WEB SYSTEM TO ADMINISTER ELECTORAL PROCESSES IN AN ACADEMIC COMMUNITY

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ABSTRACT

This paper presents a web system to administer electoral processes of representatives carried out in universities. The web system has different functionalities, such as the announcement of elections, registration of candidates and voters, electronic voting, publication of results, among others. The representatives that participate in electoral processes are teachers, students and administrative staff of the university. The main objective of the web system is to encourage the participation of the academic community in these types of processes. A comparative analysis of existing similar systems is presented, where some important features are considered, such as the possibility of the system to adapt to different devices, email notifications, vote printing, customizable interface, user authentication, text and graphic results, security, among others. The requirements gathering and the implementation of the web system are shown.

KEYWORDS

Academic Community, Electoral Processes, Electronic Voting, University, Web System

1. INTRODUCTION

Information and Communication Technologies (ICT) have evolved rapidly throughout the world, which has led to an increase in the automation of various types of processes, in most cases successfully. The automation of electoral processes has been one of the issues in which computer systems can support the protection of votes and ensure transparency in the results. Téllez (2010), Ace (2018), and Cáceres (2011) show that electronic voting systems for electoral processes have been implemented in various places around the world.

This article presents an electronic voting web system to be used in the election of representatives of university collegiate bodies, which are in charge of decision making at different levels. The representatives that participate in electoral processes are teachers, students and administrative staff of the university. The main objective of the web system is to encourage the participation of the academic community in these processes.

The rest of the paper is organized as follows. Section 2 presents some background information on electronic voting systems. Section 3 explains the composition of the two collegiate bodies that exist in the Universidad Autónoma Metropolitana (UAM), which is in Mexico City. Section 4 presents a comparative analysis of five existing electronic voting web systems. Section 5 describes the current process for electing representatives to collegiate bodies in the UAM. The requirements gathering for the construction of the web system is presented in section 6. The implementation of the web system is described in section 7, where some screenshots of the system in operation are shown. Finally, section 8 provides conclusions and future work.

2. BACKGROUND

Electronic voting systems have been used since the 1960s, when electronic card punching systems came on the market, after that optical scanner systems, later Electronic Direct Registration systems, and finally, web-based electronic voting systems that operate through the Internet (Ace, 2018). Electronic voting systems are not new, because they have been in use for several years.

Thomas Alva Edison was the first to patent an electronic vote recorder, in which an electrographic record of the votes was established; this invention aroused the interest of many people around the world (Téllez,

2010). In Mexico, around the 19th century, the idea of making the election process more efficient and reducing both monetary and human costs was born, as well as electoral fraud and the error in the counting of votes. It is important to mention that throughout history there have been several voting systems, such as the following.

1) Voting system using punched cards: the voter's option is punched in the card by means of a mechanical device; then a tab counts the perforations for each option. In this type of system, the voter must be present to vote. Although this method is now obsolete, it is still used in some states of the United States of America.

2) Voting system using a reading device: it is a system capable of reading the vote that is made with a pen on a sheet of paper. This voting process is in person; the voter must be at the polling place. It is worth mentioning that the voter does not interact directly with the system.

3) Voting system using direct recording devices: it is similar to an ATM, which has touch screens and a keyboard. The system registers the vote or alternatively another external device is used, such as a magnetic card reader. The voter interacts directly with the system.

4) Remote electronic voting system: this type of system allows to vote from any device that is connected to the Internet, so it is not necessary for the voter to attend a specific place to vote, since they can do so from their device.

3. THE COLLEGIATE BODIES

The UAM has two collegiate bodies: the Divisional Council (UAM-CD, 2020), which is the body in charge of making decisions at the division or faculty level, such as the approval of study plans and programs, the approval of programs of social service, the approval of school equivalencies for students, the approval of optional courses, among others; and the Academic Council (UAM-CA, 2020), which is the body in charge of making decisions at the unit level, such as the approval of study plans and programs, the approval of the members of the divisional editorial board and committee, the approval of the members that compose the divisional commissions, the approval of guidelines and instructions, among others.

The collegiate bodies are composed of authorities, teachers, students and members of the administrative staff of the University. In the case of the Divisional Council, it is composed of ten members: the director of the division, the heads of the three academic departments that are in the division, a representative of the teachers for each of the academic departments of the division (three representatives in total), and a representative of the students for each of the academic departments of the division (three representatives in total). The case of the Academic Council, being an instance at the unit level, is composed of a total of 33 members, among which are unit authorities, teachers, students and members of the administrative staff, as follows: vice-chancellor of the unit, the directors of the three academic divisions of the unit, the heads of the nine academic departments of the unit, a representative of the teachers for each of the academic departments of the unit (nine representatives in total), a representative of the students for each of the academic departments of the unit (nine representatives in total), and two representatives of the administrative staff of the unit.

