# A Compressive Survey of Key Challenges and Issues of Election Management System [EMS]

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*Abstract--* **Free & fair Elections will lead to election of popular & good Government in any Democratic Systems. Elections process & systems have evolved from raising hands to EVMs, Mobile voting, Internet voting to help people voice their decision or opinion on any key issues of public interest towards building a National opinion & even change Govt. & perceptions. But, there are many key issues & challenges that we encounter when we attempt to develop next generation tamper proof Election Management Systems.**

*Keywords: Voting system, EVMs, Attacks, internet voting, Voting Terminal Components, tampering of EVM.*

## I. INTRODUCTION

Voting is the foundation of a democratic system of government and very important function for citizens to opinion their franchise rights to elect best possible Government, irrespective of whether the system uses direct or representative governance. The heart of voting System is trust that each vote is recorded and tallied with accuracy and impartiality. There is no shortage of historical examples of attempts to undermine the integrity of electoral systems. The paper and mechanical systems were used, although far from perfect, were built upon literally hundreds of years of actual experience.

Earlier, there was immense pressure to replace our "outdated" paper and mechanical systems with computerized systems. There are many reasons why such systems are attractive. These reasons include, cost, speed of voting and tabulation, well suited for use by citizens with physical impairments.



Fig 1:Voter displaying ID cards [10]



Fig 2: Voterss howing indelible ink after voting[11]

An electronic voting system (on-line voting, internet voting) is an election system which uses electronic ballot that would allow voters to transmit their secure and secret voted ballot to electionofficials. With the prosperity of internet over the years, inventers start to make the use of electronic voting in order to make the voting process more convenient and raise the participation of the civic[1].

## II. PRINCIPLES OF DEMOCRACY

The basic principles of democracy are:

CITIZEN PARTICIPATION

Participation is the key role of citizens in democracy,it is not only their right, but it is their duty. Citizen Participation may include standing for election,voting in elections,debating issues, attending community or civic meetings, paying taxes etc.

EQUALITY

All individuals are equally valued;Equal opportunities should be given to all people in the country and no discrimination against race, religion, ethnic group and gender or sexual orientation.

ACCOUNTABILITY

Elected and appointed officials have to be accountable to the people.Officials must make decisions and perform their duties according to the will and wishes of the people, not for themselves.

TRANSPARENCY

People must be aware of what is happening in the country. A transparent government holds public meetings and allows citizens to attend. In a democracy, the press and the people are able to get information.

REGULAR, FREE AND FAIR ELECTIONS

In a democracy, elections are held regularly. No person or group of individuals should be denied the opportunity to vote, No candidate or party be denied the ability to be on the ballot or to freely and openly campaign for office.

HUMAN RIGHTS

Democracy emphasizes the value of every human. Human rights include

- freedom of expression
- freedom of association
- freedom of assembly
- the right to equality
- the right to education
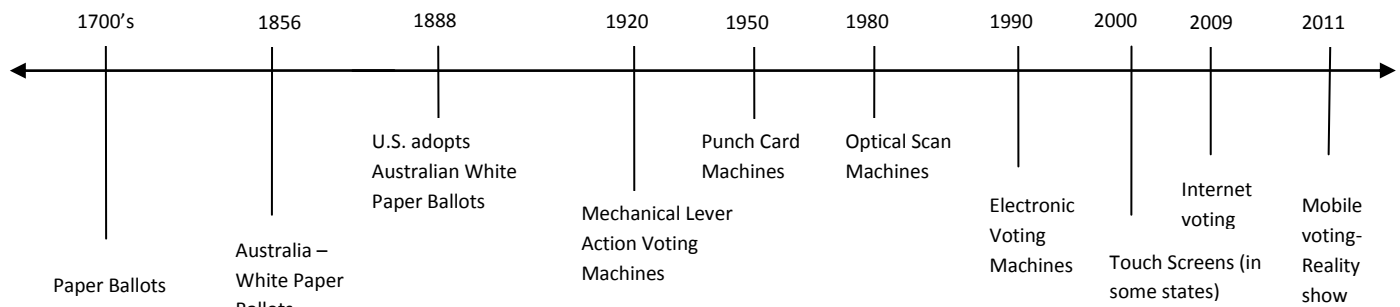
## III.     HISTORY OF VOTING



Fig 3: History of Voting systems

Voting system has progressed considerably from the raising of hands to the use of machines over the years.[2]

