



# Electronic Voting System: Nature, Origin and Its Global Application

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This article presents a comprehensive overview of electronic voting systems, their historical evolution, and categorization into four types: punch card, optical scanning, direct recording electronic (DRE), and remote Internet voting. It highlights the significance of an efficient e-voting system that upholds essential characteristics such as transparency, cyber-security, accuracy, speed, privacy, accessibility, objectivity, cost-effectiveness, and sustainability in the context of elections. The article asserts that e-voting is a fundamental and contemporary process in democratic societies that has revolutionized the traditional voting mechanism. Furthermore, it underscores the advantages of e-voting, including saving time, cost, and effort and increasing access to remote areas. The article emphasizes the crucial importance of ensuring transparency, accuracy, and security in electronic voting systems to maintain trust and integrity in the electoral process.

**Keywords:** *E-Voting, Punch Card System, Optical Scanning System, Direct Recording Electronic Voting System, Internet Voting*



## 1. Introduction

Electronic voting refers to the process of casting votes electronically. The evolution and categorization of electronic voting systems can be classified into four distinct types based on the advancement of electronic devices and technology utilized in the electoral process. These types include the Punch card voting system, Optical scanning voting system, Direct recording electronic (DRE) voting system, and remote Internet voting system (Gritzalis, 2003: 4-15).

In comparison to traditional paper-based voting, the Electronic Voting (E-voting) System involves the use of electronic means in the voting process, including marking of ballot paper, vote recording, data/information coding for transmission to the main server, and combination and arrangement of the final election result. An effective e-voting system should ensure electoral transparency, cyber-security, accuracy, rapidity, privacy, approachability, objectivity, cost-effectiveness, and contextual (social/cultural) sustainability.

Electronic voting is considered one of the basic and coetaneous processes of the human democracy which has made history to advance the process and mechanism. It is administered and conduct in a free, verifiable, transparent and accessible environment. The creation of advanced technologies with the passage of time has brought drastic changes in the history of electronic machines and in its process. (Khan, et al, 2020: 17)

Everything has its own way of following the rules, from a country's constitution to a small institute. Similarly, voters have its own way of casting the vote. Some of the fundamental rights of voters that can be applicable for all the citizens are as follow:

Citizens of a state have the right to participate in all sorts of elections. Law should be made in such a way to identity the eligibility criteria of the candidates. The government should publish all the possible procedures for the general public upon how to cast a vote through leading newspapers and electronic media before the Election Day. It is a state's responsibility to adopt modern electoral process in the way of E-voting. The election commission has to public the electoral process of e-voting for the awareness of general public.

E-voting system provides facilities to voters by reducing their time, money and efforts. It also decreases the huge cost of voting. Online voting system is a big advantage for those citizens who cannot go the polling stations. These includes may be the elderly persons, disabled or those who have no access to the polling stations, which are far away in the hilly areas. A person can cast their vote through a cell phone from anywhere, and it can be his home, office or any other working place. (Petitpas, et al, 2021: 3-4)



As per Mr. Kareem M. Abo Samra's statement, E-voting is the term used and refers to an act of voting using electronic means to cast and count votes in elections. Traditional voting systems have been developed for the purpose that it will assure the voters about their freedom to vote, personal data of the voters, and the non-modification of the casted vote during election process. Conducting election through conventional method creates many hurdles for the masses. It has its own drawbacks and complications. It takes a lot of time in preparation and counting, mistakes in counting the votes, identifying the fake and rejected votes and so on. (AboSamra, et al, 2017: 69) E-voting application is much disputed than any other application of information technology in the field of election process. It reduces human control to a large extent and focuses the casting and solving some old problems. Emphasis is put on building public trust in this new technology. (Staak, et al, 2011: 5)

## **2. Typology of E-Voting**

The word E-voting (electronic Voting) can be defined as the application of electronic devices in conducting elections so that the voters can easily cast their votes.

### **2.1. Punch card**

Through the punch card system, voter inserts a blank yellow card from top into the punch card voting machine at the polling machine. After this the voter with the help of ballot booklet punches their choice into individual holes to mark their electoral preference/choice on the card. The device identifies the punch mark and records the vote accordingly. The recorded votes are aggregated for total result. The punch card voting machines were first used in USA in 1964 for the primary presidential elections in Georgia and also in 2000 presidential elections (Everett, 2007: 5-6).

