Integrated Election Voting System: A Model for Leveraging ICT in the Indian Election Scenario

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ABSTRACT

In India, Information and Communication technologies (ICT) are being increasingly deployed in almost each sector of economy including agriculture, health, transportation, and education. But when we analyze the Indian Election Voting Scenario, it is realized that the ICT has not been exploited to its fullest extent. Recently, the Election Commission of India (ECI) has introduced few ICT-enabled initiatives, but the application of advanced ICT technologies needs to be promoted in Indian Election Voting System. In this paper, we propose E-Voting System to provide for an additional channel of voting to the Indian electorate. Further, this paper proposes the deployment model "Integrated Election Voting System" that leverages ICT technologies to integrate the existing Electronic Voting Machine (EVM) System with the proposed E-Voting System to provide a solution to the problem of low voting percentages among the Indian electorate. In addition, this paper includes results of simulations carried out to evaluate the E-Voting System. Also, the paper elaborates on the components of the proposed model, besides discussing the challenges faced by E-Voting Systems and the advantages offered by the proposed model.

Keywords

ICT, E-Voting System, Electronic Voting Machine (EVM) System, Integrated Election Voting System, Web Portal

1. INTRODUCTION

India being the world's largest democracy, holding free and fair elections here has always been a herculean task. The Election Commission of India has been discharging its constitutional duties very well. In India, the Information and Communication technologies (ICT) are being leveraged in all the sectors be it health or education or transportation. Although, a slew of e-initiatives have been rolled out by the Election Commission of India to modernize the Indian Election System, but the maximum potential of ICT is yet to be exploited to accrue its benefits.

In India, the Information and Communication technologies (ICT) are being leveraged in all the sectors be it health or education or transportation. But when we turn around and see towards the current scenario of Indian Election Voting, we discover that a slew of e-initiatives have been rolled out by the Election Commission of India to improve the way in which polling is conducted during the Indian Elections. But the maximum potential of ICT is yet to be exploited to accrue its benefits.

After studying the statistics related to electorate turnout percentages in the Indian Elections being held since Independence, it has been found out that the voting percentages has fluctuated just between 55% and 65% for the combined total of male and female voters. For male voters, it has remained between 60% and 70% whereas for female voters, it has remained between 50% and 60%. No rocket science is required to understand that these voter turnout percentages are exceptionally low and are not signs of a healthy and vibrant democracy [1].

Another well-established fact is that the people belonging to influential class and much percentage of upper middle class often lag behind in casting their valuable ballot whereas the rural electorate demonstrates higher voting percentages in the elections. Hence, we need to focus on boosting voting percentages among people from influential and upper middle class.

As a very high percentage of people from upper middle class and influential class have access to the Internet and many are equipping themselves with latest smart phones out in the market, we can leverage the ICT technologies to boost the voting percentages among them.

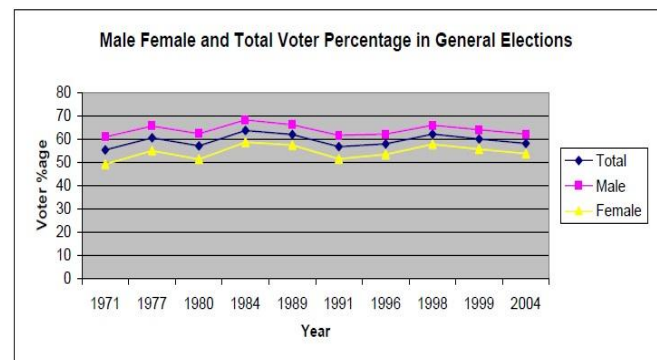
Figure 1. Male, Female and Total Voter Percentage in Indian General Elections [1]

In this paper, we propose an E-Voting System to provide a way to the people who have got internet access to be able to cast their votes at the ease of their homes or while on-the-go. Also, we have proposed an "Integrated Election Voting System" which integrates the already existing EVM Voting System with the

proposed E-Voting System. This would ensure that all the sections of the society can cast their votes wherein the people with internet access can opt to vote online and the people not having access to the internet services can continue casting their votes through the present EVM Voting System.

