

# University Elections Management Portal

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## Abstract

Elections form a critical process of many social institutions which uphold principles of representational democracy such as fairness to all and the right to have equal right by way of casting a vote [Alistair McConnachie, 2003]. This paper describes a research carried out at Taita Taveta University College, an institution of higher learning in Kenya and the process undertaken to achieve development and deployment of a web based system to promote free and fair democratic electioneering process: computerizing registration, voting and tallying process involved. The system was developed using the incremental prototyping due to the adaptive nature of web based applications and the system proved that a computerized solution is possible with elimination of human related faults that are a commonplace in employment of human clerks to manage the election process. Application of the online voting has resulted in many advantages in the efficiency of the entire electioneering process and reduced costs the university used to incur using the human clerk electioneering process.

**Keywords:** Internet Voting, Internet Securities, Fool proof

## 1. Introduction

Taita Taveta University College (TTUC) is a public university in Kenya vides legal notice No. 56 of the Kenya Gazette[Kenya, Legal Notice] as registered by the Commission of Higher Education, Kenya. On annual basis, the students conduct elections in order to elect their representatives in the student governing council. At the time of the research the college had an enrollment to the tune of 2000 students majoring in various programs of study it offered with different academic calendars. One group started its academic year in January and ended it in May. Another group of students joined in May to break for their long vacations in December and yet another team started its academic year in September till April the next year. Consequently, no single date could be scheduled to accommodate all the students. The University sets its voting date late October each year shutting out the students on long vocation (January to August Academic Calendar) and those who cannot make it to the University on that day. Moreover the traditional voting system could not be counted upon given the drawbacks in terms of collusion between the electronic officials and contestants, the queuing time, delayed results, overworked tallying officials and the undeniable fact of human errors. The existing voting system did not provide reliable statistics on voting history in the college and thus campaigners lacked the ground to apply scientific voter forecasting methods resolving to trial and error methodologies which are error prone and inconsistent.

Reinforcing a one voter one vote policy is difficult in such a situation and malpractices as rigging are not uncommon in human clerk system. Inconsistencies, election malpractices and untimely delivery of results led to questions as to the credibility and validity of the results the election results. Much expense was incurred in the production, transportation, storage and destruction of the ballot papers and ballot boxes. This called for a research to alleviate the situation whose objectives were

- i. To investigate user requirements for a web based voting portal
- ii. To provide a portal via which students of Taita Taveta University College can cast their votes online
- iii. To provide a system that automatically tallies cast votes for individual candidates
- iv. To provide a system that archives summarized reports and statistics with regard to the conduct of an election process
- v. To provide management and administration of Taita Taveta University College an easy way to manage and monitor the entire election process from a computer based interface.

The online voting system helped solve voting challenges that had been a commonplace in Taita Taveta University.

## 2. Literature Review

Voting is a democratic process whereby a group of individuals expresses its opinion and choice by way of casting a ballot. Ballot voting is often done as secret ballot where a voter's decision is not disclosed to other party. Online voting seeks to provide a web based interface via which voters can cast their votes and get results of the election process and is often referred to as internet voting or remote electronic voting. The idea of using Web as a virtual ballot box emerged in the early 2000s in USA with Arizona and Alaska pioneering the way, [newshour.com,2013]. These solutions were provided by third party software developers [votehere.com]. Several authors have had different views on the subject of online voting ever since.

Avi Robin, [A survey of Remote Voting Vulnerabilities,] present a number of security considerations

which need be borne when it comes to internet voting. According to him internet presents challenges which make development of a secure e-voting system next to impossible. He categorizes threats to e-voting security into malicious payloads and those targeting the delivery mechanism and proceeds to conclude that online voting is not technically feasible for public elections though he provides some permissibility for private elections where the political interest is not as much as in public elections.

David Chaum advocates for a scheme whereby voters could get receipts for their votes. This receipt would allow them to verify whether 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 inclusion of this improves credibility in the election process. He suggests that e-voting is technologically viable with application of cryptography and security reinforcement algorithms.

Matt Schultz and Tom Miller [2012] however protests that database matching in online voting processes had loopholes as illegal voters managed to get registered. This is a challenge that comes when a system provides online registration and should be well addressed to ensure such incidences never occur. The duo proposes a personal identity number to uniquely identify each voter and facilitate cross checking. Their insight was therefore of great aide in the design considerations of the system.