Punch card system has been with us from the last 60 years. Professor Joseph Harris with his companions from University of California came up with first punch card system. It was simple to use, cheap and inexpensive and easy to record votes that could be tabulated using computer technology at that time. It was in-expensive and was tallied in few moments. In 2000's USA presidential elections, punch card system were widely used. Almost one third (32.1%) of all the voters used punch cards. No other type widely used than these punch cards until 2000's elections. The names of the candidates were not mentioned on these punch cards. It was Votomatic in style. (Buchler, et al, 2004: 517)

### **2.2. Optical scanning**

A Voter insert machine readable ballot which can count the name of the candidates under the optical scanning voting system. The voter denotes his choice by filling in the symbol against each candidate. After this the card is fed into the computer vote tabulating device which identifies to mark and record the vote accordingly. The recorded votes are aggregated for total result. This system is also called mark sense optical scanning system (Celeste, et al. 2006: 39).



The mark-sense scanning voting has been used in USA from 1960s and 1990s (Hao, 2017: 63). It has also been initially used for various educational colleges' entrance tests from 1960 to 1996. Similarly in 1996, this system has been used in US presidential elections wherein 24.6% voters used this system along with punched card voting system (Stenbro, 2010: 8-14).

### **2.3 Direct Recording Elections**

Under the DRE system, the person who casts vote mark directly his choice on the electronic device by using the touch screen or push buttons at the polling station (Lindner, et al. 2016, 138). The voting choice is automatically recorded in the system through a removable/portable storage device. After the closing of polls, the voting data from the various polling stations are aggregated in a central computing system which calculates the total result (Zissis, 2011: 56-57).

The first DRE voting took place in 2004 USA presidential elections (Chaum et al. 2010: 175).

### **2.4 Internet voting system**

A widespread use of internet has brought much convenience for voters to cast their votes. Internet voting is divided into three categories. The first category is the polling site internet voting where the client machines are physically present at the polling station and controlled by the official polling staff. The voter visits the polling station and cast his vote through client machine in the presence of polling staff. The authentication of the voter is controlled by the official polling staff. The second type is Kiosk internet voting in which the client machines are controlled by the polling staff. However, the client machines are not present at the polling station rather they are provided at various public places like shopping malls, schools, libraries etc. The authentication of the voter is not directly controlled by the official polling staff. The third type is remote internet voting in which both the client machines and environment are not controlled by the official polling staff. The voters cast their vote at their convenience from their homes, workplaces or public internet places. The authentication process is controlled by the voter themselves. The internet voting took place in 2003 in Switzerland for the first time so that to raise the turnout by enabling the remote voters to cast their votes (Kersting, 2004: 6-7).

### **3. Advantages:**

There are many advantages in E-voting system which may reduce the barriers in the way of implementing the E-voting system. It is easier to count the votes rapidly. Chances of fraud and rigging are almost nil in E-voting system as compared to manual voting system. It is also more advantageous for those voters particularly who are blind because an audio ballot paper is likely to be efficient for blind persons. Similarly, those citizens who are abroad can easily cast their votes. Manual voting is more costly than E-voting. E-voting may save the huge expenses of a government. (Alvarez, et al. 2008: 138-142; Puiggali, 2007: 20-28).



To facilitate the low sighted or disabled voter, a different kind of system has been involved. It includes the Braille template for ballot papers, magnifiers and close circuit magnifiers. Headphones and voice prompts can also be its advantage to be used. Another benefit is that E-voting can minimize transportation of ballot boxes, ballot papers and other stationery items. Instead of manual voting system EVM's can be placed in different particular government places for people to cast their votes or people may cast their right of casting votes from their personal cell phones.

Those voters who are living in northern areas are particularly out of range in winter due to heavy snow fall. In this situation such voters may cast their votes through post office via mail, however it has its own difficulties as it may be reached to the concerned polling staff after the due date for casting vote. For such case, E-voting system can be the best and speedy solution.

