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India's Electronic Voting Machines (EVMs):

Social construction of a "frugal" innovation

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Abstract*

After the 2009 general elections in India a controversy started about the electronic voting machines (EVM) that are used nationwide since 2004. Political parties, activists, and academics raised suspicion that the machines might have been manipulated to alter the election outcome. There is no proof that EVMs have been manipulated in any of the past elections, however, concerned people claim that the risk is there. This paper takes a closer look at the Indian voting technology and the discussions around alleged security holes. The authors take a closer look at this particular controversy. Additionally we want to provide the reader with information about the Indian electronic voting system more generally. This includes reasons to change from the earlier paper ballot system and design challenges for EVM in the Indian context. We are writing within the frame of a theoretical model called Social Construction of Technology (SCOT), developed by Wiebe Bijker and Trevor Pinch (1987). Along the lines of this model we argue that after the EVM has been adopted in India, different 'relevant social groups' interpreted the EVM in diverse ways. From the social constructivist perspective we argue there has been not just one but at least three different EVMs. With time the 'interpretative flexibility' diminished and 'relevant social groups' more or less agreed on one interpretation of the EVM. The EVM has 'stabilized' and the controversy has been closed basically. We show the SCOT model to be helpful for structuring the controversy in a fruitful manner. The research questions adressed here are: How did the ECI and EVM manufacturers react to allegations made by political parties, VeTA, and voting security researchers that EVMs are vulnerable to manipulation? How was the election practice affected?

* This paper is based on the Thesis "India's Electronic Voting Machines (EVMs): perfect machines or a risk for democracy?" prepared by Maximilian Herstatt, handed in at the faculty of arts and Social Sciences of Maastricht University in June 2014

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Key Abbreviations

BEL	Bharat Electronics Limited
ECI	Election Commission of India
ECIL	Electronics Corporation of India Limited
EVM	Electronic Voting Machine
PSU	Public Sector Undertaking
SCOT	Social Construction of Technology
VVPAT	Voter Verifiable Paper Audit Trail

1. Introduction

On Friday 16th of May 2014 the results of this years General Election in India were declared. The outcome was a historic moment for the winning Bharatiya Janata Party (BJP) and the new elected Prime Minister Narendra Modi. It was described as “India's biggest election victory in 30 years” (Biswas, 2014). This is the first time that a party managed to get a simple majority, since the Congress party in 1984 won after the assassination of Indira Gandhi. In the Indian electoral system there are 543 constituencies and consequently 543 seats in parliament. To win a simple majority more than 272 seats are therefore needed. BJP won 51.9% of all seats (ECI, 2014a). The BJP used to be known for its religious extremism in advocating Hindu values and “demonizing India’s religious minorities, especially Muslims” (Kohli, 2001, p. 9). Their religious extremism has been popular with some, however it mainly was an obstacle in gaining coalition allies. Towards the end of the 1990s the BJP moderated their position, which then motivated a number of regional parties to ally with them (p. 9). Today the BJP is the leading party of the National Democratic Alliance with 29 allying parties (Kumar, D., 2014).

To hold democratic elections in India is an amazing task. In the 2014 elections 66.4 per cent from total electorate of 834,101,479 gave their vote (ECI, 2014b). The elections took place in different phases over several weeks. For making election procedures fast and efficient an electronic voting system has been employed. Electronic Voting Machines (EVMs) used in India are unique and quite different from EVMs employed in other nations like the US. Rather than large, expensive, complex and computer like systems the Indian machine is praised for its simplicity, inexpensiveness, and efficiency. The Election Commission of India is very proud of this system and stated that the machines are perfect and tamperproof (Agarwala et al, 2006, pp. 5-12). Those overly positive remarks caused scepticism amongst political parties, activists, academics and voting security specialists. It has been argued that the simplicity of EVM design has negative implications as well, when it comes to questions of transparency, verifiability and the overall security of the election practice.

Although the ECI generally claims that EVMs are tamperproof and perfect for the Indian elections, there have been occasions where EVMs malfunctioned and had to be replaced. In this year’s elections for example there were few occasion where EVMs malfunctioned in a way that regardless of the button pressed the vote would go always to the same party. The online journal ‘The Times of India’ released an article titled: *An EVM that 'votes' only for BJP stuns poll staff in Assam* (Kalita, 2014), which caused for discussion on social media

platforms like ‘Twitter’ (Hashtag: #BJPRiggedEVM). Taking into account that there are over 1.7 million machines in use those isolated instances could seem negligible. Yet members of an Indian civil society initiative called VeTA (Citizens for Verifiability, Transparency & Accountability in Elections) raised suspicion that those kinds of ‘malfunctions’ occur when people tried to tamper the EVM. This is not the first time that people raise doubt and claim that it is possible to manipulate EVMs and change election outcomes. After the outcome of the 2009 General Election political parties and concerned citizens claimed that EVMs could have been tampered and caused a wrong election outcome.

In this paper we take a closer look at this particular controversy. Additionally we want to provide the reader with information about the Indian electronic voting system more generally. This includes reasons to change from the earlier paper ballot system and design challenges for EVM in the Indian context. We are writing within the frame of a theoretical model called Social Construction of Technology (SCOT), developed by Wiebe Bijker and Trevor Pinch (1987). Along the lines of this model we argue that after the EVM has been adopted in India, different ‘relevant social groups’ interpreted the EVM in diverse ways. From the social constructivist perspective we argue there has been not just one but at least three different EVMs. With time the ‘interpretative flexibility’ diminished and ‘relevant social groups’ more or less agreed on one interpretation of the EVM. The EVM has ‘stabilized’ and the controversy has been closed basically. We show the SCOT model to be helpful for structuring the controversy in a fruitful manner. The research questions adressed here are: How did the ECI and EVM manufacturers react to allegations made by political parties, VeTA, and voting security researchers that EVMs are vulnerable to manipulation? How was the election practice affected?

2. Theoretical frame (SCOT)

> “What is needed is an understanding of technology from inside, both as a body of knowledge and as a social system. Instead, technology is often treated as a ‘black box’ whose contents and behaviour may be assumed to be common knowledge” (Layton, 1977, p. 198 in Pinch & BIjker, 1987, pp. 21-22).

The theoretical model we are using is called the Social Construction of Technology (SCOT) developed by Wiebe Bijker and Trevor Pinch from 1983 and 1987. Basically this is a

theoretical framework for explaining technological development as a social process. One of the objectives is to argue against the idea that the development of a technology is always logical and rational, following a pre-determined path. From social constructivist perspective one cannot explain why a technology 'works' in society in merely technical terms. It is not the machines but rather the people who decide over uses, meanings, and designs. More specifically relevant social groups (RSG) decide everything that has to do with a technology's development according to their needs, values etc. RSGs can be institutions and organizations, organized and unorganized groups of individuals; "key requirement is that all members of a certain social groups share the same set of meanings, attached to a specific artifact" (Pinch & Bijker, 1987, p. 30).

Now because there are several RSGs with difference in opinion it often occurs that in the development of a technology there is 'interpretative flexibility'. For example it is not unusual that users of a technology find alternative ways of using a technology, different from the intended use by the manufacturer. Or it simply means that different RSGs do not agree over a technology's use in society. RSGs can have different views, standards, aims, problem definitions, problem-solving strategies, standards, risk perceptions and so forth. The authors use the term 'technological frame' to bring together all these aspects in one concept.