This paper is structured as follows. Section 2 contains a literature review to provide insights into existing Electronic Voting Machines and recently implemented E-Voting System. Section 3 puts light on recent ICT initiatives taken by Election Commission of India. Section 4 discusses the model components of the proposed Integrated Election Voting System and depicts the detailed flowchart of E-Voting System, followed by Section 5 which provides the simulation results. Section 6 discusses the challenges faced by the E-Voting Systems. Further, Section 7 presents the several advantages offered by the proposed model and Section 8 summarizes the paper by drawing up some conclusions.

2. LITERATURE REVIEW

In his work [2], Hari K. Prasad highlights the fact that although the Electronic Voting Machines have been admired for their simple design, ease of use, and moreover for reliability and precision, but in recent times they have been criticized following widespread reports of election irregularities. Despite the criticism for EVM, the details related to the machines' hardware design have never been publicly disclosed by the Election Commission, and also they have not been subjected to a rigorous security evaluation by an independent agency. The author concludes that although the Electronic Voting Machines have simplicity in design, they are vulnerable to security attacks that can alter election results and infringe on the secrecy of the ballot results. In [11], Chris Armen identifies and discusses some of the main issues and vulnerabilities in Electronic Voting Machines (EVM). Further, the author concludes that the EVMs must be verifiable and their hardware design as well as source code should be made open to public.

In his work [3], Mayur Patil has conducted a survey of all available voting system techniques including Paper Ballot System, Electronic Voting System, Online Voting System, SMS Voting through mobile phones. The author after a comparative study of all the voting systems concludes that there is a need for developing a new voting system that combines the advantages of all the existing voting systems and overcomes the drawbacks of all those voting systems.

Tata Consultancy Services developed an Online Voting System to be implemented in the Indian State of Gujarat [4]. It was deployed on behalf of State Election Commission Gujarat in the elections to the local civic bodies of Surat, Vadodara, Bhavnagar, Jamnagar, Rajkot and Ahmedabad held on October 10, 2010 [5]. It was first of its kind project in India where online voting was also made an option for casting the ballot in the elections. It was very innovative in the sense that the people got a chance to vote from the very comfort of their home. It laid down the foundation for online voting channel in Indian elections which was not implemented till recent times.

The post-election results show that much higher voter percentages were recorded through online voting channels as compared to EVM and ballot voting systems. Also, the project results show that the voters and all other stakeholders involved were satisfied by the online voting channel. But the overall findings suggest an altogether different story. The results were disappointing as out of

a total of 8.61 million registered voters, just 183 had actually e-voted on the voting day [5].

Our proposed model is expected to provide a much better implementation of E-Voting System in terms of authentication, confidentiality, anonymity, security and privacy issues. Also, our model makes more sense to the current Indian Election Scenario as it provides for integration of the existing Electronic Voting Machines with the proposed E-Voting System.

3. ICT INITIATIVES BY ELECTION COMMISSION OF INDIA

The Election Commission of India has come up with several new ICT initiatives in the recent past. One of them that require special mention is computerization of electoral rolls [6]. This has resulted in large databases being created at the disposal of the Commission. Our proposed model leverages these existing databases along with a number of ICT technologies and security mechanisms to allow for the integration of existing Electronic Voting Machine Systems with the E-Voting Systems being proposed.

Also, the Commission has introduced Online Voter Enrolment wherein anyone who is eligible to vote and does not possess a voter card can opt to apply for the same through the web portal of the Commission. This has provided for an easy and simplified method for the citizens to enroll as a voter at the comfort of their homes [7].

Another e-initiative introduced by the Commission is a scheme which enables the political parties out in the fray to use the State owned Electronic Media for broadcasting their content. This scheme provides for a level playing field for all the political parties contesting in the elections. Also, the Commission has introduced e-filing of poll affidavits by candidates for the first time in the history of Indian Elections [8].