Collecting, verifying and calculating of vote is much laborious, intensive and time consuming. Electronic voting is very rapid which takes few hours in preparing the result. Ballot papers may take days to count. Only electronic voting can give us faster results. (Alzamel, et al, 2016: 363-364)

Less human interference, low cost, quick tabulation of results and accuracy are the main advantages, which cannot be ignored. E-voting is accessible disabled persons. E-voting can be applied both for local and general elections in a country if managed by the IT specialists through high power software which cannot be easily hacked. Computers have the capacity to record the whole data of voters and candidates. E-voting provides the best facility to the voters to cast vote from their homes. Particularly for those who cannot reach to the polling station. They feel more convenient from their homes as compare to go the polling stations. Using touch screen is more feasible and accessible for crippled voters. E-voting machines provide great facilities and easy access to those voters who are physically impaired without the assistance of someone else. E-voting can also reduce the remuneration to be paid to the polling staff. It can be a huge burden on the economy of the under-developed countries. The electoral process will be more efficient and transparent if casting vote twice illegally, miscalculation and loss of votes issues are addressed and which is possible by implementing E-voting system. E-voting is environment friendly as less number of papers is used in this system. (Khan, 2017: 1)

#### **4. Disadvantages:**

E-voting is a modern concept for common people. It is particularly for those who are illiterate and not familiar with the use of modern technologies may take time in understanding the E-voting system. IT specialists, who are hackers, know well how to hijack or hack a system. Such hackers may enter the E-voting machines and may change the results of elections as well as the voters'



privacy settings. The electronic voting machines can be costly for poor and backward countries (Batt, 2019: 1)

Some risks may be attached with new technologies in Electronic voting. The great risk is about the hackers. They can change the whole voting procedure by changing the software. Moreover the hackers can transfer virus through internet and may change the results. The programmer can steal the data of voters and may get it viral to the opponent's hands. Risks are always there in E-voting system from one problem to another. (Shanab, et al, 2010: 266)

### **5. E-voting in various countries:**

Presently, there are so many countries that are practicing e-voting systems in the form of DRE (electronic voting machines-EVMs) or remote internet voting systems, or a combination of both. Countries with electronic voting machines are the USA, Brazil, Germany, the Netherlands, Italy, Kazakhstan, Namibia, Philippines, South Korea, United Kingdom, Scotland, Bhutan, and Belgium. Similarly, countries with remote internet voting are Switzerland, Canada, Finland, Estonia, France, Spain, and Norway. Likewise, countries with Electronic voting machines and remote internet voting are India and Australia (Zissis, 2011: 59-70; Alvarez, 2008:76-78).

Embracing new technology from a voting perspective, E-voting is not a new terminology since its inception. Technology makes speedy the process of E-voting and reduces the workload where human help is needed. (Pratma, et al, 2019: 11)

#### **5.1 Countries with DRE E-voting**

DRE Machines consists of keyboard, touch screen to put and save the voters choice automatically. These machines then send the data via the internet, memory card or through printed paper. The printed paper or memory card device then receives the vote from DRE machines. DRE machines can be implemented with or without VVPAT (Voter Verified Paper Audit Trail). (Pratma, et al, 2019: 13)

##### **5.1.1 South America**

##### **5.1.2 Brazil**

Both the voting machine and biometric identity verification machines are in practice during the elections in Brazil. An audit process cannot be applied without VVPAT machines in Brazil. There is a big similarity found between Brazil's and Indonesia's voting system. Mechanism of governance is different from each other. Indonesia is a unitary republic while Brazil has a federal form of government. Government systems are similar, both being presidential with multi-party legislatures. (Pratma, et al, 2019: 22)



The TSE (Tribunal Superior Electoral), a part of the specialist electoral courts within the judicial system has been led by the public. TSE has been given the task to revise the election laws and to submit the review to the legislature for approval. It also had a responsibility to minimize the fraud and manipulation in the vote recapitulations process. TSE saw election technology as a potential solution. TSE included that with the help of new technology to be conducted after. The Brazilian parliament passes the law from the TSE homework done. Although the elections law did not specify for the E-voting machine that which type of machines would be? The law has given the orders to the TSE that it will work with the help of any political party or company to audit the code used in the machines. Slowly and gradually TSE started the voting technology and DRE was first used by the president of the TSE (Tribunal superior Electoral), Minister Sepulveda Pretence initiated the decision in 1994. The decision was made between 1994 and 1995. Civil society, political parties, and other government institutions were in favour of adopting Electronic voting in Brazil. Brazil began its journey from Paper ballots towards E-voting in 1994. There were two main reasons that TSE used to adopt E-voting. The first was to tackle the fraud issues relation, and the second was the spoiled ballots in the paper voting system. (Pratma, 2019: 236-237).

