Effectiveness of mobile voting as a supplementary method to ballot casting: Case of Bindura University of Science Education.

Munyaradzi Magomelo¹, Munyaradzi P. Mavhemwa² and David Ndumiyana³

¹²³Bindura University Of Science Education, Computer Science Department, Trojan Rd, Bindura, Zimbabwe

Abstract: Bindura University of Science Education engages into perennial SRC elections. As of late, the voting process has required students to produce the current student’s ID, then go to the ballot box and choose the candidates of choice through ballot casting. After voting, the ballot boxes are opened in the presence of all interested parties and counted. Through the enrolment of more student and expansion of the university yearly, it has become a problem to conduct free and fair elections since students from different faculties use different campuses. This has caused students to be dispersed hence conducting elections becomes a challenge. Also, variations in timetable setup have caused some students choosing not to vote while attending lectures and other activities. In addition, a greater percentage chooses not to vote due to long queues on the voting time. As a result, the outcome of the election is not the real voice of the student board. During this research two closely related elections where compared, one using the traditional paper ballot system and the other using mobile voting as a supplement to ballot casting. From the data obtained it is clear that mobile voting presents opportunity to engage more students to participate in SRC elections, thus increasing the voter turnout. Elections conducted using traditional ballot casting only had a low voter turnout ratio of only 40% students turning out for election. Comparatively, a combination of the two methods yielded a massive 85% voter turnout percentage thus outclassing the traditional ballot casting method.

Keywords: Mobile voting, elections, Ballot casting, E-democracy

1.INTRODUCTION

Democracy, in every society can be achieved when members of a community select, without fear or intimidation candidates of choice to lead them in areas that need representation and leadership. Elections worldwide allow the populace to choose their representatives and express their preferences on the way they will be governed. The heart of democracy is solely dependent on the voting in every democratic environment, thus voting is the right of every citizen. Naturally, the integrity of the election process is fundamental to the integrity of democracy itself. 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.

Bindura University of Science Education conducts perennial Student Representative Council (SRC) elections. The voting process selects members who represent the student community in issues to do with the well being of students at the university. The voting process begins with persons physically going to an election office joining queues to wait for their turns to vote. When a student’s turn to vote comes, he/she produces a student’s identification card, which will be used during the actual process of voting. However, with the different sites that the university has, it is becoming difficult for students to participate in the voting process. This research aims to research on the implementation of a mobile voting system (which can be used interchangeably with internet-voting in this research) and to assess its effectiveness as a supplement to ballot casting.

2.BACKGROUND OF THE PROBLEM

Elections have been evidence of democracy for decades. Prior to democracy was autocratic rule, which was brought to an end by revolutions and uprisings. The motto “Government for the people, by the people and for the people” became evident in society. Presently elections give voice and power to the people. The voting process in today’s world is behind its time in respect of the usage of modern ICT as seen by experience. The voting process is being seen mostly as a manual and paper based one, consider the July 2013 Zimbabwean harmonized elections. The election process at Bindura University of Science Education provides a manual way of casting ballots. This process can be overwhelming, time-consuming and prone to security breaches and electoral fraud. A manual election requires an accurate hand count of votes while determining an appropriate winner after an extensive vote certification process. A number of factors such as ballot design and unintentional voter mistakes can plague the manual election process. The Student Council elections have always been a perennial activity at the university. As of late, the voting process has required students to produce the current student’s ID, then go to the voting area and choose the candidates of choice through ballot casting. After voting, the ballot boxes are opened in the presence of all interested parties and counting begins. Through the enrolment of more student and expansion of the university yearly, it has become a problem to conduct
free and fair elections since students from different faculties use different campuses. This has caused students to be dispersed hence conducting elections becomes a challenge. Also, variations in timetable setup have caused some students choosing not to vote while attending lectures. As a result, the outcome of the election is not the real voice of the student board.

3. PROBLEM STATEMENT
Election malpractices put into question the credibility of the voting process. The current voting process leads to loss of valuable time (standing in queues and counting votes) and incur expenses through printing of ballot paper and employment of electoral officials. As a result, Bindura University annual SRC elections often yield to poor results due to poor voter’s turn out for the Student’s Representative Council elections.

4. RESEARCH OBJECTIVES
The aim of this project is to design a mobile voting system that makes use of mobile application technologies. The specific objectives of this project are:
1. To design and implement a mobile voting system for Bindura University.
2. To analyze the effects or impact of mobile voting at Bindura university.

5. RESEARCH QUESTIONS
• How can the development of a mobile voting system for Bindura University’s elections enhance elections outcome?
• Does the mobile voting system improve students’ participation in the elections?
• Can mobile voting system supplementing traditional ballot casting be effective for Bindura University?

6. RESEARCH PROPOSITIONS/HYPOTHESES
This listed the following hypothesis:

$H_0$: the use of mobile voting as a supplement to ballot casting can be effectiveness than ballot casting system alone at Bindura University.

