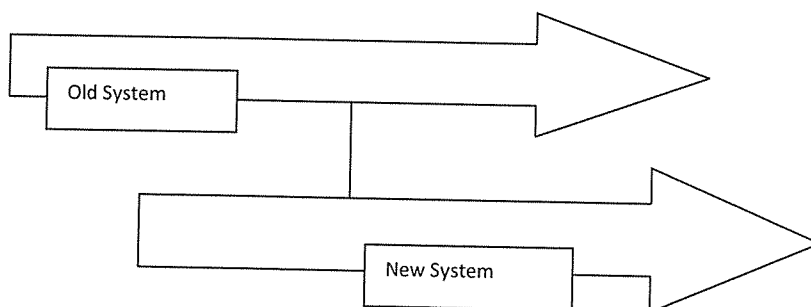


Figure 12: illustration of system conversion.

The above figure shows how the system's change over takes place. Both the new and old systems are used concurrently. This allows the users to learn how to use the new system and also the system's performance is monitored.

CHAPTER FIVE

SUMMARY, EVALUATION, CONCLUSION, AND RECOMMENDATIONS

5.0 Introduction

This chapter explains the evaluation, recommendation and conclusion arrived at by the researcher.

5.1 Summary

I have designed an Online Voting System that offers three different types of authentication measures. This indeed enables voter details anonymous makes it reliable and safe for individual during voting. The login page offers the first level of security offered by this system by making sure that only authorized user gets access to the poll results thus avoids rigging.

The use of Contents Management System (Joomla) and Mysql language has broadened my website construction and my programming and problem solving skills as well.

However, the project was characterized with a number of challenges and experiences. This among others included the limited resources especially implementation of the system on a virtual server, software, hardware, money, and time.

The methodology utilized entailed visiting websites and reviewing existing literature on the area of research.

5.2 Evaluation of the new system.

The new online voting system if implemented will achieve the following: the information system will control data redundancy in the electoral commission database thus improving performance. No vote rigging, no ghost voters. Also the system will ensure data integrity within the electoral commission since there will be only one single storage area of data (only E. C. database, no ballots at the polling stations).

The online voting system will increase efficiency and effectiveness in its operations, making it stand at the democratic environment. For instance, the system will permit only registered voters into the database to cast their votes. To make sure that this is accomplished; the system will validate the voter's user name and password.

Once a voter has cast his/her vote, he/ she will not be prompted to vote any more. However, the system will permit the voters to login in order to view the updated election results in a statistical way, but the system will not show the polling form to anyone who will have already voted.

Although the new system achieved the above performances it has some Limitations.

1. During the use of this application, only voters with some computer knowledge will enjoy this modernized voting process. Also, one is likely to forget his/her user name or password and hence not get access to the application.

2. The system has no algorithm that can be able to filter or identify different categories of voters, for instance, identify already registered voters from the non registered ones so that no one can register more than once using different names.

5.3 Conclusion

It has been proved that this online voting system achieves efficiency in conducting the voting processes, hence saving time and money. Further, it ensures the preservation of the secret ballot, accuracy, privacy, integrity and proper tabulation of the voter's intent regardless of his or her voting right, and political preferences even with the flaws that still need to be addressed. The major area in this project for further research would be, an algorithm that can be able to filter or identify different categories of voters, for instance, identify already registered voters from the not registered ones so that no one can register more than once using different names.

5.4 Recommendations

Much as the system is ready for use, the author feels that more work can be done to make it interactive. This work includes:

More research could be carried out to find out an algorithm that can be able to filter or identify different categories of voters, for instance, identify already registered voters from the not registered ones so that no one can register more than once using different names.

I recommend that an authenticated system is implemented alongside other security implementations such as firewalls, anti-virus software, spy ware, and physical security like security guards.