In the election of 1996, 30 % of the voters cast their votes directly by using electronic machines. In 1998, 35 million voters cast their votes, and in 2000 elections the whole nation voted through Electronic machines approximately 100 million voters. In 2003, the TSE ordered, congress passed law 11.503 which removed the requirement to adopt VVPAT. In this law, there was no voter verification. In 2009, the status quo changed again. The law number 12.034/09 passed that year. The TSE challenged the law in Supreme Court, but the court suspended it. (Goldsmith, 2011: 13)

### **5.1.3. Colombia**

Throughout the country, mixed methods of electronic voting machines were used for the first time with the traditional paper ballots were utilized in 1992's national and local elections. Under law 892 passed on July 7th, 2004; it modified the electoral law which opened the possibility and implementation of adopting an E-voting system in the country.

More than forty hundred thousand ago DRE machines were used. Votes were cast as on the polling day and TSE verified the result after five days. (Goldsmith, 2011: 24)

### **5.1.4 Argentina**

Argentina has twenty-four provinces, which have the power of its electoral system. Different experiences have been tested with the electronic voting system like from its institutional elections up to its design since 2003. The ever-first electronic voting occurred in the history of Argentina which took place in its province Salta in 2010. It had 1.2 million inhabitants at that time in 2010 with 850,000 voters. It was very complicated due to its mountainous area.





In 2004, the court of Salta started to evaluate the possibilities of whether to implement electronic voting and whether it can be applied. At the end of 2008, the provincial assembly of Salta passed a bill and gave authority to the provincial Electoral court to implement it. (Mirau, et al, 2012: 215-217)

## **5.2.1 North America**

### **5.2.1.1 USA**

There were some serious flaws which were exposed in 2000s elections in US. With its voting system, ballot, format, recount and other problems led other states to pass and replace the old technology with the new one. They passed a provision with the name of Help America Vote Act of 2002. (HAVA). A new E-voting technology was purchased and took part on punch card and level systems. Punch card system were first used in 1961 US presidential elections. By 1986, the Lever machines also took part in the elections. Optical scan machines were also used in US elections in 1960s. There were red paper ballots in the computers, where votes are recorded on paper sheet by filling a circle. The first DRE electronic machines were used in 1970s in USA. This system had the capability to record the votes directly. Touch screen voting system, the most recent technology was introduced in 1990s. In 2007, 27 states adopted a paper trail requirement. The technical guide lines development committee, an advisory board to the election assistance commission and the national institute of standards and technology, unanimously passed a resolution recommended that new voting systems have an independent voting record that all voters can verify. (Serdult, 2015: 34)

## **2.6 South Asia**

### **2.6.1 India**

There are 3 interesting reasons behind Indian's experience. Firstly, population-wise India is the second-largest country around the globe (900 Million). Secondly, India has a bicameral parliamentary system. Thirdly, India has a long-term experience of E-voting in her country. The first time, DRE machines were used in the southern province, Kerala in May 1982. Roundabout in 50 polling stations, DRE machines were installed. At that time, there was no law to pass by the Indian parliament to adopt the E-voting system. The Indian Supreme Court had conformed to the parliament for rules in the constitution. Under Article 61A of the constitution of the People Act 1951, it was specified for the Election commission of India to implement E-voting in elections. The election commission of India had designed simple and low-cost E-voting machines. These technologies were developed by Indian companies with DRE machines. These DRE machines were special because they have a five-meter long cable wire. These machines do not require any electricity. It runs through batteries. The E-voting system was practiced throughout India back in the 2004 elections. (Goldsmith, 2011: 29)





## **2.6.2 Bangladesh**

Bangladesh Election Commission (BEC) with the assistance of the Bangladesh University of Engineering and Technology (BUET) and Bangladesh Machine Tools Factory (BMTF) has developed a unique machine. The BEC proves that this machine they have invented is quick, convenient, transparent, secure, and easy to use. This system is designed in a way that will reduce the difficulties in vote casting, counting, and the overall polling process. BEC has also clarified that a One Time Programmable Chip (OTP) has been designed, which will protect data from infiltration. The cost is high this time but it will minimize the cost in the long term as compared to the paper-based ballot system. Electronic Voting Machines were first used on a limited scale in Chittagong City Corporation in 2010. (Goldsmith, 2011: 79-80)

