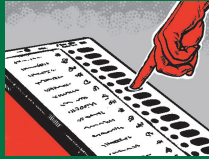


# An Inquiry into India's Election System



*REPORT OF THE  
CITIZENS' COMMISSION ON ELECTIONS  
VOLUME I*

## Is the Indian EVM and VVPAT System Fit for Democratic Elections?





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January 2021

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To all those who deposed before the Commission, too numerous to name – whether from India or abroad, whether by written depositions or participation in Zoom meetings – we must say that we are deeply grateful for it was their specialized knowledge that helped firm up the bedrock of our understanding.

This is the first of a series of reports that the CCE is planning to bring out under the title: An Inquiry into India's Election System. Each theme covered under this series had a mentor(s). It was they who sifted through the numerous depositions made, conducted their own research and finalized Thematic Reports. We must place on record our appreciation for their contributions to Professor Sanjiva Prasad, Mr Paranjay Guha Thakurta, Mr Harsh Mander, Mr V. Ramani, Professor Sanjay Kumar, Professor Jagdeep Chhokar and Ms Anjali Bharadwaj.

Mr Jawhar Sircar, Mr G. Balagopal, Professor Dinesh Abrol, Mr Thomas Franco and Mr Joe Athialy have been helping in the planning and organization of Press Conferences in different cities and translations of key documents, while Balagopal has hosted several Zoom meetings. Ms Poonam Agarwal and Ms Kavita Kabeer have shared their journalistic insights into the crafting of a media strategy and the making of short videos. To all of them our thanks.

Many have helped in this journey. If inadvertently, we have left out any names, our apologies.

**M. G. Devasahayam**  
**Sundar Burra**

## *Abbreviations*

<b>ADR</b>	: Association for Democratic Reforms
<b>BEL</b>	: Bharat Electronic Limited
<b>BJP</b>	: Bharatiya Janata Party
<b>BU</b>	: Ballot Unit
<b>CCG</b>	: Constitutional Conduct Group
<b>CEC</b>	: Chief Election Commissioner
<b>CFSL</b>	: Central Forensic Science Laboratory
<b>CIC</b>	: Central Information Commission
<b>CU</b>	: Control Unit
<b>DEC</b>	: Deputy Election Commissioner
<b>DRE</b>	: Direct Recording Electronic
<b>ECI</b>	: Election Commission of India
<b>ECIL</b>	: Electronics Corporation of India Limited
<b>EVM</b>	: Electronic Voting Machine
<b>IIT</b>	: Indian Institute of Technology
<b>LED</b>	: Light-emitting Diode
<b>MCC</b>	: Model Code of Conduct
<b>RTI</b>	: Right to Information
<b>SC</b>	: Supreme Court
<b>STQC</b>	: Standardization Testing and Quality Certification
<b>VVPAT</b>	: Voter Verifiable Paper Audit Trail
<b>WP</b>	: Writ Petition

# Foreword

Modern India's greatest pride is that it is not only the world's largest, but because of the grassroots institutional mechanisms that we have built for the panchayat raj, is also the most vibrant democracy. It gives to every Indian the world's largest number of elected representatives to ensure peoples' participation in governance at the local, state and national levels. At the national level the institution of the Election Commission of India (ECI) is mandated to ensure that this participation is not only truly representative, but also one of the world's most free.

In such a democracy, accountability and transparency are the guarantors of good health. ECI, set up under Article 324 of the Constitution of India, is expected to work with civil society to ensure this within the framework of India's Right to Information Act (RTI), 2005. In our democracy the RTI, which encourages accountability through transparency, is an expression of a profound national commitment to ensuring an open government. Not surprisingly, this commitment is shared by all political parties, forming part of the manifesto also of India's ruling party today. Citizens have consistently worked with the Commission to flag issues of concern to government or to the public. It is in this context that we might place the endeavour of researching the functioning of EVMs and VVPATs which is described in the present publication.

As the preface to the volume clarifies, our group of citizens have in our careers been associated in big ways and small in the building of the governance of India as it stands today. For them, India's Constitution has been the only scripture, and hence they are concerned that the ECI's conduct of the parliamentary elections of 2019 had led to grave doubts about its fairness, which has always been its greatest strength. The Association for Democratic Reforms, the Constitutional Conduct Group of former civil servants and the Forum for Electoral Integrity were among the civil society groups that were constrained to invite public attention to what appeared to be the ECI's shortcomings in living up to its mandate of neutrality. Many political parties, mainstream and digital media houses also joined in voicing serious apprehensions as to the manner in which the 'model code of conduct' was violated with impunity.

The ECI neither responded to criticism or sought to defend itself when patent infirmities were specifically pointed out by responsible citizens with no effort to satisfy the critics, several of whom were retired officials themselves, experienced in conducting elections. The Citizens' Commission on Elections' (CCE) came into being to go into critical aspects of the conduct of elections, call for expert advice where necessary and come up with appropriate suggestions. These are to be placed in the public domain for the consideration of Indian citizens who, at final call, should have the last word in India's governance to ensure that elections are conducted as merit the proud Republic of India.

The first sectoral report that deals with the merits of Electronic Voting Machines (EVMs) and Voter Verifiable Paper Audit Trail (VVPAT) in light of the requirement of verifiability and transparency is ready for public discussion. The functioning of EVMs has been researched by CCE's experts, specifically in light of their adherence to principles of democracy. In keeping with the law, there is an insistence on absolute transparency to facilitate the voter in the exercise of his or her choice and in ensuring that their selection is indeed reflected in the stored vote and counted as such — with no deviation whatever. These principles also mandate that the voting procedure be easily comprehended and verifiable by the voter and open to audit without complications but not concealed by the application of relevant technology.

There can be no compromise allowing for error or misrepresentation of the elector's choice, for in our view, that would be a compromise with the essence of India's democracy and therefore suborn our Constitution. Towards the end of ensuring that the elector's choice is faithfully reflected, the group has relied on expert opinions drawn from national and international experts: these explain why even those countries most advanced in information technologies have avoided the use of EVMs during polls, even despite initial enthusiasm. The recommendations are now before the citizens not only of India but before those of democracies across the world - as a gauge for assessing safeguards to democratic functioning and their conservation in light of revolutions in technology.

**Madan B. Lokur**

**Wajahat Habibullah**

January 26, 2021



## Preface

# Defending Democracy An Inquiry into India's Election System

By  
**M. G. Devasahayam\***

In the recent years India's democracy has been called into question by international watchdogs. In the 2019 Democracy Index released by the intelligence unit of The Economist Group, London, India had slipped by 10 ranks to 51st position -- a big downgrade. The Index categorised India under "flawed democracies."

Post Parliament Election-2019 there has been a sharp decline. The 2020 'Democracy Report' by the V-Dem Institute based at the University of Gothenburg puts India in the league of countries who have seen significant slides into authoritarianism. India's democratic process is 'on a path of steep decline', the Report says. This has been evidenced from the happenings over the past six years, more so during the last year and a half when there has been a consistent manifestation of a regressive authoritarian regime.

These developments turned our attention to the way in which Parliament Election-2019 was conducted, votes counted and results declared. Josef Stalin has been quoted as saying, "It's not the people who vote that count, it's the people who count the votes." In Stalin's Russia, this was the common norm. Similar and other kinds of comments were being made about Parliament Election-2019.

We also noticed that India has a deeply flawed first-past-the-post election system wherein a political party winning just about 25% of the electorate's mandate can capture power by having a majority number of MPs and impose its will on the entire population as is happening now. Let us look at Parliament Election-2019 and the composition of the present Lok Sabha. For this election India had a total electorate of 91.05 crore out of which 67.40% voters (61.86 crore) exercised their franchise. The ruling party (BJP) secured 37.36% of these polled votes which was 22.90 crores and won 303 seats. If it had

been proportional representation system BJP's seat share would have been only 201 which is far from majority. Furthermore, if BJP's vote share is to be taken as percentage of total electorate it turns out to be just 25.15%. This means that in the 2019 Parliament election the current ruling dispensation received the mandate of only one-fourth of India's electorate.

This itself is a cruel assault on representative democracy. What is worse, in the matter of Parliament Election-2019 its very integrity was called into question. In a healthy democracy, citizens are expected to take an active interest in the process and conduct of elections. The Election Commission of India (ECI), set up under Article 324 of the Constitution of India, has often worked in close collaboration with non-political organisations dedicated to the strengthening of democracy. Such bodies of citizens have provided valuable feedback to the Commission and have flagged issues of concern or alarm.

The ECI's conduct of the Parliamentary Election-2019 invited serious controversy and criticism and its very fairness was questioned, with adequate reasons, by several organisations. The Association for Democratic Reforms, the Constitutional Conduct Group (CCG) of former civil servants and the Forum for Electoral Integrity were among the several groups that were compelled to draw public attention to the lack of integrity of EVM voting and ECI's departure from neutrality. Many political parties, mainstream and digital media houses and civil society groups also voiced serious apprehensions at the manner in which the 'model code of conduct' was being violated by the ruling party without adequate retribution from the ECI. The Election Commission responded to these justified criticisms with a very alarming silence or jumped aggressively to defend its unsatisfactory handling, even when patent infirmities were specifically pointed out by several former civil servants who have also conducted/supervised elections.

The response of ECI to all these serious public concerns was indifferent bordering on hostility. So, myself along with some colleagues took the initiative to consult other anxious civil society groups and apolitical platforms. In 2019 and 2020, seminars and public discussions were held by groups like the Forum for Electoral Integrity, People First, Delhi Science Forum, Constitutional Conduct Group, Aman Biradari Trust and the Centre for Financial Accountability. Of the suggestions that emanated, a unanimous one was to constitute a body of eminent and experienced persons with domain knowledge on issues relating to elections. Thus, the Citizens' Commission on Elections (CCE) was constituted to delve deeper into critical aspects concerning elections, call for expert advice where necessary and come up with appropriate findings and suggestions to ensure that elections are conducted with fairness and integrity.

The CCE went into specific areas/themes concerning elections:

- i. Electronic Voting [EVM/VVPATs] and its compliance with Democracy Principles.
- ii. Scheduling and processes of elections and compliance of Model Code of Conduct.
- iii. Role of media including social media, fake news, etc.
- iv. Integrity and inclusiveness of the Electoral Rolls.
- v. Criminalization, money power and Electoral bonds.