$H_1$: the use of mobile voting as a supplement to ballot casting is not effective for SRC elections at Bindura University.

7. JUSTIFICATION
Voting is a vital part of the democratic process. As such, the efficiency, reliability, and security of the technologies involved are critical. Today, the development and widespread use of information technologies is changing the way people view voting processes and, ultimately, the way they vote.

The advent of mobile phones and other mobile devices has completely changed the way we connect with the world and has undoubtedly made our lives more convenient. Life has become faster and time has become a precious commodity.

Mobile voting systems have the potential to be more usable than paper. Percentages of stolen or miscounted ballots, votes lost through unclear or invalid ballot marks and limited accommodations for people with disabilities are problems associated with ballot casting. Mobile voting systems reduce the materials required for printing and distributing ballots. It also offers increased convenience to the voter, encourages more voters to cast their votes remotely, and increases the likelihood of participation for voters. Additionally, it permits access to more information regarding voting options. The electronic gathering and counting of ballots reduces the amount of time spent tallying votes and delivering results.

It is quite understandable why the turnout at the polling booths during the time of election is very discouraging. For others, who have no valid excuse to be absent, it is just plain laziness or their cynicism towards politics that act as a dampener.

Practically considered, mobile voting has many advantages, system can be implemented anywhere where there is network coverage and can work on any phone which can access the internet. It is user friendly, thus can be used by both computer literate and illiterate voters.

8. LITERATURE REVIEW
E-government and e-democracy are areas where politics and political marketing converge with computing and the internet. There is widespread discussion of e-democracy, direct democracy and e-voting in the academic and journalistic press, some suggesting that it encourages participation (above all among younger voters) in an age of political apathy, and others that it is intrinsically insecure and merely a vehicle for government surveillance. In other words, it attracts controversy.

In order to fully understand what mobile elections practices can influence in a drive towards e-government and e-democracy, it is worthwhile to understand some sources of the development of previous voting systems that where designed in other places of the world. Therefore, this chapter seeks to discuss in depth previous voting systems that have been developed so far, how they impacted in their area of study, what benefit they brought to the community at large and whether they managed to fulfill their individual set objectives and the general I.T objectives that they were intended for.

8.1 Different views for mobile voting
Different voting systems may give very different results, particularly in cases where there is no clear majority preference. Use of the internet to cast votes is also known as I-voting. According to [18] I-voting may be defined as “means the casting of a secure and secret electronic ballot that is transmitted to the appropriate elections official using the Internet”. Although Internet voting (I-Voting) is a recent phenomenon, it traces its technological roots to 1960s, when the first direct-recording electronic (DRE)
systems were used in a primary election in the United States [20] as cited by [9]. They also go on to quote [3], [7], [8], [12] who say the voting systems share many weaknesses of e-voting which include lack of an auditing trail, the potential for a large-scale subversion, and the risk of system wide failures. [9] also go on to say I-voting is however different from other forms of e-voting as it combines a publicly–accessible computerized network (i.e. the Internet) and a multitude of personal computers with different operating systems, web browsers, and security measure citing [13].

8.2 International Perspective
There are differences in the voting practices employed by different countries worldwide and advanced voting technologies of casting ones vote are a reality in many countries. As it stands today, Estonia is the only country which use mobile voting where the voters use a desktop application as well as a phone for authentication.

8.3 Regional Perspective
Electronic voting might be a solution to the election problems facing many African countries [19]. Electronic voting can also be the best option in African countries that lack infrastructure. Electronic voting will enable African countries with stumbling democracies to be able to regain their standings. Many African countries are now exploring whether e-voting is a viable option. Countries that are exhibiting progress towards shifting to e-voting include Namibia, Ghana and South Africa [17]. Many political leaders in Africa are however skeptical of an electronic voting system. In Kenya, electronic registration exercises in 2010 registration process for a single individual took approximately four to five minutes [17]. The electronic voter register was praised for its efficiency and its potential in being a reliable and secure voter register which cannot be tampered with by partisan interests. The electronic registration system was a precursor to the electronic voting system expected to be implemented in the next general elections.

8.4 The argument for mobile voting
It is useful to differentiate between e-government (the steps taken by governments to communicate to the community and encourage interactive debate) and e-democracy (a wide process including informed decision making at all levels of the community, hence e-government, expressing itself in various forms of electoral and representational participation, including that by means of e-voting, in this case we employ mobile voting). There are a number of arguments that may be regarded as supporting the case for I-voting (mobile voting) initiatives, the most important being that the use of such technology may significantly increase participation and engender administrative efficiency.