## **2.7.1 Countries with experience of Internet Voting**

### **2.7.1 Europe**

#### **2.7.2 Estonia**

Estonia is one of the best conducting I-voting examples in the world since its inception. Estonia had first introduced in its local election in 2005 with 1.9% of voters participating in Internet voting. In 2007 Estonia first used its Internet voting for parliament with 5.5% of voter's participation. A member of Estonian's Election Commission secretariat Prit Vinkel explains that internet voting in Estonia has three factors for its success. Firstly I-voting by nature is open for E-government among the public. Secondly it is a secure internet voter identification system. Thirdly it is transparent in monitoring of the system's compliance with election's principles. These three points ensure that public trust on the internet voting system is an example of evidence by increasing rate of participation in every election. In 2007, Estonia introduced a mobile-ID system. Here a mobile can be used as an ID card and card reader. (Krimmer, et al. 2018: 15-16)

#### **2.7.3 Germany**

German parliament proposed the implementation of the E-pen voting system in its 2008 elections. By using E-pen, the voter touches the ballot and it will record their choice accordingly. The choice of a voter will be scanned using a micro-camera; the marked choice will put down the voter's choice and will rerecord it by E-pen. The recorded data is then transferred through docking stations and USB cables to laptops provided at the polling centres to be counted automatically in local elections. If any of the voters activates the E-pen incorrectly or uses an un-registered E-pen, the installed application will automatically inform the election officials. (Esteve, et al, 2012: 91)

#### **2.7.4 Netherland**

In the 1960s, the secretary of the electoral council was fascinated by the mechanical voting machines used in the United States. They have convinced the Ministry of Interior (MOI) to allow for their use. A new law was implemented on November 25, 1965, that regulated the use of voting



machines by the local authority in pre-assigned polling stations. The Dutch company of manufacturing of EVM, (NEDAP) not only produced the voting machines, but also designed and developed them. Twelve hundred voting machines were in use by the end of 1980s. By the end of 1990, 95% were using voting machines.

The electoral council focused on the lack of any certificate for the tabulation software. Some certain mistakes were found in 2003 elections. The electoral council wrote a letter to the minister to deal with it. Discussing the issues arose in the Parliament in March 1998, during the local elections. The electoral council recommended a review and created a sub-commission. The sub-commission published its report in May, 1999. The report revealed that calculation errors sometimes appeared in the tabulation software. The supplier had access to the software. The sub-commission recommends that the supplier company NEDAP had to issue a certificate.

In 2004, again the issue was raised in parliament for its non-reliability and security of the NEDAP machines been purchased. The Irish government decided for not to use the EVM's in 2004 European parliament elections.

Founder of the first provider of Internet, Rop Gongrijp in the Netherlands and other computer experts, initiated a campaign "We do not trust voting computers."

Finally, the campaign filed an administrative law procedure against the approval of NEDAP machines with the district court of Amsterdam in March 2007. On 1<sup>st</sup> October 2007, the district court decertified all NEDAP computers which were in use in the Netherlands. The 1997 approval of voting machines was officially withdrawn by parliament. (Vries, et al, 2016: 4)

## **2.8 South East Asia**

### **2.8.1 Philippines**

The Philippines has started the journey towards electronic voting in the 1990s. The E-voting system was introduced first in the Philippines country on May 10th, 2010. It was a challenge for the government to register the 50 million voters. This system was followed by in 2000 islands. E-voting was implemented first in 2010. Commissions on Elections (COMELEC) adopted its plan. Its primary reason behind the E-voting was to reduce the time for counting and tabulation. Because counting process lasted for 18 hours and the tabulation took up to 40 days. Another reason was to minimize the fraud in counting and results.

Providing Electronic machines, the late allotment of funds, and time constraints, 1998, 2001, 2004, and 2007 national elections remained manual. The Philippines legislative assembly passed an Act (8436) on 22nd December 1997, which said to the election commission to use an automated



election system. The Philippines government policy was to ensure free, orderly, honest, peaceful, and credible elections. The COMELEC automates the 2008 regional elections in ARMM using DRE machines in some local parts and OMR technology in other parts.