## vi. Autonomy of the ECI and its functioning before, during and after the election.

The CCE came across severe flaws in all these areas before, during and after Parliamentary Elections-2019. Reports have been prepared on all these areas/themes and would be released in phases. But in “Electronic Voting [EVM/VVPATs] and its compliance with Democracy Principles”, the flaws appear to be near-fatal to electoral democracy. Therefore, we are dealing with this critical issue first by releasing the report on this theme for larger public discussion. The study was mentored by Dr Sanjiva Prasad, Professor of Computer Science and Engineering, IIT Delhi in collaboration with his colleague Dr Subhashis Banerjee, Professor, Computer Science, IIT, Delhi.

The CCE’s expert group reviewed the functioning of EVMs primarily on the touchstone of whether and how far their use complied with ‘democracy principles’ mentioned in the enclosed summary and is available in detail in the main report. In short, it insists on absolute transparency in facilitating the voter to exercise his or her choice and in ensuring that these selections are, indeed, reflected in the stored vote and counted as such – without the slightest deviation whatsoever. These principles also mandate that the voting procedure is easily understandable and verifiable by the voter and open to audit without complications even when relevant technology is utilised. There should be absolutely no scope for error or misrepresentation of the elector’s choice.

The group has relied on depositions and expert opinions of several national and international experts and was informed of the reasons why even the most advanced countries do not prefer the use of EVMs during polls. Among the domain knowledge holders who submitted deposition before this CCE group were Ronald L. Rivest of the Massachusetts Institute of Technology, Cambridge, USA; Alex Halderman of the University of Michigan, USA; Poorvi L. Vora and Bhagirath Narahari of George Washington University, USA; Alok Choudhary of North-western University, USA Sandeep Shukla, Professor, Computer Science and Engineering, IIT Kanpur; Douglas W. Jones of the University of Iowa, USA; Nasir Memon of New York University (Brooklyn), USA; Philip B. Stark of the University of California, Berkeley, Vanessa Teague, Associate Professor, School of Computing and Information Systems, University of Melbourne, Cyber security, Australia; MG Devasahayam, former civil servant; Bappa Sinha of Free Software Movement of India, Subodh Sharma of Computer Science and Engineering and of the School of Public Policy, IIT, Delhi; S Prasanna, Advocate, Delhi, Venkatesh Nayak, RTI activist, KV Subrahmanyam, Professor, Computer Science, Chennai Mathematical Institute, Chennai, Poonam Agarwal, media-person and Anupam Saraph, Professor and Future Designer.

These experts along with Dr Sanjiva Prasad and Dr Subhashis Banerjee of IIT, Delhi are the best brains on the subject across the globe and it would not be possible to put together another group to match this vast and varied expertise.

The report has devoted considerable time and expertise in scrutinising the technical architecture of EVMs and the accompanying VVPATs. The ECI does not appear to safeguard against the possibilities of ‘side-channel attacks’, i.e. hacking electronic devices through electromagnetic and other methods. Even the ‘software guard extensions’ of sophisticated Intel processors have proved vulnerable to interference and tampering. Just a few EVMs can swing election results for a constituency. That the processor chip in the EVM is only one-time programmable is also in doubt. In fact, latest EVMs use the

MK61FX512VMD12 microcontroller supplied by an US based multinational, which has a programmable flash memory.

Further examination is possible only when the ECI makes the EVM design and prototype available for public technical audit. It is noted that none of the ECI's experts has credentials in computer security and the Commission reposing trust in many other external entities and organisations, that could lend themselves to breach of complete security. After tracking the various stages of the EVM's movement within the election setup – before and during polls, subsequent storage, counting and declaration of results – the report opines that there are certain intervals during which the machines could be accessed without authority or tampered with.

The findings reveal that there is, indeed, no guarantee that the voter's choice has been reflected with total fidelity in all cases and thus submit that immediate steps be taken to rectify the ECI's current procedures, irrespective of the scale and extent of possible error or manipulation. Besides, domain experts have clearly stated that the present 'quality assurance' and testing strategies of the ECI certainly do not rule out scope for mischief or manoeuvring of results.

The VVPAT system was introduced to ensure that voters were able to see and check physically paper slips that emanated from the EVMs and printers attached to them. The Supreme Court had ordered introduction of VVPAT as an additional stage to assure voters about the complete fidelity of their votes but the current procedure of voting does not sync with this objective and leaves gaps that could be manipulated. This paper trail has, for instance, been rendered ineffective as the 'marked slips' pop up for too brief a time for the voter to verify her/his vote before it moves away to its sealed box. Besides, the ECI refuses to cross check the tally of counting VVPAT paper-slips with electronic results on the grounds of being unnecessary and time consuming, even though the total time taken is considerably less than the time spent in counting the traditional papers received in ballot boxes. Even though VVPAT slips of votes cast are bound to be retained for one year after polls, the ECI has destroyed these slips of the 2019 polls, leading to grave apprehensions about its bona fides. Rules regarding mandatory recount of EVM results and the compulsory counting of the VVPAT paper slips are absolutely unavoidable.

Main report as well as the Executive Summary addresses all the concerns and apprehensions in the public mind about the fairness and integrity of India's elections and has arrived at these conclusions:

**a.** Due to the absence of End-to-End (E2E) verifiability, the present EVM/VVPAT system is not verifiable and therefore is unfit for democratic elections.

**b.** That an EVM has not yet been detected to have been hacked provides no guarantee that it cannot be hacked. Thus, elections must be conducted assuming that the EVMs may possibly be tampered with.

**c.** In practice, it may be necessary to test more EVMs than even what the civil society and the political parties demand (30% and 50% respectively) to ensure verification and reliable ascertainment of results.

**d.** There must be stringent pre-audit of the electronic vote count before the results are declared. The audit may in some cases - depending on the margin of victory - require a

full manual counting of VVPAT slips.

e. The electronic voting system should be re-designed to be software and hardware independent in order to be verifiable or auditable.

### End-Note

The fallacy of first-past-the-post system combined with blind cum opaque electronic voting along with money and media power in elections could create a ruling establishment that would be autocratic, kleptocratic and oligarchic.

Constitution of India has high Institutions of Democratic Governance:

- ECI, mandated to conduct free and fair elections with integrity
- Government, to facilitate this with laws and rules
- Parliament, to enact such laws
- Supreme Court, to ensure 'democracy principles' through oversight
- President of India in whose name the entire system of governance operates

All these have failed India's electoral democracy. No wonder India is now being widely perceived as a flawed and failing democracy moving fast towards autocracy and authoritarianism. It is time 'We, The People', who are the ultimate sovereign, moved in to save India's precious democracy. For this to happen the electorate needs to be informed of the way the ECI is functioning and elections are being conducted.

This is what The CCE has done and we place the Report before the "People of India" for discussions, debate and deliberations out of which Deo Volente an electoral system of impeccable integrity would emerge to take India towards a robust and vibrant democracy.

[**Note:** For a detailed and overarching narrative on the context, backdrop and the functioning of the CCE as well the circumstances leading to its formation, please see page Nos 33-42 ]





# Report of the Citizens' Commission on Elections

## Executive Summary

### Based on depositions by:

**Poonam Agarwal**, *Journalist, The Quint.* [Deposition](#).

**M. G. Devasahayam**, *IAS (Retd).* [Deposition](#)

**Venkatesh Nayak**, *RTI Activist.* [Deposition](#)

**Prasanna S.**, *Advocate.* [Deposition](#)

**Anupam Saraph**, *Professor and Future Designer.* [Deposition](#)

**Subodh Sharma**, *Assistant Professor, Computer Science and Engineering, IIT Delhi.* [Deposition](#)

**Sandeep Shukla**, *Professor, Computer Science and Engineering, IIT Kanpur.* [Deposition](#)

**Bappa Sinha**, *Technologist, Free Software Movement of India.* [Deposition](#)

**Poorvi L. Vora**, *Professor, Computer Science,  
George Washington University, Washington, DC, USA.* [Deposition](#) (joint submission)

**Alok Choudhary**, *Professor, Electrical and Computer Engineering, Northwestern  
University, Evanston, Illinois, USA* (joint submission with Poorvi Vora)

**J. Alex Halderman**, *Professor, Computer Science and Engineering, University of Michigan,  
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**Philip B. Stark**, *Professor of Statistics, University of California, Berkeley, USA*  
(joint submission with Poorvi Vora)

**K. V. Subrahmanyam, Professor**, *Computer Science, Chennai Mathematical Institute, Chennai, India* (joint submission with Poorvi Vora)

**Vanessa Teague**, *Associate Professor, School of Computing and Information Systems, University of Melbourne, Australia* (joint submission with Poorvi Vora)

Depositions were also invited from the Election Commission of India (ECI) and the members of its technical committee, Professors D. T. Shahani (IIT Delhi), Rajat Moona (IIT Bhilai) and D. K. Sharma (IIT Bombay). However, no deposition was received. The CCE also sent a [questionnaire](#) to the ECI, members of its technical committee and some former Chief Election Commissioners; [only one response](#) was received.

## 1 Democracy principles

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The democracy principles that any voting process for public elections should adhere to are:

1. The voting process should be transparent in a manner that the general public can be satisfied that their vote is correctly recorded and counted.
2. The voting and counting process should be publicly auditable.
3. Ordinary citizens should be able to check the essential steps in the voting process. If special expert knowledge is required then all should be able to select their own experts.
4. There should be verifiability in the counting of votes and ascertainment of the results reliably without too much special knowledge.
5. An election process should not only be free and fair, but also be seen to be free and fair.
6. Election Commission should be in full control of the entire voting process, and the public at large should be able to verify.
7. Electronic processes, if they are to be used for voting, should be in sync with changing technologies and technological practices, and be subject to public scrutiny/examinability.

In this report we examine to what extent the Electronic Voting Machine (EVM) along with the Voter Verifiable Paper Audit Trail (VVPAT) based system used in India comply with the democratic principles and make some recommendations.