Dr. Michael Shamos presents Six Commandments summary of requirements for a voting which though similar to others' requirements, he maintains himself as less afraid of the catastrophic failures and sweeping fraud made possible by imperfections in electronic voting machines. Shamos is also much less impressed with paper ballots than are Neumann and Mercuri. He places a great deal of faith in decentralization to make fraud difficult to commit and easy to detect.

V. Kalaichelviand R.M. Chandrasekaran suggest online voting as a solution to curb the challenge of cheating in elections and provide a baseline for online voting system as that such a system should provide a high level of security and establish five core requirements of an electronic voting system to address issues of privacy, authentication, anonymous, uniqueness and coercion.

Acknowledging that the field of online voting has been subjected to debate for the past ten years ever since early 2000s when countries began to test it, Mr. Cuenca, expresses hope that 'it is only a matter of time when online voting will be active among cities of the world' as opposed to the forbidding approach of Avi Rubin that terms online voting an insecure venture.

Hitherto, a number of solutions have been developed to facilitate online voting five of which are reviewed in this paper.

University of Texas [A&M University] online voting system shows that web technologies can be harnessed to facilitate voting processes. The system exposes a web interface via which students log in and cast their votes during the electioneering period. In Kenya, universities and colleges have to rely on the human clerk electoral processes

### **3.1 Simply voting**

Simply Voting is a web-based voting system that facilitates online management of elections developed by Simply Voting Inc.

Simply Voting was designed from the ground-up to eliminate the risk of electoral fraud. Voters who bypass authentication or have already voted are denied access to the ballot, and ballots are checked for validity before being accepted. Nobody could ever find out what a particular voter has voted as the results are stored anonymously.

Communication between client computer and the hosting website is encrypted with 256-bit SSL, [secure shell language], the highest level of protection. The servers are "hardened" and are routinely subjected to PC I [peripheral component interconnect], Compliance security scans. Our application code adheres to guidelines set out by the *Open Web Application Security Project*.

The system requires creation of an account that will be used to manage an institutions elections right from registration of candidates and voters to release of finalized results.

**[available: [www.simplyvoting.com](http://www.simplyvoting.com)]**

### **3.2 BigPulse**

BigPulse presents an integrated solution to online elections management right from the nomination process to the finalized results presentation.

While the above systems provide solutions, an organization may not feel at home with an outsourced solution hence the need for in house developed solution which could be cheaper and easier to manage: update and maintain at will.

**[Available at [www.bigpulse-vote.com](http://www.bigpulse-vote.com)]**

### 3.3 Campus-vote.com

In this system ballot set-up and voter registration is web based, so no special software is required. The third party [campus-vote.com] provide a secure WWW server account and built-in automated email merge system for sending ballot registration info to each voter. The solution allows an institution to administer its own elections or have their staff do it.

Security is ensured by use of vote secret codes known only to an individual voter. The system provides both provisional and final results with summary statistics and graphs.

Available at [ [www.campus-vote.com](http://www.campus-vote.com)]

Other solutions are voting2point0 [[www.voting2point0.com](http://www.voting2point0.com)] and fairvote [[www.fairvote.com](http://www.fairvote.com)]

## 4.0 Case Study Development

### 4.1 Problem Statement

Management of electioneering processes at Taita Taveta University was painstakingly challenging with use of traditional human clerk electioneering process.

Scheduling a single voting date in scenarios where the members are not guaranteed, as the case for most universities, to be at the voting venue during the scheduled date provides a challenge to conducting a fair election in the universal standards of democracy.

Moreover the traditional 'human clerk' mechanism could not be counted upon given the drawbacks in terms of collusion between electoral officials and the contestants, the queuing time, delayed results, overworked officials and the undeniable aspect of human error. The existing system did not provide reliable statistics on voting history within the colleges and campaigners lacked the ground to apply scientific voter forecasting methods resolving to trial and error methodologies which are error prone and inconsistent. Reinforcing a one voter one vote policy is difficult in such a situation and malpractices as rigging are not uncommon in human clerk system.

In the light of the afore-stated challenges it was deemed necessary to come up with a system that addresses them and ensures that students vote at their comfort: wherever and whenever, control paper wastage and provide credible tallying and tabulation of votes.

### Systems Development

The University opted for an in house development solution due to the forbidding costs of third party proprietary solutions and also the need to manage its own server without relying on an external party which may introduce unreliability.

