E-voting system using blockchain technology

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***Abstract*— The growing pandemic has sadly put a halt to important social activities such as voting. Unfortunately, strict guidelines have been devised and activities which include mass gatherings have become frowned upon. This pandemic has given many opportunities to industries to provide solutions to unavailable activities or services. Research has shown data on the demand for electronic voting in this time of need. Data particularly points towards the inefficiency of the traditional ways of voting and the question is often asked about electronic voting solutions. Research gathering techniques such as questionnaires were sent to individuals of different backgrounds for aims of gathering information about the common folk's knowledge about electronic voting. Contrary to what has been collected, the findings show that individuals in particular were worried about security aspects of such system in the sense of tampering with votes. Such implications have been solved using and proposed blockchain software solution to electronic voting. This paper contains evidence and demonstration of such technological blocks building to the solution, although the field of blockchain application development is still undergoing its evolution**

Keywords—Blockchain, voting, decentralized technology, ethereum.

I. INTRODUCTION

Preliminary in this modern era, technological growth and development has erupted as one of the most significant industrialized sectors influencing all aspects of human life as we the present generation are gradually but slowly drifting through social progression through the integration and shifting to digital technologies [1]. Social technological progression through technological advancement has been the embodiment of the fourth revolution uplifting and modernizing the economy across the world, hence making the transformational process sustainably ecological whilst increasing globalization, shrinking the mass surface of the earth [2].

With unprecedented events, uncertainty to how far we can establish a modernized digital economy has proclaimed itself with the visualization or insight of what the future upholds for our upcoming generation and how we can better advance our life through the adaptation and evolvement in the technological industry [1]. For instance, the Covid 19 pandemic has change the perception and perspective of many individuals of how evolving technology has been a pathway to continuously keep our daily operations intact and ongoing, hence making our life easier as that chain of communication and integration is influenced by a charge in digital programming [3].

Unfortunately, with the pandemic escalating upon a day-to-day basis, certain real-life events, containing mass gatherings of crowds were unable to occur due to the precautionary measure aligned with safety measures of social distancing in affiliation of covid-19 being contagious [4]. Politically, Covid 19 has affected the presidential campaign and election which is significantly important as it encompasses our lawful human rights, integrity and pride of one sovereignty [5]. With this gap in technology unable to overcome accompanied with the events which cannot be postponed. Technological progression and advancement have created a new platform or a system whereby we can continue with the tradition but a better new organizational way in managing large gathering whilst being more efficient and effective with current situation [6].

Research and studies show that a worthy internet e-voting system must satisfy strong requirements such as security, integrity, accuracy, swiftness, privacy, auditability, accessibility, cost-effectiveness, scalability, and ecological sustainability [7]. E-voting or electronic voting and elections is voting that will use electric means to carry out the casting and counting of votes. Voters will be able to cast and submit their vote electronically to the election authorities from anywhere. Internet voting does sound very concerning towards secureness and integrity of votes but there are many arguments that a blockchain based system will offer a solution. Blockchain is a distributed ledger technology (DLT) and is based on a peer to peer (P2P) topology which is a form of file sharing by downloading data from different users' computers [8]. This topology is openly shared amongst users, which will create unalterable records of transactions with each of the transactions being time-stamped and linked to the previous one. Each time a group of transactions are added they form a block in the chain [8]. In much more simple terms, we can think of blockchain as a very large database which is not controlled by an entity or anyone, however changes and updates are able to take place in the blockchains only if majority of participants agree to it hence, besides being capable of managing large amounts of data, the blockchain can make processes easier by giving everybody the easy share of rights.

In the literature review, an in-depth subtopic about blockchain based voting will be explained briefly. The platform will be web based which will be displayed across all kinds of devices. When votes are casted and submitted, blockchain technology will come into play securing those votes by hashing them. At the end of the election, votes are tallied up and counted. This proposed system will also allow the election authority to fully take control of the system as if it were a normal election. The system will also allow users to confirm the submission of their vote by receiving an electronic receipt.