## 2 Concerns with the EVM

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1. In an EVM, where votes are recorded electronically by press of a button, and the voter cannot examine what has been recorded, there is no way to provide a guarantee to a voter that her vote is cast as intended (recorded correctly in the EVM), recorded as cast (what is recorded in the EVM is what is collected in the final tally) and counted as recorded. This casts doubts on a purely EVM- based system.
2. It is well known that theoretically establishing the correctness of a system as complicated as an EVM is a computationally intractable problem. It is also well known that Quality Assurance (QA) testing is never adequate to establish the correctness of an EVM, and such tests can detect only a small fraction of possible software or hardware errors (follows a common maxim that tests do not constitute a proof of correctness). Also, pre-determined and pre-set test patterns are known to be inadequate for verification of the integrity of an EVM. The present EVM system is not verifiable and therefore is unfit for democratic elections.
3. If the correctness of an EVM cannot be established then it is practically impossible to predict whether an EVM can be hacked or not. In particular, that an EVM has not yet been hacked provides no guarantee whatsoever that it cannot be hacked. Thus elections must be conducted assuming that the electronic voting machines may possibly be tampered with.
4. Voter-verifiable Paper Audit Trail (VVPAT) is one possible to way to make the voting system auditable. Using VVPAT a voter can in principle verify that her vote is cast as intended, and a suitably designed end-of-poll statistical audit can possibly determine that the collection and counting are correct. This, however, is crucially dependent on the following four requirements :
  - (b) That the VVPAT slips are in one-to-one correspondence with the electronic records. Otherwise, it needs to be clearly defined which of the two is the legal definition of a vote.
  - (b) That the VVPAT system is truly voter-verified. The correct VVPAT protocol is to allow a voter to approve the VVPAT slip before the vote is cast, and to provide an option to cancel her vote if a discrepancy is noticed. It also requires a clear protocol for dispute resolution if a voter complains that a VVPAT printout is incorrect. The ECI's VVPAT system is not truly voter-verified because it does not provide the necessary agency to a voter to cancel her vote if she thinks it has been recorded incorrectly. Also, in case the voter raises a dispute, there is no way for her to prove that she is not lying. As such, penalizing a voter in such a situation is not correct.
  - (c) There must be compliance audit, verifiable by all candidates and interested members of the general public, to ensure the integrity of the VVPAT slips. The VVPAT slips may be trustworthy at the time of voting, but it is necessary to ensure that they remain trustworthy later while auditing. Only then a subsequent statistical audit can establish the correctness of the voting process. There has to be sufficient guarantees against spurious injection or deletion of



votes after polling and before counting when the EVMs and VVPATs are in custody of ECI, without requiring any trust assumptions. Otherwise, the mere agreement of electronic and VVPAT counts cannot rule out spurious vote injections or deletions in both.

- (d) There must be post-election audit of the EVM counts against manual counting of the VVPAT slips.

It is incorrect to assume that the prevalence of faulty (or hacked) EVMs is homogeneous across the population, independent of the margin of winning votes. In fact, it may be sufficient to tamper only a few EVMs to swing an election if a contest is close. Thus, in practice, it may be necessary to test more EVMs than even what the civil society and the political parties demand (30% and 50% respectively) to ensure verification and reliable ascertainment of results.

## 3 Recommendations

1. The decision making processes within the ECI need to be much more logical, rigorous and principled compared to what it was for the 2019 parliamentary elections.
2. EVMs cannot be assumed to be tamper-proof. The electronic voting system should be redesigned to be software and hardware independent in order to be verifiable or auditable. This does not imply that software or hardware cannot be used, but that the correctness of the election outcome cannot be entirely dependent on their working correctly.
3. The VVPAT system should be re-designed to be fully voter-verified. The voter should be able to approve the VVPAT printout before the vote is finally cast, and be able to cancel if there is an error.
4. The integrity of the VVPAT slips and the EVM machines during the entire time after polling and before counting and auditing must be ensured in a manner that is verifiable by all (and especially the candidates). There should be no trust requirement on the custody chain.
5. There must be stringent audit of the electronic vote count before the results are declared. The audit should not be based on ad hoc methods but by counting a statistically significant sample of the VVPAT slips according to rigorous and well established statistical audit techniques. The audit may in some cases - depending on the margin of victory - require a full manual counting of VVPAT slips.
6. There should be legislation to decide what is to be done if the audits reveal a problem. Such legislation should ideally be based on well-established statistical procedures and not on subjective decision of a few officials.
7. There is a definite need to move away from certification of voting equipment and processes and demonstrate that the outcome of an election is correct irrespective of machines and trust on custody chains of EVMs. Two ways to do this are by adopting rigorous and well established strategies for risk-limiting audits or by using a provably end-to-end verifiable cryptographic protocol, or both. The ECI should

explore the possibilities.

8. Finally, the voting system design should be subjected to independent (of the government and ECI) review and the integrity of the election process should be subjected to independent audit. The findings should be made public. In particular, all design details should be transparent and publicly available.



# The Report

## Is the Indian EVM and VVPAT System Fit for Democratic Elections?

India's parliamentary election is the largest in the world, with 543 constituencies and well over 1 million voters per constituency on the average, and voting in India is conducted electronically since 2004. However, there is considerable doubt about the verifiability of Election Commission of India's (ECI) Electronic Voting Machine (EVM) solution and its compliance with democratic principles. This inevitably generated disquiet during the elections, especially during the 2019 parliamentary elections.

In what follows we present a brief interim analysis. In Section 1 we examine the compliance of EVM based voting with democratic principles. In Section 1.1 we briefly capture the current EVM design and the ECI's processes for conducting the elections. In Section 1.2 we examine and analyse the concerns with the EVM. In Section 2 we examine the issues related to the trustworthiness of the custody chain and post-election audits. In Section 3 we make our final recommendations.

### 1 Compliance of EVM- based voting with democracy principles

#### 1.1 The EVM design and ECI's processes

The deposition by Bappa Sinha [16] summarises the ECI's EVM design and the associated processes.

### 1.1.1 EVM features

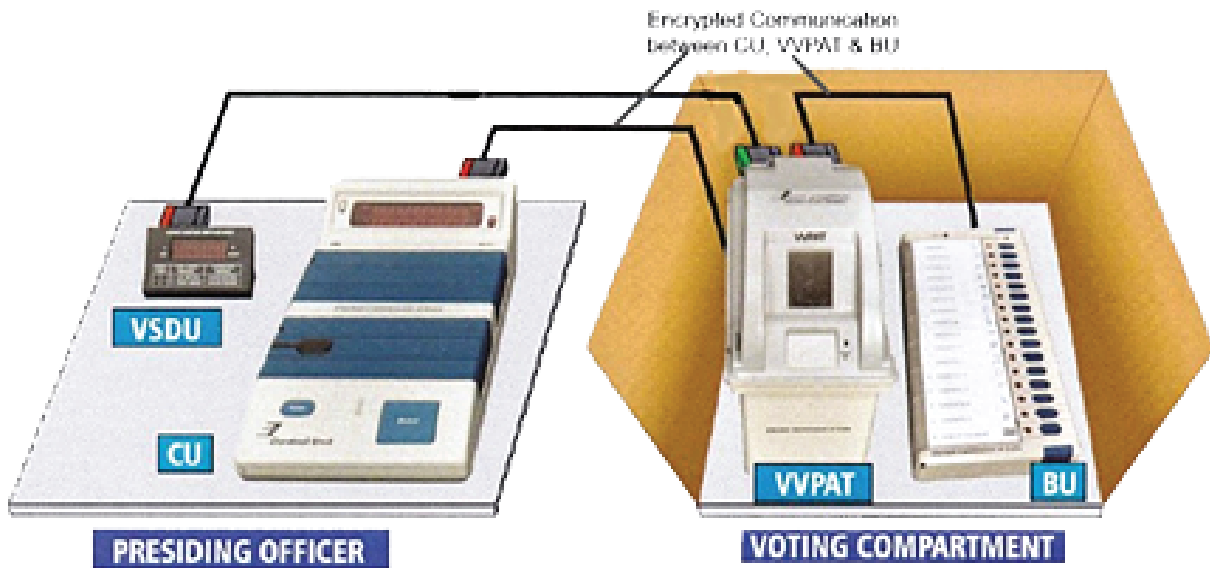


Figure 1: The schematic of ECI's EVM (original diagram from ECI's EVM & VVPAT manual).

The main features of the design are:

- It is a Direct Recording Electronic (DRE) voting protocol.
- The EVM consists of a control unit (CU) which is placed on the presiding officer's desk. The CU is connected to the Voter Verifiable Paper Audit Trail (VVPAT) printer which is then connected to the ballot unit (BU). The VVPAT printer and the BU are kept in the voter booth. The VVPAT status display unit (VSDU) is kept with the presiding officer and displays the status of the VVPAT printer.
- The different components authenticate each other using digital certificates. The system is designed to stop functioning if paired with unauthorised components. The communication between components is encrypted. It is a standalone system supposedly with no external communication channels, either wired or through radio. It only has designated interfaces for input and output of data according to specific protocols.
- As per ECI mandate it should be stand-alone (not computer-controlled) and "one time programmable" (OTP).

### 1.1.2 The voting process

The voting process using the EVM is described as follows:

1. A voter is allowed to proceed to the voting booth after eligibility and identity checks by polling officials.
2. For a vote to be cast the presiding officer must first enable the BU by pressing a button on the CU.
3. The voter casts the vote by pressing a button on the BU selecting a candidate. Once a button is pressed a light-emitting diode (LED) next to the button lights up and there is a long beep indicating that the vote has been recorded.

4. The VVPAT simultaneously prints a small slip of paper that carries the symbol, name and serial number of the candidate selected by the voter. This slip is visible for seven seconds in the viewing window after which it drops off in to a secure box.
5. Once a vote has been cast, the BU becomes inactive and does not respond to any more button presses, till the presiding officer schedules the next vote by again enabling the BU from the CU.
6. There is a mandatory 12 second delay before the CU can enable the next vote to be cast.
7. The key-presses are time stamped.