But, in India, several ICT and allied technologies need to be leveraged to improve and upgrade the mechanisms being employed for holding free and fair elections. The success of elections not lies as much as who is the winner and by what margin as is the percentage of registered voters who casted their ballot. Hence, ICT must be leveraged to its fullest potential in the domain of Indian Election Voting to boost the voting percentages and thus, ensure the success of the elections being held to elect the representatives of the people.

4. INTEGRATED ELECTION VOTING SYSTEM

This paper proposes theoretical deployment model "Integrated Election Voting System" through the use of various Information & Communication technologies including central databases for storage of E-Voter data and storage of casted E-Votes for final counting. As the name suggests, this model provides for integration of existing Electronic Voting Machine (EVM) System and the E-Voting System. The model is divided into the following components: Users, Interface Devices, Online Authentication Module, User Applications, ECI Databases, E-Voting Subsystem, and Polling Booth.

4.1 Users

The model being proposed has been designed keeping in mind all categories of users. The voters may cast their ballot either through the Electronic Voting Machines or through the E-Voting Systems.

The method chosen by them for casting their ballot depends upon which method is suitable and feasible for them.

As a large number of voters may not have access to the Internet, therefore they would have to cast their vote as is being done presently, i.e. through the Electronic Voting Machines. The model aims to boost the voting percentages among the people belonging to affluent and upper middle classes. Most of them have internet connectivity at their disposal which they can leverage to cast their votes through the E-Voting channel being offered by the proposed model.

4.2 Interface Devices

The proposed model includes all the interface devices to allow the voters to cast their votes through online applications. The users may choose to register for E-Voting and cast their vote on the E-Voting Web Portal over a desktop computer or laptop with required Internet Connectivity. The proposed model provides sufficient flexibility in terms of incorporating new devices such as smart phones. The users may choose to register themselves as E-Voters and cast their online ballots through their smart phones having popular operating system such as Google Android, Apple iOS, Windows Phone OS, Blackberry OS. The model proposes that mobile applications for all the popular mobile operating systems be developed to leverage the mobility benefits of the mobile devices such as tablets and smart phones.

4.3 Online Authentication Module

The model incorporates a two-step authentication process to authenticate the identity of users during the registration phase. First being authentication through online means. This would be followed by physical verification by an Election Commission official at the applicant's residence.

The online authentication module is implemented by asking the users to submit a prescribed set of documents through the E-Voting web portal or mobile applications which would be further processed for verification. Second level of authentication is provided for by asking the user to register an email address and mobile number in addition to other necessary details and documents. The web portal is integrated with the SMS gateway to send One-Time Password (OTP) code on the user's registered mobile phone and then that code is compared with the code the user fills in the verification module.

4.4 User Applications

The model allows the users to register as E-Voters and cast their votes either through a web portal or through mobile applications. The user may access the web portal application through a desktop computer or a laptop. Also, the user may wish to register for E-Voting and cast his or her vote through smart phones or tablets by the use of mobile applications developed for popular mobile operating systems such as Google Android, Apple iOS, Windows Phone OS and others.

4.5 ECI Databases

Election Commission of India (ECI) databases has two sub-components: Electoral Rolls and E-Voting Database.

4.5.1 Electoral Rolls
It is known that the Election Commission of India has recently computerized the electoral rolls, resulting in huge databases at their disposal [6]. Our proposed model leverages these existing databases for the integration of existing EVM Systems with the E-Voting Systems being proposed.

4.5.2 E-Voting Database

As the E-Voters from all over the country would cast their votes through the web portal or mobile applications, their votes would get stored in an encrypted form in a central database termed as E-Voting database. Also, the final counting/tallying of E-Votes would be performed by this server, thus facilitating the vote counting process as well.

4.6 E-Voting Subsystem

The E-Voting Subsystem contains four sub-components: E-Voter Database, Real-Time Tracker Module, Authentication Module, and Help Desk.