REFERENCES

1. Aronson E, (2001) Decision Support Systems And Intelligent Systems Pearson Education Inc. India
2. Case J, Bradely A, Millspaugh C (2000) Programming in Visual Basic 6.0. McGraw-Hill. New York.
3. Charles W. (2000).Electronic Voting .
4. Cranor *et al.* (Cranor 1997). Verification and Validation Issues in Electronic Voting. Computer Engineering, METU, Ankara, Turkey.
5. David Flanagan, (1997) Java in A Nutshell. O'Reilly and Associates Inc. United States of America.
6. David F. (2000).Electronic Voting Literature Review
- 7.D. Chaum (2002). Untraceable Electronic Mail, Return Addresses, and Digital Pseudonyms. <http://www.vreceipt.com/article.pdf>
8. Dr Corina Sas (2004). Public Voting System. n.day@lancaster.ac.uk
9. Dr. Michael Shamos (2002).Electronic voting - Evaluating the Threat, 2002. Maryland 21218, USA
- 10.Fujioka 1992) , Verification and Validation Issues in Electronic Voting. Institute of Applied Mathematics, METU, Ankara, Turkey.
- 11.He et al. (He 1998). Verification and Validation Issues in Electronic Voting. Institute of Applied Mathematics, METU, Ankara, Turkey.
- 12.Henry Lucas (1997).Introduction to Information Systems.California University.
- 13.Hoffer J,George F. and Valancith (2005) Modern system analysis and design, Benjamin/cummings Masachusetts.
- 14.James A. O' Brien (2003); Essential for E-business Enterprise, 11th edition, College of Business Administration, Northern Arizona University.
- 15.Jamie B. (2003), E-voting System: Specification and Design Document. Carl Steinebach, 2003
16. Jung-Ying Lai (2003), Design and Implementation of an Electronic Voting System with Contactless IC Cards, Institute of Information and Computer Education, National Kaohsiung Normal University, bukokoro@gmail.com
17. Kenneth C. Laudon Jane Laudon (2001); Essential of Management Information Systems, organization and technology in the networked enterprises, 4th edition, New York University.
18. Kenneth C. Laudon Jane Laudon (2003); Essential of Management Information Systems, Managing Digital firm,5th edition, New York University.
- 19.KYANDA SWAIB KAAWAASE (2004). A web-based voter registration tool. Makerere University.
20. Mercuri (2000).Electronic Journal of e-Government Volume 5 Issue 2 2007 (117-126).
- 21.Sako et al. (Sako 1995). Verification and Validation Issues in Electronic Voting. Computer Engineering, METU, Ankara, Turkey.
- 22.Stephen Coleman (2001). Information Communication Technology. Oxford, UK.
- 23.TADAYOSHI KOHNO (2003). Analysis of an Electronic Voting System. University of California at San Diego.
24. Jeffrey Whittin, Lonnie .D Bentley, Kevin C Dittman (2000) System Analysis And Design

Methods. McGraw- Hill. New York.

25. John Edwards, Sage Software (2006) [http://itconsulting.com/interviews/sfa-trends-chrisreich-12\(2006\)](http://itconsulting.com/interviews/sfa-trends-chrisreich-12(2006))

26. Ramachandra, T.m Nambissan, (1995) Computerized Business Application. Suned Golgotia. India

APPENDICES

Appendix I

STUDY QUESTIONNAIRE FOR ELECTORAL COMMISSION STAFF, AGENTS AND VOTERS

TOPIC: Voting System for Electoral Commission.

This questionnaire is seeking information on the voting system of Electoral Commission. The information you will provide will be treated with the highest level of confidentiality. You are kindly asked to fill the form below appropriately.

Guidelines: Put a tick in the appropriate box.

☒

Objective: design a database to record the votes and keep voters' information.

Question1

(a) Do the employees of the Electoral Commission store votes and voters' information on a database?

Yes

☐

No

☐

(b) What do you think about a database being developed to be used for storing votes and voters' information?

It's necessary

☒ y

Not necessary

☐

I don't know

☐

Objective: computerize and automate the voting process of the Electoral Commission.

Question 2

(a) Is the voting process computerized in Uganda?

Yes

☐

No

☒ N

(b) What do you think about computerizing voting process in Uganda?

It's necessary

☒

Not necessary

☐

I don't know

☐

(c) Can election process be carried out via Internet in Uganda?

Yes

☐

No

☒

(d) What do you think about design and implementation of an online voting system in Uganda?