What usually happens is that over time interpretative flexibility diminishes. Whereas in the earlier stages of a technology's development there is a variety of interpretation attached to it, in later phases one dominant interpretation evolves. This is referred to as 'closure'. "Closure in technology involves the stabilization of an artifact and the 'disappearance' of problems. To close a technological 'controversy', one need not solve the problems in the common sense of the word" (Pinch & Bijker, 1987, p. 44). Most important in this context is whether the RSGs see the problems of a technology being solved.

3. The Indian EVM through the eyes of relevant social groups

The most important and dominant RSGs in my analysis are the Election Commission of India (ECI), civil society initiative VeTA, a security research team, and economic researchers on EVMs. Political parties, Indian citizens, and EVM manufacturers appear less prominent in the way we describe the development of EVMs. we refer to political parties in rather general terms when some of them raised doubts about the integrity of EVMs. we interviewed a number of Indian citizens however not enough in order to make any general statements. And

the EVM manufacturers interestingly stayed out of the debate around EVMs themselves and there is only very little information publicly available about their stance over EVMs. The more dominant RSGs shall be introduced in more detail now.

The ECI has the superintendence, direction and control over the entire process of conducting elections in India. It is a permanent and independent constitutional body (Rana, 2006, p. 4). This means the ECI has the power to decide anything that has to do with the EVM, like its operation, security features, changes in the system. Whenever people have questions or concerns about anything related to EVMs they turn to the ECI. In December 2005 the ECI set a technical expert committee under the leadership of Prof. P.V. Indiresan, with Prof. D.T. Shahani and Prof. A.K. Agarwala of the Indian Institute of Technology (IIT). They were made responsible for examining EVM and making recommendations of possible changes in the system to the ECI (Agarwala, 2006, p. 1).

"VeTA is an independent national level Citizens' Forum for promoting Verifiability, Transparency and Accountability in Indian Elections. The Forum is a civil society initiative involving some of the best known computer experts, political scientists, public activists, administrators, academicians, legal professionals etc." (VeTA, 2010). President of VeTA is GVL Narashima Rao. He has written a book titled *Democracy at Risk! Can we trust our electronic voting machines? (2010)*, which provides detailed information about concerns raised about EVMs, instances of malfunctioning, suspicions of EVM tampering, suggestions for improvement and more. Hari Prasad is the Technical Coordinator of VeTA and is managing director of NetIndia Private Limited, an IP Surveillance & Streaming Systems & Solutions company. He is a key technical person in the controversy about EVM security in India. V.V. Rao is the National Coordinator. He is an election watch specialist and is the main petitioners in the public interest litigation filed in the Supreme Court on EVMs (VeTA, 2010).

Hari Prasad as already mentioned is one of the key technical persons, who identified vulnerabilities in the Indian electronic voting system. In collaboration with a team of researchers and computer science experts he conducted the first government independent security analysis of Indian EVMs. His team includes Dr. J. Alex Halderman, professor of computer science at University of Michigan and Rop Gonggrijp, a technology activist who played a major role in banning electronic voting in the Netherlands.

Rajnish Tiwari is a researcher at the Institute for Innovation and Technology Management at Hamburg University of Technology. In a recent publication (Tiwari & Herstatt, 2014) he used the EVM as a case study for exemplifying "frugal innovation" in India. This concept will

be explained in more depth. They were not directly involved in the controversy about EVMs, but their analysis provides an interesting perspective, contrasting the views from India

4. Research methodology

We will describe the development of the Indian EVM from its implementation to the current use of it. In this sense we are taking a historical and chronological approach. The development will be explained through the eyes of the relevant social groups mentioned, in alignment with my theoretical framework. Our research is based on document analysis of a variety of publicly available sources, including official reports from ECI, articles and books about electronic voting in India and worldwide, economic studies and technical studies on EVMs. In addition we conducted a number of interviews. We interviewed Hari Prasad in India via telephone to gain in depth knowledge about security concerns of EVMs. Moreover we interviewed Rajnish Tiwari about the economic aspects of EVMs he studied. At the beginning of our research we intended to conduct interviews with Indian citizens to gain information from people who have actually used the EVM. This turned out to be difficult, hence we prepared a questionnaire (see Appendix 2) to be filled out by them and sent back via email. This worked out and we received 24 replies (see Appendix 1 for detailed information about the interviewees). However we are not using the results in a statistic or generalizing manner. Rather we treat their replies as additional interviews and use their reports for a more detailed and richer description of my case.

5. Problems with earlier paper ballot system and corruption

> "EVMs have changed the way elections are conducted in India. Earlier it used to be a lengthy and tiring exercise including complex procedures. Now the process has been simplified" (Viswanath, 2014, interview).

India is the biggest democracy in the world and the management of elections is a huge task. This year elections were done in nine phases from 7 April to 12 May 2014. The ECI estimated 814.5 million voters and set up approximately 930,000 Polling Stations all over the country, for people to cast their vote (ECI, 2014c). Casting and counting votes used to be done manually in India. Before the implementation of an electronic voting system, India was using

a paper ballot system. In manual elections of the previous kind “a nationwide ballot could consume around 8,000 tonnes of paper and 400,000 phials of indelible ink and require some 2.5 million strongboxes to store them under heavy security until votes were counted” (Kumar & Walia, 2011). Indelible ink is still used today, to mark a persons finger after voting. The counting of votes could take several days or weeks and the number of invalid votes was relatively high. For example in 1999 there were 7,098,879 votes declared invalid, whereas in 2004 the number was 101,625 (Fig. 1). Overall the expenses for printing ballot papers, storage, transportation and hiring personnel for counting votes were becoming higher with every election and counting of votes took a lot of time and effort. Those were main incentives for the ECI to think about changing the system.

General Elections (A)	1999 (B)	2004 (C)	2009 (D)
Total seats (E-Voting)	543 (45)	543 (543)	543 (543)
Eligible electorate	619.55 million	671.49 million	716.99 million
Actual turnout	371.67 million	389.95 million	417.04 million
Polling stations	774,651	687,402	834,919
Number of EVMs used	-	1.075 million	1.368 million
Total invalid votes	7,098,879 (1.91%)	101,625 (0.043%)	198,705 (0.048%)
- of them EVM votes	-	67,121 (0.017%)	77,342 (0.019%)
Quantity of paper saved	-	8,000 tons	10,000 tons

Figure 1: Tiwari & Herstatt, 2014, p. 69: Compilation based on Election Commission of India data

Not only was the paper ballot system perceived as expensive and inefficient, it also had major security problems. One of the major problems is called booth capture. Often it happened that criminal groups, delegated by political parties, captured a polling station and literally stuffed the ballot box with large numbers of votes for the favoured candidate. Moreover the stealing of votes used to be a common practice. One of our interviewees, who comes from Bhadgaon Besar, a small village in the Himalayan mountains, said: “I remember very well that in the

villages those ballot papers were misused by wrong peoples" (Bhatt, 2014, interview). He explained that it is a common practice in India that another person casts one's vote. And not only in small villages but also when he moved to a bigger town called Mussoorie he rememberd, "once somebody else was voting for me and my vote was misused" (Bhatt, 2014, interview). As we will explain later, the problem of booth capture was addressed in the design of EVM and is technically much more difficult than in the paper ballot system. Hence in technical terms, cheating the system in this way became more difficult, however with the electronic system there are new potential threats for election fraud.