The development methodology adopted for the system was incremental prototyping due to its provision of quick feedback between users and the developer in between the development period as the users are able to test the developed components and their functionality. With incremental development the software product is released in iterative versions where each subsequent iteration is a refinement of the previous one.

### System Architecture

The system architecture involves the web browser sending hypertext transfer protocol requests to a remote web server via a communication network. The web server sends SQL queries to the database server. The database server responds with SQL result sets which it returns to the web server. The web server processes the response and responds with formatted Hypertext Mark Up Language appropriate for display by the web browser. The diagram below illustrates a generic architecture of the system.

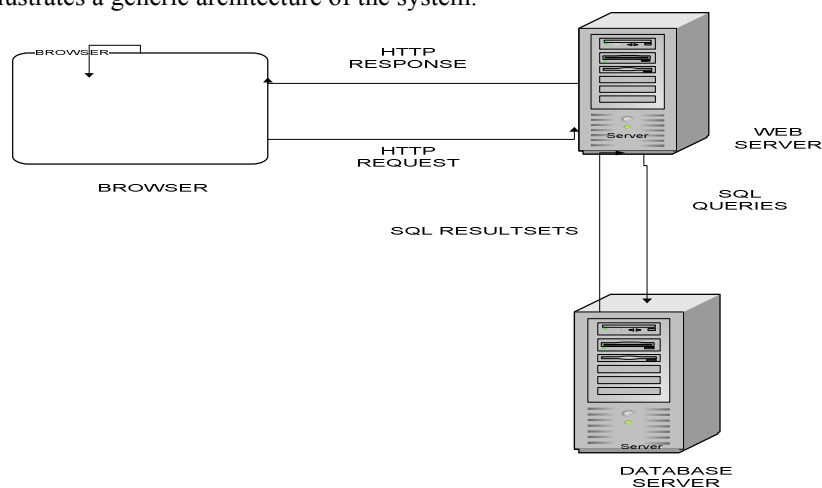


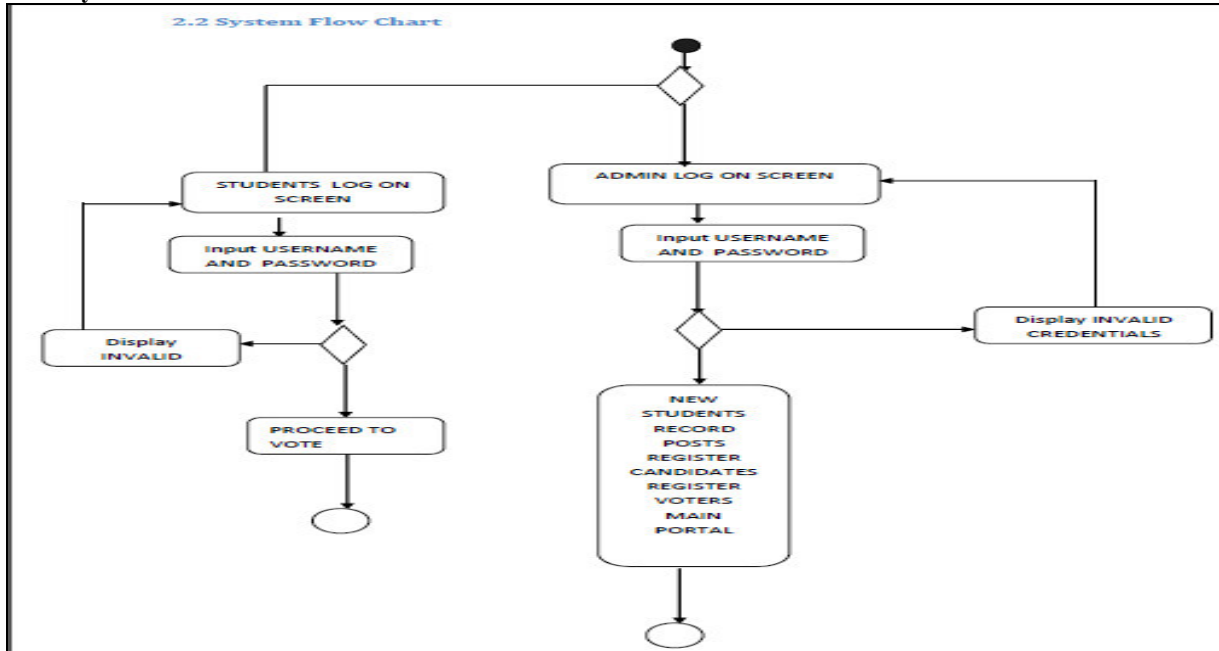
Figure 1 System Architecture

[adapted from <http://www.kuenkadesign.com/security-landscape-of-online-voting>]