The vice-chancellor, division directors and department heads are university authorities, so it is not necessary for them to be elected to participate in collegiate bodies. In the case of teacher representatives, student representatives, and administrative staff representatives, all of them must be elected through election processes where the members of their respective departments vote through ballots that they deposit in physical ballot boxes. This process takes place on a single day each year for the Divisional Council, and every two years for the Academic Council; this day is determined by the collegiate body itself, and the polls are available from 9:00 a.m. to 3:00 p.m., normally.

In these electoral processes it has been observed that the majority of the members of the university community (especially students and teachers) do not participate due to various factors, such as: there are students and/or teachers who do not have classes on the election day, and they do not attend the University; there are some other students and/or teachers who have classes at the time of the election and cannot attend to vote; or they simply do not know where the polls are located; among others.

Due to the little participation of the university community in these processes, an electronic voting web system was developed for the election of representatives to the Divisional Council and the Academic Council. It is possible for the community to access the system from anywhere and vote without having to attend the University or cancel their activities.

4. EXISTING WEB SYSTEMS

This section describes the operation and the most relevant features of five electronic voting web systems that were analyzed: Simply Voting (2020), voting system of the Taita Taveta University (Nzoka et al., 2013), BallotBin (2018), voting system of ESIME (Gallegos-García et al., 2011), and a voting system based on reliable web services (Omidi and Moradi, 2012).

4.1 Simply Voting

According to its creators, Simply Voting (2020) is a voting web system developed to eliminate fraud and keep the vote secret. The system handles two types of users: system administrators and voters. System administrators have the ability to create elections, register, edit, and delete voters and candidates. When an election is created, the following information must be provided to the system: name of the election, description, start and end date of the election, as well as the start and end time of the election.

In each election, the set of users who can vote is determined. The administrator can register them one by one, or import a file with a .csv extension that contains an identifier for each voter using only numbers, name, email and optionally a password (if not provided, the system creates it automatically). The web system gives the possibility of determining whether the voter will be able to choose one or more candidates in a given election. The system administrator registers the candidates who will be associated to the election. In the case of voters, they will have the possibility to vote in a specific election, for one or more candidates, according to what was specified in the election. At the end of an election, the results are published automatically.

4.2 Voting System of the Taita Taveta University

It is a web system that was developed at the Taita Taveta University in Kenya (Nzoka et al., 2013), which was implemented using PHP and MySQL. In order to carry out an election, two types of users are required: administrator and voter. The module for administrators allows access to the system by means of a user name and password, and only one administrator account is allowed. The system allows the administrator to add students, who will participate in the election (voters), and students who can run as candidates. The module for voters also allows access to the system by means of a registration number and a secret code as a password; this is sent to each voter via SMS. The system allows the voter to choose the candidate of their choice and send their vote. Voters can see the details of their votes without modifying them; in order to print their vote details, they must re-enter the registration number and password.

4.3 BallotBin

It is a web system that allows the management of votes or surveys (BallotBin, 2018). In the case of voting, the system allows two types of users: administrator and voter. Administrators are in charge of various tasks in the system, among which the following can be mentioned: creating the electoral ballot with its features, determining the set of candidates participating in the election, controlling who can vote, registering emails of voters participating in the election, notifying voters who were registered to vote via email and sending reminders to those who have not participated.

The system includes a voter registration module, where the emails of each voter are registered or a bulk upload through a file is also possible. For voters, the email sent to them includes a link that takes them to the voting page. Once inside, they fill out the ballot choosing the candidate of their choice and they send their vote. When an election ends the results are published; the number of votes for each candidate is displayed, the percentages of the votes are also shown, and the total number of votes obtained are visualized in a bar. BallotBin ensures that voters only vote once through the link that is sent by email.

4.4 ESIME Electronic Voting System

It is a system that is designed, implemented and tested by the students of the High School of Engineering, Mechanics and Electrical – ESIME (Gallegos-García et al., 2011), which is composed of four stages: registration, authentication, registration of votes and counting. The system has different profiles to control access to information, one for voters and one for the administrator.

Some features of the system are the following: 1) only registered voters can vote once; 2) only authorized persons can edit, add or delete system information, but they cannot interfere with registered votes; 3) the process does not depend on a public network; 4) the system has a series of algorithms to encrypt the information and avoid to be able to know who is voting for whom.