- The oldest and most traditional forms of voting, dating back to 1700's in the United States alone is to cast a vote using a paper ballot
- In 1856 Australia introduced white paper ballot, The Australian ballot lists all races and all the candidates running in these contests
- In 1888 United State recognized a need for standardizing ballot so they implemented Australia's white paper ballot
- In 1920 Machine lever action voting was introduced, One criticism of lever machines is that they only maintain total counts of votes
- Punch card ballots were first seen in polling places in the 1950's. Punch card ballots themselves contain no election specific information; they simply contain an array of numbered positions with perforated outlines or "chads"
- In 1980 optical scan machines was introduced similar to bar code reading
- In 1990 electronic voting machine was introduced, most of the countries follow EVM
- In 2000 EVM was upgrade with touch screen and new GUI
- In 2009 Internet based voting system was introduced in Switzerland.
- In 2011 Mobile voting system was introduced in reality show voting.



Fig 4: Mechanical lever based voting system [12]
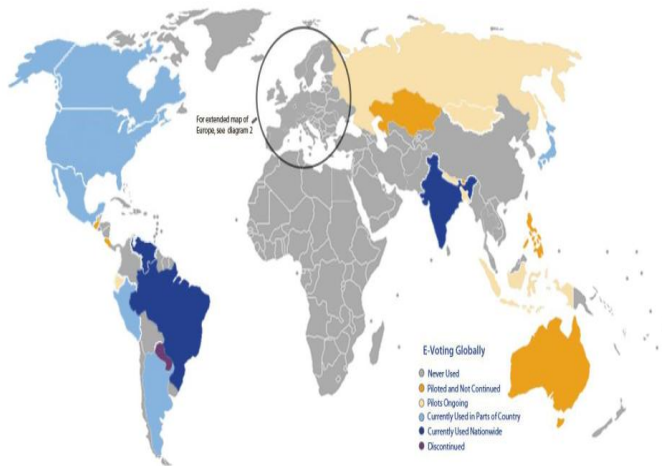
## IV. EVM IN COUNTRIES AND ISSUES



Fig 5: EVM implementation status in world [13]

### India

Following pilots since 1982, the biggest democracy in the world has successfully used voting machines throughout the entire country since 2002. Two distinct features of the Indian EVMs are the low price, significantly lower than that of most other systems, and a relatively simple technology.

The Indian system provides no paper trail, a fact that is widely accepted, given the absolute trust institutionally granted to the EMS. However, the simplicity of the system created controversy around alleged security problems in 2010 and led to the Indian Election commission to consider the introduction of paper trails in 2011 [3][6].
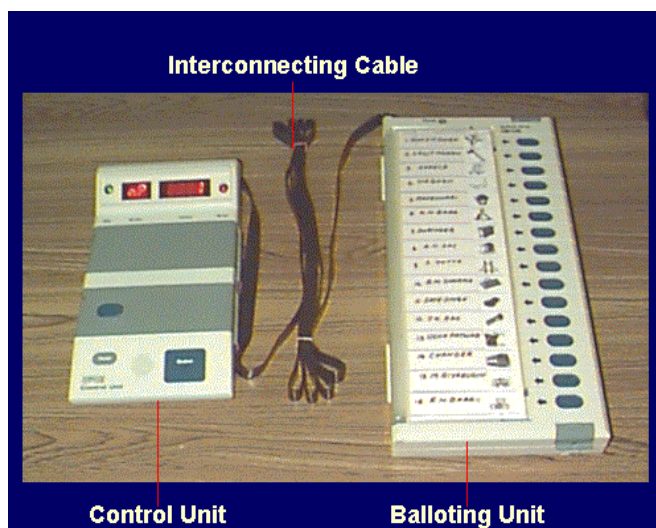


Fig 6: EVM in INDIA[6]

### Brazil

The introduction of e-voting in Brazil was motivated by economic and fraud-prevention factors. A multi-year approach for the gradual introduction of e-voting was adopted and included.

A hacking competition was organized in 2009 to create additional confidence in the technology.

Over the years citizens and stakeholders gained enough trust in the system for the paper trail that was initially included to be deemed redundant and scrapped after technical problems associated with the printers.



Fig 7: EVM in Brazil [14]

### USA

Following the 2002 Help America Vote Act, the United States saw a massive investment in voting machines, many without a paper trail.

In 2005 and 2007 the US Voluntary Voting System Guidelines (VVSG), currently the most comprehensive guidelines with specifications and requirements for certifying voting machines, were published.