## 4.2 Conceptual Design

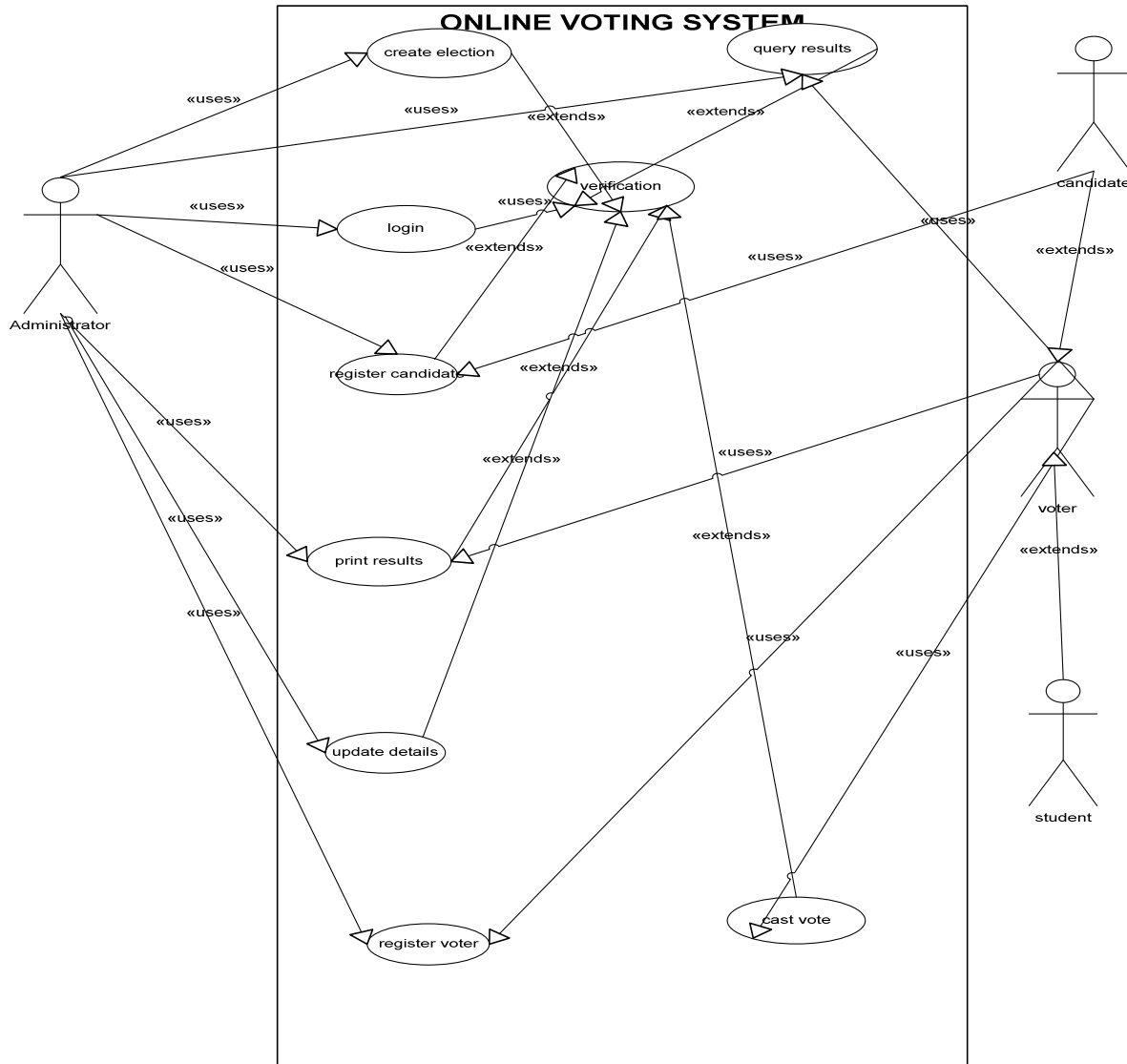
The conceptual design was done using system flowcharts and use case diagrams.

