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Conceptual Design of E-Voting System for Academic Institution

Samuel Chris Quist, LEONARD KWASHIE AMEGATSE, Dilys Dickson
Regent University College of Science and Technology,
Ghana

Abstract

Voting or casting of lots has become the main method of selecting individuals for a vacant position. There have been several methods of voting practiced over the years, ranging from raising of hand, using ballot papers, and even using pebbles as in the typical case of the Republic of Gambia. It is on this premise that this study was embarked upon to design and implement an effective Online Voting System for Academic Institutions. The concept has been implemented for the Regent University College of Science and Technology in Ghana. The results showed that the online system was outstanding with real-time results of the voting process and easy administrative management. The users of the system which involved students as well as some electoral supervisors realized the online voting system was a better, effective and more efficient way of voting in the school as compared to the paper balloting method of voting. The concept could be extended to all Institutions or organization's election once the electorates can be identified with unique Identification Numbers. It is recommended that further research and implementation should be conducted to include functionalities or features to enable the visually impaired individuals vote.

Keywords: Online Voting; Ballot; Academic Institution; Election

1. Introduction

A voting system or an electoral system is a method by which voters make a choice between options, often in an election or on a policy referendum. A manually counted paper ballot is the most commonly used method of voting around the world today. The system arose because of a desire for secrecy. Initially, voters wrote a name on a slip of paper, which they placed in a locked box. The word "ballot" is derived from the Italian word ballotta, which means "little ball" (Gill, 2011). The paper ballot system employs uniform official ballots of various stock weights on which the names of all candidates and issues are printed. Voters record their choices, in private, by marking the boxes next to the candidate or issue choice they select and drop the voted ballot in a sealed ballot box. As of 1996, paper ballots were still used by 1.7% of the registered voters in the United States. They are used as the primary voting system in small communities and rural areas, and quite often for absentee balloting in other jurisdictions (Bellis, 2010).

1.1 Background of Implemented Institution

Regent University College as institution runs the parliamentary system of government. Its Parliament is characterized by a unique representational structure being the first ever to be adapted by the institution in

the country. This system features fusion of powers, where the head of the students governing body is the head of the students' legislative body being the Executive and the Parliament respectively. The Executive is made up of three elected members, one running mate whom the speaker-aspirant files as part of his/her nominations (for the position of Deputy Speaker) and three appointed members by the Speaker in consultation with the Executive who are listed below:

- The Speaker of Parliament (Elected).
- The Deputy Speaker of Parliament.
- The Clerk to Parliament (Elected)
- The Deputy Clerk (General Services)
- The Head of Finance and Planning
- The Women's Commission (Elected)
- The Deputy Clerk to Parliament (Public Relations and Events)

The Societies (Equivalent to halls of residence in other Institutions), being the sub-communities or constituencies within the University community presents four elected members to Parliament as Members of Parliament, and the Heads of Societies (Governors) to serve as Parliamentary Chief and whips. Elections are organized by the Electoral Commission of the school every year to elect new leaders of Parliament (Seidu, 2008). Voting of leaders has been manually operated; where students queued for a very long time to vote for leaders of their choice.

2. Literature Review

A voting system or electoral system is a method by which voters make a choice between options, often in an election or on a policy referendum. A voting system enforces rules to ensure valid voting, and how votes are counted and aggregated to yield a final result. Common voting systems are majority rule, proportional representation or plurality voting with a number of variations and methods such as first-past-the-post or preferential voting. The study of formally defined voting systems is called social choice theory or voting theory, a subfield of political science, economics, or mathematics.

With the proportional representation system several members of parliament are to be elected per constituency. Basically every political party presents a list of candidates and voters can select a list that is they vote for a political party. Parties are assigned parliamentary seats proportionally to the number of votes they get.

2.1 The Gambian Voting System

The Gambians in conducting their elections through a unique voting system that was introduced in the early 1960's to address the high levels of illiteracy in the country.

This system is based on the use of tokens (clear-glass marbles) to be cast in separate iron-made drums (which serve as a ballot box) for each individual party/candidate. Each party/candidate competing in an election has a drum painted with its own identifying colours and their party symbol or photograph (Fig. 1). On Election Day, at the polling station, drums are placed behind the polling booth. Voters, after being issued a marble, proceed to the polling booth to vote. When a marble is introduced in the drum of the

selected party/candidate, by falling, it hits a bell whose sound clearly indicates to the audience in the polling station that a vote was cast. To prevent hearing other sounds, when sealing the drum, polling officers place sand or sawdust into its bottom. It is also interesting to highlight that, since the sound is like a bell, on Election Day bicycles are banned from the immediate proximity of polling stations. After the voting process has ended, votes are counted by placing the marbles into special trays (with either 200 or 500 holes), a simple system that allows counting officials to quickly ascertain the number of votes cast in each drum. The main, obvious, advantages of this unique voting system are that it is simple, affordable and locally-owned. Gambian voters are well acquainted with, and it is reputedly difficult to rig (Riley, 2007).

Figure 1: The Voting process in Gambia

2.2 Types of Electronic Voting

2.2.1 Kiosk Voting

This involves the use of dedicated voting machines in polling stations or other controlled locations. Voters mark their choice electronically (perhaps on touch sensitive screen) rather than on paper ballot. The votes are counted on individual machines, known as Direct Recording Electronic (DRE) machines, and the votes cast are transferred to the central tallying point by unspecified means. A ballot paper can be printed and retained in confidence in a ballot box as an additional check (Magi, 2007).