### 1.1.3 Design, engineering and manufacturing processes

- The EVM software was developed by a select group of engineers from Bharat Electronic Limited (BEL) and Electronics Corporation of India Limited (ECIL) independent of each other.
- Testing is done according to the software specification by multiple independent testing groups.
- The production group carries out production testing in the factory according to a Quality Assurance (QA) plan. Samples from production batches are tested by independent QA groups.
- BEL and ECIL are responsible for packaging and shipping the EVM systems to the states as directed by the ECI. Container trucks or sealed trucks with proper locking arrangements are used for transporting EVMs and VVPATs. Paper seals are put on the containers.
- All movement of EVMs are scheduled and monitored using an EVM Tracking Software (ETS) based on Global Positioning System (GPS).
- On receipt of the EVMs, the district election officers (DEOs) are supposed to video-graph the process of receipt of EVMs and then store them in strong rooms at the district headquarters.

### 1.1.4 Administrative processes

**EVM Preparation :** ECI allocates EVMs to states 200 days prior to polling. The EVMs are dispatched 180 days prior to polling and are tracked using the GPS based ETS software. There is a first level checking of the EVMs 3-6 months prior to polling where the internal parts are checked and the CU is sealed. The EVMs are assigned to constituencies using a first-stage randomization software 3 weeks prior to polling. In a second stage randomization the EVMs are assigned to polling booths two weeks before polling. Finally, after the last date for candidate withdrawal, the ballot paper is fixed on the BU, the candidate names are entered in an alphabetical order, a mock poll is conducted and the BU is sealed.

**Polling day processes:** The serial numbers of the EVM components are shared with the candidates and the polling agents so that they can inspect before commencement

of the mock poll. A mock poll of at least 50 votes is conducted in each polling station and the EVM and VVPAT tallies are compared in presence of the polling agents. After the mock polling is over all buttons of the CU other than those used for polling are covered with paper seals. These paper seals are signed by the polling agents.

After polling is over the presiding officer presses the close button, after which no votes can be cast. The complete EVM unit is sealed and signed. Polling agents are allowed to put their own seals. The representatives of the candidates are allowed to travel behind the vehicle that carries the EVMs to the counting storage rooms. The counting storage rooms are sealed and guarded by the Central Reserve Police Force (CRPF). Candidates are allowed to put their own seals on the strongroom.

**Counting day processes :** First the EVM serial numbers, seals, the start and end times as recorded are verified by both election officials and polling agents. The CUs that do not display the result because they were not closed properly, or in case the total number of votes reported by the CU does not match that reported by the presiding officer, are kept aside for scrutiny. After announcement of results candidates or counting agents can apply for VVPAT counts for the returning officer to decide.

Because of the above systems and processes the ECI and several other commentators [16] believe that electronic voting using ECI's EVM is safe. In particular, they believe that though there can be no formal guarantees against hacking, hacking is practically impossible because of the tight processes and the secure custody chain of control. Further, they believe that since the EVM is not connected to network it cannot be hacked remotely.

## 1. 2 Concerns with the EVM and our analysis

While banning electronic voting the German Constitutional Court made the following observation:

The use of voting machines which electronically record the voters' votes and electronically ascertain the election result only meets the constitutional requirements if the essential steps of the voting and of the ascertainment of the result can be examined reliably and without any specialist knowledge of the subject...The legislature is not prevented from using electronic voting machines in elections if the possibility of a reliable examination of correctness, which is constitutionally prescribed, is safeguarded. A complementary examination by the voter, by the electoral bodies or the general public is possible for example with electronic voting machines in which the votes are recorded in another way beside electronic storage.

Several depositions [3, 14, 18, 12, 11, 10, 7] have raised concerns that the EVM based voting may not measure up to the standards laid down by the German Constitutional court. Specifically:

- The **democratic principles** that any voting process for public elections should adhere to are [3]:

1. The voting process should be transparent in a manner that the general public

can be satisfied that their vote is correctly recorded and counted.

2. The voting and counting process should be publicly auditable.
3. Ordinary citizens should be able to check the essential steps in the voting process. If special expert knowledge is required then all should be able to select their own experts.
4. There should be verifiability in the counting of votes and ascertainment of the results reliably without any special knowledge.
5. An election process should not only be free and fair, but also be seen to be free and fair.
6. Election Commission should be in full control of the entire voting process, and the public at large should be able to verify.
7. Electronic processes, if they are to be used for voting, should be in sync with changing technologies and technological practices, and be subject to public scrutiny examinability.

- The compliance of the ECI's EVM+VVPAT based voting system to the above principles hinges crucially on the verifiability of the EVM and the voting and counting process. Much of the elaborate and complex processes of Sections 1.1.3 and 1.1.4 are required precisely because public verifiability of the election process is doubtful and the requirement of trust on various authorities is inevitable.
- Verifiability cannot be established by inviting people to hack the hardware system. ECI's challenge for demonstrating hacks is not meaningful, not only because sufficient time and access to tools were denied, but also because something has not yet been hacked provides no guarantee whatsoever that it cannot be hacked [14]. Indeed, there are numerous examples of EVM hacking all over the world, including an earlier version of the Indian EVM [14, 5].

It appears that possibilities of side-channel attacks [4] have not even been considered [3, 14]. There are numerous examples from all over the world of hacking electronic devices through electromagnetic and other channels [4], including of the Software Guard Extensions of sophisticated Intel™ processors [8]. In view of such possibilities the claims that the EVM has no external communication channels appear to be naive, especially considering that so much is at stake. After all, with modern data analytics it may require targeting the EVMs in just a few polling stations to swing the election results for a constituency [14, 15, 18].

- The OTP (one-time programmable) aspect of the EVM is doubtful [16, 3, 14], because, in a response to an RTI query, it was revealed that the latest EVM uses the MK61FX512VMD12 microcontroller (from an US based multinational) which has a programmable flash memory. However, Sandeep Shukla [14] points out that it cannot be written to if the JTAG pins are fused and memory lock bit is set. Unfortunately, this is impossible to verify since the details are not publicly available [7] and the EVM design and prototype has not been made available for public audit.
- Experts declaring it safe does not make the EVM+VVPAT verifiable. Besides, none of ECI's experts have credentials in computer security [14]. In addition to experts,

ECI seems to be reposing trust in many other entities and organisations - including hardware manufacturers, software developers and testers, system assemblers and unmodelled custody chains - and is thus not entirely in control [3, 18, 11].

- Many claims of the ECI and its experts do not stand up to scrutiny. Some examples are 'EVM is unhackable' [14, 15, 18, 12], 'functionality tests and mock polls are sufficient' [12, 18], 'randomization of EVM allocations makes the process safe' [18], 'safe because candidate order is not known when EVM is sealed' [18], 'mutual authentication of EVM components makes it safe' [18], 'ECI's procedures cannot be circumvented' [3, 18, 11], 'ECI's VVPAT protocol makes the voting process verifiable' [18, 12, 11]; all these claims have been convincingly challenged in the cited depositions received by the CCE.
- Testing is never adequate to declare an electronic system as complicated as an EVM failsafe and verified [18, 12]. An EVM system composed from its components can exist in one of a very large number of internal states, which, almost surely, is an exponential function of the configuration parameters. Examination of such large systems is an intractable problem, which often compels the examiners to rely on weaker forms of verification such as quality assurance (QA) methods - for instance, testing. However, well documented studies have shown that such weaker notions of verification can only detect a fraction of software errors (follows a common maxim that tests do not constitute a proof). In particular, it may be impossible to determine with reasonable amount of computation or testing whether such systems can ever reach a compromised state, perhaps due to hacking, where the democratic principles are violated [12]. Also pre-determined and preset test patterns are known to be inadequate for verification of the integrity of a hardware-software codesign of a system as complex as an EVM [18].
- Thus elections must be conducted assuming that the electronic voting machines may possibly be tampered with [18, 12]. The long time window - over the cycle of design, implementation, manufacture, testing, maintenance, storage and deployment - may provide ample opportunity for insiders or criminals to attempt other means of access [18]. There is an overwhelming requirement of trust on such custody chains; such (often implicit) assumptions of trust in various mechanisms make the election process unverifiable [18, 12, 11].
- ECI's VVPAT system is not voter-verified in the true sense [18, 12, 11]. The correct VVPAT protocol is to allow a voter to approve the VVPAT slip before the vote is cast, and providing an option to cancel her vote if there is a discrepancy [18]. There is no clear protocol for dispute resolution if a voter complains that a VVPAT printout is incorrect, as there is no non-repudiation of a cast vote [12]. Also, there is no guarantee that every VVPAT slip that is counted has been verified by a legitimate voter, or that every voter-verified slip is counted. The VVPAT audit can at best ensure that the electronic and VVPAT tallies match, but that by itself - without compliance audit [17] based protection against spurious vote addition or deletion in a manner verifiable by all candidates provides no real guarantee [12, 18, 11].
- The overall lack of transparency and public auditability, which are crucial for democratic principles of public elections, are worrisome [16, 3, 14, 18, 12, 11, 10].



The non-verifiability of the EVM based voting protocol makes it impossible to rule out unpredictable manipulations by unpredictable entities, including by foreign players. It is essential that all aspects of an election may be observed and independently-verified by the public to engender trust [18, 7, 14].

## 2 EVM/VVPATs before and during polling, storage, counting and declaration of results

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### 2.1 Trustworthiness of the custody chain of EVMs

Several depositions have raised concerns regarding the efficacy of the processes described in Sections 1.1.3 and 1.1.4 for maintaining the integrity of the polling process. Specifically in the Lok Sabha Elections 2019 :

- The ECI and the manufacturers-cum-suppliers of EVMs – ECIL and BEL–appear to have been evasive in response to RTI queries [7]. In addition, the information on the audits conducted by STQC (Standardisation Testing and Quality Certification Directorate, Ministry of Electronics and Information Technology) and CFSL (Central Forensic Science Laboratory) have also been sketchy and evasive [7].
- The reluctance by the authorities to share information publicly – despite the Central Information Commission’s (CIC) recommendation made in 2018 that information relating to the software used in EVMs be made public in the larger public interest – is surprising and worrisome [7].
- There were discrepancies in the voter turnout/ votes polled data on the Electronic Voting Machines (EVMs) and the votes counted data on EVMs in over 373 constituencies [1, 3]. The four highest discrepancies were of 18,331, 17,871, 14,512 and 9,906 votes where the EVM votes were in surplus. These numbers are clearly too large to be explained by inadvertently counted mock polling data.
- Not only have there been no explanations forthcoming from the ECI regarding the discrepancies, but the ECI also pulled down the data after an explanation was sought [1].
- About 2 million EVMs were stated to be missing from the election commission. The ECI had no explanation for this [3, 18].
- After the final vote was cast there were video reports from at least 10 different places of new EVMs being moved into strong rooms. ECI said these were reserve EVMs, but provided no evidence for this, and no explanation for why they need to be moved just before counting rather than at the time of voting, when there was, in some cases, weeks between voting and counting. They also provided no explanation as to why, as required by the EC rules, there were no security officers accompanying these vehicles, and why these vehicles were often un-numbered, un-official vehicles. Doubts arise as to whether these are part of the 2 million missing EVMs. There have also been reports of irregularities in the counting process [3].