### 4.2.1 System flowchart



[adapted from ]  
**Figure 2 Flowchart**

### 4.2.2 Use case diagram



[adapted from <http://www.agilemodeling.com/essays/umlDiagrams.htm>]

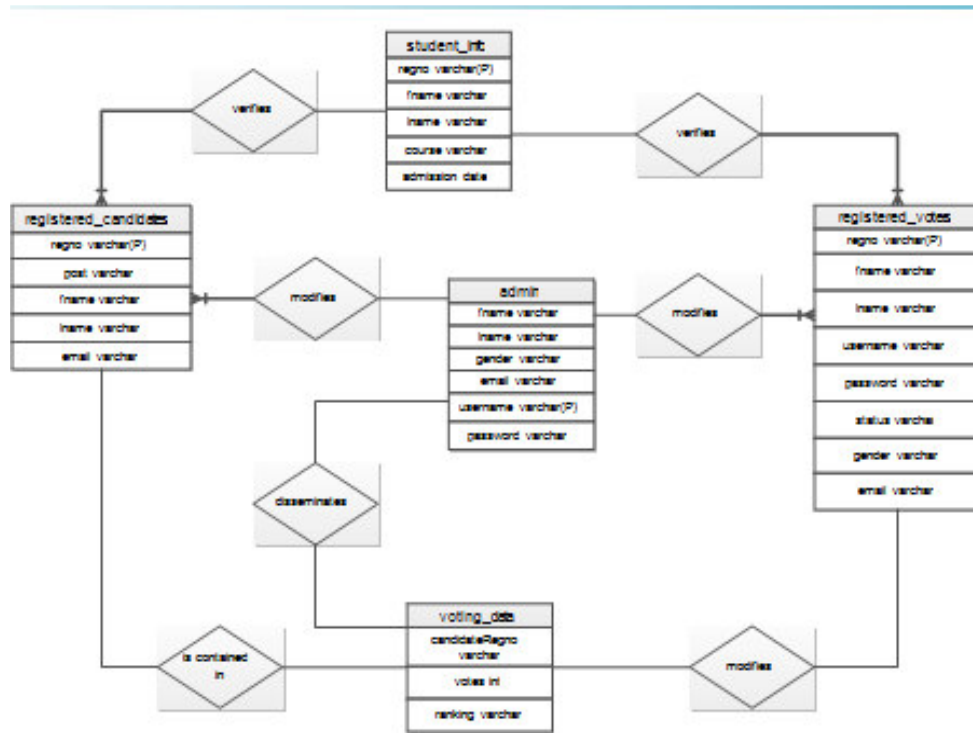
**Figure 3 System Use Case**

### 4.3 Physical Design

The system design was implemented using an entity relationship diagram which captures the relationship amongst the entities in the system.

#### 4.3.1 Entity Relationship diagram

The various entities in the system are as represented in the entity relationship diagram below.



[adapted from [http://folkworm.ceri.memphis.edu/ew/SCHEMA\\_DOC/comparison/erd.htm](http://folkworm.ceri.memphis.edu/ew/SCHEMA_DOC/comparison/erd.htm)]

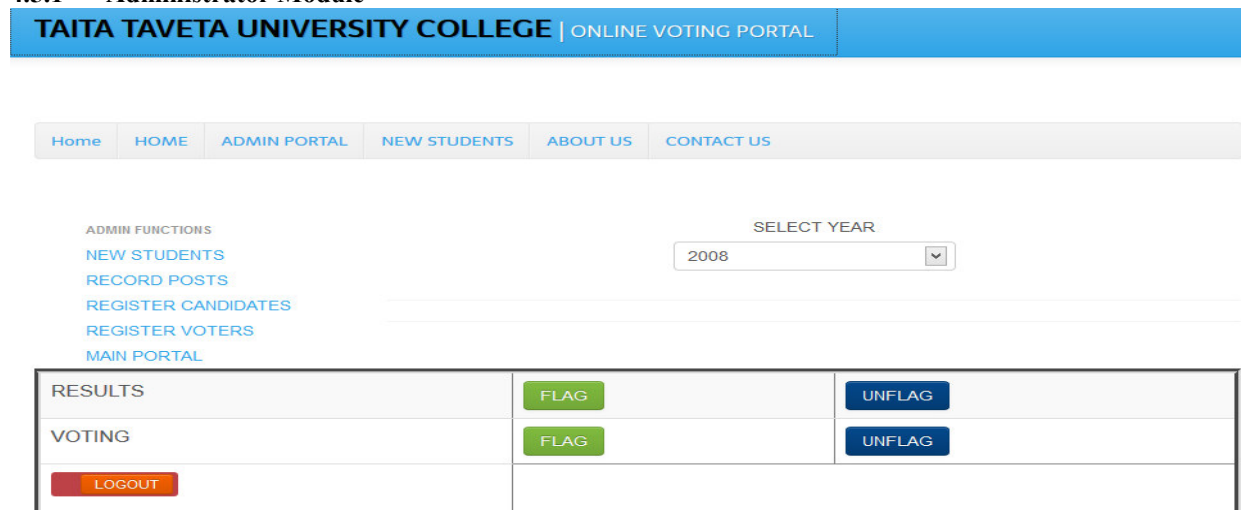
**Figure 4 Entity Relationship Diagram**