[5] suggested that I-voting also represents a natural or logical progression in voting technology. I-voting can reduce the cost of staffing polling stations and fund the costs of voting machines. I-voting can potentially reduce the number of errors made by both the voters and the electoral administrators, and allow for easier adoption of uniform standards in the ballot format, since it could be transmitted via the internet from a central election agency to all local and regional polling places [5], [6]. Advocates of I-voting suggest that voter participation will increase among those who choose to vote via the internet. I-voting has the potential to increase voter participation by eliminating physical barriers that prevent many voters from going to the polls. Such barriers include work schedules, geographic distance, physical immobility and travel abroad.

One paper considers the important issue of remote-access voting as a means for supporting the expansion and refinement of democratic processes across the world through increased citizen participation [14]. Election officials believe that I-voting can be considered a valid voting option if it offers at least the same level of security as traditional remote voting methods. On the other hand, many data security experts doubt that the current internet infrastructure is safe enough to support such an important function. I-voting is still far from being a voting option for US citizens residing in the States; however, it is considered a promising alternative to facilitate voting for those living overseas according to [11]. Many non-voters do not go to the polls because of the inconvenience of registering and/or transportation issues. The acceptance of technology and e-voting is the first step in enabling citizens to register routinely to vote online. Positive consequences of this evolution will be the elimination of long lines at polling places and an allowance of the ultimate voter anonymity. For those who do have access to polling places, the voting procedure will be more efficient, more accurate, and faster. The technology can help reduce some of the common mistakes voters make in the booth by providing immediate feedback on their votes, ensuring against unintentional voter fraud by voting too many times for the same candidate, as was alleged to have occurred in the recent Afghanistan presidential elections. It could eliminate voting for the wrong candidate, because the voters may inadvertently misread the interface, as alleged in the US presidential elections of 2000.

During the 2001 gubernatorial election in Virginia, e-voting systems were used in some of the state’s districts. According to the Century Foundation (www.tcf.org), which reviewed the results, the lost-vote rate went from between 600 to 700 votes in the 2000 election to only one vote in the 2001 election. It proved that new voting technology could replace some of the traditional methods of voting, such as the paper ballots and lever machines.

There are now over 510 counties throughout the USA that use e-voting devices, according to Election Data Services (EDS), a Washington-based research company. A logical assumption is that as more people become comfortable with modern technology and computers, the more acceptable online voting will become. By reducing the
number of errors in the voting process from both voters and electoral administrators, the use of I-voting would be financially advantageous. Highly intelligent software along with online help, in the place of the labor-intensive methods employed by most polling stations, could aid voters when completing the ballot. It is hoped that by adopting a uniform standard of procedures, the ballot format would be easier to transmit via the internet from a central election agency to all local and regional polling places [5].

Proponents of I-voting argue that it constitutes a logical progression of the democratic election systems that are currently using electronic voting for the preparation of voter registration and ballot counting [5], [6]. I-voting is probably a logical integration of the voting process into election management with election officials in many countries strongly supporting the move to I-voting, thus mobile voting as a way to permanently eliminate paper-based system.

8.5 Security
E-security measures are perhaps the most hotly debated issue surrounding I-voting. High levels of security are not only essential to elections, but it is also imperative that a validated system is instituted before the citizenry relies solely or partly on I-voting. For a democracy to flourish there must be confidence in the integrity in its elections, since the political ramifications are great. There are many security factors that are evident when votes are cast via the internet. Internet security is usually just one step ahead of the next creative assault and public resources for the protection of users are woefully deficient [13], [16].

Attacks on commercial and government web sites are common occurrences on the internet, not to mention the thousands of computer virus propagations, the shutdowns caused by event-driven traffic and the deliberate denial-of-service (DOS) attacks [13], [16].

The security issues for I-voting have been compared to the security issues surrounding medical records and credit cards. One of the greatest challenges is building a system that can ensure the privacy of the ballot box while at the same time prevent someone from electronically stealing an election. Ironically, the more secure a system is made; the harder it becomes to operate and control; so the question then becomes how much investment in education and training is necessary to educate users? These same users may not wish to be educated in a technology-based system, or may fear a voting system that appears to be highly automated and impersonal.

Internet security for voting may be more difficult to execute than the security initially established and maintained for e-commerce and library databases. Many people view online voting as comparable to online financial transactions, and are unaware of the many risks they take even when dealing only with secure web sites through SSL (secure sockets layer) protocol and related authentication schema. For example, if a family member uses someone's credit card without his or her permission, it is not considered a security threat or failure. However, if that same family member votes on another family member's behalf, whether or not they have consent, it is considered a security failure. Essentially, according to [8] the right to vote is not transferable, and must not be delegated, sold, traded or given away. In the event of a security failure in an I-voting system incident, the anonymity requirements of public elections will make it difficult to detect and recover from such failures. There is no anonymity in e-commerce, so detection and recovery is much easier, typically completed by cross-checking receipts, statements and bills. Most errors and frauds can be detected and recovered through refunds or legal action.

In I-voting, there may be no receipts, because receipts would violate anonymity, possibly enabling vote buying, coercion or intimidation [8]. It is for these and other reasons that the development of a secured I-voting system is complex and has no analogue in the e-commerce world.

