Blockchain and Aadhaar Based Electronic Voting System

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Abstract—**Elections frequent in multiple parts of the country. Being the largest democracy, India, takes several months accomplishing elections. Additionally, elections demand government works, development, cost, tenure, etc. Since 1999, EVM's had been in widespread use that ensures voting could be made tamper-proof. India introduced Electronic Voting Machines (EVM) way back in 2004 for its parliamentary election with 380 million networked voters. EVM, being an electronic system, was used to record votes. Only Bharat Electronics Limited and Electronics Corporation of India Limited conduct EVM and VVPATs (Voter Verifiable Paper Audit Trail) checks. The sole solution to the issue is introduction of Aadhaar; a unique identification number.**

This work introduces a novel concept that provides fraud free (tamper- less), paperless election in India. It will reduce much burdens of money, paper, human/ skilled people from governments. In summary, this work provides a Simple, Reliable, Affordable concept, i.e., using Blockchain technology and Aadhaar for providing paperless electronic voting in India.

Keywords— Blockchain Technology for Voting, Aadhaar, Indian Citizen, Paperless Voting, Fraud-less Voting.

I. INTRODUCTION

The Aadhaar project seems to be the largest national identity project in the world, initiated by the Indian government in August 2010, aimed at collecting resident biometric, demographic data and storing this in a centrally controlled database [1].It is also widely recognized as the UID (Unique IDentification), a project initiated by the Indian government in which each Indian citizen is given a unique number to identify. The number will allow people to take advantage of plethora of benefits and services. Today, over 10 million people have enrolled in this project or have issued Aadhaar number through this project [2]. This card is used in many welfare scheme via linking with person account or mobile number, *i.e., to reduce bogus people, or fraud or corruption in the system.*

In 2008, with the emergence of the world's favourite crypto currency 'BitCoin' *(based on distributive ledger technology, i.e. called Blockchain Technology)* [3], knowledge of the mysterious and specific technology behind it has also increased. Today tons of developers realized Blockchain's importance and are now rushing their concepts towards development. Blockchain 1.0 to Blockchain 4.0, we reached into a new era where Blockchain is used as a service for many applications Blockchain-as-a-Service (BaaS) is the third party that builds and operates cloud-based networks for businesses developing Blockchain apps. Baas is a model which is based on the Software as a Service (SaaS) and operates in a similar manner. It enables customers to utilise cloud-based solutions to develop, host and start operating on the Blockchain their own. Significantly, this is a cornerstone in the Blockchain ecosystem that is seen as increasing the acceptance of Blockchain across companies.

Hence, both services are in trend now a days and in integration can do much innovative work, or can provide efficient solution to India or nay country' citizen. Note that if a country do not have Aadhaar project then the citizen of that country can use any schemes or services which provide them proof of identity like passport, social security number to get similar results like Aadhaar.

A. What is Aadhaar Card?

Aadhaar is a 12-digit, personal unique id issued on behalf of the Government of India by UIDAI (Unique Identification Authority of India) [2].This number will serve as proof of identity and address across the country. Anyone, regardless of gender and age, a citizen of India and who meets the UIDAI verification process can enroll for Aadhaar. Each person could enroll for Aadhaar only once, which is cost-free. Every Aadhaar is special to a person and remains valid for life. In future years, Aadhaar would allow you to have access to services such as banking, Mobile telephone, other government and non-governmental facilities. Aadhaar is going to be to:

- Online, cost-effective and quickly verifiable
- Special and secure enough to remove the large number of false and duplicate identities in government and private domains
- A random number produced, devoid of caste, creed, religion or geographical classification

B. What is Blockchain?

The block chain is an uncorrupted, digital data ledger for transactions which functions as a distributed data system that

stores incredibly similar data blocks across the entire network *(means that the system does not have a single fault point and cannot be managed by any single node / user / entity because it is distributed)*[4]. A network of blockchains relies on consensus, too. That is, it automatically verifies any transaction that happened during that span of time at regular intervals / checks in it. These types of transaction are called 'blocks,' hence the term 'Blockchain.'.