#### 4.4 Implementation

The system was implemented using PHP and MySQL server technologies. FrontlineSMS was used as a gateway for routing bulk SMSs which involved: voter secret codes, reminders on voting date and basic voting guidelines. The client side was done in DHTML set of technologies.

#### 4.5 System Modules

##### 4.5.1 Administrator Module



Copyright 2012 Designed by [www.ttuc.ac.ke](http://www.ttuc.ac.ke)

**Figure 4: Administrator Main Page**

#### Administrator log in

1. Use the link admin log in from the main portal
2. Enter administrator username and password.
3. Note the system currently provides for one administrator account.



4. Click submit to log in to your admin panel

#### Administrator's Panel

1. Add new student

Use the New Student link to open new record form

2. Add new Voter

Use the link Record Voters to register a student as a voter.

3. Adding new Candidate

Use the link Record Candidates to register a student as a candidate contesting for an elective post

4. Adding new post

Use the link Record Posts to add new posts to be contested for

5. Flagging on and off

Use the select year drop down and click flag or u flag to toggle between true or false states of voting or election flags.

Note voting flag is can only be set true for the current year only.

#### 4.5.2 Voter Module

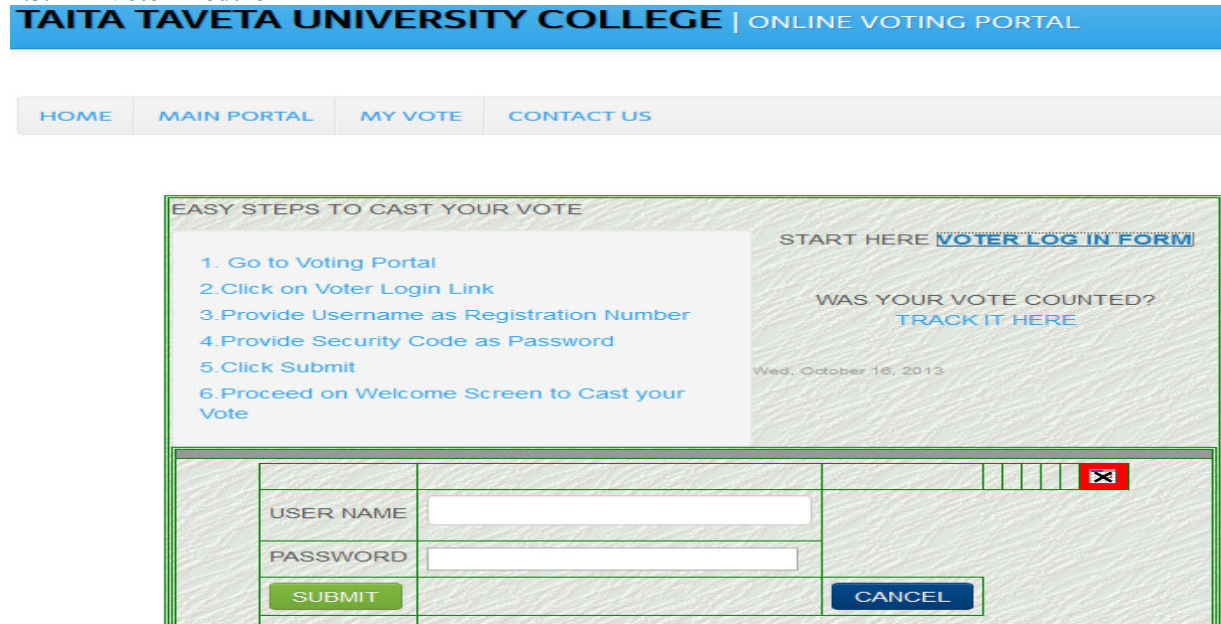


Figure 5 Voter Main Page

#### Voter log in

1. Use the link voter log in on the main portal
2. Enter your registration number as the username
3. Enter the secret code sent to you via SMS during registration as the password