A general issue, which is still occurring nowadays, is that Indian politicians buy their votes. This is especially the case for poor people and slum inhabitants, since they will most likely care more about what to eat than about national politics. "Quite a few Indian politicians may be accused of literally buying their votes from the electorate," Rajnish Tiwari explained to us (Tiwari, 2014, interview). Hari Prasad put it this way: "The thing is that the politicians in India are buying votes. They buy each vote at 500 to 1000 bucks; sometimes go to 5000 bucks. And money and liquor play a major role in Indian elections. Though there are lots of organizations which are trying to bring awareness among the public, but still the corruption goes" (Prasad, 2014, interview). Overall the ECI and Indian citizens I interviewed agree that the election system, as it used to be, posed too many problems and had to be replaced by another system.

6. Implementation of EVMs

Because of "recurring expenditure on printing, storage, transportation and security of ballot papers," the ECI discussed electronic voting for the first time in 1977 (Saini, 2013, p. 68). In collaboration with ECI the PSU Electronics Corporation of India Ltd. (ECIL) developed a prototype by 1979 (Tiwari, 2013, p. 89). In 1983 they were used for the first time in the Delhi Metropolitan Council Election. Then in the 1998 Assembly elections in Madhya Pradesh, Rajasthan and Delhi EVMs were used in 16 out of 543 constituencies. The ECI considered their use a success and hence decided to make use of EVMs on larger scale. "Being a peaceful State with a high literacy rate, Goa became EC's choice for experimenting with EVMs on this scale as a 'historic step'" (Rana, 2006, p. 13), and the ECI saw this as a crucial step in modernizing electoral management. On national scale EVMs were employed in the 2004 General Elections for the first time, and have been used since then in all General Elections and State Assemblies (Rana, 2006, p. 4). "In view of huge quantity requirements, another

PSU, BEL (Bharat Electronics Limited), Bangalore was involved in mass manufacturing" (Saini, 2013, p. 68).

The ECI has been proud of introducing this machine and described EVMs as "perfect", "infallible", "tamperproof", with "no need for technological improvement" (Halderman, 2011, lecture; ECI 2009a). But not everybody was so enthusiastic about the implementation. Several sources revealed initial "scepticism of the political parties as well as the intelligentsia" (Saini, 2013, p 68). An Indian citizen I interview remembered that "people have been talking about it and there was a huge discussion of course also among intellectuals. Many people were saying it might be that people will manipulate with it and that was one concern. […] I remember that young people were for that and traditional people were sceptical" (Bhatt, 2014, interview). I propose that the ECI uses the technological frame 'the perfect EVM', which collides with the scepticism of a number of political parties and academics. Before we go deeper into discussions about EVMs we want to explain in more depth how the machine is operated, what challenges were to be incorporated into the design and what are main technical features.

Figure 2: Indian EVM consisting of a ballot unit (left) and a control unit (right) joined by a five-meter cable. (Prasad et al, 2010).

Figure 3: Behind plastic doors there is black close button and result button (left). Display unit on the right (Prasad et al, 2010).

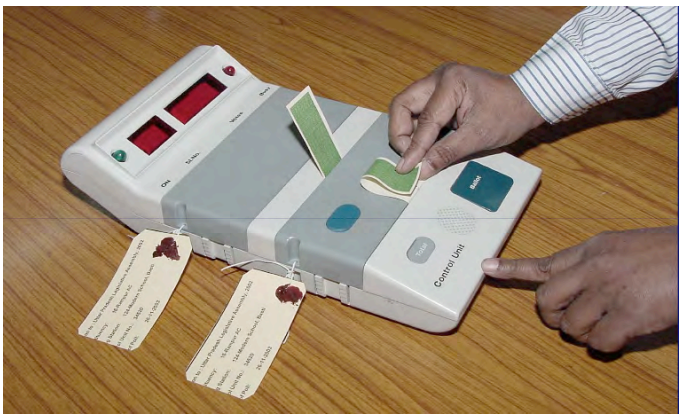

Figure 4: Sealing the EVM (Brahmam, 2002).

7. Voting on an EVM

Before voting, eligible voters have to enrol with the ECI. “S/he is issued a Voter ID card known as Voter ID card or Personal Identification card. S/he has to carry and show that card at the time of voting. Once found valid, voting is permitted by the Presiding Officer of the booth” (Bansal, 2014, interview). When the voter enters the Polling Booth and is in front of the machine, a green light flashes on the Control Unit (Fig. 2), which indicates the machine is ready to receive a vote. After the voter cast her vote, a red light flashes and there is a loud beep sound (12 seconds long). The next vote can only be cast after the presiding officer resets the ‘Ballot’ button (Fig. 3). Once everybody cast their vote a seal consisting of string, paper and wax (Fig. 4) is opened and the presiding officer presses the black close button (Fig. 3). From now on no more votes can be cast and the machine is ready for counting. Armed escorts are transporting the polled EVMs to “strong rooms with a double lock system and guarded 24x7 by armed police” (ECI, 2014c). Strong rooms are supposed to be watched round the

clock and monitored by security cameras. On counting day a second seal is opened and the personnel presses against the result button (Fig. 3). On the display the EVM will show the total number of votes cast, the number of candidates and the number of votes for each candidate (Prasad et al., 2010, p. 3).

8. Design challenges for ECI and manufacturers

When the ECI delegated ECIL and BEL to design an electronic voting machine, a number of challenges particular to the Indian context, had to be considered. This includes the cost of those machines, power supply, natural hazards, illiteracy, technological illiteracy and booth capture.

Due to the huge amount of machines employed all over the country and due to a limited budget, the ECI wanted to keep costs as low as possible. Through the eyes of the economic research team this goal has been achieved successfully: compared to other nations such as the USA, Indian voting machines are much more inexpensive (Tiwari & Herstatt, 2014, p. 70). Each machine comes at a price of Rs. 8670 plus taxes from the manufacturer (ECIL, 2012-13), which translates to 104.76 Euros (at current exchange rate of 1 Euro = 82.8 INR, 2014).

The geography of India poses challenges, since many polling stations across the country are in remote areas without electricity supply. In past elections the polling officials have made amazing efforts to make voting possible in even the most remote villages in the Himalayan Mountains or the deserts of Rajasthan. Their means of transportation include boats, elephants, camels and ferries and sometimes the polling teams are trekking through many kilometres of jungle (Rana, 2006, p. 1; Chandrashekhar, 2014). “There are areas where you have to walk for 6 days to reach the polling station” (Shukla, 2010, panel discussion). Due to those obstacles Indian EVMs are entirely operating on battery power and are stand alone machines, not connected to any network (Prasad et al., 2010, p. 3). Compared to the old paper ballot boxes, EVMs are lighter, which also makes transportation easier. So generally EVMs are a relief for the ECI.

Extreme temperatures - from the freezing Himalayan mountain to boiling heat in the jungle and deserts – and other environmental hazards like dust and pollution, pose further challenges for EVM design and operation. Sometimes it rains so hard that the roads to the polling centres are not motor able and the only way is travelling on elephant back (Rana, 2006, p. 162). EVMs must withstand those extreme conditions and have the capacity to absorb external shocks. Often EVMs are stored for extended periods in facilities that lack climate control. The

Expert Committee of the ECI wrote in one of their reports about dangers from “attack by vermin, rats, fungus” that might cause malfunction (Agarwala et al., 2006, p. 6). In the eyes of the government these kinds of challenges are successfully addressed in the EVM design: The government of India has stated they are robust enough “to withstand rough handling and variable climatic conditions” (GOI, 2009, p. 181).