4.6.1 E-Voter Database
To achieve the objectives of proposed election voting model, a centralized and efficient database is required to store and manage the data of millions of E-Voters. The online registration as E-Voters collects prescribed set of documents from the applicants and stores them into a centralized database at the back-end. The E-Voter central database is to be owned and managed by the Election Commission of India which will store all the E-Voter related data. The access level of database for the registered E-Voters would be limited to registration, verification and authentication purposes.

4.6.2 Real-time Tracker Module
This is another important component of the proposed system. This module would be interfacing with the E-Voter database to maintain the list of registered E-Voters. It would be providing real-time tracking of the vote status as VOTE CASTED or VOTE NOT CASTED for all the registered E-Voters. Also, it would be interfacing with the E-Voting nodes at all the polling booths to provide them with real-time data about the vote status of all the registered E-Voters.

4.6.3 Back-End Authentication Module
This module embodies all the authentication mechanisms required to authenticate the E-Voters before allowing them to cast their vote. The web portal or mobile applications for E-Voting would require the E-Voters to login into their accounts through a set of username and password generated at the time of registration as E-Voter. The authentication module would see if the login details entered by the user actually match with any of the existing accounts. If it matches, the user gets access to his or her account. Then, this module follows a two-step authentication process to authenticate the identity of users during the voting phase. First, the user is authenticated through the registered email address by sending a verification web link to it and asking the user to click on that web link to proceed to the E-Ballot paper. After choosing a candidate, the user is required to authenticate using the registered mobile number by providing the correct One-Time Password (OTP) code as sent onto his or her registered mobile number before final submission of online vote.

4.6.4 Citizen Helpline
The model also incorporates a Citizen Helpline, which would be a common platform for all the E-Voting related issues faced by the citizens. The helpline would resolve the problems encountered by

E-Voters during registration process or online election voting process.

4.7 Polling Booth

In present election scenario, the polling booths are equipped with the EVM Systems. The proposed model provides for E-Voting nodes as well within the premises of the polling booths.