Five technologies were in use in the 2010 elections. The DRE, OMR, PCOS (Precinct count optic scan), (CCOS) central count optical scan, and OES (open election system). (Goldsmith, et al, 2011: 167-168)

## **2.9 The Study of Electronic Voting**

### **2.9.1 Norway**

The ministry of local government and regional development by the Norwegian government appointed a committee to assess e-voting in 2004 when a question is raised about electronic voting. This report simply stated that the purpose of E-voting is to make electronic voting easy for the people of Norway. The induction of e-voting will increase accessibility, reduce costs and expenses, will make the process of E-Voting fast & accurate. The internet voting application started its journey in 2009. In May 2011, 10 pilot municipals had tested e-voting online in a youth council election. The Norwegian Internet voting application has reached a high degree of accessibility in September 2011. It was its first use in political elections. (Trechsel, 2016: 28)

### **2.9.2 Countries which discontinued E-voting technologies**

Here are three cases which have discontinued e-voting technology in their respective countries, Germany, the Netherlands and Paraguay.

#### **2.9.2.1 Ireland (2004)**

Irish government started its journey for using e-voting in 1998. The trials were conducted until 2002. The Irish government also decided for the implementation of e-voting incoming 2004 European and local elections, for which the pieces of equipment have been procured from a Dutch company (NEDAP) for 53 million Euros. The government has established a committee to review the E-voting machines tests. They published a report on 29th April 2004, which these machines were not in a position to recommend the coming election. It was a possible violation of vote secrecy. These machines were not given full time to re-test before using. Irish officials took a decision and stated that there will be no usage of electronic machines in the 2004 elections. After this, the Irish Government announced and decided not to proceed with the electronic machines. (Esteve, 2012: 88)



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### **2.9.2.2 Netherlands**

The Netherlands started its journey of the electronic voting system in the 1990s. Criticism started in 2000 because it had concerns on lack of secrecy and evaluation reports with verifiability of machines. The Netherlands government made two committees in 2006 to look into the matter of electronic voting system. The committee issued a report that due to concerns over transparency and verifiability, the ballot paper should only be used in polling stations. In 2007, the regulation was withdrawn. (Esteve, 2012: 90)

### **2.9.2.3 Paraguay (2008)**

The agreement between the Paraguayan Supreme Electoral Court of Justice and the Supreme Electoral Court of Brazil had been done in 2001 with the usage of electronic voting machines. Paraguayan government borrowed a small number of Brazilian voting machines for trials base to use in local government elections. The agreement was extended with 6000 voting machines that have been provided for the presidential and parliamentary elections. In the coming years, Paraguay borrowed more electronic machines. The political opposition parties opposed the electronic voting machine sometimes. (Esteve, 2012: 90)

### **2.9.2.4 Switzerland**

The idea to digitalize the elections began in the late 1990s. In the mid of 2008, I-voting was available overseas. Switzerland has the highest number of online voting trails. Switzerland's I-voting is based on the internet. Citizens have to sign up to the government portal. In this system, the voter must be present at the municipality. On the other hand, the Geneva and Zurich models do not require registration. Voters would receive mail from the government to log in, and then the people would cast their votes through the Internet. The Internet voting system took place firstly in the city of Geneva in 2003. In 2004, on a federal level, the I-voting started. (Germann, 2014: 198)



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## 2.10 Conclusion

In conclusion, electronic voting has revolutionized the traditional method of voting by offering a more accessible, efficient, and cost-effective method of casting votes. The evolution of e-voting systems can be categorized into four groups based on the advancement of electronic devices and technology used during the electoral process. These categories include the punch card voting system, the optical scanning voting system, the direct recording electronic (DRE) voting system, and the remote Internet voting system. An effective e-voting system should ensure electoral transparency, cyber-security, accuracy, rapidity, privacy, approachability, objectivity, cost-effectiveness, and contextual sustainability. E-voting systems provide facilities to voters by reducing their time, money, and efforts, and it decreases the huge cost of voting. Online voting system is a big advantage for those citizens who cannot go to the polling stations. However, e-voting is much disputed than any other application of information technology in the field of the election process, and building public trust in this new technology is crucial. Overall, electronic voting is a significant advancement in the field of democracy and is expected to make the electoral process more accessible, efficient, and transparent.



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