4.5 Voting System based on Web Services

It is a proposal for a voting system based on reliable web services (Omidi and Moradi, 2012). The system has the following components: 1) encryption and decryption component, which is a module that ensures that the information is secure and that it is encrypted when it is sent; 2) intrusion detection system and SSL, which are components that ensure that the information exchanged between the web server and the client is encrypted in order to ensure that it is not accessed and have secure connections; 3) component for the registration of votes, in which the votes are stored as long as there is no more than one vote per voter; 4) component for presenting the results, which is in charge of calculating the votes for each candidate and presenting them to the authorities.

For each voter there is a personalized interface depending on the features of the voter. For example, if the voter is visually impaired, the system provides them with audio so they are able to vote. In order for the voters to vote, days before the election, they are given a card containing a username and password that will allow them to enter the voting portal. This password and username were previously registered in the system's database. Once the voter enters these data, the system verifies that they have not vote.

4.6 Systems Comparison

This section presents Table 1, which shows the features that were taken into account for the analysis of electronic voting systems. The tick indicates that the system has the feature, and the cross indicates that it does not have it. The systems presented in Table 1 are those that were analyzed in the previous sections: S1) Simply Voting, S2) Taita Taveta University voting system, S3) BallotBin, S4) ESIME electronic voting system, and S5) voting system based on web services.

Table 1. Comparison of features of the analyzed systems

Feature	S1	S2	S3	S4	S5
F1) Web system	✓	✓	✓	✓	✓
F2) Adaptable to mobile devices	×	×	×	×	×
F3) Notifications via email	✓	×	✓	×	×
F4) Vote printing	✓	✓	×	×	×
F5) User authentication	✓	✓	✓	✓	✓
F6) Custom interface	✓	×	×	×	✓
F7) Presentation of results in text	✓	✓	✓	✓	✓
F8) Presentation of results in graphs	×	×	×	×	×
F9) Single vote	✓	✓	✓	✓	✓
F10) Registration of election	✓	✓	×	×	✓
F11) Registration of candidates	✓	✓	✓	✓	✓
F12) Registration of voters	✓	✓	✓	✓	✓
F13) Complaints and suggestions	✓	×	×	×	×
F14) Confirmation of the vote	✓	×	✓	✓	×
F15) Security	✓	✓	✓	✓	✓
F16) Creation of categories (voters)	×	×	×	×	×

5. CURRENT ELECTION PROCESS

This section presents the current process for the election of representatives of teachers, students and administrative staff, which is carried out in different stages that are described below.

First stage: publication of the call. At this stage, the call for the registration of candidates for the election of teachers, students and administrative staff is published for each of the corresponding departments. In order to carry out the rest of the stages of the process, there must be a published call.

Second stage: registration of candidates. At this stage teachers, students and members of the administrative staff are involved. Anyone can register, but the head of the technical office is the one who decides if they meet the requirements to be a candidate. Subsequently, a list is published with the registered candidates for each department.

Third stage: voting. In this stage teachers, students and administrative staff participate, who issue their vote for a particular candidate from their department. This is done on a particular day, on which ballot boxes are set up for the election to take place for each department.

Fourth stage: publication of results. At this stage, the results are presented in text to the entire community. It is important to mention that at this stage the electoral committee (council members) is involved, who is in charge of counting the votes and subsequently issues a report with the results of the election. At this stage, a report is also published with the disagreements or anomalies that were found in the electoral process, if any.

Figure 1 shows the complete process graphically, with each of the stages for the election of representatives of teachers, students and administrative staff that belong to the collegiate bodies of the UAM. The people involved are also illustrated in each of the stages.