It's necessary

☒

Not necessary

☐

I don't know

☐

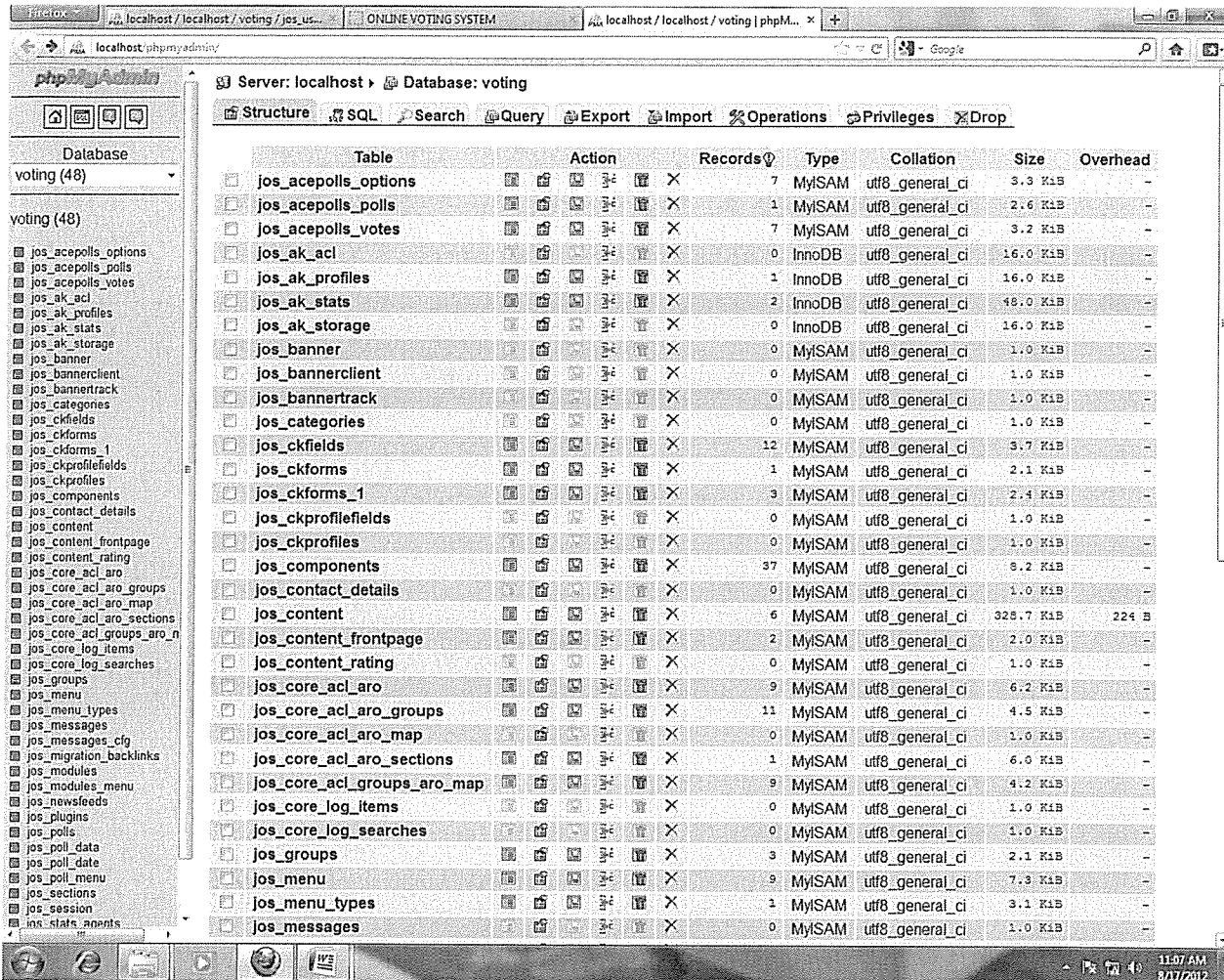
OBSERVATION CHECKLIST

Checklist for observing employees and polling agents performing their duties at Electoral Commission

1. Were the employees using a database to store votes and voters information? If yes what kind of database and which database management system were they using?
 2. Which kind of system were they using? Was it manual or computerized? Was the current system efficient?
 3. Were the employees efficient while doing their job? How long did it take to serve one voter?
 4. Approximately how many voters can cast their votes per hour?
 5. Were the votes and voters' information records organized so that it enables easy retrieval or votes counting?
 6. Approximately how long does it take to come up with election results report after voting?
 7. Do Ugandans in diaspora vote? If yes, how do they vote?
- If no, what do you suggest to facilitate them for voting?

Appendix III

Online voting system Database as made by Joomla contents management system



The screenshot shows the phpMyAdmin interface for a database named 'voting'. The left sidebar lists the database structure, and the main area displays a table of database tables with their respective actions, record counts, types, collations, sizes, and overheads.