## 2.2 VVPAT counting

### 2.2.1 The controversy

The issue of how many EVMs need to be checked by comparing the electronic tally with a manual VVPAT slip tally has also been mired in controversy.

- In its letter dated February 13, 2018, the ECI directed state chief electoral officers to mandatorily verify VVPAT paper slips in only one randomly selected polling station in each assembly constituency. The statistical basis for this directive was however unclear [3, 10].
- At the request of the Election Commission, Abhay Bhatt of Indian Statistical Institute, Delhi, and others provided a report describing how many EVMs should be cross-checked and why. The report recommends the cross-checking of only 479 EVMs across the country, independent of how many total EVMs there are (some reports mention that they considered a total of 10.35 Lakh EVMs). It says that, if a fraction of 2% or more of the EVMs are faulty, cross-checking 479 chosen at random across the country will be sufficient to detect this fact with virtual certainty [3, 10, 18, 11]. This was also supported by Rajiv Karandikar of the Chennai Mathematical Institute [3].

In response to petitions in the Supreme Court from representatives of the civil society and opposition parties that the then standard of cross-checking one EVM per assembly constituency was not sufficient, the EC used the Bhatt Report to claim that their approach resulted in checking 4,125 EVMs over the entire country and was hence more than sufficient. However, the Supreme Court ordered the Election Commission to increase the number of cross-checked EVMs to five per Assembly constituency in order to assuage the concerns of the petitioners (this corresponds to 20,625 EVMs across the country). The court later turned down another set of petitions filed by civil society groups and opposition parties to count 50% of EVMs per constituency, saying that this was not necessary. The ECI claimed that manual VVPAT counting in 50% of the constituencies will delay the announcement of results [3, 10, 18].

- The rationale behind the SC's directive for cross checking only 5 EVMs per assembly constituency against manual VVPAT counts was never explained. It does not seem to have any statistical basis [3, 10, 18].
- Not cross-checking sufficient number of EVMs even after widespread public suspicions, and 21 opposition parties as well as civil society asking for it, diminishes public faith in the process [3].
- The SC also failed to direct what 'decision rules' must be followed by the ECI in the event of discrepancies between manual counting and electronic counting. [3, 10].

## 2.3 The analysis

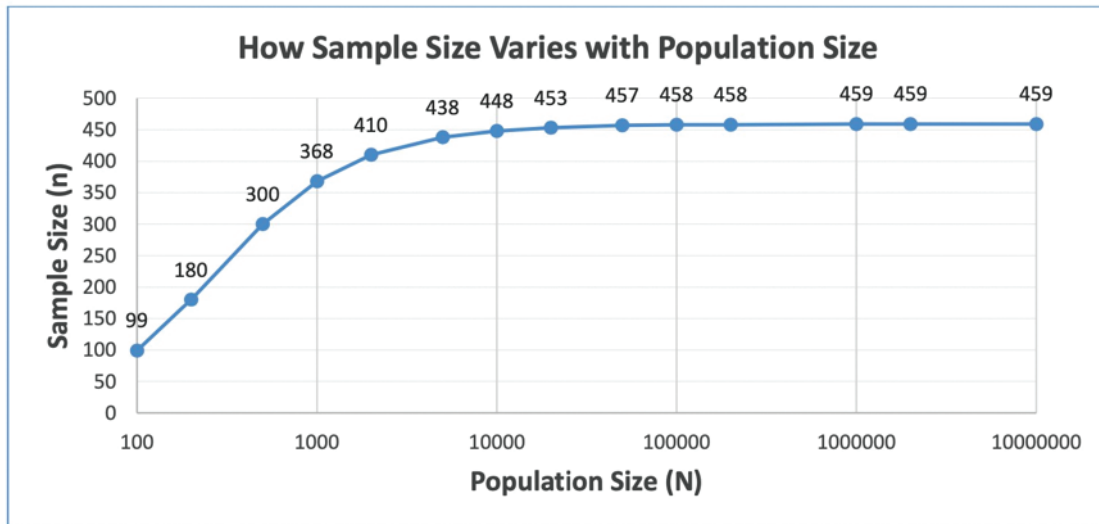


Figure 2: Sample size required as per hypergeometric distribution to detect at least one faulty EVM with 99% probability in a population with 1% faulty EVMs. In this particular example, it is seen that increase of population size beyond about 10,000 ( $N/n > 20$ ) has little or no impact on the sample size. The figure has been taken from [13].

<i>Population Boundary</i>	<i>Population Size (N) (Number of EVMs)</i>
Assembly Constituency	$\approx 30$ to 300
Parliamentary Constituency	$\approx 300$ to 1800
A State as a whole	Ranging from 589 (Sikkim) to 1,50,000 (U.P) For 9 States $N < 10,000$ For 20 States $N > 10,000$
India as a whole	$\approx 10,00,000$

$\approx$  is the symbol for 'approximately equal'.

Figure 3: Defining population. The figure has been taken from [13].

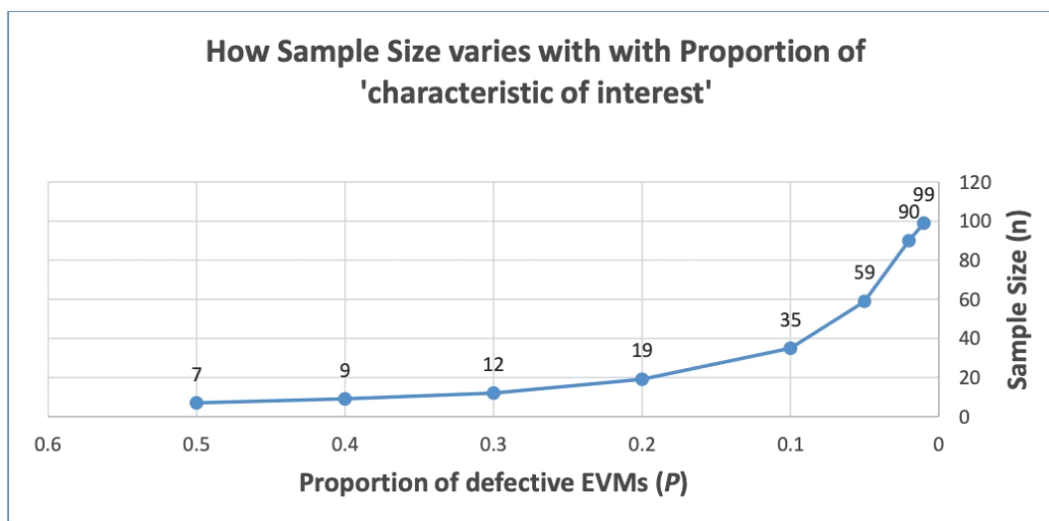


Figure 4: Variation of sample size with proportion of faulty EVMs fixing the population size to  $N = 100$ . The figure has been taken from [13].

- In probability theory and statistics, the sufficiency of sampling is usually determined by the hypergeometric distribution. It is a discrete probability distribution that describes the probability of  $k$  successes (random draws for which the object drawn has a specified feature, in this case a defective EVM) in  $n$  draws, without replacement, from a finite population of size  $N$  that contains exactly  $K$  objects with that feature, wherein each draw is either a success or a failure. [This is very similar to the binomial distribution that describes the probability of  $k$  successes in  $n$  draws with replacements.]
- In an analysis using the hypergeometric distribution, Shetty [13] shows that if 1% of the EVMs are assumed to be defective (give a mismatch with the VVPAT count), then, for a 99% probability of detecting at least one defective EVM, the sample sizes required, for various population sizes are given as per Figure 2. Figure 3 defines population. Figure 4 shows how the sample size must vary with the proportion of faulty EVMs.
- Quoting Shetty [13]

Studying Figures 2 and 3 together, it is obvious that if the EVMs used in an Assembly Constituency are defined as the population, the population size ( $N$ ) will be very small; the sampling fraction ( $n/N$ ) will be very big; and the sample size ( $n$ ) will vary considerably across Assembly Constituencies. The same is true if the EVMs used in a Parliamentary Constituency are defined as the population.

If the EVMs in a State as a whole are defined as the population, there is considerable variation in population size from the very small (Sikkim) to the very big (Uttar Pradesh). For the nine smaller States with population size less than 10,000 EVMs, the sampling fraction ( $n/N$ ) will be quite big and the sample size will vary considerably across the States. For the 20 bigger States with population size greater than 10,000 EVMs, the sample size will 'hit a plateau' in the 450s and further increase in population size will have little or no effect on it. If the EVMs used in India as a whole are defined as the population, due to the 'plateau effect', the sample size is just one more than that for U.P.

- In view of the above, in most cases (almost all) ECI's prescribed sample size of "one EVM per assembly constituency" will fail to detect a faulty EVM with a very high probability. See [13] for details. Using a similar analysis Vora *et al.* [18] show that with a 2% rate of faulty EVM, the SC's directive of checking 5 EVMs per assembly constituency will fail to detect a faulty EVM in roughly 50% of the cases.
- The Bhatt report is clearly based on the profoundly mistaken premise of taking the whole country as one population. At a 2% fault rate the Bhatt approach is designed to detect only if roughly 20,000 EVMs are faulty. It completely misses the point that swinging a few tens of thousands of votes, with far fewer faulty EVMs, is sufficient to swing a single Lok Sabha seat [3, 18, 10, 11, 14].
- Note that, if the margin between the winner and the second highest vote getter is small, fewer EVMs need to be rigged, and, to detect this, more need to be checked. If the 'population' has to be defined at the level of an assembly constituency, the number of EVMs to be cross checked will depend on the margin, and, while it can be smaller than 30%, it can be larger than 50% as well. For example, in the extreme case of the margin being only one vote, a complete manual count will be necessary. In view of the above, the civil society and opposition party concerns that 5 EVMs per

constituency are not sufficient appear to be reasonable.