The technology has attracted the attention of associates across a wide range of industries, including healthcare, real estate, transportation infrastructure and finance [5]. By storing information from innumerable devices and allowing parties to be established devoid of federal cloud, the blockchain is capable of tracking, coordinating and bearing communications. Now, each and every service provided by Blockchain Technology, can be included here as: Reliability, Trustee Operation, Decentralized Control, Distributive Storage, Fault Tolerance, Immutability, Data Integrity, Data Authentication, No-Double Spending, Log Management, Auditability, and Autonomous operation.

C. Significance of Blockchain

- **Disintermediation:** Blockchain offers immutability in transactions and distributed ledger design which are essential criteria to remove the need for an organization trust enforcer [6].

- **Transparency:** Blockchain implementations facilitate the development in the ecosystem of a shared record of operation to which all market players have real-time access.

- **Provenance:** A permanent record of transactions is retained from the first transaction on the Blockchain. This greatly decreases the risk of multiple asset types and the need for related mitigation operations. This capacity would enable the incidence of theft, fraud and the abuse of high-value assets and intellectual property rights to be reduced. It will also support assets where worth is determined by its provenance by having a digital footprint on the Blockchain [7][8].

  Decentralization, accountability, and security (with building trust) are core properties of a Blockchain. Apart from characteristics, Blockchain has the following benefits to users/ organizations:

- **Time savings:** Transaction duration for complex, multi-party interactions are slashed from days to minutes. Transaction settlement is faster, because it does not require verification by a central authority.

- **Cost savings:** Blockchain takes the edge off expenses in several ways:

  - Marginal oversight is needed because the network is self-policed by network participants.

  - Intermediaries are reduced as participants exchange items of value directly.

  - Duplication of effort is eliminated as participants access the shared ledger.

- **Data Validity and Tighter security:** Blockchain's security features protect against tampering, fraud, and cybercrime. Once you are in, the data is hard to tamper due to blockchain's nature. If a network is granted permission, it enables creation of members-only network with proof that members are who they say they are and that goods or assets traded are exactly as represented.

  Bear in mind that, Blockchain can be used in any application to store data securely and with anonymity. Then it does not mean that similar Blockchain can be used/ built for business. As discussed above, Blockchain can be as publicly or privately (permission to specific person only). Some are granted permission while others are not. A permissioned network is critical for a Blockchain for business, especially within a regulated industry. It enhances privacy; improve audit-ability and increases operational efficiency. Blockchain builds trust through five attributes in business/ individual applications:

- **Distributed and Sustainable:** The ledger is commonly shared, updated and upgraded every time a processing happens, and is easily duplicated or replicated within the users in real-time. Since, it's not under the ownership of any particular establishment; the Blockchain offers a framework which is immaculately independent of individual instances.

- **Secured, Private, and Indelible:** Authorisations and encryption aid to keep away data flowing into malicious hands thus assures and verifies the validity and identity of the participants. Privacy is easily imposed through cryptography complemented by data partitioning methods to ensure participants are succumbed to selective access/visibility into the ledger. As per the agreement of the conditions, users will not be allowed to modify/harm the record filled with processed transactions.

- **Transparent and Auditable:** Since the users participating in a particular process can access the same records, they're capable of validating the transaction procedures and authorising ownership identities for the third-party middle-men.

- **Consensus-based and Transactional:** All the active users are obliged to agree towards the validity of a process and this is moderated with consensus algorithms. Each of these networks is efficient enough to develop the situations under which a process happens.

- **Orchestrated and Flexible:** Since business rules and smart contracts can be easily incorporated into this framework, Blockchain networks evolve mature to complement end-to-end business techniques and a plethora of other activities.

