2012 3rd International Conference on e-Education, e-Business, e-Management and e-Learning
IPEDR vol.27 (2012) © (2012) IACSIT Press, Singapore

The Usability, Creditability and Security of E-voting System in Education Sector*

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Abstract. This paper introduces a usability experiment related to e-voting system, which aims to evaluate e-voing systems based on usability factors. This is done by developing e-voting system which aimed at improving the voting process by overcoming the pitfalls in the paper-based voting systems. However, there are usability problems are expected to appear with the application of e-voting systems. As a result, an e-voting system was developed and 7200 from PAAET student union were participated, and the system usability and credibility data were recorded. The result highlighted those design aspects that affects usability of e-voting systems, this is based on user preferences and usability. Finally, the research presents guidelines for developing usable and credible e-voting systems that can be made more accessible to designers.

Keywords: E-voting, usability, creditability, security, PAAET

1. Introduction

Voting is a regular practice in almost all democratic societies. Paper-based voting is the common method used in elections. It was originated as a system where votes are cast and counted manually by hand, using paper ballots. Manual counting requires a physical ballot that represents voter intent. The physical ballots are read and interpreted; then results are individually tabulated. Such a voting system may be used for recounts in areas where mechanical or automated counting systems are used.

Although this kind of voting systems is dominant by majority of election systems and in most countries, it is not without problems. Often, election results are followed with claims of cheat or fraud in the election process or due to procedural errors in counting or voting itself. In recent years, many incidents and problems in election process were documented. Other disadvantages of manual voting include slowness in both election process and results disclosure.

Electronic voting technology (also known as **e-voting**) may offer advantages compared to other voting techniques. It can speed the casting and counting of ballots and can provide improved accessibility for disabled voters [2]. Polling place of electronic voting or Internet voting examples have taken place in many countries including USA, Australia, and EU. In Middle East, humble attempts to use e-voting took place, including Kuwait were it being used in parliament elections in 2005, but a number problems faced the attempt and halted since then.

Although, applying e-voting system can overcome many paper-based voting systems issues, other problems related to security, usability, and creditability do still exist. Since the e-voting is relatively new and immature, there are a number of experiences and lessons that can be benefited from. For instance, a number of documented problems of e-voting were reported since the year 2000 presidential elections [1].

* The research is sponsored by PAAET on contract no. BE-10-12; Public Authority of Applied Education and Training, Kuwait
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The goal of this paper is to convey the experience of deploying the e-voting in the student elections of the Public Authority of Applied Education and Training (PAAET) in Kuwait. In this e-voting system, it was intended, among others, to eliminate the "invalid ballots" that usually appear in paper-based elections over past years. The results, however, shows relatively high number of "wrong votes" due to execution errors which voters made during e-voting. Execution errors occur when the prior intention by voter was correct, but the action was not as intended [6]. This happens due to improper or confusing designs. We are going to present the issues related in design recommendation and guidelines stemmed from the experience of implementing e-voting system in education sector of Arabic culture in Kuwait. We are going to describe, analyze, and list the outcomes of the PAAET E-voting system. Then, we will focus on the usability, credibility and security issues, and conclusion.

2. PAAET Student Union E-voting Election System

2.1. Paper-based method

The Public Authority of Applied Education and Training, PAAET (polytechnic university in Kuwait) decided to implement electronic voting system for the student union elections in the academic year 2009/2010. The e-voting system was developed by the PAAET Information Center. The objective was to overcome the difficulties faced the elections during the paper-based elections in past years and to save time and efforts in counting the votes to expose the results. The Faculty of Students Affairs at PAAET administrates the whole election process. PAAET consists of five faculties and ten training institutes and encompasses more than 26,000 students. For the election purpose, a number of eighteen voting centers are established around the campuses and distributed on eight geographic locations. The election system used the typical paper-based method and consequently a number of problems were encountered and repeated every year. The problem includes among others, slowness in procedures and inaccuracy of results. Also, high number of "*invalid ballots*" of wrong casting due to unawareness of the voters by the election rules. Also, the transmission of ballot boxes physically from the ballot centers to the central office, to start the consolidating procedure is done manually using tabular method, was a tedious job. For these reasons and others, the PAAET authorities decided to utilize the technology to computerize the voting system in replacement to the paper-based method.

2.2. PAAET e-voting system

The main objectives of the proposed e-voting system are formulated to:

- Fast results disclosure
- Accurate results counting
- Eliminate "invalid ballots"

Physically, the system consists of a controller and a number of voting devices as depicted in Fig.1. Each voting device is given a distinct number and connected to a private printer. The voting devices are connected by local network to the controller. The controller controls the voting devices by closing and opening sessions for voting. The (electronic) votes from voting devices are consolidated into a database in the controller.