The total adult literacy rate in India in 2008-2012 was about 62.8 per cent (UNICEF, 2014). Hence the machines need to be easy to use and not require written instructions. Political parties and candidates use graphical symbols (Fig. 5) in their campaigns, which are then found on the ballot unit (BU). “The Presiding Officer will have a card-board replica of the ballot unit with him” (GOI, 2009, p. 182), to demonstrate to the illiterate voters how to vote. An Indian citizen explained to me in an interview: “Illiterate people find it easier to press a button than putting stamp on a paper” (Verma, 2014, interview). Hence in technical terms electronic voting does not pose any problems for the illiterate.

On the other hand there are still people in India who are unfamiliar with technology and there have been reports of people from tribes who felt intimidated by the machines (Rao, 2010, p. 44). Moreover blind voters have also been taking into consideration and the machines are made braille compatible. The problem of booth capture as such cannot be prevented with the EVMs. “However, the machine can not register more than 5 votes in a minute or 300 votes in an hour whereas a ballot box could be stuffed with any number of ballot papers“ (GOI, 2009, p. 184).

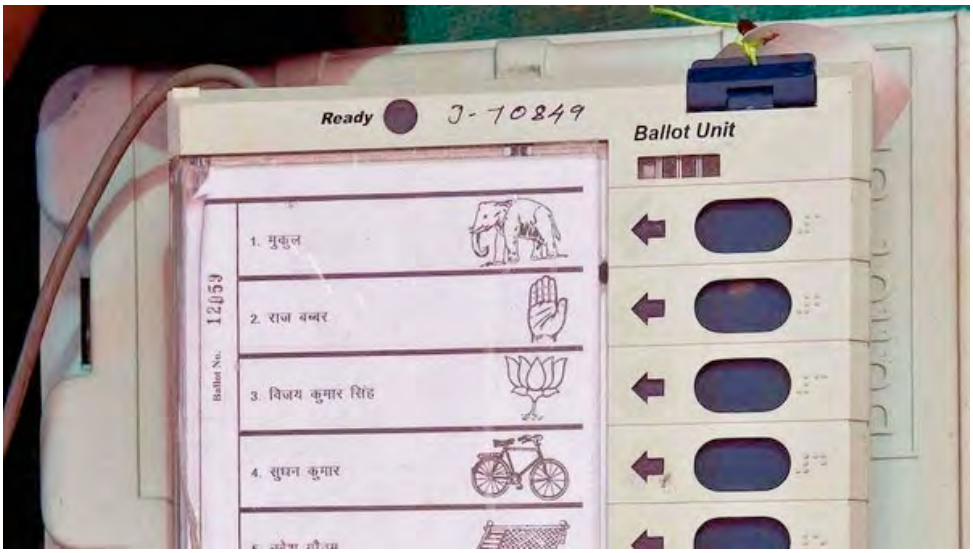

Figure 5: Party Symbols on the Ballot Unit (Kumar, 2014)

Considering all the aspects addressing particular challenges in India, we can make some general statements. From a technical engineering perspective EVMs seem to be well adapted to the particular circumstances: The machines are described as light and robust and do not need electricity. They can be carried easier than earlier ballot boxes, they withstand extreme climate conditions and they work in remote villages without power supply. From an economic perspective EVMs are a good solution, because they are cheaper than the earlier paper based system and do use considerably less paper. Counting is much faster and efficient and there is no need to hire extra personnel, which saves money as well. From a social perspective, EVMs take into consideration specific needs so that everyone is theoretically able to vote. And from an environmental perspective it has been argued that because of the high savings on paper (Fig. 1) EVMs have less of an impact than the paper ballot system. All of these points were incentives for the ECI to be optimistic about the machines and use the frame 'the perfect EVM'.

9. Economic research team framing the EVM as frugal innovation

For R. Tiwari and C. Herstatt the Indian EVM is a "frugal solution" that preserves democratic processes in India (Tiwari & Herstatt, 2014, p. 71). It is a "technically robust and cost effective solution with creditable acceptance" not only in India but also in other developing nations in Asia and Africa (p. 71). For instance Indian EVM were employed in Bhutan and the reaction from the Election Commission of Bhutan was: "The decision was made in view of the EVM's simplicity and ease of use, portability, being battery-powered as well as convenience, speed and reliability in counting" (EC Bhutan, 2011 in Tiwari & Herstatt, 2014, p. 70). Frugal innovations are "new or significantly improved products (both goods and services), processes, or marketing and organizational methods that seek to minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption, and disposal) with the objective of significantly reducing the total cost of ownership and/or usage while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards" (p. 29). They see the particular attraction of the machine in its "low-tech system, which does not need electricity or Internet networks and yet provides a 'good-enough' solution" (p. 71).

Tiwari and Herstatt see India as an emerging "hub for 'frugal innovations'" (Tiwari & Herstatt, 2012a, p. 2). Solutions from India are often adapted in other developing nations of Asia, Africa and Latin America as well. According to them Indian entrepreneurs are especially good responding to resource constraints in creative ways and "creating solutions that are able to circumvent given environmental constraints in a cost effective way" (p. 2). They interpret the Indian EVM as part an emerging paradigm of "low-cost innovations targeted at economically weaker sections of the society," or put differently targeted at price sensitive and unserved consumers (Tiwari & Herstatt, 2012b, p. 2) In the case of the EVM this is not directly the case, since we cannot talk of the ECI as unserved consumer. Therefore it makes more sense here to refer to the users of the EVM. Since the implementation of EVM a larger number of people can vote in India and it has been argued that illiterate people find voting more comfortable than on paper ballot.

10. Interpretative flexibility of the EVM

So far we have described two RSGs and their technological frames. The ECI uses the frame 'the perfect EVM' and the economic research team uses the frame 'low-price, good enough EVM'. Both RSGs do not problematize the EVM and basically see the EVM very well fit for the Indian context. Both for the ECI and economic researchers the simplicity of design plays an important role. Resource constraints, and a number of design challenges, resulted in a voting system that is considerably less complex than other EVMs employed elsewhere. Alex Halderman (Assistant professor of electrical engineering and computer science at the University of Michigan) explained about the US voting machines that they are "very complex, large, expensive, computer like systems […] they run full fledged operating systems and have the regular software security problems" (Halderman, 2011, lecture). The simplicity of Indian EVMs shall be explained in more depth below. It has been argued that the simple design does also have negative aspects, especially when it comes to security issues. In this sense there was interpretative flexibility created around the EVM.

11. VeTA alleges vulnerability and security holes

The debate on the integrity of the EVMs started with the 2009 General Elections, after an election outcome that was surprising for political parties, election analysts and others. Some raised the suspicion that the dubious election outcome is connected to malfunction or

manipulation of EVMs. The parliamentary chairperson of the Bharatiya Janata Party (BJP) L.K. Advani rasied doubts about the security of EVMs and demanded from the ECI to revert to ballot paper, unless EVMs are proven to be tamperproof (Jha, 2009). Other leaders of political parties like Ghulam Nabi Azad (Congress party) stated: "EVMs were manipulated during the poll which resulted in defeat of many Congress candidates" (IANS, 2009). Chandrababu Naidu (Telugu Desam Party) and Jayalalithaa (AIADMK) raised concerns as well and "the EVM debate had acquired urgency and national prominence" (Jha, 2009). What were reasons for making such statements? What is behind these allegations?