2.2.2 Internet Voting (i-voting)

This is a specific case of remote electronic voting, whereby the vote takes place over the Internet such as via a web site or voting applet. Sometimes also used synonymously with Remote Electronic Voting. In this project, the term e-voting is used with the specific meaning of Internet voting (Magi, 2007).

The Internet voting system was used in the national referendum in Geneva canton of Switzerland in 2004. In Switzerland, elections or referendums are held four or five times a year. There are 580.000 Swiss citizens living abroad, to compare with 7 million inhabitants in the country. It is important to provide them with an efficient and simple voting system. Approximately 52% of the Swiss population has Internet access, both at home and at the workplace. For all these reasons, the governments, both in Geneva and at

the Federal level have decided to develop Internet-voting solutions. The voting cards were sent to voters a few weeks before the voting day. The voting cards were smartcards with private keys validated by a local Public Key Infrastructure service provider. The voting cards were valid for voting operation only. Voters made their choices and confirmed these with the private keys and personal data (date of birth and place of birth). The votes were encrypted in the voting servers by using special public voting keys. The voting system separated voters' personal data and ballots to guarantee the principle of voting privacy. The political parties, in order to check democracy of the votes delivering process, share the keys for triggering votes' counting process. By the polling of 2003, the 73% of the Swiss population support online Internet voting. However, the Internet voting system has been applied only in referendums. More than 80% of the voters want the system to be implemented for the elections too.

In 2003, Estonia initiated the project of e-voting. The aim was to implement e-voting in the elections of the local government councils in 2005. In January 2004, a group of American security experts revealed the security report of Secure Electronic Registration and Voting Experiment (SERVE). The SERVE system was planned for deployment in the 2004 primary and general elections and allows eligible voters to vote electronically via Internet. Secure Electronic Registration and Voting Experiment (SERVE) was developed for primary and general elections in 2004.The SERVE system would have allowed the eligible voters to vote via Internet (Jefferson, Rubin, Simons & Wagner, 2004). The eligible voters of SERVE were mainly overseas voters and military personnel. The target group was 6 million voters. The US Department of Defense terminated the SERVE project in the beginning of year 2004 because a group of security experts had found that the SERVE system was not sufficiently secure. The projects of the kiosk voting systems have been more successful in the USA. In these systems, like in the paper-based elections, a voter goes to one's home precinct and proves that he/she has a permission to vote there by presenting one's identity card. After that, PINs, smartcards, or some other tokens for authentication are given to voters. Having a token, a voter is able to cast a vote by using a direct recording electronic machine (Kohno, Stubblefield, Rubin & Wallach, 2004). A public opinion poll held in 2004 showed that 68% of American voters had supported kiosk voting systems while 15% were against it. On the other hand, the positive trust in relation to remote voting systems was 32% and negative attitude was 47% (Newkirk, 2004).

In 2004, there was an intention to develop the e-voting systems for the European Parliamentary elections and local elections. However, in spring 2004 the decision was made to terminate the development of e-voting systems and concentrate on the voting system via post. The decision was influenced by recommendations of the American security experts, which caused the termination of the Secure Electronic Registration and Voting Experiment (SERVE) project.

Estonia has been developing an online Internet voting system since 2003. There were many political discussions whether to allow the implementation of an e-voting system. The Estonian e-voting system was involved in the municipal elections in autumn 2005. On the other hand, a public opinion poll said that general support to e-voting is 73% of voting age inhabitants (Maaten, 2004), but the real result was 1.8% e-votes of all votes. There were not successful attacks against the e-voting system. The target group of the e-voting system was One million voters. The security experts are more skeptical about e-voting than the public. Their greatest worries are not related to malicious attacks against e-voting servers, but the system

and programming errors and the security of private computers. Another complicated problem seem to be the contradicting properties of correctness and privacy harmony. Additionally, a majority of countries does not apply e-voting to all citizens, but solely to electors' resident abroad. This property expresses also some kind of unreliability (Maaten, 2004, Madise & Martens, 2006).

3. Description of the Voting System at the Implemented Institution

The existing system of voting in Regent University College of Science during Parliamentary election is highly manual. Prior to the Election Day, a period for registration is set to start and end on a particular day. Such a period is announced to the students using the various mass communication medium including e-mail and posters. During that period the electoral commission officer is expected to collect the printed copy of all students' information in order to be registered.

On the Election Day, a polling point is created for each of the three schools in the university, that is, the School of Business and Leadership (SBL), School of Informatics and Engineering Technology (SIET), Faculty of Arts and Sciences (FAS). Each polling point is given ballot papers and the list of students in that faculty or school. The name of a student given the franchise is cancelled when the ballot paper is issued out. This process is repeated for all the days until election is finally over. This is done so as to help the Electoral Commission generate report concerning the number of students who voted from a particular school.