  As discussed above, Technical measures such as proof of work, Practical byzantine fault tolerance, Delegated proof of stake and proof of stack have been used/ implemented to improve the security of Blockchain. Hence, virtually anything of value can be tracked and

traded on a Blockchain network (due to using consensus function/ ledger mechanism), reducing risk and cutting costs for all involved.
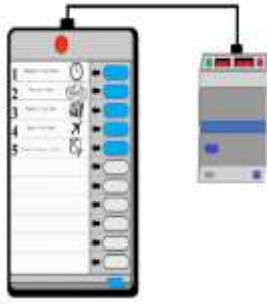
D. Voting system in India

Fig. 1. Electronic Voting Machine (EVM) – A Sample

The Lok Sabha, India's lower house of parliament, has 543 seats elected. To form a majority government any party or alliance requires a minimum of 272 MPs [9].About 814 million people are registered to vote at 930,000 polling stations-100 million more than the last elections in 2009-up from 830,000 in 2009.Both voting booths will use Electronic Voting Machines (EVMs).India's electoral commission will oversee the whole process.

a) Names of the representatives are listed in the majority of constituency languages and scripts. Candidate is often known by a symbol to support electors who are illiterate: for example, the lotus for BJP or a hand for Congress. Candidates, who are not affiliated, may pick a symbol from an accepted list.

b) To cast their vote, voters press the Blue button next to their candidate of choice. A button for None of the above is available for the first time, as well as a serial number in Braille to aid visually disabled electors.

c) The control device saves the votes and is powered on a battery to allow it to continue operating in the event of a power failure. The serial number of each candidate displays during counting, along with the total vote casted.

d) Pressing the Close button below the flap stops election officials from counting any further votes. It is used at the end of polls, or if someone barge into a polling station with the intention to cast illegal votes.

e) The device is secured with old-fashioned wax, combined with a safe strip from the election commission and a serial number to discourage anyone from tampering with the machine containing the voting records.

Corruption, joblessness, price hike, weak economy and women's insecurity are the main issues of a nation. A fair election gives strong vision to a nation and for making better policy for their citizens. Hence, the organization of this article is discussed as: section 2 discusses about related work in detail. Section 3 discusses about our motivation writing article on or Blockchain Technology and Aadhaar. Section 4 discusses the problem in crystal clear terms. Further, section 5 provides proposed solutions and benefits of our proposed system. Lastly, this work is concluded highlighting scope for future researchers (including governments) in section 6.

II. RELATED WORK

Since India gained independence in August 1947, general elections had to be held to elect a fully representative government on the basis of universal adult suffrage [10]. Thus, Article 324, requiring the creation of the Election Commission as an autonomous constitutional body, entered into force on 26 November 1949 and several other laws entered into force on 26 January 1950 (when the Indian Constitution came into force)[11]. On 25 January 1950, the day before India became an Autonomous Democratic Republic, the Election Commission was officially established. On 21 March 1950, the first Chief Electoral Commissioner, Shri Sukumar Sen, was appointed. From 1950 to 16 October 1980, the Commission used to function as a single member body, but was changed to a three-person body from 16 October 1989 to 1 January 1990. It was restored to the form of a single member organization in the year 1990, on 1 January [12].

As a Supreme Court judge, the same salary and benefits are provided to the Chief Election Officer and two election commissioners. All three Commissioners have shared decision-making power and, in the case of any difference of opinion on any issue, the decision is taken by a majority. The term of office of the CEC and ECs shall be 6 years of age or up to 65 years of age, whichever is older. The first delimitation rule was released by the President, in consultation with the Election Commission and with the approval of the Parliament on 13 August 1951, for the first general elections of both the Lok Sabha and Vidhan Sabhas. Parliament adopted the first Act of 12 May 1950 (Representation of the People's Act, 1950) specifically providing for the compilation of electoral rolls and the second Act of 17 July 1951 (Representation of the People's Act, 1951) setting out the process for the conduct of elections to both the House of Parliament and Vidhan Sabha in order to create a legislative structure for the conduct of elections. By 15 November 1951, electoral rolls for constituencies had been released by all states. The total number of voters (except Jammu & Kashmir) was 17.32.13.635 compared to the total Indian population (excluding Jammu and Kashmir), 35.66.91.760., according to the 1951 census. From October 1951 to March 1952, the First General Elections for the Lok Sabha and Vidhan Sabhas were held [12]. On 2 April 1952, the first Lok Sabha of 497 members was elected. On April 3, 1952, the first Rajya Sabha was formed, comprising 216 members. The very first constitutional election was held in May 1952, after the creation of both the House of Parliament and the State Legislative Assemblies, and the first directly elected president took office on May 13, 1952. At the time of the first general election in 1951-52, the Commission recognized 14 political groups as multi-state parties and 39 parties as state parties. Seven National Parties and 40 State Parties are officially recognized.