Table	Action	Records	Type	Collation	Size	Overhead
josepolls_options		7	MyISAM	utf8_general_ci	3.3 KIB	-
josepolls_polls		1	MyISAM	utf8_general_ci	2.6 KIB	-
josepolls_votes		7	MyISAM	utf8_general_ci	3.2 KIB	-
josepolls_acl		0	InnoDB	utf8_general_ci	16.0 KIB	-
josepolls_profiles		1	InnoDB	utf8_general_ci	16.0 KIB	-
josepolls_stats		2	InnoDB	utf8_general_ci	18.0 KIB	-
josepolls_storage		0	InnoDB	utf8_general_ci	16.0 KIB	-
josepolls_banner		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_bannerclient		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_bannertrack		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_categories		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_ckfields		12	MyISAM	utf8_general_ci	3.7 KIB	-
josepolls_ckforms		1	MyISAM	utf8_general_ci	2.1 KIB	-
josepolls_ckforms_1		3	MyISAM	utf8_general_ci	2.4 KIB	-
josepolls_ckprofilefields		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_ckprofiles		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_components		37	MyISAM	utf8_general_ci	8.2 KIB	-
josepolls_contact_details		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_content		6	MyISAM	utf8_general_ci	328.7 KIB	224 B
josepolls_content_frontpage		2	MyISAM	utf8_general_ci	2.0 KIB	-
josepolls_content_rating		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_core_acl_aro		9	MyISAM	utf8_general_ci	6.2 KIB	-
josepolls_core_acl_aro_groups		11	MyISAM	utf8_general_ci	4.5 KIB	-
josepolls_core_acl_aro_map		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_core_acl_aro_sections		1	MyISAM	utf8_general_ci	6.0 KIB	-
josepolls_core_acl_groups_aro_map		9	MyISAM	utf8_general_ci	4.2 KIB	-
josepolls_core_log_items		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_core_log_searches		0	MyISAM	utf8_general_ci	1.0 KIB	-
josepolls_groups		3	MyISAM	utf8_general_ci	2.1 KIB	-
josepolls_menu		9	MyISAM	utf8_general_ci	7.3 KIB	-
josepolls_menu_types		1	MyISAM	utf8_general_ci	3.1 KIB	-
josepolls_messages		0	MyISAM	utf8_general_ci	1.0 KIB	-

Figure 13 shows Online voting system Database as made by Joomla contents management system.

(Joomla basically provides a framework for your content. You manage it through a GUI in a web browser, so you don't have to ever see the php/css/whatever of your pages.)

Appendix IV

Users table

Server: localhost Database: voting Table: jos_users

Showing rows 0 - 8 (9 total, Query took 0.0004 sec)

SQL query:

```
SELECT *
FROM jos_users
LIMIT 0, 30
```

Query results operations

Print view Print view (with full texts) Export

Show: 30 row(s) starting from record # 0

in horizontal mode and repeat headers after 100 cells

Sort by key: None Go

	id	name	username	email	password
☐	62	Administrator	admin	havuga@gmail.com	f8957ccfaa538f90e3ee3f6b2d313013.99wTU02bp0B5qkM0k...
☐	63	KEMBABAZI	JACKLINE	kembajackline@yahoo.com	581617f871485d2875046784b1e7af28:1X0wpr53dIAjqtAZy...
☐	64	MUWUMUZA	JUSTUS	justo@yahoo.com	e54a4fa681a5896460d6db1543e6c279.KS7deCEuZW5dm1nc...
☐	65	KATO	EMMA	emma@yahoo.com	5578b38943e3035696e2462c7066d983.7yRicBaTR4GVmKM...
☐	66	WINNIE	NATUKUNDA	natu@yahoo.com	7ffdc1626f3369f4c4bab6c6fa3a42bf.5RrjLzZpq00p1xTg...
☐	67	GEREVAZ	HABUMUGISHA	habagervais@gmail.com	c9e003bef165ec8dbaa1c821b15d6185.chDuhNoFIKTrkcvhX...
☐	68	NKURUNZIZA	INNOCENT	innocent@yahoo.com	729d8aeb946088b8f6736016f148f6a7.yoMh2VOE4oIB8Hf2k...
☐	69	KAMAU	JOHN	john@yahoo.com	77ba8aadb40257aa16d9c9829f096ca2.E9As9Z6q1nlcq8e7b...
☐	70	BERNARD	BEN	ben@yahoo.com	4789af23b9d56cf71862c6269367521b:XQOJLF5iomJl1401C...