4. Conceptual Design of System

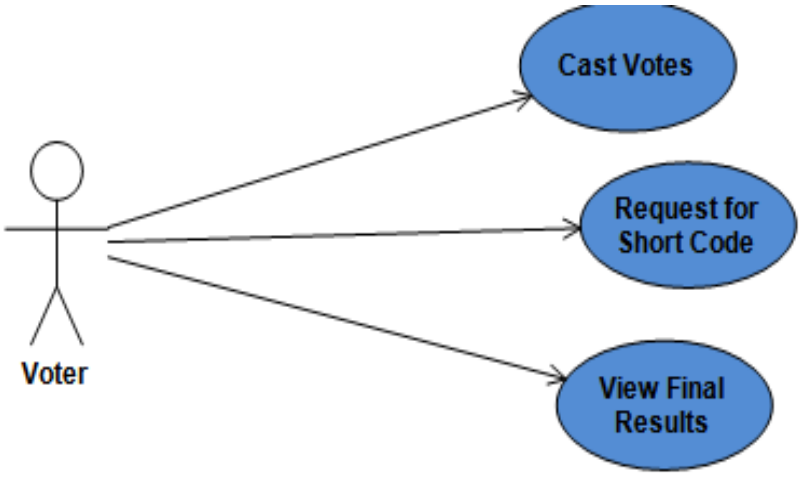

Figure 2: Use Case Diagram for the Voter

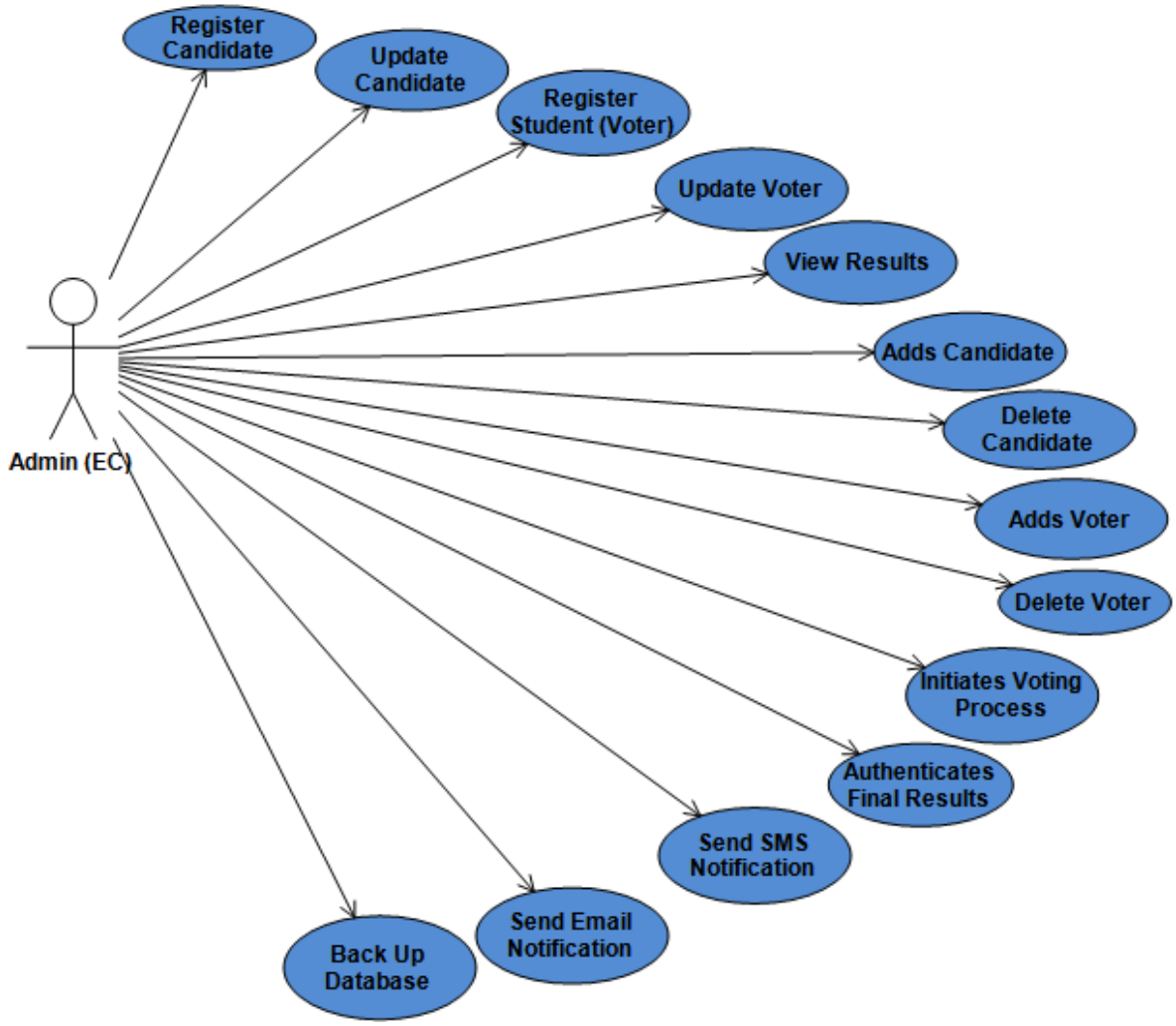

Figure 3: Use Case Diagram for Admin (Electoral Commissioner)

- **Add Voter / Aspirant:** the administrator can add a new and unregistered voter or aspirant to the database in other to allow him or her vote during election.
- **Update Voter/ Aspirant:** the admin can update a voter's or aspirant's information in the database. In case a voter changes his or her name, telephone number, location, programme and level, the admin can change that information to reflect in the database.
- **Delete Voter:** The administrator can delete a voter or multiple voters from the database by clicking on the delete button. This will help the administrator delete voters that are not supposed to vote.
- **Stop Election:** the administrator can stop the voting process when time is due just by clicking on the stop voting button.
- **View Results:** the administrator can view results of the voting process. This helps the administrator track the voting process and also help him in the declaration of election results of the various positions. However this can only be done when an election has closed.