8.6 Implications for online information sharing and retrieval
Although there are some interesting issues within the discussion of I-voting, the current evolution of such voting technology is based on the development and acceptance of e-voting technologies for gathering and tabulating election results. As with the adoption of any new technology, there are important cultural issues that will play a role in the future of online voting. The implications for online information sharing and retrieval are grounded in the necessity for widespread acceptance of its accessibility and security.

The long-term implications of voting for local, county and presidential officials via the internet are still unclear. As noted by [6], there is a strong relationship between IT-infrastructure and applications of e-government that aid the promotion of e-voting and I-voting technologies. It may be years, if ever, before a truly secure, relatively risk-free internet service, such as I-voting, is developed. Finally, voter anonymity may be jeopardized under this voting mechanism.

8.7 Benefits of mobile voting compared to traditional ballot casting.
There is a brief and largely successful history involving applications of information communication technologies (ICTs) and computer technology to assist in data capture and tabulation of democratic elections. While several critical issues have been identified, none has been so significant that an end-game strategy should be invoked rather than continued innovation. m-voting, a subset of i-voting would reduce the cost for staffing polling stations, and also the funds needed to pay for the running of the elections. m-voting could also reduce the number of errors made by both the voters and the electoral administrators, and allow for easier adoption of uniform standards in the ballot format, since it could be
transmitted via the internet from a central election agency to all local and regional polling places [1]. Mobile voting in the case of this research, has the potential to increase election turnout by providing voters with a convenient voting mode that does not require them to leave their homes or offices [9]. Even geographic distance is no longer an issue in participation in elections as army personnel and their families [8], college students [15] and business people can exercise their civic right and vote from anywhere around the world regardless of any time differences. If this is not enough, consider the potential for simplifying the voting process for the elderly and the disabled, and add to that cost savings from using a freely available technological infrastructure (i.e. the Internet) and privately-owned personal computers [9]. Since many democracies face ever-decreasing voting rates, the opportunity to reverse, or at least, stop the trend, and increase turnout seems particularly promising [15].

8.8 General conclusions
Good systems, if well implemented, can propel democracy to the next level. Digitally e-voting and subsequently m-voting demands the integrity of those in-charges and the efficiency of the system. The system that is being proposed will fill the gap by: providing an actual mobile voting system which will enable the voter to authenticate himself or herself and vote right on the mobile phone. The adoption of electronic support for internet-voting systems in any country would entail a considerable overhaul of traditional voting methods. Voters would eventually depart from having many forms of traditional voting methods and data-gathering processes to having just two methods, delivered by the superior connectivity characteristics of I-voting. Many of the security issues debated involve technically based solutions, currently being developed, to thwart attacks on e-commerce sites. It may be years, or never, before a 100-percent-secure, risk-free internet service, such as I-voting, reaches its full potential. But, the same can be said about the numerous voting systems that are currently in place, and for the most part, nations still conduct their business and the political systems are still relatively stable despite the controversies associated with election fraud. It is logical that the more educated technology users would want the opportunity to vote via the internet. Many candidates maintain a web site to communicate their political views and to attract the educated and technologically sophisticated voters. In addition, the sense of community and the character of sponsored elections may be damaged if governmental agencies do not move toward a more technological and reliable method of voting.

In view of the literature obtained from the various researchers including those of e-voting and i-voting, the general view that was discovered by the researcher was that mobile voting is a promising field with a brighter idea that can drive the globe to e-democracy society. The next section highlights the research methodology.

9. RESEARCH METHODOLOGY
Methodology has included the use of fact-finding methods such as data collection, analysis, design tools and development. Information system project methodology can be captured from the activities of the System Development Life Cycle (SDLC).

Two closely related elections (faculty representation body elections) were conducted and the students are asked to cast their votes using both the mobile system and the traditional ballot casting within a stipulated space of time. The voter turnout ratio was then calculated after the elections are over. Effectiveness of the system was analysed by comparing the turnout ratio with that obtained when using tradition ballot casting method only.

9.1 Research design
The key to a successful project is proper design, the design stage involves coming up with the different modules of the system and their intended functionality. The design had to be based on the information collected during system analysis. The system interfaces should be designed with the end user in mind making the design process easier and make the designed work easier to implement. The interaction between the different modules had to be clearly shown with the use of relevant UML diagrams while database design should be done with use of Entity-Relationship diagrams.

9.1.1 Design methods
Design process of both the administrator’s and user interface was done using software development model that suitably suits websites that can be accessed by any mobile gadget that can access the internet by limiting the graphics in the design. The mobile voting system was implemented using:

- PHP language
- ForeUs software.
- The researcher used MySQL database management system

9.1.2 Design Structure
The figure below illustrates the flow of data at the front-end and the backend

User (Front end)

![Diagram of Frontend Design](image)

Administrator (Back end)

![Diagram of Backend Design](image)
9.1.3 Design hardware
- Mobile Phone
  Mobile phone acted as the main hardware for Mobile Voting System on the client part. The fast growing of the mobile technology has benefited and improved the quality of life. With this specification, the objective to develop a low cost system would be met.
- PC or Laptop
  In the development work, a PC was used for programming and website hosting process.