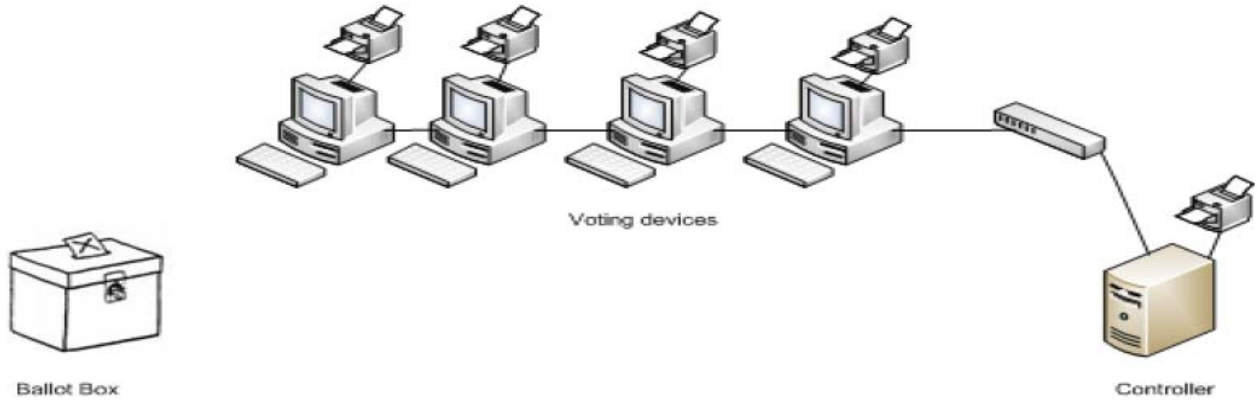
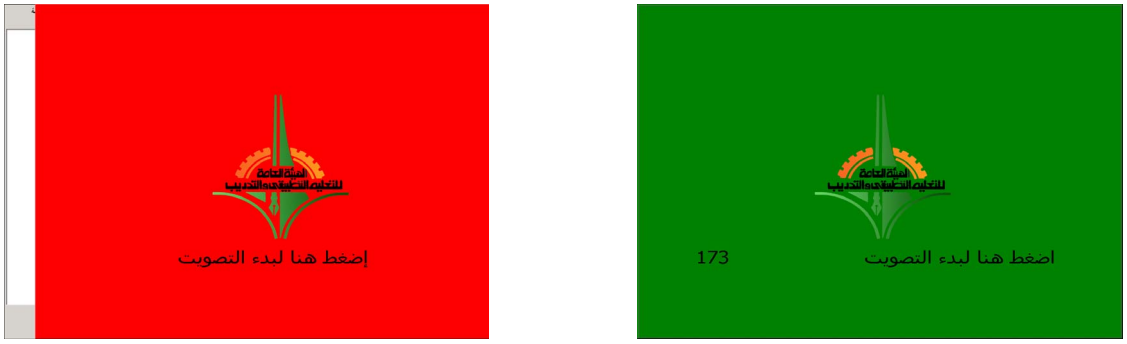


Fig 1. A Schematic Diagram for E-voting Election Center



a) Closed session b) Opened session

Fig. 2. Starting screens of the e-voting system

Operationally, the election system consists of three stages: authentication, voting, and casting in the ballot box. The authentication stage aims to ensure the identity of the voter. The authentication is performed manually by the administrator who checks the identification of the voter and ensures his/her eligibility with the list of names in the database stored in the controller device. Once authenticated, the administrator opens a session on one of the closed devices (i.e. closed sessions is red colored display); assigned specifically for the voter. The voter is guided with the number of the voting device and a maximum allowed time of three minutes is counted to reach the device and start voting. Then, in the voting stage, a session is opened (the display color of the screen is changed from red to green) on the specified voting device for three minutes only (otherwise the session is closed and the display color is changed from green to red) to allow the voter to reach the voting device as in Fig. 2. The voter will first see a green-colored screen with a welcome message; once the voter clicks on any button, the user is displayed with another screen with option to choose either one complete list of candidates or to choose a maximum of seventeen candidates distributed over the lists.

Voting for group was implemented in the system in just one mouse-click to automatically selecting all the seventeen members of a particular list; voting for individuals was implemented in the system to independently selecting at most seventeen candidates individually from various lists (at most seventeen mouse clicks).