4.7.1 EVM Polling Nodes

In present elections, votes are being casted through the use of Electronic Voting Machines (EVM). The beauty of our model lies in the fact that the existing Electronic Voting Machine (EVM) Systems have been retained in the proposed Integrated Election Voting System.
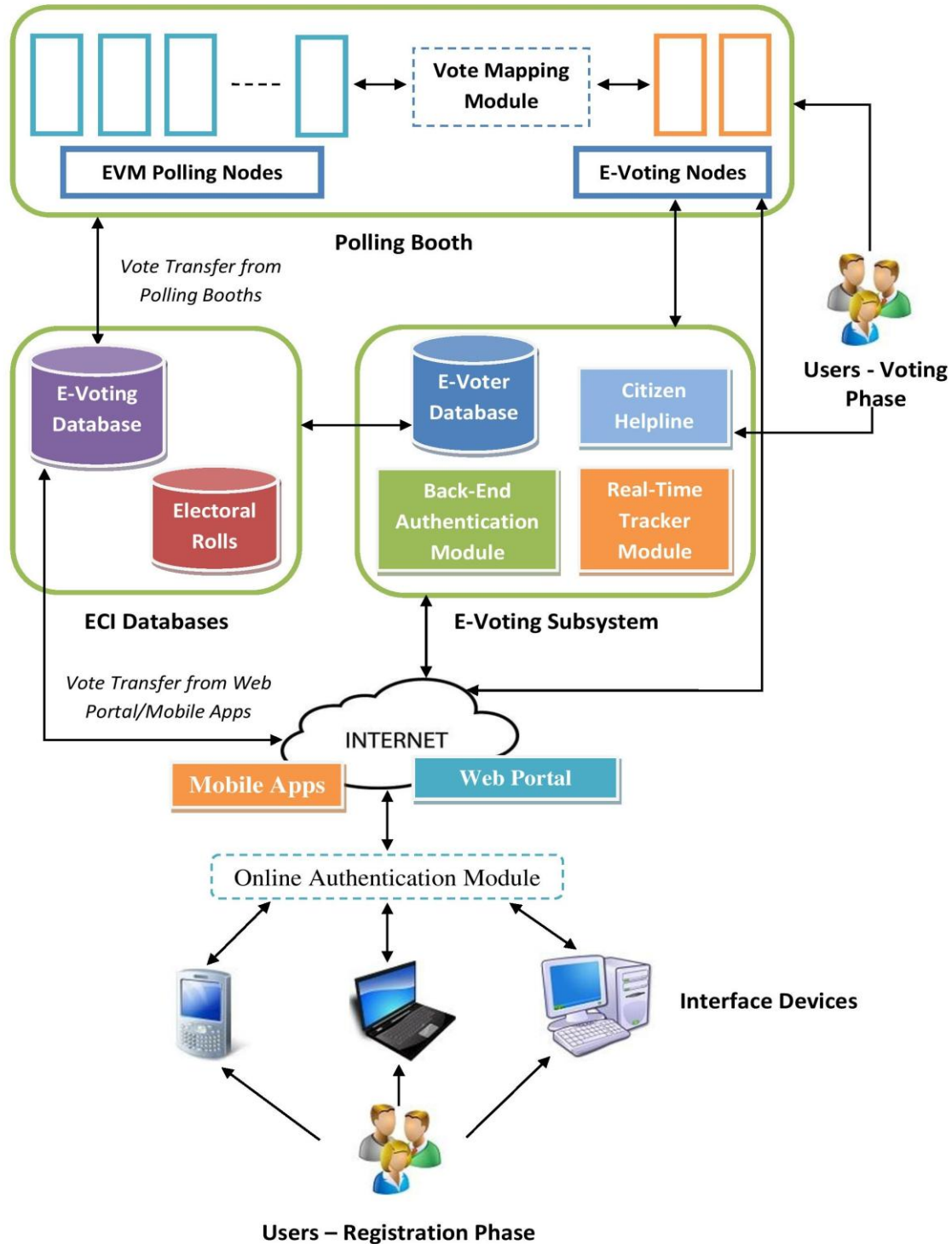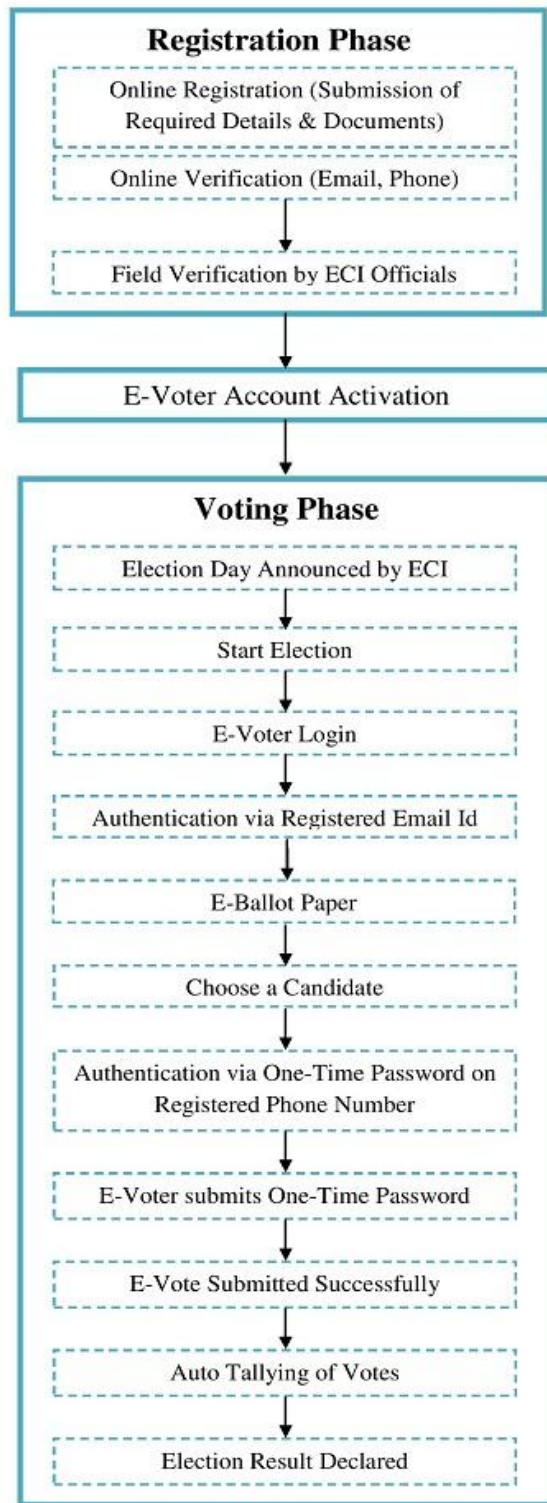