9.2 Development of the system
9.2.1 System design
The system analysis and design methods that was used include, class diagrams and n entity-relationship diagram. A simple outlook of what happens in the mobile voting system.

![Figure 3: Outlook of the mobile voting system](image)

Input login details

![Figure 4: Use case for casting a vote](image)

9.2.2 Methods used in the system design.
Use case diagrams
Use-case modeling is a technique used to describe the functional requirements of a system. It makes it easier to show the functional requirements in an abstract way therefore acting more like a communicating tool between the stakeholders and the developers. Table 1 shows vote casting use case.

<table>
<thead>
<tr>
<th>Table 2: Use Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use case name</td>
</tr>
<tr>
<td>Actor(s)</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Typical flow of events</td>
</tr>
<tr>
<td>Precondition</td>
</tr>
</tbody>
</table>

9.2.3 Requirements specification
System users:
- Students
- System administrator
The requirements where classified according to each user:

1. Functional requirements details
Statements of services, the system would provide how the system should react to particular inputs and how the system should behave in particular situations.

Student module
i. Login - Each student would obtain a unique login user name and password when they register and activate their accounts after they are asked to supply their credentials. This is the design of how the login interface would look like.

![Figure 5: Design for the login panel](image)
iii. Results – students are able to view results before and after elections period. After clicking on the results panel, the student is directly directed to the interface such as shown below.

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Number of votes</th>
<th>Vote %</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>Candidate 2</td>
<td>2</td>
<td>50%</td>
</tr>
<tr>
<td>Vice President</td>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>Candidate 1</td>
<td>2</td>
<td>100%</td>
</tr>
<tr>
<td>Candidate 2</td>
<td>2</td>
<td>50%</td>
</tr>
<tr>
<td>Secretary</td>
<td>1</td>
<td>100%</td>
</tr>
<tr>
<td>Treasurer</td>
<td>2</td>
<td>50%</td>
</tr>
<tr>
<td>Candidate 1</td>
<td>1</td>
<td>50%</td>
</tr>
<tr>
<td>Candidate 2</td>
<td>1</td>
<td>50%</td>
</tr>
</tbody>
</table>

Figure 7: Results

iv. Campaigns – students are able to view candidates profile even before login. The campaigns forum can only viewed before and after elections. Candidates can post their motivation speeches here, including their profiles.

System administrator module
The system administrator keeps the system running and therefore should have more access than any other user. Only the administrator can access the administrative site after supplying a unique username and password. To ensure security, the administrator is denied access to the administrative site during the voting period lest he/she will alter elections results. The administrator can set vote time, update candidate information and position information. Administrator should be able to form the back end.

- Update user profiles.
- Delete user (voters and candidates) profiles.
- Reset passwords-administrator should be able to reset password for users who would have forgotten their passwords.
- Should have access to all system components

Below is the design of the administrative panel.

Figure 8: Administrator’s panel

9.2.4 Database design
(i) MySQL is a relational database management system that is well known for its reliability and dynamics when it comes to database management. It offers good security for databases as well. It also allows for multiple user interaction with database, at the same time allowing for rapid insertion, deletion and updating of entries into the database.
(ii) The database includes the following tables:
(iii) admin (level, password, username)
(iv) candidate (id, position, name, platform, votecount, speech)
(v) position (IDNo, position, limit)
(vi) student (stuid, fname, lname, program, year, myoption, gender, email, nextofkin, signed_up, vote_stats)
(vii) votecount (CandID, position, result)

9.2.5 Implementation

- Hardware
  (viii) Testing on the mobile phone was done on a few different kinds model such as Nokia, Sony Ericsson, and Samsung. All over the testing, it was found that some of the phones could not display site’s interface, thus some pictures were missing. This kind of difficulty is normally caused by version of the phones as some had a bigger screen and had powerful graphics compatibility, thus these would display better.

- Graphics
  (ix) The usage of graphics in this program was minimum. The reasons are twofold: first, to reduce any processing and space requirements imposed on the mobile device.
  (x) Secondly, since there are a lot of varieties of mobile device specifications (such as differing screen sizes, etc.), any graphic that looks fine on one mobile device might be distorted on another. As such, we saw it best if we kept graphics out entirely to preserve compatibility.