The 'Balloting Method' for voting for the First and Second General Elections was adopted by the Election Commission in 1951-52, and 1957. Each candidate was given

a separate ballot box at each polling centre in a screened cabin under such a scheme, and the voter was only allowed to drop his ballot paper, the centrally pre-printed paper ballots, into the selected ballot box of the candidate. The Commission has switched to a 'marking process' for casting a ballot since the 3rd General Elections in 1962. The two numbered ballot papers must be put in a common ballot box. In 1982, in part of Kerala's Parur Assembly Constituency, the Electronic Voting Machines (EVMs) were first used experimentally. Later, in 1998, the widespread use of EVMs began. The EVMs were first used for the 14thLok Sabha General Election in 2004 at all polling stations in the country. Since then, both the Lok Sabha and Legislative Assembly elections have been carried out using EVMs. From 1951 to 1952, 15 general elections to the Lok Sabha and 348 general elections to the Vidhan Sabhas took place and the country is now fully based on the 16th nationwide election to the Lok Sabha. In 2019, the 17th Lok Sabha election was conducted on the basis of the VVPAT (Voter Verifiable Paper Audit Trail), which priced approximately 60,000 crores. If we prefer to use Aadhaar and Blockchain-based electronic voting, we could cut costs (in the total number of votes per booth) for actions, fraud, money, accountability and voting.
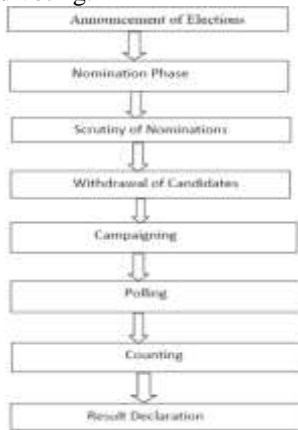

Fig. 2. Process of collecting votes

III. MOTIVATION FOR BLOCKCHAIN TECHNOLOGY AND AADHAAR

In India, conducting elections is a hectic task, which involves a mammoth of skilled work force to organize smoothly. A lot of money, paper, and time is too needed for its smooth processing and need a central database to store the voter's votes. Such issues include a lot of things in India or every other nation to hold elections. For example, in India elections are organized every year in 28 States and Union Territories for divergent leadership positions like MPs, MLAs and many more. The issue with centralized database is the ability to modify the stored data; censor otherwise legitimate data changes, or fraudulently add data. This decreases political trust, and system gets prone to corruption. To avoid such predicament, there is a dire need to move digital voting. But again malicious attackers (or hacker, executed or appointed by government agencies) may fraudulently alter the election

results. Aimed to combat such digital frauds, we require a tamper-proof system which should be transparent and certainly cheaper. Such features are provided by us through our work using Aadhaar and Blockchain Technology. This work provides a tamper-proof, transparent, cheaper, distributed, and trusted voting system for a developing democratic nation.

Hence, this section covered motivation towards Blockchain, Aadhaar and election or voting system. Now, the next section will define our problem in clear and concise manner.

IV. PROBLEM DEFINITION

Wasting a lot of money, tenure through conducting election in India for months stooped several undeveloped work or ongoing projects over the years. Election in India posed as biggest voting event in the world as more than 800 million Indians are participating in the polls over 8-10 weeks to retain/elect a new representative. Note that a government can tamper a maintained database for its own benefit/ power. While, there should not be any motive like to falsify the database's contents, etc. which can affect voting or counting of votes. Currently, election in India is conducted by the election commission of India which is an autonomous body, and has maximum power during election. Even if it can be assured that a fraudulent alteration to the database would never be implemented by the responsible organization (an expectation that is already too much for many to ask). But remember that there is still the possibility of a hacker adding fake voters to the list (because all voters list is created by machine now days) breaking in and manipulating the database to their own ends. This will increase fraud and will enhance corruption in the existing voting system. Hence, we need a tamper-proof which can distributed, affordable, reliable, transparent, trusted services to both entities like participating parties in the elections and voters who are eligible to cast their vote.