Figure 2. Model Architecture for Integrated Election Voting System

Registration Phase

- Online Registration (Submission of Required Details & Documents)
- Online Verification (Email, Phone)
- Field Verification by ECI Officials

E-Voter Account Activation

Voting Phase

- Election Day Announced by ECI
- Start Election
- E-Voter Login
- Authentication via Registered Email Id
- E-Ballot Paper
- Choose a Candidate
- Authentication via One-Time Password on Registered Phone Number
- E-Voter submits One-Time Password
- E-Vote Submitted Successfully
- Auto Tallying of Votes
- Election Result Declared

Figure 3. **Detailed Flowchart of E-Voting System**

4.7.2 E-Voting Nodes

The E-Voters are free to cast their votes at the comfort of their homes or while on-the-go. But, it may happen that some voters may experience poor quality of Internet service or complete loss of Internet access at their place or may even face some issues while validating their identity before actual online voting.

Therefore, to tackle such unexpected situations, the model proposes the inclusion of E-Voting nodes at all the polling booths so that such E-Voters are able to visit their nearby polling booth and cast their vote.

4.7.3 Vote Mapping Module

The USP of our model lies in the integration of already existing Electronic Voting Machine Systems and the proposed E-Voting Systems. It may happen that some users are not able to authenticate themselves due to loss of access to registered mobile number or registered email address. Such issues would act as barriers for the users to successfully cast their vote online. Therefore, a mapping module is required which provides for a referral system through which the user who was otherwise registered as an E-Voter is able to cast his or her ballot at the EVM polling node. The referral system would generate a referral token for the E-Voters which would make it possible for them to be able to vote through the EVM. Hence, the vote mapping module helps in integrating the existing Electronic Voting Machine Systems and the proposed E-Voting Systems.

5. SIMULATION RESULTS

In this paper, we have performed simulations to test and assess the efficiency and effectiveness of the proposed E-Voting System. The simulation model incorporates an Oracle database system for storing the records of candidates and E-Voters, including their personal details and authentication data. Further, the simulation model contains modules which emulate E-Voters and the E-Voting process itself.

An E-Voter would have to login into the E-Voting Web Portal through his or her unique set of username and password generated earlier during the E-Voter registration process. Upon successful login, the E-Voter would be sent a verification web link over the registered email id and the E-Voter has to click on that web link in order to authenticate and proceed to the E-Ballot paper. Then, the E-Voter would be presented with a list of candidates from his or her constituency, along with their names and photographs. The E-Voter would select a candidate of his or her choice. After choosing a candidate, the E-Voter would have to enter the correct One-Time Password (OTP) code as sent onto his or her registered mobile number before he or she is authorized for final submission of online vote. Consequently, the voting process for a given E-Voter would be complete and the vote would be added to the vote tally of the chosen candidate.