Implementation design
(xi) After determining all the requirements in the design of the system and all the relations and entities involved, now it time to design the user interfaces.

i. Home page
  (xii) The page is implemented with the end users in mind that is making the page’s graphic user interface simple, straightforward at the same time achieving this without reducing the page’s functionality. Each link is specific to the stipulated end users (i.e. student); this has the advantage that users do not have to go through complex paths or clicking unnecessary links to get to their intended destinations.

ii. Student login page
  (xiii) When students click the “Click Here” link they are directed to the voting login page where they have to enter their login details. The page is implemented firstly as a control measure to prevent unregistered students from voting and secondly as a security measures. Login interface secret password verification interface, error
messages if login is invalid and display voting options if login is valid. On first login, the user is asked to supply answers to the asked questions and to change the provided default password inorder to activate ones account. If a person choose to vote using traditional ballot casting, he/she cannot logon on the mobile voting system lest some people will vote many times.

9.3 Data collection approaches
(xiv) The authors used two methods: Observation and document review. Research instruments used were interviews, hypothesis and questionnaires. People of experience to be interviewed include a representative from the competing parties and the elections administrators.

9.3.1 Research instruments (Interviews, hypotheses and questionnaires)
(xv) In the researcher’s quest to achieve the second objective, the researcher conducted a mock election which users chose their choice into which they intend to cast their votes and check whether students are customizing well with the new setup through interviewing. Questionnaires were of prevalence important as they gave a more unbiased report of the project’s status. Questionnaires were designed to measure people’s perception on a phenomenon and assess elections voter turnout.

9.3.2 Population and sampling
(xvi) The researcher engaged Bindura University students. The sample size to be used is sixty students. To come up with this sample size, the researcher chose a random sampling technique which assumes that all entities in which the research was carried out had an equal value. It was of the best wish of the researcher that the engaged population will accurately represent the whole students’ body of the university. The researcher collectively and selectively interviewed the students to evaluate the effectiveness of mobile voting system amongst students who would have used the system. The researcher put all mechanisms which will guarantee an unbiased result extraction from this sample space.

9.4 Data analysis procedures to be used
(xvii) The data from questionnaires and interviews were compiled and analyzed in a deductive and objective manner. Trends were illuminated through such techniques as linear regression of statistical data, which allows the researcher to make both conclusions and predictions about the behaviour of a population.

(xviii) There was a close comparison on the observations done from students’ response during the day of the mock elections, assessing which voting system students opted for, the mobile voting system or the traditional ballot casting. Enough time was given to students to freely complete the questionnaires and the results from the mock election are collected, put together and analyzed. A graph was drawn to check the voter turnout rates. The questionnaires provided the researcher with the students’ perceptions to mobile voting, a drive toward an e-government hence all strengths and shortfalls of this platform was ascertained.

9.5 Methods of data analysis and presentation
The data analysis methods that were used are: tabulation, representative diagrams such as graphs and pie charts. Critical analysis was carried out from the data obtained from students with much emphasis being put towards the independence of opinion to facilitate an unbiased result. Both qualitative and quantitative data was collected. As for qualitative data a descriptive approach was used to present and analyze data. Quantitative data was presented in tabular and graphical forms.

10. RESULTS AND ANALYSIS
After successfully implementing the system and collecting data there is need to analyse the data collected in order to derive meaningful conclusion. This section is going to examine the results obtained from the research and try to present them in a more meaningful way.

10.1 Data Presentation and analysis
The responses that the researcher obtained were eighty nine percent which represent a higher portion of the population. The cross-section of respondents is wide enough to warrant reliable findings and conclude that most of the respondents, students in particular are aware of the subject under study and are also eager to control and or add to other.

The largest numbers of respondents or questionnaires were distributed to students since they are the final users of the system and are somehow directly affected by the system. The table 2 shows a summary of questionnaire sent-responses received ratio.

<table>
<thead>
<tr>
<th>Table 3: Questionnaire Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target group</strong></td>
</tr>
<tr>
<td>Students</td>
</tr>
<tr>
<td>Elections administrators</td>
</tr>
<tr>
<td>Party representatives</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

10.2 Summary of questionnaire responses

Q1. The option to vote via the Internet influenced your decision to vote in the election.

The table below shows a summary of the responses on the above question.

| Table 4: Questionnaire Responses on influencing decision to vote |
The graph diagrammatically illustrates questionnaire responses summary.

![Graph showing questionnaire responses](image)

The majority of mobile voters found the process straightforward, 78 per cent rated the system as very easy to use. The majority of comments were positive about the system. Only 22 per cent of mobile voters found the process less convenient than going to the polling station because they were not used to technology.

**Q3. You have confidence that your vote would remain secret and would not be misused or altered once cast?**
The table below shows responses on the question according to the security of the system.

<table>
<thead>
<tr>
<th>Responses</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>4</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Agree</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Disagree</td>
<td>9</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>25</td>
<td>41.6</td>
<td>41.6</td>
<td>41.6</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The graph which shows responses from the above question of maintenance of secrecy.