II. LITERATURE REVIEW

A) *Domain Research*

First, we must understand what an e-voting system is. As simple as it may sound, an e-voting system is the use of some electrical devices which may be voting machines (e-vote) or simply an internet browser (i-vote) [9]. Typically, to our understanding as human beings, our main concern with e-voting would be security and integrity of such an e-voting system. A study conducted by [10] stated that security gaps in a e-voting system has the possibility to compromise the privacy and integrity of voters which would cause a vote to be casted without the intention of the voter, a fault in transmission or false counting.

On the other hand, an article written by [11] discusses the benefits of an e-voting system could be useful for absentees making them vote from almost anywhere and could reduce the cost of voting and resulting values would be instantaneous and accurate. Further benefits stated by [11] include that e-voting is more accurate in terms of counting and reducing risks of fraud where an example would be a voter being bribed at the polling station which would cause him to change his voting intentions. Despite what [11] had studied, we humans cannot come to a patriotic decision whether to let our one and only freedom of voting to be controlled by machines. The problem arises out of fear or failure, or as [10] argues, the threats of e-voting lie in the hands of hackers, software errors, misbehaving system administrators, malware.

B) *Factors affecting traditional voting.*

An article written by [12] states that in 2005, Estonia switched to e-voting for its elections. The author states how Europe saw this as an opportunity to modernize their elections and facilitate ballot box access for voters who are abroad through digital means. Thus, e-voting is seen as a solution to increase voter turnout. Statistical evidence can be found in the same article by [12] shows that during a European parliament turnout since 1974 voter turnout had reduced by 20% in 2014. In another study written by [14] , it is seen that Estonia's online election which had a centralized digitalized identity system with citizen ID numbers preventing fraud and the IDs and personal factors had been removed to ensure the anonymity of votes. The story is not quite the same for Australia. In the same article by David, he states that Australia was considering moving to online voting, but the government was still having doubts about secureness and integrity. Another observation by (Wen, & Buckland,2016) article, show a similar advantage than what [14] [12] [15] states that online voting is faster, convenient and has fewer accidental votes provided the right technology. Majority of Australians wanted a solution for them not to stand in very long queues or being far away from polling stations. We have seen recently in the United States of America how the mail voting system had been so inconvenient [15] leading to recounts in some states due to inaccurate beliefs and the election itself took around a week for the results showing the inconveniency of the system.

On the other hand, the idea of e-voting using blockchain technology could solve problems that COVID-19 brings upon the surface of our planet. Halting many socio-economic activities across the globe as a world health emergency had been declared in 2020. A recent magazine by Forbes written by [16] shows that online voting is the future in USA.

[16] states that online voting eliminates the need for people to stand in long crowds with anxiety over covid-19. To contrast what [16] has stated, a recent study by [17] in Malaysia show that a recent election that had been held in one of the worst hit states by covid has caused serious spikes in the infected number of the Malaysia population as they said they did not have any choice. Fig 1. Shows the diagram displays National and subnational Elections which have been postponed from 21st February 2020 until the 1st of February 2021. At least 75 countries across the globe have decided to postpone elections due to COVID-19.

Fig. 1. Map representing in highlighted colors, number of countries with cancelled elections due to covid-19

C) *Factors that discourages e-voting*

Besides global wide problems and solutions as discussed in the above literature (Factors affecting traditional voting), problems and issues will at most certainly arise when an e-voting system is deployed. Firstly, everyone tends to think about the security behind an e-voting system and how well would it cope with the threats that oppose such a system. All information systems are vulnerable towards computer attacks whether the latest technology has been used. Threats towards a voting system such as a malicious payload where there would be a harmful program installed on a personal computer that could secretly hide itself and alter votes, spoofing sites are also common where a fake website would be created in order to phish for credentials and finally DDOS attacks (Denial of service) attacks whereby the network would be flooded by request from bots and cause the operation to shut down.

In another research paper written by [18] , the authors look into the Universal declaration of Human Rights [6], for technical requirements and it was found that the system should have equal and free suffrage. This means that equality is guaranteed if a voter is properly identified to prevent unauthorized or double voting and freedom is obtained when voters can't be linked to their casted votes [18].