- Thus, in practice, election outcomes may be changed by tampering significantly fewer EVMs than even what the civil society demands consider, and it is incorrect to assume that faulty (or hacked) EVMs are distributed homogeneously across the population without considering the margins. However, with rigorous risk-limiting audit procedures that consider the margins [6, 2, 18, 17], it should be possible to audit election outcomes without necessarily manually counting all VVPAT slips. Complete manual counting should be last resort.

## 3 Final recommendations

The analysis in the above two sections clearly demonstrates that the decision making processes within the ECI need to be much more logical, rigorous and principled compared to what it was for the 2019 parliamentary elections. Ad hoc systems and processes without adequate analysis of the properties and the guarantees should be avoided. Only then can elections using electronic means adhere to standard democratic principles, appear to be free and fair, and engender confidence in election outcomes.

Specifically, we make the following recommendations for the future:

### Software and hardware independence

The electronic voting system **should be re-designed to be software and hardware independent in order to be verifiable or auditable. EVMs cannot be assumed to be tamper-proof.** As defined by Rivest [9], a voting system is software (hardware) independent if an undetected change in software (hardware) can not lead to an undetectable change in the election outcome. Any solution that relies crucially on the correctness of the EVM is not software and hardware independent [18, 12].

### End-to-end (E2E) verifiability

**One way to achieve software and hardware independence is to use E2E verifiable systems with provable guarantees of correctness [18, 12, 11, 2].** The overall correctness of voting is established by the correctness of three steps: cast-as-intended indicating that the voting machine has registered the vote correctly, recorded-as-cast indicating the cast vote is correctly included in the final tally, and counted-as recorded indicating that final tally is correctly computed. There must also be guarantees against spurious vote injections [12]. These guarantees should be publicly verifiable.

**ECI should explore the possibility of using an E2E verifiable system [2].**

### Re-design of the VVPAT system

The VVPAT system should be **re-designed to be fully voter-verified [18, 11, 12].** The voter should be able to approve the VVPAT printout before the vote is finally cast, and be able to cancel if there is an error.

Moreover, in case a voter disputes that the vote has been incorrectly recorded, there must be a clear method of determination either in favour of the voter or in favour of the authorities [12]. This may not be possible in a pure DRE based system like the ECI's

EVM, because the machine may not make the same error when tested and because it is not possible to determine, without doubt, whether it did originally make the error. In this case, the voter cannot be penalized.

### End-of-poll audits

To be compliant with democratic principles there is a definite need to **move away from certification of voting equipment and processes and demonstrate that the outcome of an election is correct irrespective of machines and custody chains of EVMs. Two ways to do this** are by adopting rigorous and well established strategies for compliance and risklimiting audits [6, 17, 2] or by using a **provably end-to-end verifiable cryptographic protocol**, or both [2, 18, 12]. In any case, **the ECI needs to change the currently prescribed policy for VVPAT based audit with more rigorous risk-limiting audit based sampling strategies [6] before the results are announced.**

Also there must be a clear pre-announced protocol for deciding the outcome - including possible re-polling - if there is a mismatch between the VVPAT and the electronic tallies [3].

### Legislation

There has to be legislation **to deal with the cases when the audit, and subsequent recount, reveal a problem.** Legislation will also be required **to regulate when, and if, a candidate can request a hand count.** Best practices suggest that such legislation be based on established statistical principles, as opposed to the judgment of individual election officials, to the extent possible [18].

### Independent review

The voting system design should be subjected to independent (of the government and ECI) review and the integrity of the election process should be subjected to independent audit. **The findings should be made public.**

### Transparent processes

Finally, the election processes need to be completely transparent and should not have too many requirements of trust on authorities and experts, including on ECI [3, 10, 18, 12, 11]. All design details should be publicly available. Also, there should be more public consultations, and public and civil society concerns should be transparently and fairly handled.

Finally, if we opt for electronic elections and bring computer science and statistics into public life, then we cannot leave their disciplinary rigour behind.

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## A Citizen's Perspective

# 'Democracy Principles' in India's Elections

By  
**M. G. Devasahayam\***

Elections are the essence of democracy and are meant to translate the consent of the citizens into governmental authority. There are broadly five types of voting systems in use around the world:

- i. Paper Ballots (PB). Vote recorded on paper and counted by hand.
- ii. Direct Recording EVM. Vote recorded in memory. Counted electronically.
- iii. Direct Recording EVMs with Voter Verified Paper Audit Trail (VVPAT).
- iv. Vote recorded in memory and printed on paper. Counting done electronically and by hand facilitating verification/auditing BEFORE declaring result.
- v. Machine-readable Paper Ballots that are scanned and electronically counted using Optical Mark Recognition (OMR) technology.
- vi. Internet-based Voting or Online Voting. Most vulnerable, not suited to India.

There are other types also. India abandoned i) above and adopted ii) and now in the

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process of implementing iii). But though VVPATs have been installed in every EVM counting continues to be done electronically. This violates fundamental 'democracy principles.'

**'Democracy Principles' in elections in the Indian context are:**

- i. The election process should be verifiable in a manner that the public can be satisfied that their vote is correctly recorded and counted.
- ii. The process be subject to public scrutiny/examinability.
- iii. Ordinary citizens should be able to check the essential steps in the voting process with out special expert knowledge.
- iv. There should be transparency in the counting of votes and ascertainment of the results reliably without special knowledge.
- v. The entire process should not only be free and fair, but also be seen to be free and fair.
- vi. The Election Commission should be in full control of the entire voting process

Under the PB system voters could examine and verify the accuracy of the ballot-paper, candidate's name and symbol and verify whether it has been correctly marked. Examinability gives knowledge and that gives satisfaction that he/she has transferred the sovereignty to the candidate of his/her choice. In the case of an election dispute physical reconstruction of the vote for authentication is possible. Vote counting was open and transparent.

In EVM voting everything is done inside a machine in an opaque manner without examinability, verifiability, knowledge, and satisfaction as to whether sovereignty has been transferred to the candidate of the voter's choice. Under the EVM system all that a voter does is to press a button, see a light and hear a sound. All that the voter has is a chance to look at a VVPAT slip for seven seconds. He/she has no idea whether the vote has been correctly recorded and counted.

According to experts, end-to-end verifiability of the vote cast, vote recorded, and vote counted, independent of the hardware, continues to be the biggest bugbear of India's elections.

## **Under Electronic system ECI has lost control**

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There is another serious dimension to this problem. Under the ballot papersystem, the ECI had full control and supervision over the manufacturing of ballot-boxes, printing of ballot-papers its despatch and counting of votes. Not so with EVMs. Public Sector Undertakings (PSUs) Bharat Electronics Limited (BEL), Bengaluru, and the Electronic Corporation of India Limited (ECIL), Hyderabad, manufacture EVMs and they are not under the control or supervision of the ECI. Instead, they are under the direct control of the Union Government headed by a Minister from the ruling party. These entities share the confidential software programme with foreign chip manufacturers to copy it on to micro-controllers used in the EVMs. When these foreign companies deliver micro-controllers fused with software code to the EVM manufacturers, neither the manufacturer nor the ECI officials nor the technical advisers can read back their contents because they are locked.

What is worse, even the PSUs seem to have lost control of EVMs on election duty and

private engineers have taken over the critical tasks of checking and maintaining EVMs and VVPATs, starting from First Level Checking till the end of counting. **It is clear, therefore, that EVM voting does not comply with any of the 'democracy principles' which are paramount.**

Article 324(1) of the Constitution of India vests with the Election Commission "the superintendence, direction and control of the preparation of the electoral rolls for, and the conduct of, all elections to Parliament and to the Legislature of every State and of elections to the offices of President and Vice President". **Under PB system EC had 'control' over the entire conduct of election, but under EVM system it has almost completely lost control. Therefore, elections conducted under EVM system ab initio becomes unconstitutional.**

## Election Commission's position

Despite this reality the ECI has been persistently and consistently defending, protecting and cherishing EVMs. Successive Chief Election Commissioners (CEC) have been openly claiming that these machines are robust, un-hackable and cannot be tampered with. Some of them even went to the extent of serenading it as 'infallible.' (1 to 6).

More recently, in early November, 2020 amidst disputes raised during Bihar elections regarding the integrity of EVMs, the Deputy Election Commissioner in charge of EVMs made this open statement: "It has been clarified time and again that EVMs are absolutely robust and tamper-proof. Even the Supreme Court has upheld their integrity more than once." (6 & 7) Notice was issued to the ECI on November 23, 2020 followed by reminder on December 7, 2020 to provide evidence of such "upholding of EVMs integrity by the Supreme Court."

The ECI did not respond even after one month and some of us moved the Delhi High Court to give suitable direction to the ECI. On December 31, 2020 the ECI responded by quoting an innocuous observation of the Supreme Court on April 8, 2019 in the Writ Petition (C) No. 273/2019 N Chandrababu Naidu & Ors Versus Union of India & Anr: *At the very outset the Court would like to observe that neither the satisfaction of the Election Commission nor the system in vogue today, as stated above, is being doubted by the Court insofar as fairness and integrity is concerned. It is possible and we are certain that the system ensures accurate electoral results* (7).

But, the ECI deliberately concealed what the Supreme Court pronounced in M.G. Devasahayam & Ors. Versus Union of India & Anr in Writ Petition (C) No. 23/2019 on that very day: *We express our reluctance to go into the issues regarding the integrity of the EVMs which have been raised at a belated stage. The petition was filed in the month of December 2018 raising various technical issues which are not possible to be gone into at this stage* (8).

The Apex Court made the obiter dicta on the "fairness and integrity" of the "system in vogue today...ensuring accurate electoral results..." without even "going into the issues regarding the integrity of the EVMs". And the ECI flaunts it as Gospel truth!