Hence, this section discusses that why current or existing voting system in many countries is breached by many possible attacks (insider or outsider). Note that for outsider or external attacker refer article [13]. Now, next section will discuss our proposed method or model as an essential part of this article (or our work).

V. AN EFFICIENT ELECTRONIC VOTING SYSTEM USING BLOCKCHAIN AND AADHAAR

This section uses Blockchain and Aadhaar to provide our new model for free, paperless and open voting nationwide. As discussed above, we are facing many problems in current voting system because centralized authorities are in the charge for handling and resolving issues [14]. But, dire straits happen if these responsible authorities try to meddle with the voting. For that, we can suggest electronic voting systems (general without Blockchain), but there is a chance for an external or internal attacker to change or tamper the data bases (which is centralized or decentralized). Hence, to avoid such critical cases, we need a system which should be distributed, decentralized and open to public all the time and access it, at

anytime and anywhere. Such systems can build trust in citizens of a nation and the elected government. This kind of functionality and features is provided by Blockchain. Note that this section discusses how we can make a tamper-proof electronic voting system based on Aadhaar and Blockchain.

A. Blockchain and Aadhaar based Electronic Voting System

Here we vote for the effective implementation of technology for Blockchain. By casting votes as transactions that keep records of the balances of the votes, we can generate a Blockchain. In this way, everybody can agree on the final number, because they can count the votes individually, and because of the audit trail of Blockchain, they can check that no votes have been altered or deleted, and that no illegal votes were included [15].
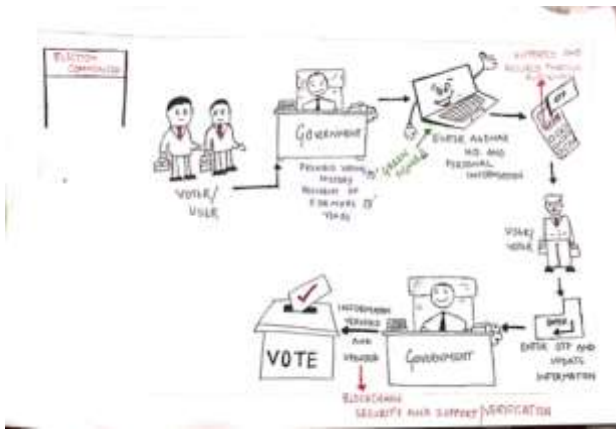

Fig. 3. Process of collecting votes

But here, the most rational solution is to ensure that an online or offline election database or system cannot be manipulated by any single party. For that, we need to make the database accessible to allow someone to save a duplicate copy of the database, and in many other words. In this way, by comparing it with all the others, everybody can be confident of keeping everybody's copy of the database. This is sufficient as long as the database is fixed; however, there is a consensus problem when changes to the database have to be made after sharing [16]: Which of the organizations that hold a copy of the database defines what changes can be allowed and in what order have those changes taken place? Notice that two methods of consensus are used by Blockchain, such as proof of work and proof of stake in its work process. We make our Block chain-based system tamper-proof and backed by these structures of consensus.

Figure 3 offers a full overview of how the election movement can be brought together through Blockchain and Aadhaar. Note that any legitimate proof of address for a secure and trusted, open and distributed voting process may be referred by other nations. If any of the entities can make changes at any instant, the replicated copies of the database will easily get out of sync and there would be no consensus as to which copy is accurate. If all the organizations agree on one, which makes changes first, and all the others copy from it, then you have the right to revert changes you do not want.

Furthermore, if that one person disappears, before all the others can unite to select a replacement, the database will remain stuck. Both entities can agree to make changes and copy changes from the one whose turn it is, but this opens up the issue of who determines who will get a turn when.