On the other hand, an e-voting system must be one that is able to be trusted. Since we shall be voting over the internet and there will be an abundance of private information being transmitted, a voter should be concerned about his/her information being transmitted over the internet. In simple terms, an e-voting system is considered a black-box application in which it performs its intended tasks but is blindly trusted by users. Solutions that has been devised that contains cryptographic methods involving end-to-end verifiability at which blockchain technology share a common benefit with.

D) Critical concepts of Blockchain based Voting. Voting with coins

Blockchain is an append only service data structure in which data is stored in distributed ledgers that cannot be tampered with or deleted. Blockchain technology will provide a development environment for highly secure, decentralized, anonymized, audible record chains which are presently used in cryptocurrency systems. In present day, Blockchain is used primarily for cryptocurrency transactions such as Bitcoin and Ethereum. However, thanks to blockchain technology, developers can use the same concepts applied to cryptography with Bitcoin or Ethereum to produce decentralized applications (Dapps) because of their inherent resistance to modification to the transactions on the distributed ledger blockchain. This technology draws power from peers or nodes on the network to verify, process, and record all of the transactions across the system. The decentralized nature of blockchain make transactions incorruptible since each record is easily verified by every nodes in the blockchain network. The network does not exist in one exact place hence cannot be taken down or be influenced by a central authority. The process of e-voting has been tried by many start-ups but has proven difficult as there were large gaps in security in those platforms. Blockchain can help solve the challenges of past non-blockchain e-voting systems with the use of smart contracts. Smart contracts can be thought of as self-executing programs stored on a blockchain that run when conditions defined are met [9].

Smart contracts eliminate the need for a middleman for transactions removing time and conflict. Hence, smart contracts allow for smooth authentic transactions without the need for third parties [9]. Smart contracts work through programmable logic "if/When….then…" statement actions. These actions can include sending funds to another party's wallet, registering your insurance details or better yet, casting a vote for a certain candidate in an election.

III. SIMILAR SYSTEMS

There contain similar systems on the market with respect to e-voting solutions. The developer shall get inspiration from the top e-voting platforms currently in use and apply some similarities to his own system. The three top e-voting platforms used today are; Opavote, SimplyVoting & NemoVote. In Table I, the similarities of each system are discussed.

```
/* Allow another contract to spend some tokens in your behalf */
function approve(address _spender, uint256 _value)
    returns (bool success) {
    allowance[msg.sender][_spender] = _value;
    return true;
}

/* Approve and then comunicate the approved contract in a single tx */
function approveAndCall(address _spender, uint256 _value, bytes _extraData)
    returns (bool success) {
    tokenRecipient spender = tokenRecipient(_spender);
    if (approve(_spender, _value)) {
        spender.receiveApproval(msg.sender, _value, this, _extraData);
        return true;
    }
}

/* A contract attempts to get the coins */
function transferFrom(address _from, address _to, uint256 _value) returns (bool success) {
    if (balanceOf[_from] < _value) throw;                 // Check if the sender has enough
    if (balanceOf[_to] + _value < balanceOf[_to]) throw;  // Check for overflows
    if (_value > allowance[_from][msg.sender]) throw;   // Check allowance
    balanceOf[_from] -= _value;                           // Subtract from the sender
    balanceOf[_to] += _value;                             // Add the same to the recipient
    allowance[_from][msg.sender] -= _value;
    Transfer(_from, _to, _value);
    return true;
}

/* This unnamed function is called whenever someone tries to send ether to it */
function () {
    throw;     // Prevents accidental sending of ether
}
```

Fig. 2. Example of a smart contract

TABLE I. SIMILARITIES OF SYSTEMS TAKEN INTO CONSIDERATION

System	Platform	User roles	Subscription	Security
OpaVote	Web	Admin & user	Yes	SSL encryption
NemoVote	Web	Admin & user	Yes	End-to-End encrypted
SimplyVotin	Cloud web based	Admin & user	Yes	AES-256 Encryption
i-Voter	Web	Admin & user	No	Blockchain Technology

Based on Table I, the developer shall use the similarities of the top 3 e-voting systems. Through thorough research of these systems, it was found that each system were hosted on the web, had an admin role and user role, had paid subscriptions and using sophisticated security features such as AES-256 encryption, SSL encryption and End-to-end verifiability. However, in our solution, the developer shall implement blockchain technology as means for security. With respect to paid subscriptions, it is not necessary for the solution to come with paid services. These similarities shall be reflected into the solution and project scope.