In the simulation model, the speed of the E-Voting process rests upon the network response time. For our case study, we have presumed an infinite network bandwidth. In our ongoing study, we have recorded and analyzed the database response time as a function of number of E-Voters accessing the E-Voting Web Portal simultaneously. In view of space limitation of this publication, we have restricted our simulation case study to 2000 E-Voters. We finally analyzed the performed simulations to assess the efficiency and reliability of the proposed E-Voting System. As shown in Figure 4, it is noted that the database response time is negatively affected when the E-Voting Web Portal is accessed by increasing number of E-Voters. But during the course of simulations, our system was found to be reliable enough for real life deployment in the Indian Election Scenario. The simulation results of the E-Voting System reveal a number of important factors that need to be redressed before the final implementation of this system.
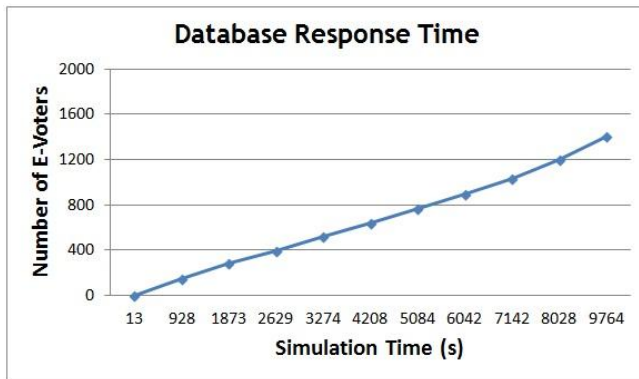
Figure 4. Bar Graph depicting the relation between Database Response Time and Number of E-Voters

6. CHALLENGES FOR E-VOTING SYSTEMS

Presently, the E-Voting Systems are facing the following challenges:

6.1 Compliance to Laws & Regulations

The inclusion of E-Voting in the Indian Elections would require its acceptance by the law as an additional means of voting by the citizens of the country. Also, it needs to be in accordance with the guidelines and legal requirements issued by the Election Commission of India.

6.2 Authentication

The model incorporates various authentication mechanisms to authenticate the identity of users during the registration phase. It includes a two-step authentication process. First being authentication through online means. This would be followed by physical verification by an Election Commission official at the applicant's residence.

The online authentication module is implemented by asking the users to submit a prescribed set of documents through the web portal or mobile applications which would be further processed for verification. Another level of online authentication is provided for by asking the user to submit an email address and phone number in addition to other necessary details and documents. The web portal is integrated with the SMS gateway to send One-Time Password (OTP) code on the user's registered mobile number and then that code is compared with the code the user fills in the verification module.

6.3 Confidentiality

The confidentiality of votes casted through E-Voting System can be ensured through the use of various cryptographical tools. Although the third-party tools vendors cannot be fully trusted, but need to be made accountable to the law enforcement authorities [9].

6.4 Security

The entire E-Voting System and the E-Voter database would be operating using the Internet services which makes them more susceptible to online threats. Therefore, multiple layers of security would be implemented through use of firewall, anti-virus, SSL to ensure highest levels of security for the web portal and mobile applications. Also, various encryption mechanisms would be employed to ensure that the login id and password of all the E-Voters are stored in an encrypted format in the databases.

6.5 Reliability

Although the reliability of the software assumes critical importance during large-scale application of E-Voting Systems, but the adoption of highest software quality standards and thorough testing can ensure reliable software. Also, the reliability of the databases is of major concern as the correctness of the counting of votes is totally dependent upon the integrity of the data stored on these databases. The casted votes are stored in an encrypted form in the voting database. As the data is susceptible to be accessed or corrupted by unauthorized users, systems must be in place to create a backup of the voting database in real-time [9].

6.6 Anonymity

In E-Voting Systems, ensuring the anonymity of the voters is of prime concern. The system should not store any mapping between a particular vote and the voter who has casted that vote, while at the same time there should be some method of verifying that the vote has been casted by a valid voter [9]. This can be made possible by the use of blind signature techniques invented by David Chaum [10].