The voter supposed to finish the selection within three minutes and to choose a maximum seventeen candidates. For this reason, the voting screen supplied with a timer which decreases by seconds; and with a counter increases on each new selection. Once the user selects the candidates, a review screen of the choice made is displayed with a submission button to submit his/her ballot electronically to the controller. Once the voter confirms his/her selection, a print-out ballot is printed automatically. The printed ballot contains the entire names of the candidates sorted alphabetically and a symbol in front of the names the voter selected. The printed ballot contains also an identification number at the button of paper. The number is actually is concatenation of four numbers: the student id-number, the voting- device number, election center number, and a random number. Finally, in the ballot stage, the voter drops the printed ballot in the ballot box. The paper ballots are used to crosscheck with the electronic results in cases of dispute only.

The system described above was implemented in eighteen election centers, distributed among the colleges and institutes of PAAET. At the end of the election day, all the ballot boxes and the controllers were moved to the central office to start counting process. The counting process is performed electronically by connecting all the controllers to a server that is prepared to retrieve the votes of each controller to a main database in the server. Then, a SQL program counts the votes and produces the elections results and statistics in milliseconds.

The statistics generated from the system shows that among 25,000 registered and eligible for voting, only 7200 student were actually participated in this e-voting election. Among them 371 vote was indicated as "invalid". The ballot box was kept as backup only for appeal cases from candidates who might be skeptical from credibility of e-voting results. However, the credibility of the e-voting system was tested indeed; the

ballot box was counted manually and the results were cross checked with results of the e-voting system and both were identical.

2.3. Security Analysis

The security of an e-voting system depends on the technology used or the services provided. However, issues like authentication, anonymity, privacy are common concerns and essential requirements in any e-voting system [4]. In evaluating the security of PAAET e-voting system, one can analyze the following issues:

Authentication: this requirement ensures the eligibility of voters, which means that only individuals belonging to the group (registered & citizens students) may vote. Authentication in the PAAET e-voting system is achieved manually through matching and checking the identity of a voter with the list of names.

Anonymity means that no observer can learn how a voter voted. This requirement however, was not fulfilled in the e-voting system. In fact, each printed ballot is tagged with a unique number formed by concatenation of four numbers: the student-id, voting-machine, election center, and a random number. The goal was to achieve *individual verifiability*, which means a voter can verify that his/her vote counts for the correct candidate, and *eligibility verifiability*, which means that anyone can verify that the set of cast votes originates only from eligible voters, and eventually to achieve *universal verifiability*, which means given the set of cast votes, anyone can verify that the announced result is correct. This precaution was needed, being first attempt of deploying e-voting system, to reassure skeptical voters of e-voting system and to provide evidence against possible appeal to the outcomes of the election.

Privacy is not fully achieved since the tag number might expose the identity of the voter (if needed to do so).

3. Improved E-voting system

The lessons learned from the system were depicted in an improved version of the e-voting system. The original e-voting system discussed in Section 2 used the mouse as pointing-device, and the interface used dropped-menus to select the group (list) of candidates. The improved version of the e-voting system has changed in both hardware and software. In hardware, a 17" touch screen replaced the typical monitor and mouse device. From the software side, the interface was improved to guide the user in step by step manner with guiding and alert messaging for possible miss action. The first improvement was that all candidate names (individual and groups members) were displayed on the screen, in button-shape, and sorted in alphabetical order. This gives an equal chance to all candidates to display their names; besides it resembles the actual paper-based ballot. At the same time, the names of the groups (list) were displayed at the bottom of the screen. When a voter wants to vote for a group, he or she can touch the corresponding group-name button and consequently all the candidate names belonging to this group are marked with a tick on the corresponding name-buttons. The other improvement was that each group buttons was given a color, and consequently their candidate names buttons have the similar color. The individual who are belonging to specific group were marked with star symbol rather than a color. Fig. 3 represents a snapshot of the improved e-voting system.

Fig. 3. Snapshot of the improved e-voting system

These enhancements in the designing the interface has improved the usability and creditability of the e-voting system and have reduced the confusing that appeared in the first design that led to high number of invalid ballots.

4. Conclusion

The paper conveys the experience of implementing e-voting system. It focuses on the importance of careful design of the user-interface devoted to the use of wide range of users of different level of expertise with using computers. The system should be easy to use, simple to understand, and free of confusing designs.

5. Acknowledgment

The authors wish to thanks the Researches Department at the Public Authority for Applied Education and Training (PAAET) for their generous funding of this research under contract number BE-10-12.

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