IV. TECHNICAL RESEARCH

The proposed system is a web application built using JavaScript libraries which shall be explained further into this chapter. Our system architecture is modelled based on the front-end technologies, the back-end technologies and finally the Ethereum blockchain network.

A) Front-end technology used

- *Embedded JavaScript Templating*

The front-end will be written using Embedded JavaScript templating (EJS). EJS is a popular template view engine, and it offers the ability to write HTML, JavaScript and CSS. EJS offers developers to reuse code for common components such as headers and footers.

B) Back-end technology used

Node.JS

Nodejs is a JavaScript based platform which in charge of server-side environment services. In other words, you can decide the backend for your program which you can write in JavaScript [19]. One of the main reasons as to why so many developers use NodeJS as a backend service is because their front-end is based on JavaScript and having a backend environment written in JavaScript as well means that the communication between the front and the backend would be done in the same language making it cross-functional.

- *Express.JS*

ExpressJS is a framework that runs within NodeJS providing for the developer resources to create and maintain servers. Developers write server-side logic using ExpressJS for you web application [20]. The framework has a very easy learning curve and will be used with NodeJS for server-side scripting.

C) Libraries/Tools used

Web3.Js

Web3js is a collection of libraries which will allow a user to interact with a local or remote Ethereum node in order to create decentralized apps (Dapps) [21]. A decentralized

application has got three main components namely, taking input from the user from the fontend building the requests to be sent to the smart contracts, the wallet signs transactions and sends them across the network and finally the last component, which is the smart contract which defines the business logic of the decentralized application. It is possible to interact with smart contracts from the front-end using JavaScript.

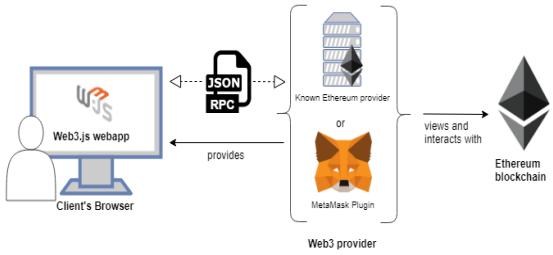

Fig. 3. Decentralized application architecture

- *Ethereum blockchain and the EVM (Ethereum Virtual Machine)*

Throughout this project, the application will be using the Ethereum blockchain. Ethereum is an open source, decentralized most actively used blockchain in the world which features smart contract functionality. Ethereum is considered as a network of computers which come to consensus on a growing series of blockchains that keep permanent tamper proof records of information which constantly is being verified by a network of computer nodes.

In order to commune with the Ethereum blockchain the developer has to write smart contracts which are programs that govern the behavior of accounts within the Ethereum state [22]. The language used to write smart contracts is called solidity which is a well-known curly bracket language similar to JavaScript.

The web application contains one of the most important features which highlight this project. This is the Ethereum virtual machine. The EVM, is based on blockchain platform allowing developers to create "Dapps" Decentralized applications. This feature is loved amongst programmers because of its no downtime and information objects are kept safe from modification.

- *Rinkeby Test Network*

The rinkeby test network is an Ethereum network which is used by developers to run tests for their decentralized applications. The currency used on the network is valueless and only used for testing purposes. Using the rinkeby test network, allows the developer and this project to be controlled without the need for spending real money to get cryptocurrency for transactions. To access the contents of the test network, https://etherscan.io/ tracks down transactions that goes on within the network. Currently, the test network has birthed over 12000000 blocks.

- *Truffle suite framework & Ganache*

Ganache is a personal blockchain for rapid Ethereum web app development. Ganache is usable throughout the entire development life cycle allowing you to; develop, deploy, and test your decentralized apps (dApps) in a safe and deterministic environment.