6.7 Multiple Voting

In order to prevent multiple voting through the same account, the system would permit only single instance of voting through each account. In case, a person loses the access of his or her account or someone else votes on his or her behalf, then the affected person may visit the polling booth to cast the ballot.

6.8 Issues during E-Voting

In some cases, issues may arise while a user is in the process of casting the vote through online means. It may happen that the server on which the E-Voting web portal has been hosted goes down due to excess traffic load. In that case, the user would have to visit the polling booth and get a referral token generated using the services of the vote mapping module and cast the vote through the Electronic Voting Machine (EVM) system.

Also, the user may lose access to the registered phone number or email address required for authentication purposes. In such cases too, the user would have to visit the polling booth to cast the ballot. Another issue can be that the user is having access to poor quality Internet services or has completely lost access to the Internet. Then, the user has the option to visit the polling booth and use the E-Voting nodes over there to cast the ballot online.

7. ADVANTAGES OF PROPOSED MODEL

The model being proposed offers several advantages, some of which are as follows:

7.1 Dual Channels of Voting

The proposed model integrates the existing EVM System with the E-Voting System, thus providing dual channels of voting to the citizens.

7.2 Increase in Voting Percentages

As the model integrates the existing EVM System with the proposed E-Voting System, the people having Internet connectivity at their disposal, especially those belonging form

affluent and upper middle classes can leverage the E-Voting channel and cast their ballot online. This would certainly boost the voting percentages from the currently prevailing low levels.

7.3 E-Ballot Paper

The online ballot has many advantages such as the user can change the font attributes like color and size as per his or her suitability.

7.4 Faster Systems

The E-Voting method lets the voter cast his or her ballot in less time as compared to the traditional EVM Voting method. The time required for travelling to and from the polling station and the time otherwise required for standing in long queues would be saved.

7.5 Mobility

The E-Voting System gives the freedom of casting the vote from anywhere in the country. This is beneficial for the voters who are regularly out of their constituency. The model adds portability to the system in the sense that it works on Internet and therefore, the user can cast the ballot while on-the-go using an internet supporting device and wireless Internet connectivity.

7.6 Data Management

Separate central databases would be maintained for storage of E-Voter database & E-Voting database. Both these databases would be maintained and managed by the trained personnel of Election Commission of India, thus ensuring secure and efficient data management.

7.7 Localization

The model provides for the E-Voting web portal and mobile applications in various regional languages of the country, further enhancing the acceptability of the proposed model.

7.8 Aid for the Voters

The E-Voting System can prove to be a boon for handicapped people who otherwise find it impossible to reach the polling booth to cast their vote. They can opt to cast their ballot through the online means. Similarly, the ill and/or injured ones can use the E-Voting System to cast their ballot through online means. This would ensure that our Election Voting System is truly participative and inclusive. Further, a voter may be out of his or her constituency during the election voting day. Our model offers them with an option to cast their ballot while on-the-go.

8. CONCLUSION

Although the Election Commission of India has recently rolled out a number of Information and Communication technologies (ICT) based initiatives, but the ICT still remains to be exploited to its fullest potential to streamline the Indian Election System. This paper proposes the deployment model "Integrated Election Voting System" that integrates the existing Electronic Voting Machine (EVMs) Systems with the proposed E-Voting System. The proposed model, in addition to various ICT technologies, leverages existing computerized electoral rolls being maintained by the Election Commission of India. The simulations carried out for the E-Voting System confirm its reliability and efficiency. Also, it is expected that the proposed model would improve the security, confidentiality and authentication of the existing electoral system, in addition to achieving its design objective by boosting the voter participation levels in the Indian Elections, thus offering a truly participative election voting model.

Further, proper integration of biometrics within the proposed model would certainly add to its security. Also, cloud computing is another such emerging technology that can be explored for application in the Integrated Election Voting System (IEVS). But the modalities of both these technologies need to be worked out before their inclusion in the proposed model.

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