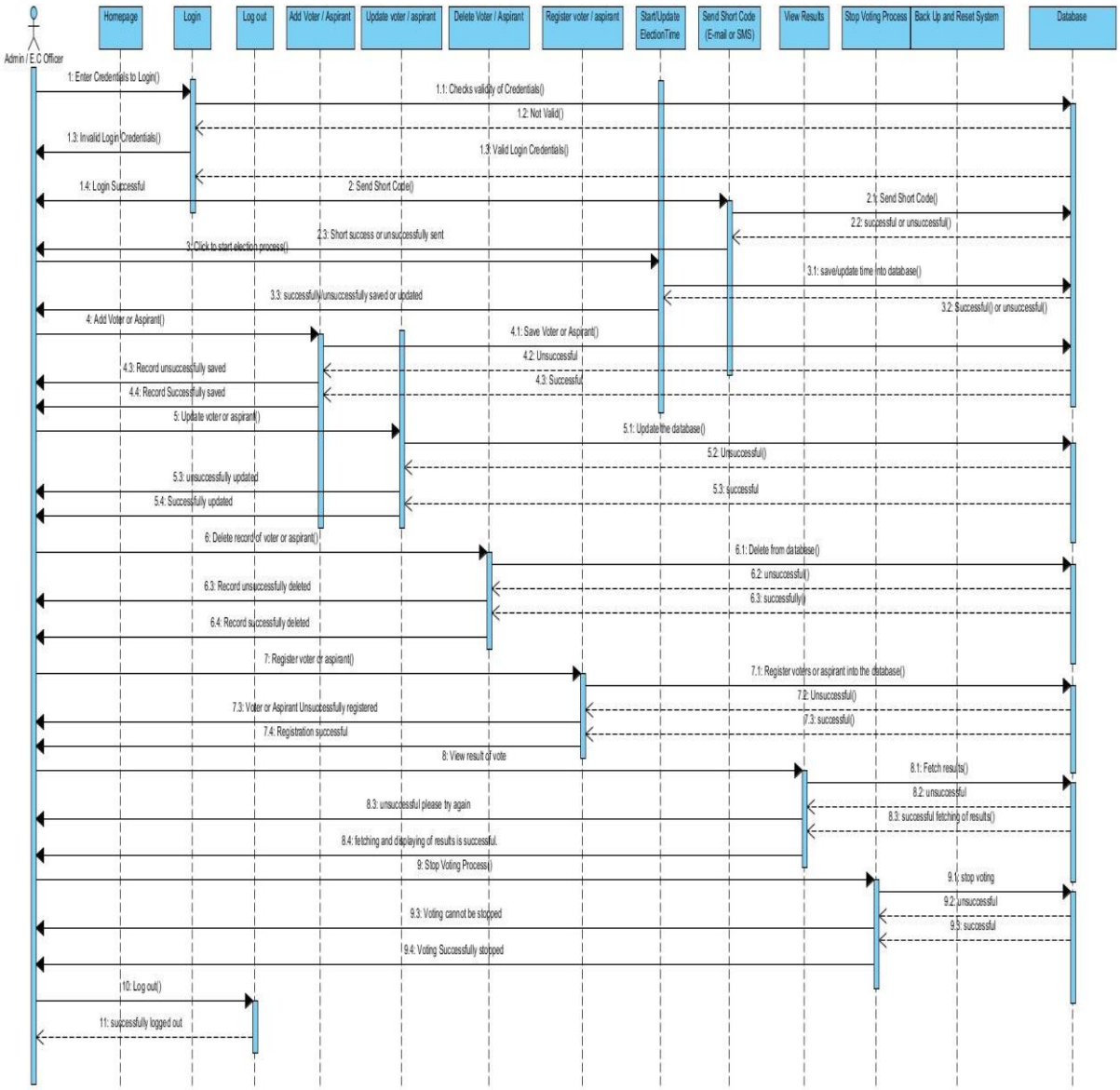

Figure 4: Sequence Diagram for Administrator (Electoral Commission Officer)