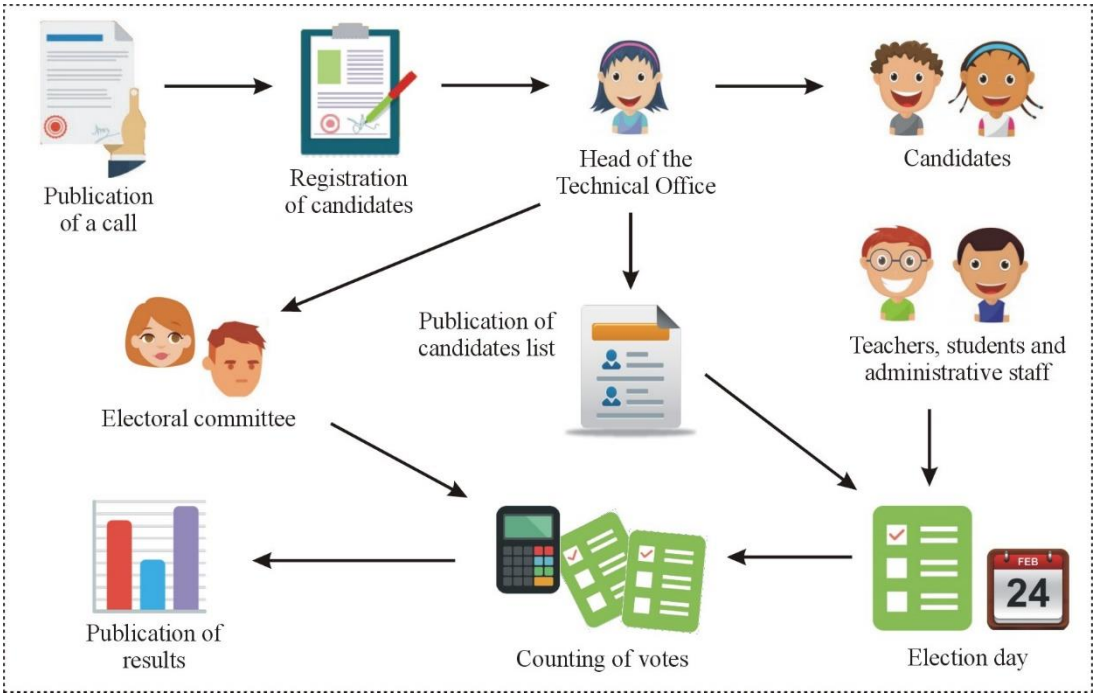

Figure 1. Process for electing representatives in the UAM

6. REQUIREMENTS GATHERING

In order to develop the electronic voting system presented in this paper, an iterative and incremental methodology was used with several stages that were carried out in each iteration as stated by Jacobson et al. (1999), Booch et al. (2005), and Sommerville (2015): requirements gathering, analysis, design, implementation and tests. This section presents the requirements gathering that was carried out, for which it was decided to go to the Head of the Technical Office of the Academic Council of the UAM, since she is the person who knows the entire process of electing representatives to unit level. Several interviews were carried out and the necessary information was obtained to know in detail each of the stages of the elections. Below there are some examples of the requirements, classified into user and system requirements, obtained from the interviews and the documents collected. Within the user requirements, it was requested that the system should provide access to four different types of users: administrator, teacher, student and member of the administrative staff.

6.1 Requirements for the Administrator

Creation of a new call, in which the important dates and times of the election process are specified, such as the date and time of publication of the call, date and time of registration of candidates, both initial and final, as well as the dates for the day of voting and the publication of results.

Call calendar, in which it is possible to view the important dates of a call that has been published, such as the dates of registration of candidates, voting and publication of results.

Modification and elimination of a call, in which it is possible to modify or delete a call that has been created, but not published. The calls that have already been published do not accept modifications.

Visualization of applicants, in which it is possible to view the applicants who have registered in each department, both for teachers, students and administrative staff. It must also be allowed to indicate whether an applicant becomes a candidate if it meets the requirements specified in the call.

Visualization of results, in which the results obtained in the elections by department will be shown. The visualization must be textual and through graphics for a good interpretation.

6.2 Requirements for the Teacher, Student and Member of Administrative Staff

Registration of the applicant, in which the teacher, student or member of the administrative staff can register their information and the documents that support their request, so that they are later evaluated by the Head of the Technical Office (administrator) and it is determined if they can be candidates.

Notification of acceptance, which will be used to inform an applicant if it has met the requirements to be considered as a candidate in an election.

Voting ballot, which will be used for users to issue their vote. Photos of candidates, their names, and only one candidate (teachers or students), or two candidates (administrative staff), must appear on it.

Visualization of vote, which will allow the user to see their vote, once the user has issued it.

Visualization of results, which will be available once the voting is finished. The results must be public, so that a user can visualize the results of any department that has been in election, regardless of their affiliation.

6.3 System Requirements

Some of the functional requirements that were identified are the following:

1) When creating a call, the system must verify that all the fields have been filled in correctly, as well as make a validation of the dates that are entered in a call. For example, it should not be possible to create a call with a voting date that is later than the results publication date.

2) When making a request for registration as an applicant, the system must verify that all fields have been filled in correctly, as well as notify the applicant if they have been accepted as a candidate, once the administrator has validated their information.

3) When making a request to issue a vote, the system must check if the user has already voted. If not, the system must visualize the ballot with the photos and names of the candidates registered in their department. In case the user has voted, the system will show the details of the vote.