While so, in December 2020 in response to a detailed questionnaire on the subject sent by the Convener of CCE, a former CEC, Mr N. Gopalaswamy sent this brusque and dismissive reply: *My quick response to your Q.s on EVM. The EVMs were reliable and are reliable. The addition of VVPAT has only strengthened that conclusion... On the issue of the*

*number of polling stations per constituency that should be taken up for the VVPAT cross-checking, the ECI decided on 1 and I am sure the ECI had not decided it at its whims and fancies but had based it on expert opinion rendered to it. You can seek a copy of the expert opinion to satisfy yourself. Anyway, the SC in its wisdom raised it to 5 per AC and that is the norm now. Finally, the issue of reliability of the EVMs has been debated and discussed ad nauseum and so one more discussion is unnecessary in my view. But if it is your wish, go ahead by all means.*

## **EVM/VVPATs before and during polling, storage, counting and declaration of results**

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Replies to Right to Information (RTI) queries reveal that about 2 million EVMs were stated to be missing from the Election Commission(9). The records of the two public sector companies who manufacture EVMs say that they have been paid Rs 116 crore more than what the ECI says they have been paid according to declared contracts, raising the question of what work this extra payment was for, and who made it.

The ECI says the EVMs can be programmed only once, making hacking unlikely. However, there are reports that it can be programmed several times. There are other reports saying that the EVM machine can be manipulated by connecting it to cell phones, blue-tooth devices, replacing parts of it, and other forms of manipulation, apart from physical replacement of it by other EVMs.

After the final vote was cast there were video reports from at least 10 different places of new EVMs being moved into strong rooms(10). The ECI said these were reserve EVMs, but provided no evidence for this, and no explanation for why they need to be moved just before counting rather than at the time of voting, which was, in some cases, weeks later. They also provided no explanation as to why, as required by the EC rules, there were no security officers accompanying these vehicles, and why these vehicles were often un-numbered, unofficial vehicles. Doubt arises as to whether these are part of the 2 million missing EVMs! There have also been reports of irregularities in the counting process.

Media source said that it had deep-dived into two sets of data shared by the ECI: first, the voter turnout/votes polled data on the EVMs and second, the votes counted data and had found serious discrepancies in the two sets of data in 373 constituencies which went to polls in the first four phases of the election(11). When this source raised the issue of discrepancies with the ECI the ticker mentioning “final voter turnout” mysteriously disappeared from the EC’s website (eciresults.nic.in). When asked why the ticker and the data have been removed from the website, there was no response.

## **Machine-voting has no Integrity**

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Integrity of EVMs has been challenged from the time they were introduced in 1999. It flared up after Parliament election-2009 and EVMs were exposed on many grounds: the whole world has discarded similar EVMs; use of EVM is unconstitutional and illegal; EVM software and hardware are not safe; EVMs are sitting ducks; insider fraud, storing and counting are concerns; the ECI is clueless on technology and there is trust deficit.

BJP's trouble-shooter Subramanian Swamy (now an MP) challenged the EVM in the Delhi High Court and got a judgment in January 2012, wherein the Court expressed reservations on EVM with this ruling: Dr Swamy is right to the extent that it cannot be ruled out that EVMs may be vulnerable to frauds. There may be security issues as well. Since there was no relief, Dr Swamy took it to the Supreme Court and got the order to have VVPAT in every EVM vide its judgment dated October 8, 2013. This ipso facto meant that EVM should be used for voting and all the printed slips in the VVPAT machine should be counted before declaring results.

Pursuant to the order of the Supreme Court and other directives the ECI arranged for all EVMs to be accompanied with VVPAT for the 2019 general elections. Main purpose was to bring in accuracy, verifiability and transparency in the casting and counting of votes. Without counting of VVPAT paper slips in a significant percentage of polling stations in each assembly constituency, the objectives of verifiability and transparency in the democratic process would remain unrealized.

But, in defiance of this basic principle, vide its letter dated February 13, 2018 the ECI directed state chief electoral officers to mandatorily verify VVPAT paper slips in only one randomly selected polling station in each assembly constituency. This being around 0.5% sample size which is pathetically low, defeated the very object of installing VVPATs in all EVMs which tantamount to non-implementation of Supreme Court Order.

Hence on April 10, 2018 the Forum for Electoral Integrity (FEI), wrote a detailed letter to the ECI explaining the need for a much higher sample for verification so that EVM-voting adheres to basic 'democratic principles.' The FEI suggested that VVPAT slips must be simultaneously counted for a sample size of at least 25% of the polling stations in an assembly constituency with the samples drawn randomly from the different strata and verified with the electronic count. If any variation was found, then the entire VVPAT slips in the constituency should be counted and tallied with the electronic count before declaring the result. This would have brought about substantial degree of integrity in the 2019 Parliament election. But that was not to be!

The ECI's reply dated May 1, 2018 signed by the Deputy Election Commissioner (DEC) in charge of EVM was typically bureaucratic and only gave technical, administrative, legal, and physical security arguments in favour of EVMs. Not a whimper about democracy principles and electoral integrity emphasized upon in FEI's letter. This matter, therefore, went before the Constitutional Conduct Group (CCG) of retired civil servants many of whom have conducted, monitored, and observed elections during their service. This CCG held a well-attended conclave on the subject in Delhi on June 8, 2018 and thereafter on July 4, 2018 submitted a memorandum on the subject to the Chief Election Commissioner (CEC). On the CEC's advice a brainstorming session on the subject was held July 21 at Indian Institute of Management (IIM), Bangalore. This was followed by some more interaction between the ECI and the CCG.

While so, an expert opinion on statistical sample size from Dr SK Nath, former Director General, Central Statistical Organisation (CSO) and an international consultant was sent to the ECI. The ECI formed an expert committee and invited Dr Nath to participate. The first meeting of the committee was held on October 4, 2018 at the Indian Statistical Institute (ISI), New Delhi. Its representatives said that taking election in the whole

country as single event, the sample size needed for entire country (10.35 lakh EVMs) was only 479 and that the sample size may be treated as constant as it doesn't vary much with population size. Faced with such absurdity the Committee collapsed.

## Summary disposal by Supreme Court

Concerned with the hostility of the ECI towards 'democracy principles' and the lack of integrity of EVM-voting, a Writ Petition was filed in the Supreme Court duly supported by Dr Nath's expert opinion taking Assembly constituency as population with a 98% confidence level of tamper-free and a bias-free election. Taking average of 240 polling stations per assembly constituency (which is mostly the case) at least 92 polling stations have to be cross verified by manual counting which works out to be well over 30%. Petition contended that such cross-verification and counting of VVPAT slips is essential in the interests of 'Democracy Principles' that elections should adhere to.

A Supreme Court (SC) bench presided over by Chief Justice of India admitted our WP in early January 2019 and issued Notice to the ECI. Faced with irrefutable facts, the ECI avoided filing a counter and when it did, it was the same parrot-like narration of the technological and administrative arrangements without even touching upon the democracy principles of examinability, verifiability, knowledge of the voter and transparency in counting. At this stage 21 political parties entered the scene by filing a separate WP seeking 50% VVPAT slip count.

The DEC filed a common counter affidavit making blatantly false claims(12). Among other falsehoods, the affidavit claims that there had not been any mismatch in the VVPAT and EVM tallies conducted in the past two years, and that the ECI had only received one complaint about a VVPAT recording an incorrect vote since 2013. The DEC also made the absurd claim that 50% VVPAT verification would delay the counting process by up to five or six days whereas even under paper ballot system with 100% counting almost all results including large parliament constituencies were declared within 10 to 16 hours of start of counting.

But the 'height of perjury' goes to the false claim of a non-existent report of the ISI in favour of a miniscule sample size. The DEC's affidavit notes that a three-member committee authored the study. The so-called ISI Report, taking election in the entire country as a single event, claimed that tallying of 479 randomly selected booths was enough to verify the fairness of the elections above 99.99 confidence level!

On verification it transpired this "Committee" was set up by the DEC-by writing a letter, not to the Director of ISI, Kolkata but to the head of its Delhi unit, asking for "associating with the commission and collaborating towards resolving the issues elaborated above...". It did not ask ISI to form an expert committee; it only asked the Delhi unit head to collaborate with the ECI in examining the issue. An RTI reply shows that this letter addressed to Delhi unit head was received but the ISI has no further record of any action taken or the formation of a formal "ISI" committee as per the Standard Operating Procedure (13). The composition of the body seems to be a private decision worked out by the DEC and Delhi unit head, without any ISI process and the report, therefore, is a private one and not that of the ISI.

**Tallying a large number of VVPAT slips with electronic count is to convince peo-**

ple of the integrity and fairness of the elections. Even without any demand, the ECI should have done this suo moto. Not only they did not do this but went to the extreme extent of filing an affidavit in the Supreme Court (based on a non-existent ISI Report) suggesting a near zero sample size of a just 479 randomly chosen booths (out of total 10.35 lakh booths i.e. 0.03%). The ECI did this despite widespread public suspicion about EVM voting and 21 opposition parties as well as civil society seeking relief. This shows the ECI's insincerity towards its constitutional mandate and total disregard for elementary principles of democracy.

As against this let us see what the former CEC S.Y. Quraishi who introduced VVPATs during his tenure has to say (14):

*I was heading the CEC when VVPAT was introduced in 2010. When EVM controversy was quite high in 2010, we had an all-party meeting where all political parties agreed to VVPAT. Some political parties are still questioning EVM and demanding voting through ballot papers. I suggested two models. First was that the winner and runner up may appeal for recounting of two EVM machines where they suspect something. The second model was to do the reverse, instead of counting on EVMs, count on VVPAT machines. Actually, counting of VVPAT and EVM machines take nearly 20 to 25 minutes each. So, instead of counting on EVM, let's count VVPAT slips, both would take same time, but the confidence level would go up among the contesting candidates. Let's do it on a pilot basis in some constituency. Reversing the process, which means counting VVPAT slips, would enhance transparency and credibility of the electoral system. Counting of ballot papers is a long process. It was a big paper sheet. Opening it, checking it and then counting takes a much longer time. Whereas VVPAT is a 3-inch slip and hardly takes much time. Counting through a VVPAT machine or through an EVM, both take almost the same time. So, in the end there would not be much difference whether we count EVMs or VVPAT slips. I discussed it with some officials of the EC and suggested these changes in the process to increase the credibility of the electoral system.*

Yet, strangely enough, when the case came up for hearing on April 8, 2019, the Supreme Court summarily disposed of the matter. Herewith is the operative portion of the order:

...our considered view is that having regard to the totality of the facts of the case and need to generate the greatest degree of satisfaction in all with regard to the full accuracy of the election results, the number of EVMs that would now be subjected to verification so far as VVPAT paper trail is concerned would be 5 per Assembly Constituency or Assembly Segments in a Parliamentary Constituency instead of what is provided by Guideline No. 16.6, namely, one machine per Assembly Constituency or Assembly Segment in a Parliamentary Constituency...