- *Metamask plugin*

Metamask is an internet browser extension which makes it easy to commune with the Ethereum blockchain and provides a wallet for your browser. Metamask has a pair of keys private and public. Metamask allows for swift and smooth Ethereum transactions on the Ethereum blockchain. In this research, metamask will be used for every blockchain transactions.

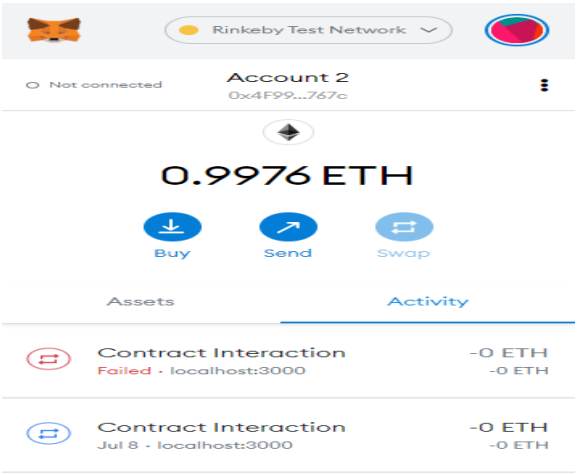

Fig. 4. Metamask transaction

- *IPFS, decentralised file storage. (Inter Planetary File Storage).*

Since the developer shall be using blockchain technology for this project, there must be needs to store some sort of data throughout the project. For example, a login module must need to store user information. Using a database won't be helpful because it would destroy the whole purpose of a decentralized application. IPFS creates a type of file storage system which keeps track of files and their respective versions from everyone in a network. In other words, storing files on a distributed network is possible. IPFS works by storing the hashes to files on the blockchain itself. Those hashes are used to find the location of the file.

  - There are no servers hosting the web application, hence, all content will be pulled from the blockchain directly served from IPFS.
  - Your private key grants permission and access to your identity.

D) System architecture

If we put each of the above technologies together, we will have a visual representation of what the system will look like on paper. Fig 5. below demonstrates the system architecture.

E) System analysis

The system is built on Microsoft visual studio code creating a decentralized web application. The system uses HTML, CSS and Javascript (EJS) as its front-end development tools and technology while NodeJs & ExpressJS takes care of the server-side environment services. In this layer, IPFS file store provides a way to store files using cryptography. Web3JS is the JavaScript library that contains functions which the developer uses to communicate with the blockchain smart contracts on the blockchain.

Provided the user has Ether on their wallet, metamask wallet will always pop up upon transactions. The metamask wallet prompts the user to pay a total amount of ether in order

to accept the transaction. Once transaction is complete the information is sent to the rinkeby test network which is a virtual Ethereum environment. An example of a transaction would be clicking on the login button or casting a vote towards a candidate.

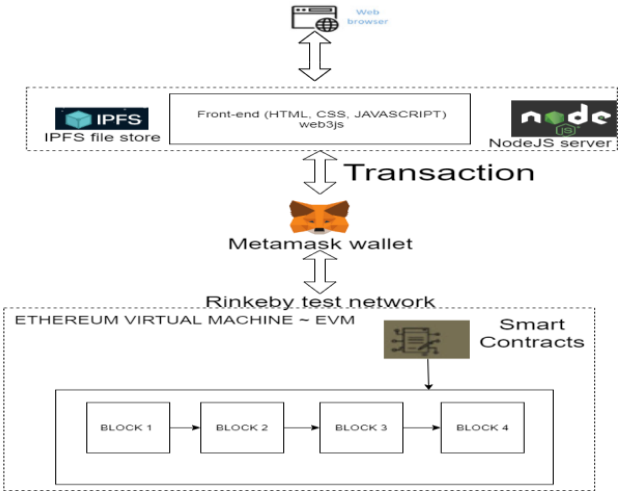

Fig. 5. System architecture

The final layer is the Ethereum virtual machine. This part of the architecture is where the blockchain is located. In this project, the developer is using the rinkeby test blockchain which allows developers to test their Dapps. The details about each block which include block number, nonce, block hash and transaction hashes can be found on the test networks domain (etherscan).