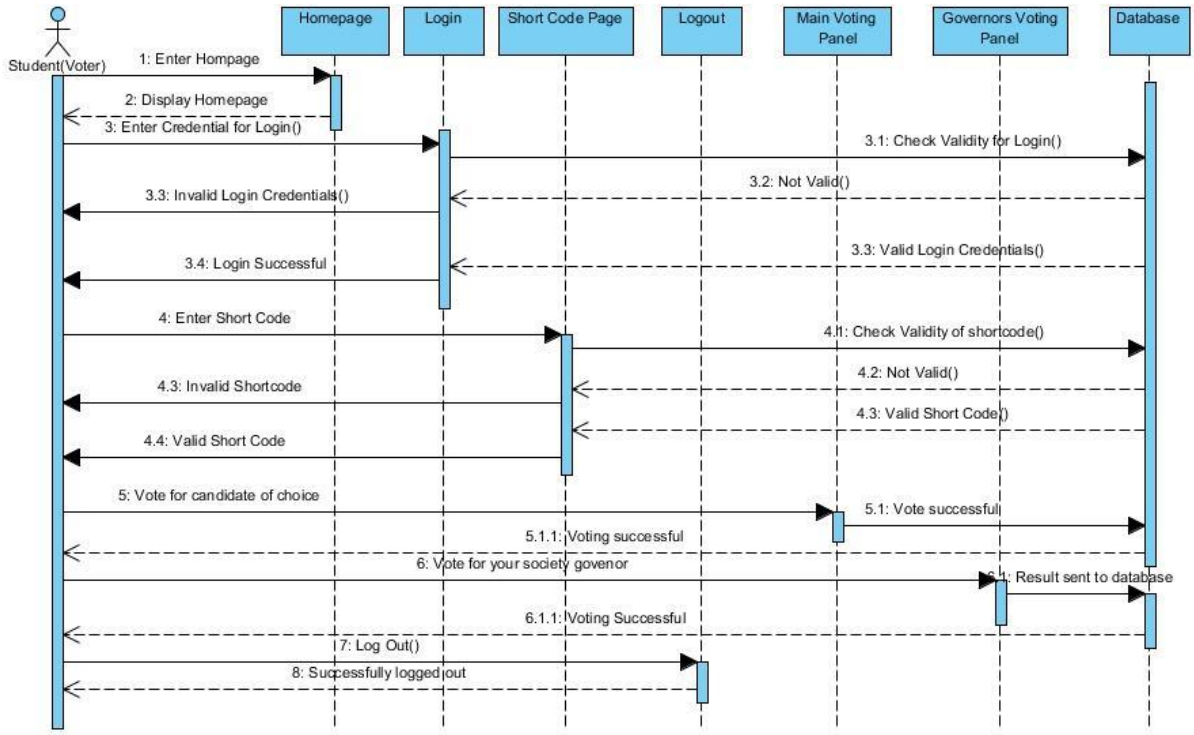

Figure 5: Sequence Diagram for Student (Voter)

4. 1 Use Case Description

Preconditions for Voting

Preconditions

-Registered Voter

-Valid Login Credentials

Success Guarantee

Vote Successfully Cast

Main Success Scenario

1. System Sends Unique Code to each Voter by SMS
2. Voter logs in to the system with Student ID and Unique Code
3. System Authenticates Voter
4. System Displays Candidates for a Particular Position
5. Voter Select one of the Candidates
6. System tally the vote Cast for the select Candidate
7. System Logs out the Voter