Voter's Portal

#### Voting

1. Select the preferred candidates on the drop down lists for each of the post.
2. Click the submit button to cast your vote

#### Confirming your vote status

Use the link "confirm vote" on the main portal

1. Use the link Vote Confirmation link on the main portal
2. Enter username and password (secret code)
3. Click submit
4. You will be presented with a certificate with your voting details.

#### 4.5.3 General Users Module

The main portal has updated statistics for the current year on

1. Voter turn- out by hostel
2. Voter turn -out by department
3. Voter turn- out by gender
4. Voter turn -out by academic year

#### **4.6. System Deployment**

The following steps were followed to deploy the system after testing and acceptance by the organization

i. Subdomain creation

A subdomain was created to host the webpages and all other files as images, the cascading style sheet files and javascript files.

ii. Database importing

Using the hosting account, the database file was imported from the localhost (hosting environment) of the testing server.

Address: *www.vote.ttuc.ac.ke*

#### **4.7. System Maintenance**

The system maintenance is divided into the four main sections of maintenance as will be routinely carried out in the lifecycle of the system. Maintenance will be carried out at intervals of four months to ensure smooth running of the system.

##### **4.7.1 Corrective Maintenance**

Corrective maintenance involves those activities dedicated to fix potential bugs not initially detected and foreseen by the designers and will involve

- i. Having a help desk assistant to assist in error report logging as will be reported by users of the system
- ii. A provision for notifying the development team of the error to have the error fixed
- iii. Testing fixes of bugs and their impacts

##### **4.7.2 Adaptive Maintenance**

Changes in the organization will impact on the system and call for maintenance activities. Such activities that fall under adaptive maintenance are:-

- i. reorganizing and restructuring the database to reflect new admission criteria
- ii. addition of new tables in the database
- iii. adding new web pages that reflect added functionalities
- iv. integrating new technologies as biometrics in the system

##### **4.7.3 Perfective Maintenance**

This will be necessitated by the organization's desire to improve and realize more functionality from the system and will involve tasks as

- i. Upgrading from one web hosting server to another
- ii. Upgrading web hosting account
- iii. Adding more functionalities
- iv. Optimizing the portal for mobile and handheld devices using WML.

#### **5.0 Lessons Learned**

Voters are not always contented with the human clerk electioneering processes and would buy any attempt to alleviate this situation and more so reduce the time that one needs to spend in queues. As such online voting portals are highly welcomed as long as they prove to provide security and maintain the secrecy that is called for in voting. On the other hand developers have to be tasked to come up with simple yet secure systems as most users are put off by complexities against the ever evolving challenges to e-voting. While we cannot fully integrate with SMS functionalities helped increase safety and reliability of the system as this facilitated relying of voting information such as provisional results and confirming one's voting status.

#### **7.0 Recommendations**

Social Institutions which have democratic processes should embrace web technologies to manage their electioneering processes as this will improve their effectiveness of rendering such processes and save them huge costs and time. The application of web based approaches in solving electioneering processes should be applied even in managing national elections in developing countries. Moreover, with the advancement in technologies, biometric measures such as face and finger print recognition algorithms could be applied to enhance security and improve credibility of online voting systems. Thus this research forms a basis for further research on e-voting.

#### **8. Conclusion**

Web based portals provide a great opportunity to organizations, institutions and geographical entities as counties and countries which can be harnessed to promote free and fair elections. The system presented in this article provides a solution to many problems prevalent in democratic processes and can be extended to national politics level by countries in the developing world with some modification.