System use case diagram

Based on the use case diagram represented below, the two user roles are admins and user. The admin can;

Login

- Create Election
- Add Candidate
- View Cnadidates List
- Verify Voters
- Change Password
- Manage election
- Logout

Users can;

- Login
- Cast vote
- Update information
- Verify Vote
- Logout

The basic system process is as follows: First the admin launches the smart contract to the blockchain. Then the admin creates an election with appropriate candidates. Once the election is started, users can login the system and select the election to participate in and cast a vote towards their preferred candidate. Admins have to verify individual votes.

Once election end time is due. The election automatically ends. The admin tells the system to tally up the votes. Users can see election results. Everything from logging, creating elections, voting is transaction based. Each of the transaction can be seen happening on the blockchain.

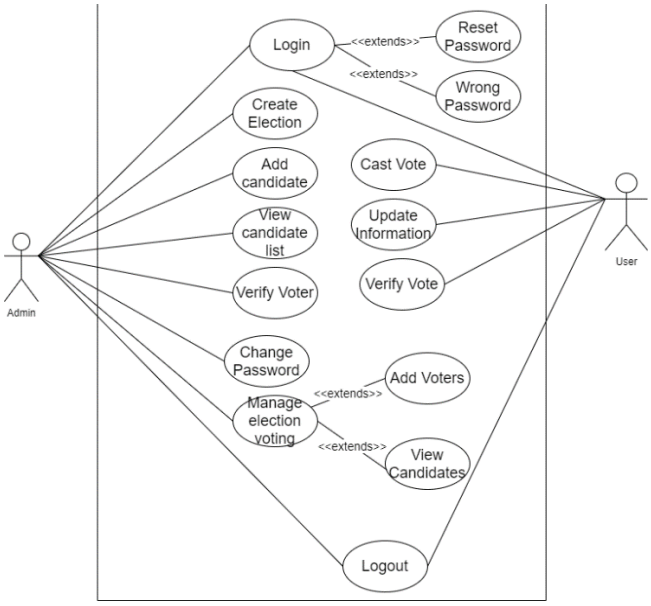

Fig. 6. System use case diagram

V. CONCLUSION

To conclude, it is safe to say that the objectives of the research has been met successfully. Through research, it was found that electronic voting applications are in demand in several parts of the world and in fact, some countries already have their own voting platform such as Estonia. The only difference is that these platforms do not use blockchain technology as there is still much more potential to be found with this technology. Thus, the developer has developed and demonstrated an e-voting platform which uses blockchain as its main technology.

Despite the massive effort currently being put into producing DApps, software engineering practices are still being used in BOS software development in an ineffective manner. In fact, the field is still in its infancy, and a set of tools or approaches for modelling and managing the quirks of the challenges that software developers experience while working with Blockchain based software systems are still a source of interest for researchers. Instruments and traditional software engineering methodologies have not yet been applied. Altered and changed to fit the new software paradigm. A logical software engineering approach could greatly aid in overcoming many of the issues plaguing Blockchain development by providing developers with tools similar to those used in traditional software engineering to address architectural design, security concerns, testing planes and strategies, and improve software quality and maintenance. Researchers in software engineering have a great opportunity to begin studying a topic that is both essential and brand new, by adapting and adjusting concepts, techniques, instruments, and ideas that have previously been established in software engineering to this new software technology. In fact, the project demonstration can be really valuable to blockchain

firms as it can be considered paradigmatic example of blockchain smart contract implementation.

REFERENCES

[1] M. Fitzgerald, N. Kruschwitz, D. Bonnet, & M. Welch. "Embracing Digital Technology, A New Strategic Imperative." MIT Sloan Management Review, 2013.

[2] J. Olah, N. Aburumman, J. Popp, M. A. Khan, et al. "Impact of Industry 4.0 on Environmental Sustainability. Sustainability." Sustainability, vol. 12, no 11, p.4674, Jun. 2020.