![Graph showing results on security](image)

Confidence that the vote would remain secret and would not be misused or altered once cast was high; only 15 per cent expressed a lack of confidence about secrecy and 8 per cent strongly disagreed and were not confident that there would be no misuse or alteration of cast votes. Voters could not have stopped the process at any time once started and voted in the traditional manner, so even though a few were not confident about the process they still chose to use it.

**Q4. Mobile voting method can be used in future elections.**

The table below shows responses on the question according to the security of the system.

<table>
<thead>
<tr>
<th>Responses</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>4</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>Agree</td>
<td>0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Disagree</td>
<td>9</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>25</td>
<td>41.6</td>
<td>41.6</td>
<td>41.6</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The graph which shows responses from the above question of maintenance of secrecy.

![Graph showing results on security](image)
Table 6 below shows how the voters responded when asked the above question.

**Table 7: Questionnaire Response on applicability in future elections**

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>6</td>
<td>6.0</td>
<td>60.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Strongly</td>
<td>11</td>
<td>11.0</td>
<td>110.0</td>
<td>110.0</td>
</tr>
<tr>
<td>Unsure</td>
<td>22</td>
<td>22.0</td>
<td>220.0</td>
<td>220.0</td>
</tr>
<tr>
<td>Strongly</td>
<td>28</td>
<td>28.0</td>
<td>280.0</td>
<td>280.0</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>100.0</td>
<td>5900.0</td>
<td>5900.0</td>
</tr>
</tbody>
</table>

The mobile voters were asked whether they would be happy to use the method in future elections, more were prepared to use it in future students representative council elections (82 per cent). Those who were undecided or would not use mobile voting in a general election had two main reasons: security concerns; and a lack of occasion afforded by voting remotely.

**Q5. Will the mobile voting system be effective at BUSE? Is prior internet experience a factor that caused people to choose to vote via mobile voting?**

According to the responses obtained from the questionnaires experience proved to be a contributing factor to some attitude driven complications.

Resistance to change was a characteristic to those who did not have prior experience of the internet since most of their questionnaires reflected that they had never used online methods for voting, there was no way they could have favored mobile voting. Table 6 shows the responses.

**Table 6: Questionnaire Responses based on prior internet knowledge**

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>59</td>
<td>54.0</td>
<td>540.0</td>
<td>54.0</td>
</tr>
<tr>
<td>No</td>
<td>22</td>
<td>22.0</td>
<td>220.0</td>
<td>220.0</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>100.0</td>
<td>5100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

10.3 Responses towards ease of use and convenience

The elections administrators acknowledged the convenience of the system because it did not require manual collection of ballot boxes so that they may be counted at a central place; cost in terms of both time and money were in this case catered for.

10.4 Responses the security of the system

Responses from both the election administrators and the voter concerning the security of the system were that most of the population trusted the system and had confidence that their votes will not be used for wrong reasons or altered. Since the system was the one which performed vote tallying, user and administrators trusted the system because it eliminate human error associated with the traditional ballot casting method. The table below shows the results collected on the security of the system.

**Table 8: Questionnaire Responses to the system being secure**

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>19</td>
<td>85.0</td>
<td>190.0</td>
<td>190.0</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>20.0</td>
<td>40.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>100.0</td>
<td>2300.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

10.5 Assessment of factors that influence the effectiveness of the system.

**Q1. Navigation response by internet enabled phone Ownership**

The table below is a cross tabulation from the questionnaire responds.

**Table 8: Cross tabulation of navigation response by smartphone ownership**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphones</td>
<td>14</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>5</td>
<td>24</td>
</tr>
</tbody>
</table>

From above data (68%) many of whom owned smart phones were in agreement against 6 (32%) who are against the statement which says “Navigation and Data Entry is Easy”. This easiness in navigation may influence on the choice of the voting option.

We assume that those who voted in favour of the implementation of the mobile voting system in the elections to come had a better knowledge on computer systems.

10.6 Acknowledgement of the effectiveness of the system.

**Comparison tables for overall rating of the mobile voting system against current ballot**

Two elections were conducted (one using ballot casting and the other one using mobile voting supplementing ballot casting) and questionnaire were issued so that those who participated could give the overall rating of the two systems. The table below illustrates a summary of the responses obtained on the overall rating of the system.

**Table 9: Results of the overall rating of the current system and the mobile system.**

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>2</td>
<td>39.0</td>
<td>39.0</td>
<td>39.0</td>
</tr>
<tr>
<td>Poor</td>
<td>3</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Fair</td>
<td>3</td>
<td>30.0</td>
<td>30.0</td>
<td>30.0</td>
</tr>
<tr>
<td>Good</td>
<td>1</td>
<td>21.0</td>
<td>21.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>100.0</td>
<td>1000.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
The graph which shows results obtained on the overall rating of the system.