By 2008 many states required paper trails, making voting machines without a paper trail obsolete. As of 2010, 40 states have moved towards requiring paper trails[7].



Fig 8: EVM in USA [7]

### Estonia

Internet voting was introduced as an additional voting channel in 2005 and enjoyed widespread trust from the very beginning. Estonia is a conflict-free country that enjoys a high level of trust in its institutions, and e-voting companied a wider program of digitalization of its institutions.

### Venezuela

When DRE-based e-voting was introduced in Venezuela in 2004, trust in the impartiality of the EMB was very low.
The technical weaknesses of the system, which did not eliminate the theoretical possibility of cross-checking voters and votes, created a critical situation just a few days before the 2005 election.

### Netherlands

In 2008 e-voting was suspended after 20 years of use when activists showed that the systems in use could, under certain circumstances, endanger the secrecy of the vote.

In spite of the problems, many stakeholders, especially mayors and voters, still trust e-voting. On the basis of positive experiences from the past they are asking for a reintroduction of voting computers.

**Germany**

In 2009 e-voting was declared unconstitutional. According to the constitution all elections must be public. The Constitutional Court ruled that this principle requires that the key steps of an election including vote casting and countingbe subject to public scrutiny which should not require any specialized knowledge.

**UK**

In 2005, after various local pilots, it was concluded that e-voting systems were expensive, brought about no increase in turnout, and lacked an adequate audit trail. Paper voting was more trusted.

## V.     ELECTION MANAGEMENT SYSTEM-EMS

The key functions of EMS are:

- Database of precincts and ballot styles
  - Necessary for voting terminal setup
  - Necessary for interpreting and reporting results
- Prepares ballot logic and ballot layout
- Database of election results
  - Precinct results
  - Cast vote records (electronic ballots)
  - Event logs
- Report generation
  - County& region wide summary
  - Precinct-by precinct summary
  - Turnout, blank ballots, undervotes
  - Ballot image reports
  - Event log reports[4]

**Voting Terminal Components**

- File system
  - Highly reliable
  - Tamper evident
- GUI
  - Needs to minimize voter errors
  - Should "inspire voter confidence"
- Election logic and data
  - Protocols for election open close, etc.
  - Cast vote records
  - Event log[5]

## VI.     REQUIREMENTS FOR EMS

**Accuracy:Candidate totals should reflect voter intent.**
Sources of inaccuracy: Voter confusion, carelessness, User interface weirdness (e.g. "jumping votes"), Software bugs, hardware failures, Administrative error, tallying problems (e.g., Access capacity issues)and Fraud.

**Availability:Voters need to be able to cast their rights**
Causes of failure: Software unreliability (crashes, freezes), Hardware problems like Failed componentsDead batteries, Administrative error (e.g., failure to plug machine in), Insufficient capacity/provisioning and Denial of service.

**Transparency:**Elections must provide proof of accuracy. Processes must be observable, Paperless e-voting doesn't do very well on this. Results must be *auditable* (it must be possible to check results independently) There are many aspects of election auditing.

**Privacy:**Voters votes should be secret; this is to prevent intimidation, Creates major problems for fraud detection and prevention. Sophisticated methods to stop,Electronic emissions and Spy cameras in polling place.

**Non-coercibility:**Voter should not be able to prove how he/she voted to a third party to prevent vote-selling/coercion. Vote selling has been a major problem in the USA and elsewhere. Concerns in voting can be boiled down to a few simple concepts, described here. Valid elections must meet each of these concerns.

**Lack of Evidence:** The voter should not be able to prove to anyone which way he has voted. Together with the privacy condition, this prevents vote-selling and coercion. If there is no way to assure a third party of which way a vote has been cast, bribes and threats are ineffective.

**Fraud-Resistance:** Each qualified voter should be able to vote exactly once and no other persons should be able to vote on other's behalf. The system must verify the identity of each potential voter and determine their status, but must not allow this information to become associated with their vote.

**Ease-of-Use:** Elections must serve the entire public. This includes people with various levels of technological familiarity, various languages, and various physical capabilities (vision, hearing, etc.). Any systemic bias in the error rates between these groups could unfairly alter the election results. Additionally, the poll workers running each voting stations have minimal training and technical skills. Setting up and administrating the system must be simple.

**Scalable:** Large elections must serve millions of people. The system must scale to handle these elections as well as smaller precinct-specific ones.