## References

- [1] Kang'ethe, M. S. (2002). *Introduction to Software Analysis and Design and Design*. Nairobi, Kenya: Envision Publishers. pp. 34-40.
- [2] McNurlin, C Barbara & Sprague, H Ralph, Jnr, 2002, *Information Systems Management in Practice*, Pearson Education Publishers, University of Hawaii, pp. 34-40.
- [3] Interim independent Electoral Commission, 2013, Interim Independent Electoral Commission, Nairobi, viewed 29th September 2013, <http://www.iiebc.org>.
- [4] T. M. Carbaugh. (2003) "*Secretary of State Kevin Shelley Announces Directives To Ensure Voter Confidence in Electronic Systems*," California Secretary of State.
- [5] D. L. Chaum. (2010), "*Untraceable Electronic Mail, Return Addresses, and Digital Pseudonyms*," Communications of the ACM, Vol.24, No.2, 1981, pp.84-88.
- [6] Rebecca Mercuri, "A Better Ballot Box?," IEEE Spectrum, Volume 39, Number 10,
- [7] Institute Policy Institute, 2000, "*Report of the National Workshop on Internet Voting: Issues and Research Agenda*," Proceedings of the 2000 Annual National Conference on Digital Government Research, pp.1-59.
- [8] A. M. Keller, et al (2005), "*A PC-based Open-Source Voting Machine with an Accessible Voter-Verifiable Paper Ballot*," Proceedings of the USENIX Annual Technical Conference, U.S.A. , p.52.
- [9] T. Kohno et al (2005), "*Analysis of an Electronic Voting System*," IEEE Computer Society, pp.27-40
- [10] Avi Rubi, "*Security Considerations for Remote Electronic Voting over the Internet*", AT & T Laboratories, Floharm Park
- [11] A. Anand and D. Pallavi, (2012). "*Analysis of an Electronic Voting System*," International Journal of Modern Engineering Research, Vol2, pp.2631-2634.
- [12] M. Andrews and J. A. Whittaker, (2006). "*How to Break Web Software: Functional and Security Testing of Web Applications and Web Servers*".
- [13] Alvarez, M. and T. Hall (2004) ."*Point, Click & Vote. The Future of Internet Voting*." Washington: Brookings Institution Press.
- [14] Burton, A.M. (2000). "*Does the revolution begin here? How the Internet may (or may not) change political communication*". School of Journalism and Communication, Carleton University. Ottawa, Canada.
- [15] Chaum, D. (2004) "Secret-Ballot Receipts: True Voter-Verifiable Elections." IEEE Security and Privacy, January/February 2004
- [16] Coleman, S. et al. (2002) "*Elections in the 21st century: from paper ballot to e-voting*." Report by The Independent commission on Alternative Voting Methods. London: Electoral Reform Society
- [17] Gerck, E. (2001) "*Voting System Requirements*". Presentation at WOTE 2001
- [18] Smith, V. (2002) "*Computerized Balloting is Taking Over Elections In Maryland--But Can We Trust the Results?*" Baltimore Citypaper Online, December 11 - December 17, 2002.
- [19] Snellen, I. (2001) "*ICTs and the Future of Democracy*." International Journal of Communications Law and Policy. Published March 8, 2001.
- [20] Shamos, M.I. (2004) "*Paper v. Electronic Voting Records: An Assessment*".
- [21] Watson, R. and B. Mundy (2001) "*A Strategic Perspective of Electronic Democracy*". Communications of the ACM. January 2001/Vol.44, No.1. Pp 27-30.
- [22] Scottish Qualification Authority (2013). *Creating Screen Based Prototype*. [ONLINE] Available at: [http://www.sqa.org.uk/e-learning/IMAauthoring01CD/page\\_09.htm](http://www.sqa.org.uk/e-learning/IMAauthoring01CD/page_09.htm). [Last Accessed 11 October 2013].
- [23] Coleman, Stephen. "*Just How Risky Is Online Voting?*." Information Polity: The International Journal of Government & Democracy in the Information Age 10.1/2 (2005): 95-104. Education Research Complete. Web. 15 June 2012.
- [24] SimplyVoting (2013). *Requirements of Online Voting*. [ONLINE] Available at: [www.simplyvoting.com/about](http://www.simplyvoting.com/about). [Last Accessed September 1 2013].
- [25] Bigpulse (2013). *Secure Online Voting*. [ONLINE] Available at: [www.bigpulse-vote.com/about](http://www.bigpulse-vote.com/about). [Last Accessed September 1 2013].
- [26] CampusVote (2013). *Reliable Online Voting*. [ONLINE] Available at: [www.campus-vote.com/about](http://www.campus-vote.com/about). [Last Accessed September 1 2013].

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