![Graph showing overall rating of current and mobile system](image)

**Figure 4: Overall rating of current and mobile system**

The issue of convenience was one of the ways that the researcher used to measure effectiveness of the mobile voting system. Respondents acknowledged that the system was easy to use, with the majority of the respondents agreeing that they found the system user friendly and convenient. Nevertheless, most internet voters agreed that the use of mobile voting can increase voter participation and were confident that their vote would remain secret and would not be misused or altered once cast thus most voter agreed that the overall quality of the voting system was good. With the majority of the respondents acknowledging change, the researcher concluded that to a larger extent supplementing traditional ballot casting with mobile voting can increase elections voter turnout and eliminate costs incurred by the traditional system.

**Comparison tables for voter turnout of elections held using the current methods of voting and the one using mobile voting supplementing ballot casting**

The mobile voting study pilot worked well overall. Mobile voting proved to be effective as a supplementing method to ballot casting in order to increase the voter turnout ratio as observed in the above tabulations. Elections conducted using traditional ballot casting only had a low voter turnout ratio of only 24(40%) students turning out for election. Comparatively, another elections conducted yielded a massive 85% voter turnout percentage thus outclassing the traditional ballot casting method. Diagrammatic represented, the comparison can be shown using the tale below.

**Table 10: Table showing results on the voter Turnout of Current and mobile systems**

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>%60</th>
<th>%50</th>
<th>%40</th>
<th>%30</th>
<th>%20</th>
<th>%10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>240</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voting systems</td>
<td>240</td>
<td>100.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile voters</td>
<td>26</td>
<td>10.0</td>
<td>65</td>
<td>65</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile voters</td>
<td>29</td>
<td>12.0</td>
<td>60</td>
<td>60</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>69</td>
<td>28.0</td>
<td>100</td>
<td>100</td>
<td>59</td>
<td>36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobile voting</td>
<td>60</td>
<td>25.0</td>
<td>100</td>
<td>59</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voter turnout</td>
<td>60</td>
<td>25.0</td>
<td>100</td>
<td>59</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Below the diagrammatic representation of the above tabulated results.

**Table 11 : Rate of Vote casting**

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Vidt Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>240</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Male voters</td>
<td>115</td>
<td>47.9</td>
<td>61.5</td>
<td>79.0</td>
</tr>
<tr>
<td>Female voters</td>
<td>125</td>
<td>52.1</td>
<td>38.5</td>
<td>21.0</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**10.7 Performance of the website**

To assess the effectiveness of the mobile voting system, it is also essential to assess its performance.

**Website reaction time measurement**

After four trials, the response time was averaged to be 0.612 seconds which is in the same range of 5s (DNS lookup and connection time) under the [22]. The site [22] was also used to test the performance of the researcher’s website and the produced results gave mobilevoting.byethost33.com an average index speed of 624 and a score of 84/100 with an average load time of 0.612 seconds. The connection time taken to download a webpage was also calculated basing on different connection rates. Due to the absence of too much graphics in the website (for it to be compatible with a wide range of mobile gadgets), the maximum downloading time for mobilevoting.byethost33.com was recorded at 22.75s at a connection rate of 14.4k. This falls in the range found on [21] meaning that the researcher’s site is performing optimally.

**Time taken to cast a vote as per questionnaire responds.**

Above 74% percent of the respondents indicated that the system took at most 10 minutes or at least 2 minutes to upload an assignment. Basing on this notion the system can be said to be effective since the researcher used this aspect as one of her measures of effect. However, 3.9% of the respondents indicated that the system was not reliable and also that it does not complete execution or takes even more time, more than time taken casting your vote using the tradition method, holding other factors constant.
low voter turnout ratio usually associated with this type of elections. To address the research questions, effectiveness was assessed after the turnout ratio of two closely related elections where compared, one using the traditional paper ballot system and the other using mobile voting as a supplement to ballot casting.

It is clear from the data obtained that mobile voting presents opportunity to engage more students to participate in SRC elections, thus increasing the voter turnout.

On the mock elections the results also showed that students who used the mobile voting were more than those who had to cast their votes using the traditional method.

11.2 Recommendations and Future work

The researcher recommends the design and implementation of mobile voting systems which can be used to conduct elections at higher levels (parliamentary, provincial or presidential), if governmental agencies can move toward a more technological and reliable method of voting so that we can conclude that mobile voting can indeed increase voter turnout. Future research is needed to evaluate the appropriateness of the selected model to alternative samples. The chosen model should be applied to different contexts in addition to student ages and different programs in order to paint a clearer picture of the general public’s intention to use a mobile voting system. Specific suggestions would be to target subjects who do not use the internet as frequently as the subjects in this sample, but may find mobile voting to be an attractive option.

The development of such a system was an insight to e-government and e-democracy. The system would help in reducing the frequency election fraud and costs through the employment of polling officers. Future work has to consider internet security since it is still prone to many breaches and thus security is compromised.

REFERENCES:


[22] http://www.webpagetest.org/result/120320_TE_3N5Q9/1/details/