B. Benefits of our proposed work

a) Reducing cost: We propose a blockchain-based scheme that satisfies the basic e-voting properties offering a degree of decentralisation and putting as much power of the mechanism in the voters' hands. Large-scale conventional elections, especially when there are hundreds of geographically distributed voting centres with millions of voters and are very expensive in the long term [17].We incorporate the blockchain framework and Aadhaar into the e-voting process and establish an e-voting protocol that is both feasible and generic.

b) Increasing Percentage of Total Votes (per booth): Polls were always subject to understatement. Voting has been the subject of voter fraud worldwide in particular. It could leave us wondering how the outcome of elections could vary incredibly if the apt consensus of the people could be reflected. Blockchain may clearly show to be an answer over-looked by governments and their citizens.

c) Increasing transparency: Every nation demands a framework that ensures legitimate voting registration with recognisable proof. They should have a voting platform that optimises the process of looking cast a ballot. In short, the election result must be transparent and straight-forward [18]. The benefits of an open source voting system is that it is open and has no restrictive calculations, allowing residents and offices to review the utility and enhance safety.

d) Increasing trust on Governments: Blockchain may prove to be the fix that government and citizens were looking in order to boost the vote. It is because many experts think it offers the four most prominent features needed by any voting system: security, accessibility, auditability, and transparency.

e) Reducing bogus/ fraudsters: The blockchain functionality such as encryption and immutability [18] make it nearly impossible for someone to cast an unlawful or fraudulent vote, or to make adjustments once registered.

f) Distributed and globally recognized: Compared to polling via a blockchain system, conventional voting is costlier, vulnerable to manipulation, less reliable and easily corruptible. Blockchain technology offers a reliable and safe way to store data. It maintains security while remaining open to public inspection, making it ideal for voting. This is why countries such as Japan are now introducing blockchain to their voting system in order to make the voting system more accessible and simpler.

Blockchain, as disused above and in [15], is controlled by a set of rules, called the consensus protocol. These rules specify which improvements can be made to the database, who can make those improvements, when they can be made etc. There have been two main forms of consensus protocol recently: the first is Proof of Work (PoW), and the other is Proof of Stake (PoS). An unchangeable, unchallenged distributed digital asset ledger is a forum for honesty and trust.

The implications are overwhelming not only for applications to vote, but also in nearly every sector of society such as financial services sector, retail, logistics, etc. is basically an open network built for peer to peer censor free interaction. The peer may be a company, or a person. Blockchain offers a chance to redraw the structures and challenge the orthodoxies that remain in the business model today. Blockchain would dramatically increase transparency among players levelling up the playing field on the platform. It begins to question current competitive advantage models which take benefit of existing risk models and asymmetries in knowledge.

Hence, this section discusses our proposed model, i.e., Blockchain and Aadhaar based electronic voting system for countries that are facing difficulties in conducting lections smoothly or facing charges of fraud. We assure with our work that we can provide transparent voting systems to citizens across many nations (also providing maximum reliability, trust and fault tolerance). Now, in the ultimate section we will conclude our work in brief with essential future enhancements.

VI. Conclusion And Future Enhancements

Our work started with the popular event of elections in many countries and then discussed several essential technologies like Blockchain, Aadhaar, etc. Also, this work explained the grandeur history of voting systems India since 1950. It was aimed to assess the implementation of Blockchain to incorporate distributed electronic voting systems as a service (including Aadhaar). Note that we used Aadhaar, in our work, to check the eligibility of electors participating in an election. We then proposed a modern, Blockchain-based electronic voting system that fixed all the limitations we encountered [19]. Our work explored the potential of distributed ledger technology via a case study summary, namely the election process and the implementation of a Blockchain-based framework that enhanced transparency and reduced the cost of conducting a national election. As a result, our work completely complied with the criteria of developing tamper-proof electronic voting systems and recognizes the legal and technical drawbacks of using Blockchain as a Service (BaaS) to implement such systems.

As future work, Network attacks might destroy network trust thus devaluing the stake. A 51 % attack would allow attacker to buy 51 % of the network stake[20], which would be incredibly costly because the higher the stake, the attacker buys, the higher the cost, and using that stake to attack the network will result in a total loss as the value of the stake is lost in the attack. So, we can work for avoiding such attacks in Blockchain based election systems. Also, creating blocks take more time, so will be time consuming, it depends on internet so connectivity of internet, and verifying new blocks in minimum time on a public network always will be a critical challenge for us in near future. To sum it all up, researchers are suggested to read [21, 22, 23, and 24] for knowing possible uses of blockchain with other emerging technologies like Artificial intelligence, Internet of Things, etc., in near future.

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