4) When making a request to visualize the results of an election, the system must display the results in text and graphically, regardless of the affiliation of the user who made the request.

5) The system must respect the dates for each of the stages of an election. For example, the system should not allow the registration of candidates if a call has not been published; it cannot allow voting if it is time to register or publish results; it cannot visualize the results if it is time to register or vote; etc. Each stage of the elections has a date and time, and these must be verified by the system.

Some of the non-functional requirements that were identified are the following:

1) The system must have a friendly interface for each of its users.

2) The system must adapt to different resolutions, mainly for mobile devices.

3) The system should not reveal the relationship between the user student, teacher or member of the administrative staff and the candidate for whom they voted.

7. IMPLEMENTATION OF THE SYSTEM

This section presents some screenshots of the electronic voting system that was developed. Figure 2 shows the web page that allows the administrator to create a new election call, in which all the necessary information must be provided, such as: name of the call, date and time of publication of the call, start and end dates and times for the registration of candidates, date and time of publication of the accepted candidates, date and time the voting will take place, among others. There is a menu on the left side panel to navigate between the different sections to which an administrator has access: calls, applicants and results.

Figure 2. Interface for creating a new call

Once the call has been created successfully, the system displays the calendar with all the important events related to the call, such as: publication of the call, registration of candidates, publication of the list of candidates, voting, publication of results, etc. In the case of a teacher, student or member of the administrative staff user, they have access to the published calls. Figure 3 shows a screenshot with the calls that have been published in the system. The user who is using the system in this case is a student.

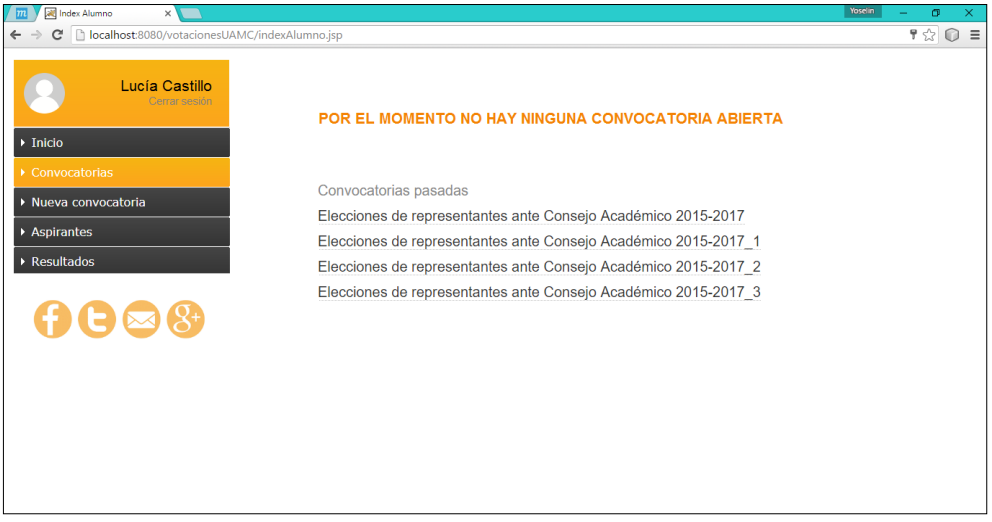

Figure 3. Visualization of calls in the system

A student who wishes to register as an applicant in a call for a student election must provide all the information requested in the system: full name, nationality, address, email, telephone numbers, academic division to which the student belongs, department or degree in which it is enrolled, enrollment, quarter of admission, etc. Registration for applicant teachers and administrative staff members is carried out in the system in a similar manner.

8. CONCLUSIONS AND FUTURE WORK

This paper presented a voting system for the election of representatives of the collegiate bodies that belong to the UAM. The objective of this system is to encourage the participation of the university community in this type of electoral process, since it has been observed that there are various reasons why face-to-face voting has not been very successful.

A comparison of existing electronic voting systems was shown with their relevant features, and the current process of electing representatives for university collegiate bodies was described. The methodology used to develop the system was presented, which included the requirements gathering for students, teachers and members of administrative staff. The implementation of the system was also discussed, with some screenshots of the system in operation, such as the creation of a call and the visualization of calls.

As future work, it is necessary to evaluate the system by a group of users from each sector involved (teachers, students and members of the administrative staff), to test its correct functionality; its usability when performing specific tasks within the system; and the perception of its use to carry out electronic voting. According to the results of these evaluations, the system will be adjusted, to later test it in elections of future representatives of the Divisional or Academic Councils.

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