Check All / Uncheck All With selected: ☐ ☐

Figure 14 shows the users table. The users' passwords are encrypted.

Appendix V

Votes table

The screenshot shows the phpMyAdmin interface for a database named 'joe_acepolls_votes'. The table 'joe_acepolls_votes' is selected, and the SQL query 'SELECT * FROM joe_acepolls_votes LIMIT 0, 30' is executed. The results show 7 rows of data.

	id	date	option_id	poll_id	ip	user_id
☐	1	2012-08-09 14:35:06	7	1	2130706433	63
☐	2	2012-08-10 15:10:20	3	1	2130706433	65
☐	3	2012-08-11 11:37:55	3	1	2130706433	66
☐	4	2012-08-13 14:17:59	6	1	2130706433	67
☐	5	2012-08-14 12:16:16	2	1	2130706433	68
☐	6	2012-08-15 11:20:45	1	1	2130706433	69
☐	7	2012-08-15 12:10:11	6	1	2130706433	70

Figure 15 shows the votes table

Appendix VI

Registration table

The screenshot shows a web browser window displaying a database interface for an "ONLINE VOTING SYSTEM". The interface is for the "voting (48)" database. The SQL query executed is:

```
SELECT *
FROM jos_ckfields
LIMIT 0, 30
```

The query results are displayed in a table with 12 rows and 10 columns. The columns are: ☐, ☐, ☐, ☐, ☐, ☐, ☐, ☐, ☐, ☐, **id**, **fid**, **name**, **label**, **typefield**, **defaultvalue**, **mandatory**, and **test**.

☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	id	fid	name	label	typefield	defaultvalue	mandatory	test
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	1	1	FIRSTNAME	FIRST NAME	text	t_initvalueT===[-]t_maxchar===25[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	2	1	LASTNAME	LAST NAME	text	t_initvalueT===[-]t_maxchar===25[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	3	1	GENDER	GENDER	radiobutton	t_listHRB===optrb0==M M -]optrb1==F F[-]t_displ...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	4	1	AGE	AGE	text	t_initvalueT===[-]t_maxchar===[-]t_texttype===da...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	5	1	ADDRESS	ADDRESS	text	t_initvalueT===[-]t_maxchar===50[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	6	1	FATHERNAMES	FATHER'S NAMES	text	t_initvalueT===[-]t_maxchar===50[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	7	1	MATHER	MOTHER'S NAMES	text	t_initvalueT===[-]t_maxchar===50[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	8	1	OCCUPATION	FATHER'S OCCUPATION	text	t_initvalueT===[-]t_maxchar===50[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	9	1	OCCUPATION	OCCUPATION	text	t_initvalueT===[-]t_maxchar===50[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	10	1	NATIONALITY	NATIONALITY	text	t_initvalueT===[-]t_maxchar===25[-]t_texttype===...	1	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	11	1	SUBMIT	SUBMIT	button	t_typeBT===submit	0	
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	12	1	RESET	RESET	button	t_typeBT===reset	0	

The interface also includes a sidebar with a list of database tables and a bottom status bar showing the time as 11:32 AM on 8/17/2012.

Figure 16 show the voters' registration table

Appendix VII

Poll menu table

Server: localhost Database: voting Table: jos_poll_data

Showing rows 0 - 11 (12 total, Query took 0.0004 sec)

SQL query:

```
SELECT *
FROM jos_poll_data
LIMIT 0, 30
```

Query results operations:

Print view Print view (with full texts) Export

Show: 30 row(s) starting from record # 0 in horizontal mode and repeat headers after 100 cells

Sort by key: None Go

	id	pollid	text	hits
☐	1	1	YOWERI KAGUTA MUSEVENI	1
☐	2	1	BESIGYE WARREN KIFEFE	4
☐	3	1	BETTY OLIVE NAMISANGO KAMYO	3
☐	4	1		0
☐	5	1		0
☐	6	1		0
☐	7	1		0
☐	8	1		0
☐	9	1		0
☐	10	1		0
☐	11	1		0
☐	12	1		0

Check All / Uncheck All With selected: ☐ ☐ ☐

Show: 30 row(s) starting from record # 0 in horizontal mode and repeat headers after 100 cells

http://localhost/phpmyadmin/sql.php?db=voting&table=jos_poll_data&goto=tbl_sql.php&dontlimitchars=0&checkall=1

11:13 AM 8/11/2012

Figure 17 shows the poll menu table