There was not a word about 'democracy principles' and the 'decision rules' that must be followed by the ECI in the event of discrepancies between manual counting and electronic counting. Five VVPAT machines per Assembly constituency arbitrarily determined by the SC just increased the sample size from microscopic 0.5% to miniscule 2% whereas we had asked for reasonable 30% and political parties 50%! A review petition was filed against this order with strong evidence of EVM-VVPAT fraud and malfunctioning in the first three phases of Election-2019 as well as perjury committed by the DEC regarding the "ISI Report". This petition also had solid grounds--factual,

constitutional and legal. Yet the bench headed by the CJI arbitrarily dismissed it on May 7, 2019 without even listening to the senior advocates who had lined up for argument! This paved the way for the conduct of Parliament Election-2019 in an unfair manner without adhering to even basic “Democracy Principles.” This is in total violation of Articles 324 and 142 of the Constitution.

In utter desperation 21 political parties pleaded with the ECI to at least count the measly 2% VVPAT slips upfront and do the verification before the main electronic count. It would have served some purpose if this had been done front-end as requested. But the ECI rudely rejected this very genuine demand and pushed the “verification” to the back-end well past midnight. In the event, NOT even one VVPAT slip was counted and matched before the entire electronic count was done, results announced and everything including singing and dancing was over. There has been an avalanche of reports about mismatch and excess counting in many booths and constituencies. Except for routine and bureaucratic replies, the ECI maintained a stony silence and just did not respond to the outcry.

Faced with such unfair election and deeply perturbed by the massive discrepancies between the votes polled and votes counted, the Association for Democratic Reforms (ADRs) and the Common Cause filed a WP in the Supreme Court. Here is a relevant extract:

That as per the research conducted by a team of experts with the petitioner organization there have been serious discrepancies between the number of voters in different constituencies (i.e., the voter turnout data collated and provided by the Election Commission) and the number of votes counted. That the study of the discrepancy patterns in all the constituencies based on the data made available on the main website of the Respondent No.1 (EC) and so also the ‘My Voters turnout App’ has given the following conclusions:

- *The Master summary of 542 constituencies shows discrepancies in 347 seats. 195 seats are without discrepancies whatsoever.*
- *The discrepancies range from 1 vote (lowest) to 101323 votes @ 10.49% of the total votes (highest).*
- *There are six seats where the discrepancy in votes is higher than the winning margin.*
- *The total volume of discrepancies amounts to 7,39,104 votes put together.*

The WP also stated that even though the results for all constituencies were declared by the EC on May 23, 2019, the Commission itself admitted on June 01, 2019 that the Index forms of all 542 Parliamentary Constituencies were expected to reach them from Returning Officers shortly thereby admitting that up to June 01, 2019 the EC had not received the actual data and that the declaration of results was not on the basis of recorded data by the Returning Officers. This is a fatal flaw that not only questions the integrity of the election but also the very legality of the Parliament constituted thereof!! Notice has been issued to the ECI and nothing is known as to when it will come up for hearing!

Such unfair Parliament-2019 election led to a bizarre happening during the Haryana



Assembly election that followed in October 2019. Two days before the polling date, there was a video showing Bakshish Singh Virk, BJP candidate for the Assandh constituency addressing a campaign meeting thus:

*You will have to pay for a five-second mistake for the next five years. We will come to know where a person has voted. You should not have any wrong perception about it. Many people do not tell deliberately to whom they voted, but if you ask us who you voted for, we shall tell you that too, because Modiji's and Khattarji's eyes are very sharp. May you press any of the buttons, all the votes will go to the 'lotus' (BJP's symbol) as we have fixed all the EVMs." (15)*

Except giving a routine notice to Virk and despatching a special observer to that constituency ECI did nothing. Bihar election in November 2019 also had similar complaints and allegations which were summarily rejected by the ECI.

And, due to the ECI's adamant behaviour as well as excessive secrecy and opacity, suspicion about EVM-VVPAT fraud refuses to die down and the fairness and integrity of India's election and democracy have come under serious suspicion among the public which is widespread.

## End-Note

Combined with the fallacy of the first-past-the-post system and the totally blind and opaque electronic voting, money and media power in elections could create a ruling establishment that would be autocratic, kleptocratic and oligarchic. We have seen this trend clearly emerging from the way the government, formed out of the Parliament election-2019, has been functioning and the way it responds to genuine people's struggles and protests. The massive farmer's movement is a case in point. In the event India may be heading towards a 'failed state' as described by Robert Rothberg in his seminal Book *When States Fail: Causes and Consequences*:

*Failed states offer unparalleled economic opportunity - but only for a privileged few. Those around the ruler or ruling oligarchy grow richer while their less fortunate brethren starve. Immense profits are available from an awareness of regulatory advantages and currency speculation and arbitrage. But the privilege of making real money when everything else is deteriorating is confined to clients of the ruling elite.... The nation-state's responsibility to maximize the well-being and prosperity of all its citizens is conspicuously absent, if it ever existed. Corruption flourishes in many states, but in failed states it often does so on an unusually destructive scale. There is widespread petty or lubricating corruption as a matter of course, but escalating levels of venal corruption mark failed states.*

This triple-whammy cannot be countenanced in the world's 'largest democracy' which is home to one-sixth of the human race.

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## Annexure

# Some questions for the former Chief Election Commissioners, present CEC and Election Commissioners as well as the Members of the Technical Advisory Committee of ECI regarding the security and integrity of EVM voting and VVPAT counting

- 1 In view of the fact that electronic recording and counting are black-box (opaque) and hence nontransparent, what guarantees do the voters have that their votes are recorded as intended and counted as recorded? Are they able to examine and verify their votes and ascertain the results reliably, which is a fundamental requirement of electoral democracy?
- 2 ECI's steadfast claim that the EVM is tamper proof and sound appears to be deeply problematic. It is well known in literature that the correctness verification of a system as complex as an EVM is computationally intractable [Mercuri, 1992]. It is also well known that it is not possible to know every vulnerability; neither is it possible in general to determine how a software or hardware module will perform in all circumstances [Rivest, 2008]. In particular, it is well known that it is impossible to test for every situation, and testing and quality assurance can never provide complete

guarantees [Vora, 2017, 2019]. In fact, there have been scathing criticism of an earlier version of the ECI's EVM design – which was based on a similar hardware-design principle – at reputed computer science forums [Halderman, 2011, Wolchok et al., 2010]. What then is the scientific basis for the statement that EVM based voting is correct and tamper-proof?

3 Security by obfuscation is not acceptable in modern computer security analysis [Shukla, 2018]. Why then is the EVM design and implementation not available for public scrutiny?

4 Conventional wisdom on electronic voting suggests that elections relying on electronic voting machines should be conducted assuming the machines can be tampered with, and must rely on end-to-end verifiability [Bernhard et al., 2017] and risk mitigating audits [Stark and Wagner, 2012]. There should be no need to repose trust in any single authority or custody chain for the correctness of elections in a democracy. Yet, not all of ECI's processes are verifiable or publicly auditable. Why?

5 There are several cryptography based electronic voting systems that are end-to-end verifiable [Bernhard et al., 2017] and software independent [Rivest, 2008]. Why has the ECI not considered one such?

6 The correct VVPAT protocol is to allow a voter to approve the VVPAT slip before the vote is cast [verifiedvoting.org, Goggin et al., 2008], and to cancel her vote if there is a discrepancy. The voter should be able to cancel the vote before it is cast without having to interact with anyone. The VVPAT system deployed by ECI does not follow the above principle– because there is no way to revoke the button press and destroy the VVPAT slip– and is hence not truly voter-verified. Does this not require urgent fixing?

7 In case of a challenge the VVPAT system does not support unambiguous dispute resolution with a clear determination of whether a voter's claim is correct or not, because an EVM can potentially behave differently when observed during further testing [Vora, 2019]. In fact, there is no way to prove that it will not. Also, there is no way for the voter to establish that she is not lying. This protocol appears to be fundamentally flawed and violates principles of natural justice. In view of this, is a stringent punishment for voters unable to prove a reported discrepancy not unsound?

8 Matching the VVPAT tally and the electronic count for an EVM can only ensure parity, but cannot rule out the possibility of simultaneous spurious vote injection or deletion in both. Also, there can be no guarantee – without reposing faith in the custody chain – that every VVPAT slip that is counted indeed corresponds to a valid vote cast according to the protocol, or, conversely, that every valid slip is counted. Is this sound?

9 Elementary statistical analysis [Shetty, 2018] shows that ECI's prescribed sample size of "one EVM per assembly constituency" will fail to detect a faulty EVM with a very high probability. In fact, a simple statistical analysis using the hypergeometric distribution reveals that with a 2% rate of faulty EVM, the Supreme Court's directive of checking 5 EVMs per assembly constituency will fail to detect a faulty EVM

in roughly 50% of the cases. Why is the ECI persisting with such an obviously faulty protocol?

10 Several irregularities have come to light: there were discrepancies in the voter turnout votes polled data on the Electronic Voting Machines (EVMs) and the votes counted data on EVMs in over 373 constituencies with the EVM votes in surplus by large margins [Agarwal, 2019]; not only were there no explanation for the above but the ECI also pulled down the data after an explanation was sought [Poonam Agarwal, 2020]; an RTI filing revealed that 20 lakh EVMs claimed to be delivered by the manufacturers are not in the possession of the EC [The Wire Staff, 2019]; another reveals that the micro-controller chip used in EVMs is not one-time programmable as claimed by the EC [Vinita Deshmukh, 2019, Shukla, 2018]. These belie the ECI's claims of a tamper proof device and process. Why is the ECI not taking cognizance of so many public concerns?

11 Finally, is the Election Commission in full control of the entire electoral process like the design and manufacture of EVM/VVPAT, manufacture of microprocessor and their burning in to EVM, writing and installation of software, counting methods and other technical functions as envisaged under Article 324 of the Constitution of India?

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