A civil society initiative called VeTA (Citizens for Verifiability, Transparency & Accountability in Elections), looked into instances of EVM malfunctioning in depth and detected vulnerabilities in the electronic voting system. From their perspective there are "three essential elements have come to the fore as universally important for a voting system" (Rao, 2010, pp. 189-90): It should be transparent, meaning, "voters should be able to 'observe' the voting and counting process without any specialized knowledge" (p. 189). Voters should be able to verify that their vote has been cast properly "through a proper examination of the physical record of ballots" (p. 189). In terms of accountability, problems or attempts at election fraud should be detectable instantly in order to introduce the necessary steps for remedy. VeTA finds that all of these criteria were met appropriately with the earlier paper ballot system, yet the current electronic system does not meet any of them: voters have no way of knowing whether their vote is cast correctly or not. There is no physical proof for cross verifying the results from the EVM in case of doubt. If something goes wrong inside the machine or the machine has been manipulated there is no way of proving it (p. 190). Clearly VeTA has a different technological frame than ECI and economists. They use the frame 'vulnerable and risky EVM'.

They expressed all their concerns towards the ECI in form of writ petitions. V.V. Rao the national coordinator of VeTA played a major role in the communication with the ECI. In response the ECI organized a public challenge for all political parties, petitioners, activists and any one else "to come and demonstrate the points made in their allegations" (ECI, 2009). Present at this demonstration were the technical expert group appointed by ECI and engineers representing the manufacturers ECIL and BEL. The ECI had organized 100 real EVMs from various states for this and promised them full access to the machine. The team of VeTA took up this challenge and came to demonstrate how to tamper with the EVM on 17th August 2009 (ECI, 2009).

What were the results of this presentation? According to the official ECI report “none of the persons, who were given the opportunity, could actually demonstrate any tamperability of the ECI-EVM, in any of the hundred machines put on display. They either failed or chose not to demonstrate. The Election Commission would like to underline that it always had a firm conviction and complete satisfaction that EVMs could not be tampered with” (ECI, 2009). However, the interpretation of VeTA of this meeting is quite different form this official report. According to their statements the team was halted after 10 minutes (Rao, 2010, p. 103; Rao, 2010, panel discussion). When they started to open up the machine and inspect the insides of it, representatives of ECIL claimed that they were doing reverse engineering. In the eyes of the manufacturers and the ECI reverse engineering could not be allowed and in fact violates the property rights of the manufacturers. The ECIL representatives threatened the team will legal actions in the Hon’ble Supreme Court. After this incident the ECI modified the public challenge and stated: “You may do only normal tampering” (Rao, 2010, p. 108).

12. EVM as a black box

The incident just described shows that the ECI did not have clear ideas about how transparent they wanted to be. In the beginning they promised full access to the EVMs, but during the presentation both ECI and manufacturers changed their mind. This clearly shows that the security of EVM relies on the secrecy of what is inside the machine and how it works technically. Both ECI and manufacturers treat the machine like a black box, because everything that has to do with the insides, technical details, source code etc. is held secret and is not publicly disclosed. Prof P.V. Indiresan, chairman of the expert committee on EVMs stated publicly that: “In these government firms actually not more than three to four people know what the source code is. It is kept secret. These are fairly junior officials they are not very senior officials. From what we know of their character they will not disclose.” (Indiresan, 2010, panel discussion). In other words not even the ECI knows about technical details of the EVM software and they rely entirely upon the integrity of the manufacturers. In this respect the security of EVMs relies on trust.

Interestingly the manufacturers themselves seem to stay completely out of the debate. Hari Prasad explained to me that the only argument the manufacturers make over and over again is: “trust us the machines are secure. The chip manufactures Microchip, Japan and Renesas, US are reputed companies and they will not cheat us, we trust them” (Prasad, 2014, interview). The kinds of responses that both ECI and manufacturers make towards concerned

people are not technical. However the kind of questions VeTA asked to them and the problems they identified were often technical in nature. So the kind of language that is used differs.

13. Opening up the black box

The discussions took a radical turn, when in February 2010 Hari Prasad was approached by an anonymous source who gave him full access to a real EVM. In collaboration with experts on voting security including Alex Halderman from the US and Rob Gonggrijp from the Netherlands, they conducted the first government independent security analysis (Prasad et al, 2010). This was the first time anyone outside of the government or manufacturers saw what is inside the machine. Their results were made open to the public, so that Indian citizens as well could form their own opinion. They conclude, “in spite of the machines’ simplicity and minimal software trusted computing base, they are vulnerable to serious attacks that can alter election results and violate the secrecy of the ballot” (p. 1). To prove this claim they demonstrated two attacks “using custom hardware, which could be carried out by dishonest election insiders or other criminals with only brief physical access to the machines” (p. 1)

Neither the manufacturers ECIL and BEL nor the ECI have ever released detailed technical descriptions of the EVMs’ inner workings. The authors describe the hardware of an EVM based on their own observations and tests: “The control unit (Fig 2) contains the main circuit board. The centrepiece is the EVM’s CPU, a Renesas H8/3644-series microcontroller driven by an 8.8672 MHz crystal oscillator” (p. 4). The display board (Fig 3) connects to the main circuit board via a 16-pin ribbon cable. The control unit connects to a ballot unit where the voter presses the button. The ballot unit board is described as a “simple device,” because it has no CPU of its own. It uses two electronically programmable logic devices that interpret signals coming from the control unit. In their technical terms the EVMs use a “simple embedded system design” (p. 5). Most other electronic voting machines employed worldwide “rely on commodity operating systems and run election software containing tens or hundreds of thousands of lines of code, the EVM software is compact, consisting of only a few thousand instructions that run directly on the hardware” (p. 5).

We will not go into more detail about the insides of EVMs. But there are some relevant conclusions to draw from their analysis: The authors are disclosing technical details about EVMs that were intended to remain secret because of property rights. Descriptions of ECI and manufacturers of EVMs are limited to instructions on how to use and operate the machine.

Hence the kind of language they are using differs from the computer science language the authors employ. Another important point is concerning the simplicity of EVM design. In the economists technological frame of 'low-price, good enough technology' simplicity is regarded a beneficial aspect of the EVM. In their terms the simplicity of EVMs is mainly explained due to the minimalistic design and the low price. In the 'perfect machine' frame of the ECI simplicity of EVM design is the necessary outcome, resulting from the challengers that had to be faced in the Indian context. The simple design is necessary mainly because of budget constraints, and to enable an easy voting experience for all citizens. In terms of the security researchers simplicity refers to the technical insides of the machine. From their perspective EVMs are simple compared to other voting machines they have analysed previously. Yet the simple design poses significant security problems and "makes attacks involving physical tampering far easier" (p. 6). We propose both the members of VeTA and the security researcher team use the technological frame of 'vulnerable and risky EVM'.

In their analysis the researchers identify three different classes of vulnerability: dishonest look-alikes, tampering with machine state, and insider attacks using secret software. Those are examples of possible ways to physically manipulate the machine and change election outcomes. In all cases criminals would need physical access to a certain percentage of all machines. They explain that EVMs are usually stored in large numbers; this highly concentrated way of storing increases the risk for attacks and makes tampering in large numbers theoretically possible.