Extensions

2.a Incorrect Details

1. Prompt voter

2. Continue at 2.

6.a More Position to vote for

1. Prompt User

2. Continue at 4.

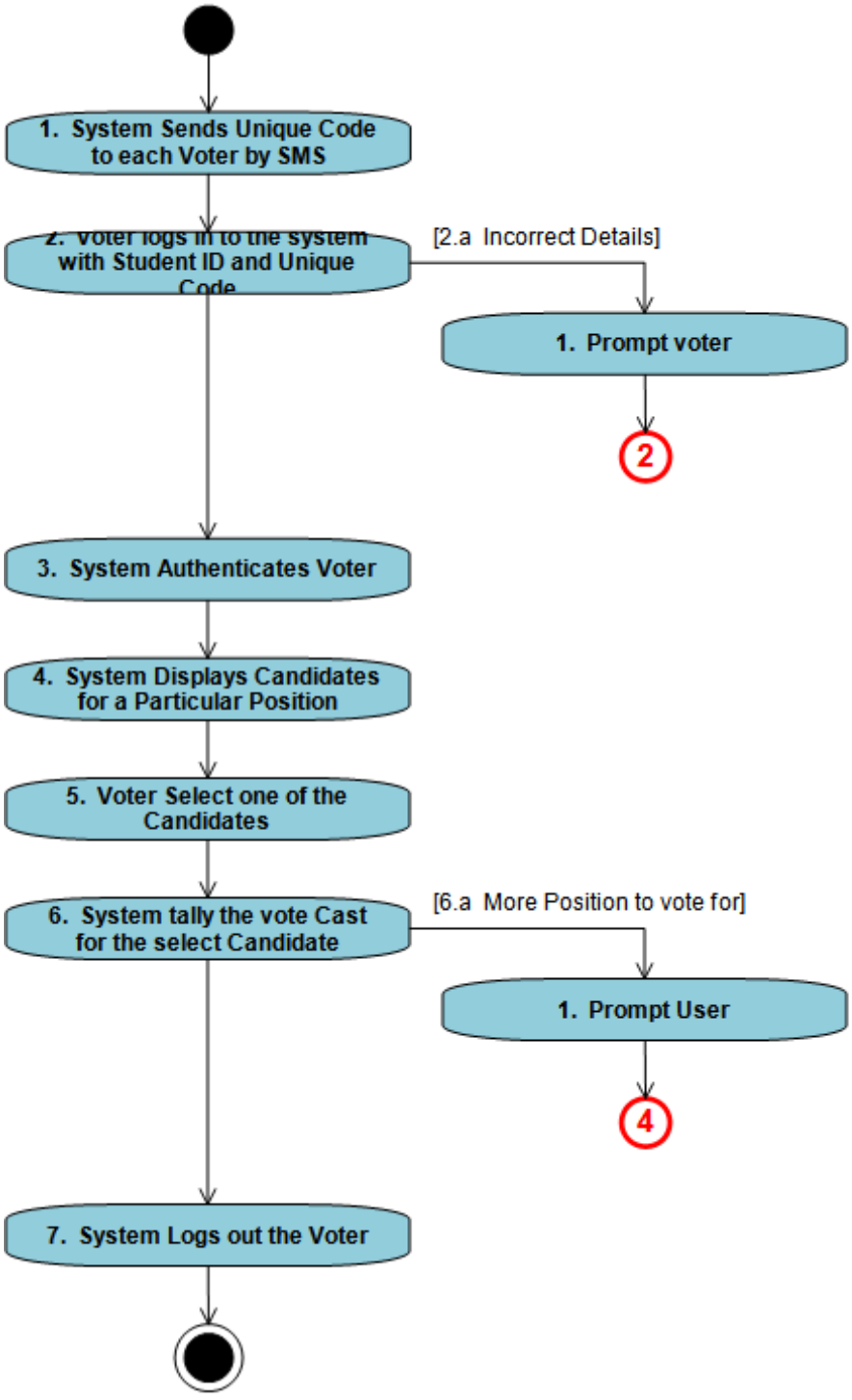

Figure 6: Activity Diagram for the Voting Process

4.2 Class Diagram for the Voting System

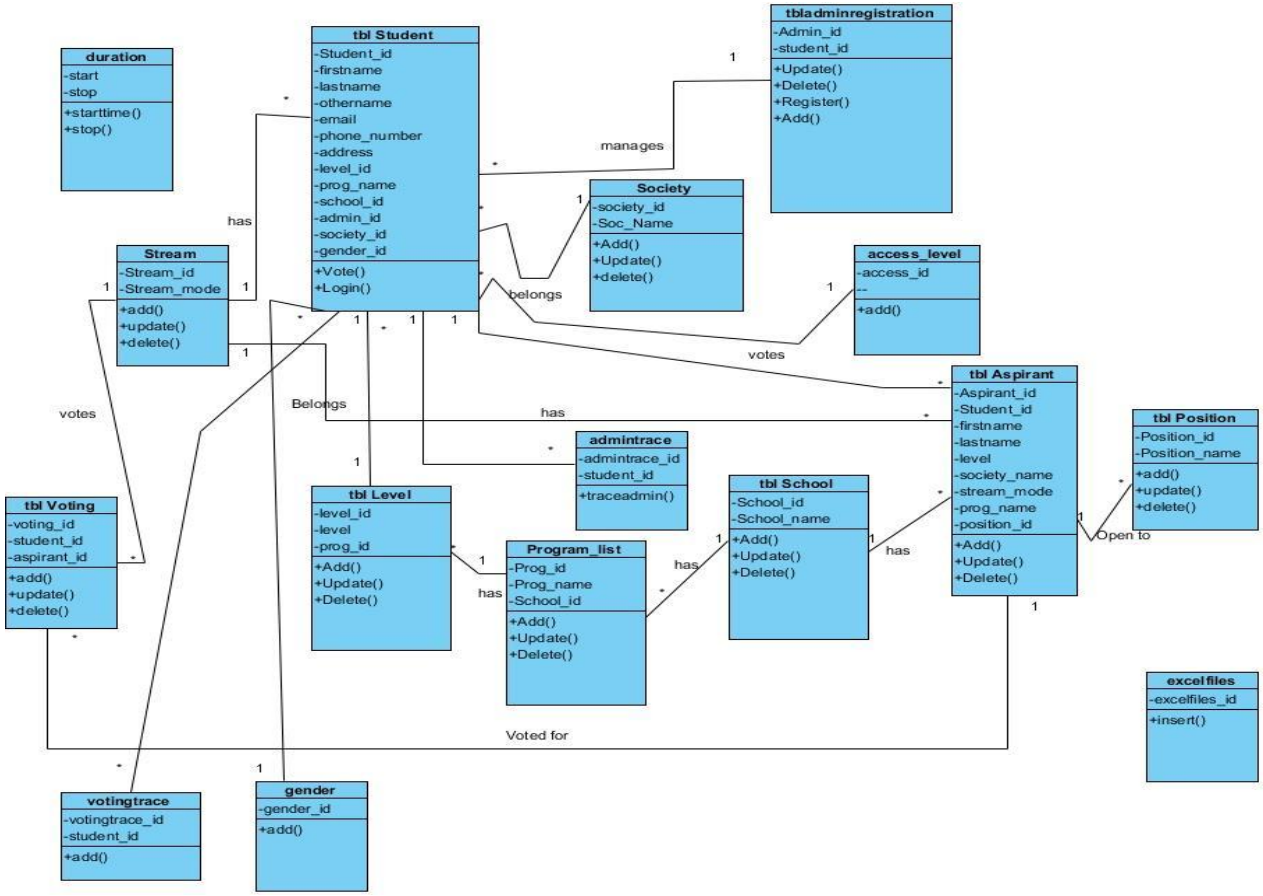

Figure 7: Class Diagram for Voting System

4.3 Data Flow Diagram

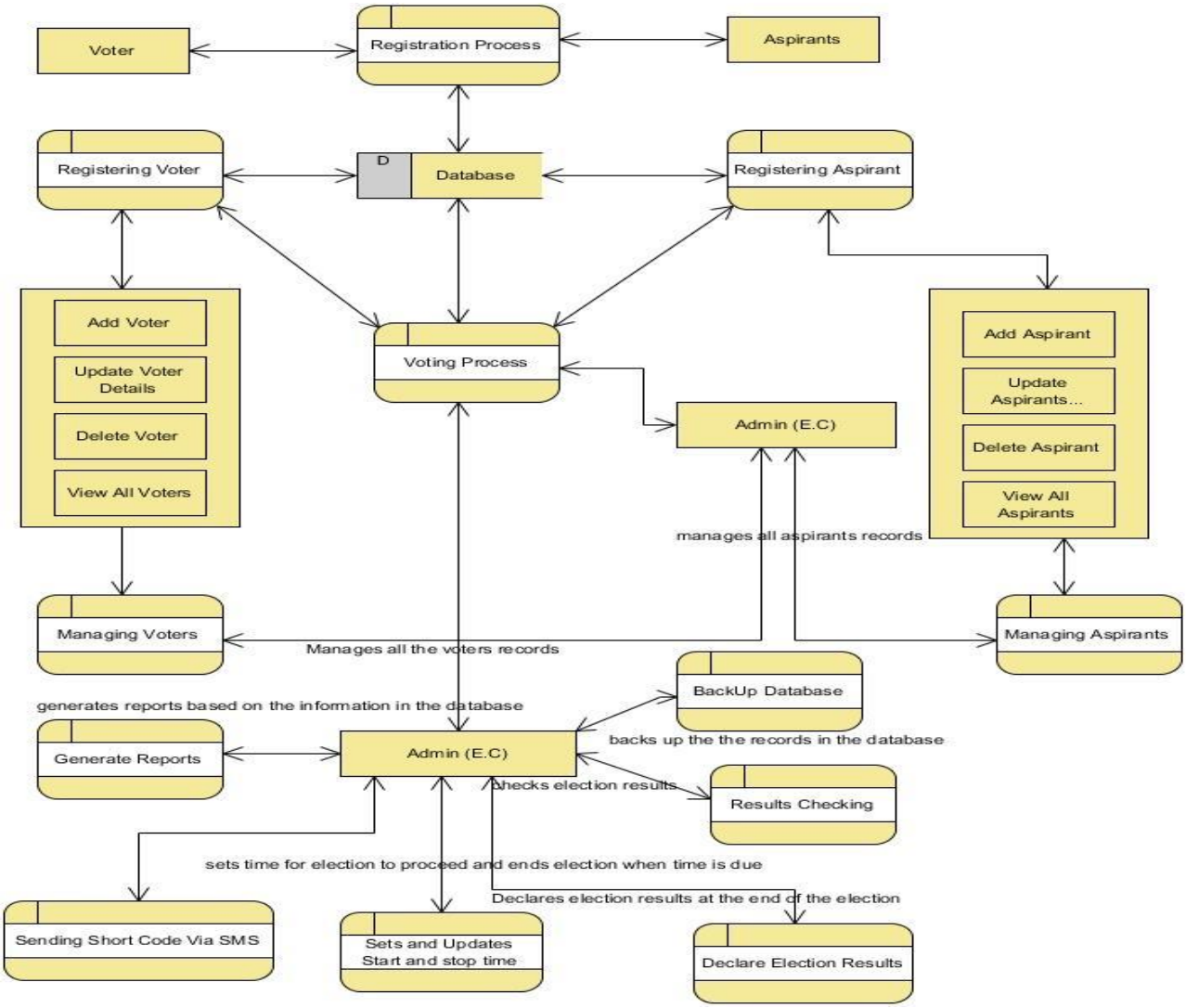

Figure 8: Data flow Diagram for Online Voting System

4.4 Description of the System

The system allows users to make inputs into the system through the use of the interfaces that have been created. The system provides the following input services;

The system validate the username and password entered by the Admin to check if they match and have the authorization to access the system and carry out functions they intend to do but with the Voter the system asks for the username and Short Code as password sent to his or her phone via email or SMS prior to voting for further verification.

If the details entered are correct for the Admin the system takes him or her to the Admin Dashboard which gives him the opportunity to access other pages like;

- Manage Aspirant page
- Add new voter
- Update voter
- Stop Election

- Start Election
- Delete Aspirant etc.

In the case of the Voter, the system takes him or her to the voting panel where he or she can vote. If the credential entered are not valid for both the Admin and the Voter, the system displays an error message which re-opens the login section or form for the users to re-enter the correct or valid credentials. The system counts the number of failed login attempts to the system. If the failed login attempts exceed three (3) times, the system sends a text message to the registered phone number of the user indicating the login attempts. The user can then request for a new password short-code via the prior registered e-mail address. The Electoral Commission Chief Loads all aspirant onto the system by capturing their names, position they aspire to, their phone number and their picture. The system generates a unique code for each aspirant and sends the code