**Seed:** As a result of exposure to computer-counted ballots, the American public now demands that at least preliminary results are available within several hours of polls closing. Any voting system that requires lengthy counting time will not be acceptable.

**Low Cost:** Cost is a major concern for countries selecting voting systems. A lower-cost, less-secure system is oftentimes more attractive than a higher-cost alternative. If a system can't be implemented cheaply, it isn't useful[6].

## VII.    ATTACK AND TAMPERING EMS

**Potential attackers**

- Hackers
- Candidates
- Foreign governments
- Criminal organizations

**Generic attacks**

- Programmer,system administrator, or janitor adds hidden vote-changing code
- Code can be concealed from inspections in hundreds of ways
- Code can be triggered only during real election
- Using "cues"- date, voter behavior
- Explicitly by voter, poll worker, or wireless network
- Change small % of votes in plausible ways

**Possible Tampering of EMS**

- Tampering with the hardware chip or software by adding malicious code like Trojan horse or misconfiguration can alter vote totals or favor a particular candidate. Swapping of chips/boards enable Trojans to favor a candidate
- Hacking can take place during transportation, handling, polling station, storing places, repair, maintenance etc.
- Abusing the administrative access to the machine by election officials, might also allow individuals to vote multiple times
- Manipulated EVM's can corrupt the entire memory as well as hang the Control Unit and rendering E2PROM unreadable
- Vote tampering ( changes the votes by adding, dropping or switching votes )
- Disrupt voting (Malware can be used to cause voting machine to malfunction frequently)
- Electronic interception
- Misuse of authority to tamper with or collect information on software or election data[8]

## VIII.    PROBLEMS IN EMS AROUND THE WORLD

- The Federal Constitutional Court of Germany declared EVM's unconstitutional, in March 2009
- In 2006 in Netherlands, licenses of 1,187 voting machines were withdrawn, after a citizen's group named 'We Do Not Trust Voting Machines' demonstrated that in five minutes, from up to 40 meters away, they could hack into the machines with neither voters nor election officials being aware of it
- The Supreme Court of Finland declared invalid the result of a pilot electronic vote in three municipalities of 2009
- United Kingdom's The Open Rights Group declared it could not express confidence in the election results, citing "problems with the procurement, planning, management and implementation of the systems concerned", in 2007
- Ireland abandoned an e-voting scheme, in 2006
- There were serious discrepancies in the Diebold systems EVM's predominantly used in Brazil's 2006 elections

## IX.    PROBLEMS IN EVM'S IN USA

- In April 2004, California banned 14,000 EVMs because the manufacturer (Diebold Election Systems) had installed uncertified software that had never been tested, and criminal prosecution initiated against the manufacturer
- During 2004 Presidential elections, in Gahanna, Ohio, only 638 votes were cast, but EVM result declared Bush received 4,258 votes to Kerry's 260
- A study by UC Berkeley's Quantitative Methods Research Team reported that irregularities associated with EVMs may have awarded 130,000 - 260,000 votes to George Bush in Florida in 2004 [9]

## X.    MAJOR OBJECTIVES OF EMS

- Completeness and adherence to voting protocol
- Ensure availability and reliability of voting system

- Authenticity of voters, vote cast and non-traceability of votes
- Maintain integrity of digital ballot against security vulnerabilities
- Minimize cost to Government

## XI. CHALLENGES AND ISSUES IN ELECTORAL PROCESS

- Ability to Deal with Complex Elections
- Accessibility
- Less Polling Staff
- Elimination of Invalid/Incorrectly Cast Ballots
- Speed of Counting
- Standard Adjudication of Ballots
- Accurate Tabulation of Results
- Fraud Prevention
- Transparency
- Confidence
- Audit of Results
- Secrecy of the Ballot
- Setup Procedures for Electronic Voting Machines
- Tendered Ballots
- Consequences of Breakdown
- Confusion for Illiterate/Uneducated Voter
- Voter Education
- Specialized IT Skills
- Storage of Equipment
- Security
- Consequences of Fraud
- Cost

## CONCLUSION

After the above said in depth literature & Technology survey of various EMS we have covered in this survey paper, commencing from History & evolution of EMS all such key issues, challenges, systems, solutions, System design approaches like Hardware, internet, mobile and software voting.

As a part of my future Research work, we wish to develop,through system engineeringa tamper proof hybrid EMS [with Hardware & Software systems working together] that will solve many of the above listed problems to evolve a next generation EMS.

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