14. Proposed attacks on the Indian voting system

One of the possible attacks they propose is substituting a 'dishonest display board'. They constructed a fake display that looks exactly the same as the original, containing a Bluetooth radio. They build software for a mobile phone and with this application information can be sent to the display and let a certain percentage of votes be shown for the favoured candidate. The signalling from mobile phone to display board would have to be done at any time before the public counting of votes. This attack involves replacing hardware components with a dishonest look-alike. Another attack they thought of involves only temporary application of new hardware (p. 8).

They constructed a device, which can be connected to the memory chip recording the votes. This clip-on device would have to be used at any time between the polling of votes and the public counting. They explain "in India, counting sometimes takes place weeks after

voting, so criminals could wait for an opportunity to tamper with the machines while they are in storage" (p. 8). This little device (they called it 'Clippy', see Fig. 6) allows criminals to steal votes. The researchers constructed 'Clippy' in a way that attackers can select a number from 0 to 9 on a little switch. The numbers stand for the political candidates and usually the first nine ballot positions include the major national parties. Once the preferred candidate is selected 'Clippy' executes a vote-stealing program. The program runs in two passes: first, it reads the vote data and calculates how many votes to steal from each candidate; second, it rewrites the list of votes, stealing votes as calculated in the first phase" (p. 9).

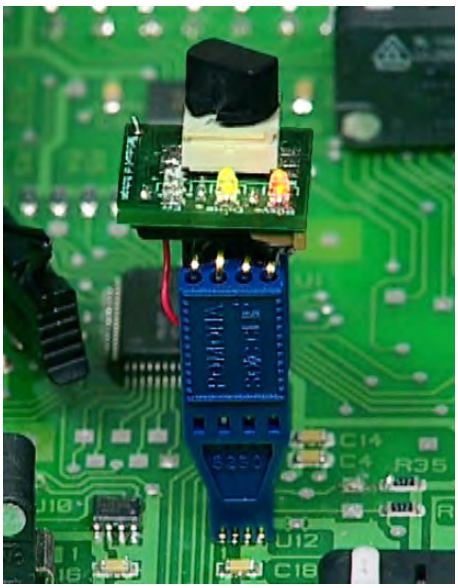

Figure 6: 'Clippy' (Prasad et al., 2010)

How realistic are those two attacks proposed? One might argue that considering the large amount of EVMs (over 1.7 million) those attacks are simply not manageable. The security researchers argue that this might not even be necessary. "A small number of tightly contested seats often determine which party holds a majority in the parliament" and hence it would be enough to tamper with a 'small' fraction of EVMs (p. 10). Another obstacle to realise those attacks is posed by the seals. However those seals are described as extremely weak, consisting of stickers, strings, melted wax and plain paper labels (Fig. 4). Those are rather simple materials, which could be easily bought at the supermarket. This way of sealing has been taken over from the earlier ballot paper system. Ballot boxes used to be closed and sealed with wax in a similar fashion (Hauser and Singer, 2001, p. 306-7). It is a simple, low-tech solution and it is debatable, whether this system is secure enough.

Another major security flaw in their opinion is the fact that the Indian EVM does not produce any physical record of the votes cast, which is also the major concerns raised by VeTA. However there is a possibility of cross verification. In a public discussion Prof. P. V. Indiresan (chairman of technical expert committee) explains: It is possible to "check *every single vote* that has been done, who did it and to whom the person voted. […] It is possible to cross check, who voted for what and when, because there is a real time clock in every machine" (Indiresan, 2010, panel). This means that it is possible to find out what individual citizens votes for and hence violates the secrecy of the ballot. The security researchers propose to implement a paper trail (VVPAT) that would produce a small print out for every vote cast. This would allow for a different kind of cross verification. Moreover voters could see with their own eyes whether their vote has been recorded correctly. All in all they argue that EVM are treated as black boxes because everything that has to do with the technology's insides is kept secret. The machine itself is a black box, because the voter cannot verify with her own eyes whether her vote is cast correctly.

I have now pointed out that the EVM has interpretative flexibility and proposed a third way of framing the machine, which is fundamentally different from ECI's and economists' frame. I now look at how the 'vulnerable and risky EVM' frame was received by ECI and its expert committee. Finally I will explain how the interpretative flexibility diminishes and the controversy is closed.

15. Reactions by ECI and expert committee

On 29, April 2010 Hari Prasad appeared on Telugu TV channel. He made a demonstration of how to tamper with EVMs and publicly announced that he gained access to a real EVM, manufactured by ECIL, from a source whose identity he wants to protect (ECI, 2010). After this he was charged with the theft of the voting machine and according to his own account: "they put me in jail for eight days" (Prasad, 2014, interview). The official comment by the ECI was: "While the Commission has every respect for technologists and is always open to suggestions for improvement in the voting system, it cannot overlook any illegal act, especially the theft of a public property like the EVM given in its custody for conduct of elections." (ECI, 2010a). In this sense the ECI realized that the electronic voting system could be improved. Hari Prasad and his team aimed an improvement of the EVM security, but in order to do so they needed full access to a machine. This was not granted by the ECI, but they have found a different way and exposed a number of vulnerabilities.

The fact that Prasad gained access to a machine itself could be interpreted as an indication that it *is* possible to gain access to the machine. Either the security measures to protect EVMs were not strong enough or the anonymous source was an insider being concerned about EVM security as well. Although the ECI later claimed that they are open for suggestions their initial reaction was the arrest of Hari Prasad. Fellow researcher Alex Halderman's comment on this was: "This is like the pentagon paper situation here. This is a case where citizens are critical against those in power and those in power are retaliating against them for their criticism. We want you to work with us and we'd be very happy to work with you to make this system better. That's all of our goal, to have secure and fair elections in India" (Halderman, 2010, panel discussion).

Initially the ECI denied all allegations made by petitioners and the security researchers. However this changed over time. On August 9, 2010 a workshop for electronic voting technology and trustworthy elections took place in Washington, DC. In this workshop a panel discussion on the Indian EVM was scheduled. First panellist is P.V. Indiresan, who was the chairman of the technical expert committee, set up in 2005 by the ECI, to examine EVMs and give recommendations (Agarwala, 2006, p. 1). Prof. Indiresan used to be a director of the Indian Institute of Technology – Madras (IIT). Second panellist was Narasimha Rao, president of VeTA. Third, Alok Shukla, working for the Election Commission of India. And forth J. Alex Halderman, professor of computer science at University of Michigan, specialized on voting security.

P.V. Indiresan argued that all allegations of possible attacks are theoretical in nature. In practice EVMs are tamperproof until somebody can bring evidence that past elections have been manipulated. Interestingly his way of responding to alleged security problems is by using analogies or telling stories from everyday life: "Friends, there is a very well known story about NASA. They spent millions of dollars to find out how to make a pen that could work in space. They couldn't do it. Finally they asked the Russians: how do you manage? They said, we use pencils. So you see the Indian system is like a pencil. Your system is a much more complex one." (Indiresan, 2010, panel discussion). By this he refers to the US electronic voting system. Similarly the ECI representative Alok Shukla, stays with the technological frame of 'the perfect machine' and denies that any of the allegations of EVM malfunctioning or possibilities of tampering are practically possible. Both Shukla and Indiresan concluded that the proposed ways to tamper with EVMs are unlikely to happen. Contrary to the allegations made they both argued that the system of sealing the EVMs is

highly secure and nobody has ever managed to tamper with the seals. At that point they did not see any reasons to change the system.