and the details of aspirant to the aspirant via SMS to the aspirant's phone with a confirmation request. When the aspirant confirms receipt of the SMS by replying "OK", the system adds him/her to the Aspirants page. The Electoral Commission Chief also load all valid student's ID, Name, Level, Department, Society, valid mobile phone number and a Picture. On the day of election, the Electoral Commission Chief activates the system to allow students to log into the system in a secured network environment to vote. Once one student log in to the system on the day of the election to cast his/her vote, the system locks the Electoral Commission Chief out of the system. The Electoral Commission Chief can only get into the administrative portal by clicking on the "**End of Election"** Button, in which case the election ends and no student can log in unless the entire system is reset for the next election period. The Students enters their ID number as user name and the system sends a unique code to the phone number of the student. The system request the student to enter the unique code sent to the phone number. The system validates the code entered by the Student. Once it is validated the system take the student to the voting portal (Figure 10). The system allows for a maximum of three trails at each validation stage after which the system locks the ID number for an hour. Other IDs would however work on the same system within that period. The voting portal displays the entire aspirant under the position they aspire to eg: Speaker, Women Commissioner, and Governor for the student's society, etc. The student selects an aspirant for each position. For Verification and Authentication purposes the "**vote"** button is only activated only when a student selects an aspirant for each position. Once a student vote, the system logs him/her off the system and locks his/her ID from logging into the system again. The system calculates or counts the total vote for each aspirant once the EC chief clicks on the "**End of Election**" button. The system then sends the collated results for each position to all aspirants for that position.