16. Closure of the EVM controversy

Different relevant social groups had different perspectives on the alleged tamperability and security problems with EVMs. Moreover the kinds of remedies that have been proposed by them also differ and it is worth looking at them. In the SCOT model closure of a technological controversy does not mean to 'solve' a problem in the common sense of that word, but rather look at whether relevant social groups *see* the problem as being solved.

When presidents and heads of political parties raised concerns about EVM security towards the ECI in April 2010, they considered it might be necessary to revert to the paper ballot system (Jayalalitha et al., 2010). They argued, "many democracies like Germany, Ireland and Holland and the United States of America have either banned use of EVMs or imposed stringent safeguards for their use" (Jayalalitha et al., 2010). Also VeTA argued that reverting to paper ballot could be a solution to the problem. From their perspective the paper ballot system is the most transparent and verifiable way of voting and this is the reason why other countries are using paper ballot. The ECI responded that Indian EVMs are not comparable to any other EVM employed elsewhere, because they are stand alone machines, which cannot be networked and do not have an operating system (ECI, 2010b). They did not consider reverting to the old paper based system an option.

As mentioned before both manufacturers ECIL and BEL stayed completely out of the public debate around EVM security. Their way of closing the debate was rather rhetorical than technical in nature. Instead of responding to any of the technical vulnerabilities detected in a technical sense, they argued that the concerned people should just trust them and their cooperating companies. The proposition to just trust everyone who is involved in manufacturing EVMs was also made by the technical expert committee of the ECI.

At the beginning of the controversy the ECI generally simply neglected that there are any security flaws in the system and stayed with the frame of 'the perfect EVM'. They also argued that there are much more advantages in the electronic system compared to the paper system (concerning invalid votes, paper saving, booth capture, efficiency of counting etc.). In terms of security the general assumption made by the ECI is that the risk of EVM being manipulated is very low. At a later stage of the controversy the ECI acknowledged that the alleged security flaws and ways to cheat the system are at least possible in theory. However in

practice elections in India have never been manipulated and hence there are no reasons to adopt any changes. After continuous discussions with concerned people and activist groups the ECI “finally realized that the problem is real” (Prasad, 2014, interview). In the 2014 General Elections for the first time a paper trail (VVPAT) has been added to the EVMs. Although this paper trail is only introduced on an experimental level, this has been a relief for most of the people concerned.

We argue that the interpretative flexibility of EVMs has diminished to the extent that almost everyone agrees on the EVM in its current use. Hari Prasad said that he and his team are still fighting and Rob Gonggrijp: “in my opinion, India is trying to do as little as possible in terms of actual change, merely experimenting with paper trail here and there” (Gonggrijp, 2014, email). However we sense that the general opinion about the current EVM is positive. All of the 25 Indian citizens interviewed within ths research have been overly positive about EVMs and generally regarded the security much higher compared to the old ballot paper system. And although there have been instances of EVM malfunctioning in the current elections, those instances are so marginal that they can almost be neglected. Hari Prasad is optimistic that the EVM with paper trail will succeed, although the federal government did not allocate the necessary funds yet to implement the VVPAT on large scale.

17. Conclusion

We explained the social construction of the Indian EVM. The concepts of relevant social groups, interpretative flexibility, technological frame, and closure turned out to be useful in structuring and analysing my case study. Interpretative flexibility occurred when political parties, VeTA and others opposed ECI’s technological frame of ‘the perfect EVM’, by claiming that EVMs are vulnerable and pose a risk for Indian democracy. The Security research team led by Hari Prasad and VeTA used the frame ‘vulnerable and risky EVM’. In many respects the electronic voting system has advantages over the paper ballot system. Yet in terms of transparency and verifiability, VeTA and the security research team claim that the paper ballot system had advantages. More radically it has been argued by them that paperless electronic voting will never be secure. Initially the ECI denied all their claims and arguments and was reluctant to make any changes. However in the 2014 elections a paper trail was added to the system on experimental basis. This decision was decisive for closure to occur in the controversy. Yet the controversy has not only been closed in technical terms. Many of the allegations that were made about EVM malfunctions and manipulation possibilities were

simply answered by neglecting them. VeTA and the security research team have made a number of technical claims in terms of security flaws. Generally the way the ECI and manufacturers responded was not with technical language.

Rather everything that has to do with the inside of the technology was concealed and kept secret. Keeping technical details like the source code secret (known by only three or four people), was interpreted differently among RSGs. ECI, its technical expert committee and manufacturers believed the secrecy of technical details was necessary to prevent reverse engineering and to conserve property rights. In their eyes this was a good base for a trustworthy security system. However VeTA and the security researchers argued that this is a major security flaw. Looking at the present situation of electronic voting in India I think it is fair to say that the EVM has stabilized and the controversy has been closed, although there are still some isolated individuals who fight for their voice to be heard.

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Appendix 1 – Information about interviewees

Name	Expertise, Position	Function	Place, Date
Dr. Rajnish Tiwari	- Senior Research Fellow / Postdoc at the Institute for Innovation and Technology Management at Hamburg University of Technology - Co-Founder, Center for Frugal Innovation	- Providing invaluable information about Indian elections, economic aspects of EVMs, historical background of EVMs in India	Hamburg, 14.04.2014
Prof. Dr. Cornelius Herstatt	- Head of the Institute for Innovation and Technology Management at Hamburg University of Technology	- Information about the connection between EVMs and frugal innovation	Hamburg, 14.04.2014
Hari Krishna Prasad Vemuru	- Managing director of NetIndia Private Limited (Hyderabad) - Technical Coordinator of VeTA	- Key technical person who exposed vulnerabilities of Indian EVMs -	1. Hyderabad 04.05.2014 (via telephone) 2. Hyderabad, 08.05.2014 (via Skype)
Rob Gonggrijp	Technology activist from the Netherlands	Brief email contact about current status of EVM security in India	Amsterdam, 24.05.2014
Ram Prasad Bhatt	- B.A. in English Literature, Economics, Politics - Since 2003: Teacher at Hamburg University for Hindi language	- First Indian citizen I interview - Very knowledgeable person, providing me with valuable insides about Indian voting culture	Hamburg, 23.04.2013
Name (Age, Gender)	**Highest education degree obtained; current**	**Function**	**Written information**

	profession		**via Email (received)**
Dr. R. Kishore		Most helpful in connecting me to a number of Indian citizens with experience in electronic voting	
Darshan Kumar Jain (23, male)	Bachelor of Engineering; student	Indian citizen	06.05.2014
Anonymous (26, male)	Bachelor in Engineering; student	Indian citizen	06.05.2014
Tharun Kumar Balakrishnan (26, male)	MSc; student	Indian citizen	07.05.2014
Anonymous (47, female)	MSc Nutrition and Dietics; Homemaker	Indian citizen	07.05.2014
Anonymous (51, male)	MBA, MSC Psychology; Business/Psychologist	Indian citizen	08.05.2014
Saurabh Vaid (30)	Patent Attorney	Indian citizen	08.05.2014
Vivek Kumar (52, male)	MSc Tech.; Service	Indian citizen	10.05.2014
Meenu Kumar (49, female)	MSc Psychology; Homemaker	Indian citizen	10.05.2014
M.L. Bansal (65)	Post graduate in Mathematics; Retired as DGM from IBM India	Indian citizen	10.05.2014
R.L. Saxena (57)	Self employed professional	Indian citizen	11.05.2014
Anju Maheswari	House Wife	Indian citizen	07.06.2014