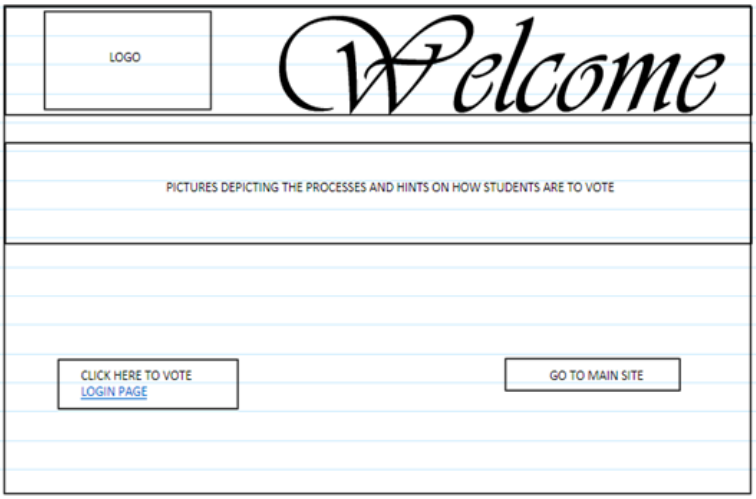

Figure 9. Welcome/Index Page

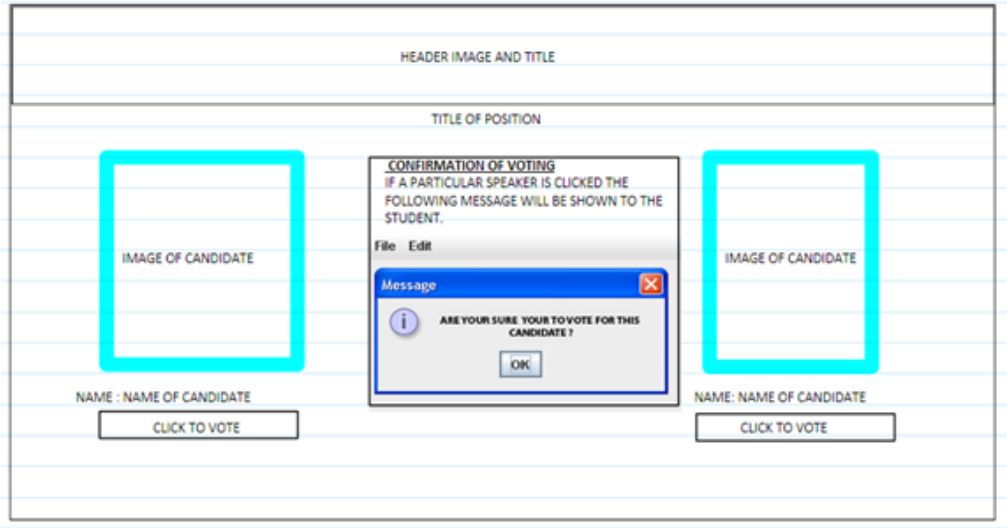

Figure 10. Voting Page or Layout for all positions

5. Conclusion

The e-voting system implemented in the academic institution where users were all technologically savvy, helped reduced the logistics needed for electing leaders to the various positions. The system has made it possible for all students to be able to cast their vote without having to necessarily report to campus or a specified location. All aspirants get the tabulated results on their mobile devices once the election is closed by the Electoral Commission Chief in charge of the election. Students welcomed the development acknowledging that; the online voting system was a better, effective and more efficient way of voting in the institution as compared to the paper balloting method of voting. The concept could be extended to all Institutions or organization's election once the electorates can be identified with unique Identification Numbers. It is recommended that further research and implementation should be conducted to include functionalities or features to enable visually impaired individuals vote with no or minimal assistance.

6. References

Bellis, M. (2000). The history of voting machines. [Online article], (November 1998) [cited January 29 2004], Available at: http://inventors. about.com/library/weekly/aa111300b. htm.

Gill, K. An illustrated history of voting methods and systems.

Jefferson D., Rubin A.D., Simons B., Wagner D., A Security Analysis of the Secure Electronic Registration and Voting Experiment (SERVE). 2004. Retrieved June 7, 2016 http://www.servesecurityreport.org/. 21.01.2007.

Kohno, T., Stubblefield, A., Rubin, A. D., Wallach, D. S., Analysis of an Electronic Voting System. 2004.

Maaten, E. (2004). Towards remote e-voting: Estonian case. Electronic Voting in Europe-Technology, Law, Politics and Society, 47, 83-100

Madise, Ü., & Martens, T. (2006). E-voting in Estonia 2005. The first practice of country-wide binding Internet voting in the world. Electronic voting, 86.

Magi, T., (2007)," Practical Security Analysis of E-Voting Systems", Master of Information Technology Thesis, Department of Informatics, Tallinn, University of Technology, Estonia.

Magomelo, M., Mavhemwa, M. P., & Ndumiyana, D., (December, 2013), Effectiveness of mobile voting as a supplementary method to ballot casting: Case of Bindura University of Science Education, IJETTS, Vol. 2, 6.

Newkirk, M. G. (2004). US public opinion toward voting technologies. InfoSENTRY Services.

Riley, R. (2007). Playing Marbles: The Gambia's Electoral System. Harvard International Review, 28(4), 6.

Rt. Hon. Baba Seidu, et. al, "Introduction of Leadership in Regent Parliament" in The Ultimate Voice (Constitution of Parliament), 2008-2009, pp. 4

Wolchok, S., Wustrow, E., Isabel, D., & Halderman, J. A. (2012, February). Attacking the Washington, DC Internet voting system. In International Conference on Financial Cryptography and Data Security (pp. 114-128). Springer Berlin Heidelberg.