(32, female)			
Anup Mahapatre (28, male)	Bsc of Engineering; Engineer	Indian citizen	07.06.2014
Jeet Sharma (32, male)	BA History; District Secretary (Korba) – Youth Congress	Indian citizen	07.06.2014
Laxman Dewangan (34, male)	Graduate; service	Indian citizen	07.06.2014
Dilendra Yadav (32, male)	Graduate; service	Indian citizen	07.06.2014
Gajanan Hedau (52, male)	Bachelor of Technical and Chemical Engineering; Service	Indian citizen	07.06.2014
Indrakesh Yadav (27, male)	12^{th} grade; driver	Indian citizen	07.06.2014
Jejy Sarada Viswanath (36, male)	Bachelor in Technology; construction	Indian citizen connecting me to many of his friends and colleagues to fill out the questionnaire	07.06.2014
Shiv Prasad Pradhan (31, male)	Msc; Job	Indian citizen	07.06.2014
Parvati Nair (30, female)	MSc - Human Rights & BSc - Clincal Nutrition & Dietetics; Dietetics	Indian citizen	07.06.2014
S.N. Gupta (36, male)	BE (Civil Engineer); Construction (Metal & Mining)	Indian citizen	07.06.2014
Sunil Kumar Singh (45,	BE; General Manager	Indian citizen	07.06.2014

male)			
Rajesh Kumar Verma (32, male)	MBA; service	Indian citizen	07.06.2014
R.A. Narayan	M.Com.; business	Indian citizen	07.06.2014

Appendix 2 – Questionnaire

Questionnaire about the use of Electronic Voting Machines (EVMs) in India

My name is Maximilian Herstatt and I am studying at Maastricht University in the Netherlands. For my final exam I am writing about the use of EVMs in India and discussions around them. The way elections work in India really fascinates me and I find it amazing how it can work in such a big country. I am interested in knowing, how different groups interpret EVMs (Indian citizens, Election Commission of India, political parties, the manufacturers ECIL and BEL, scholars etc.). There have been several occasions in which EVMs were scrutinized for their security, which created uncertainty in some cases whether the machines are really tamperproof. In the current General Elections 2014 there were a few news reports claiming that in several instances EVMs malfunctioned and votes would go to just one party, regardless which button would be pressed.

I would like to understand better, what is behind those claims and the detected security problems and what different groups think about it. Moreover I would like to find out more about the implementation of EVMs in India. Which were the major groups involved in the implementation of EVMs and were citizens involved in the decision making process?

Please fill in the information you are comfortable with in the right column. In case you are filling in the survey electronically please click on the ***grey boxes*** ☐ *to write a text or select an option. With your approval I would like to use the provided information for my final exam at Maastricht University. If you have any questions or remarks please contact me via email: maxherstatt@gmx.de or phone: 0031619564754. Please send the filled out survey to my email before* ***6th May 2014****. Thank you!*

1. About the survey participant	
1.1. Name (*voluntary information*)	
1.2. Age	

1.3. Gender	☐Male	☐Female
1.4. Place of residence		
1.5. Are you politically active?	☐Yes	☐No
1.5.1. If yes, are you member of a political party?	☐Yes	☐No
1.6. What is the highest education degree you have obtained?		
1.7. What is your profession?		
1.8. To which income group would you identify as belonging to?		
2. General questions about the election practice in India and the use of EVMs		
2.1. Have you ever voted in a state assembly or national election in India?	☐Yes	☐No
2.1.1. If yes, how many times have you participated in a state assembly and/or national election in India		
2.2. Have you ever voted on an EVM?	☐Yes	☐No
2.3. If yes, please share your experience in the following aspects of ease of use (*please evaluate on a scale of 1 to 4, where 1 = very good, and 4 = not good at all*):		
2.3.1. Self-explanatory mechanism	☐1 ☐2 ☐3 ☐4	
2.3.2. Intuitive use	☐1 ☐2 ☐3 ☐4	
2.3.3. Perceived reliability	☐1 ☐2 ☐3 ☐4	
2.4. Could you please describe your voting experiences, so far, in more detail? (For example: access to polling stations, facilities, security measures, helpfulness of polling staff, instructions on how to use the EVM, handling of the EVM, etc.)		

2.5. When you compare using EVMs with the conventional paper-based ballots how would you rate the EVMs in terms of the following measures (*please evaluate on a scale of 1 to 4, where 1 = very good, and 4 = not good at all*):	
2.5.1. Ease of casting votes	☐1 ☐2 ☐3 ☐4
2.5.2. Speed of the voting process	☐1 ☐2 ☐3 ☐4
2.5.3. Speed of the counting process	☐1 ☐2 ☐3 ☐4
2.5.4. Reliability of the results	☐1 ☐2 ☐3 ☐4
2.5.5. Environment friendliness	☐1 ☐2 ☐3 ☐4
2.5.6. Others (*please specify below*)	
	☐1 ☐2 ☐3 ☐4
3. Specific questions about EVMs	
3.1. What is your overall opinion about the use of EVMs in the state assembly or national elections?	
3.2. Have you actively followed the discussion about using EVMs in the media?	☐Yes ☐No

3.2.1. If yes, what was your initial impression of EVMs?	☐positive ☐negative ☐neutral
3.2.2. How did you perceive the introduction of EVMs?	☐positive ☐negative ☐neutral
3.2.3. Have you changed your opinion since then and if yes, why?	
3.2.4. Do you think that citizens, as stakeholders of a democratic election process, were sufficiently involved in the decision making process of introducing EVMs?	☐Yes ☐No ☐Can't say
3.3. Have you ever been part of the polling personnel?	☐Yes ☐No
3.3.1. If **yes**, how would you rate the EVMs in terms of the following quality measures (*please evaluate on a scale of 1 to 4, where 1 = very good, and 4 = not good at all*):	
3.3.1.1. Ease of casting votes for the voters	☐1 ☐2 ☐3 ☐4
3.3.1.2. Ease of explaining the use of EVMs to the voters	☐1 ☐2 ☐3 ☐4
3.3.1.3. Speed of the voting process	☐1 ☐2 ☐3 ☐4
3.3.1.4. Speed of the counting process	☐1 ☐2 ☐3 ☐4
3.3.1.5. Ease of installation	☐1 ☐2 ☐3 ☐4
3.3.1.6. Technical reliability	☐1 ☐2 ☐3 ☐4
3.3.1.7. Others (*please specify below*)	
	☐1 ☐2 ☐3 ☐4

4. Security aspects of EVMs	
4.1. Have you ever heard of any security problems with EVMs?	☐ Yes ☐ No
4.1.1. If **yes,** please share which problems you have heard about.	
4.2. Taking into consideration all aspects, which ballot system is, in your opinion, comparatively more suitable and reliable for a trustworthy democratic process in India?	☐ EVMs in their present form ☐ EVMs with some modifications ☐ Paper-based ballots ☐ Other (please specify) ----------
4.3. What measures, if any, do you think are required or would be beneficial to further increase the acceptance of EVMs (for example in terms of the ease of use and (perceived) reliability)	
5. Please feel free to share any other thoughts/comments with us	

Thank you very much for you time!