[3] Techvision. An update to our 2020 Technology Vision trends. Driving Values During COVID-19. Techvision. Accessed on: Dec 17, 2020. [Online]. Available: https://www.accenture.com/_acnmedia/PDF-126/Accenture-Technology-Vision-2020- COVID19.pdf

[4] B. McCloskey, A. Zumia, G. Ippolito, L. Blumberg, et al. "Mass gathering events and reducing further global spread of COVID-19: a political and public health dilemma.". Vol.395, no10230, pp 1096-1099. 2020.

[5] B. McCloskey, A. Zumla, G. Ippolito, L. Blumberg, P. Arbon, A. Cicero, et al. "Mass gathering events and reducing further global spread of COVID-19: a political and public health dilemma". The Lancet, vol. 395, no. 10230, pp.1096-1099, 2020.

[6] T. S. James, S. Alihodzic. "When is it Democratic to Postpone an Election? Elections During natural Disaster, COVID-19 and Emergency Situations" Election Law Journal, vol. 19, no. 3, pp. 344-362, 2020.

[7] B. Marr. "How The COVID-19 Pandemic Is Fast-Tracking Digital Transformation In Companies." Forbes.[Online].Available: https://www.forbes.com/sites/bernardmarr/2020/03/17/how-the-covid-19-pandemic-is fast-tracking-digital-transformation-in-companies/?sh=4fb147b0a8ee

[8] R. Taş, & Ö.Ö. Tanrıöver. "A Systematic Review of Challenges and Opportunities of Blockchain for E-Voting." Symmetry 2020, vol. 12, no.1328, 2020.

[9] L. Mearian. "What's a smart contract (and how does it work?)". ComputerWorld United State. [Online]. Available:https://www.computerworld.com/article/3412140/whatsa-smart-contract-and-how-does-it-work.html

[10] A. Barnes, C. Brake, T. Perry. "Digital Voting with the use of Blockchain Technology". Plymouth University. [Online]. Available: https://www.economist.com/sites/default/files/plymouth.pdf

[11] V. TeogueV. Teogue. "Can we trust online voting?". TheConversation. [Online]. Available: https://theconversation.com/can-we-trust-online-voting-616 [Accessed: Apr. 5, 2021].

[12] D. Glance. "Despite expert's fears, Australia should be moving to electronic online voting". TheConversation. [Online].Available:https://theconversation.com/despite-experts-fears-australia-should-bemoving-to-electronic-online-voting-61832 [Accessed: July 4, 2021]

[13] K. Stewart, J. Taylor. "Online Voting: The Solution to Declining Political Engagement?". [Online]. Available: https://www.rand.org/blog/2018/03/online-voting-the-solution-to-declining-political-engagement.html

[14] Technative.io. "Tech For good E-voting could be faster, cheaper, and more". Technative. [Online]. Available: https://technative.io/e voting-could-be-faster-cheaper-and-more-accurate/

[15] R. Wen, R. Buckland. "Lessons in trust from Americas experience with electronic voting". [Online]. Available: https://theconversation.com/lessons-in-trust-fromamericas-experience-with-electronic-voting-69716.

[16] H. Kassai. "The U.S. Election and the pandemic: Is E-voting The way forward?" [Online]. Available: https://www.forbes.com/sites/forbestechcouncil/2020/09/10/theus-election-and-the-pandemic-is-e-voting-the-way-forward/?sh=543b2d80e650

[17] J. Sipalan. "Malaysia says FDI inflows dropped 56% in 2020 to $3.4 bln.". Reuters. [Online]. Available: https://www.reuters.com/article/malaysia-economy-investment-idINL3N2L014I

[18] M. Prandini, L. Sartori, A. Oostveen. "Why electronic voting?". International Conference for e-Democracy and Open Government. DOI: 10.13140/2.1.4173.0561, 2014.

[19] M. Gajda. "Why use Node.js web development? Scalability, performance and other benefits of Node based on famous web application.". The Software House. [Online]. Available: https://tsh.io/blog/why-use-nodejs/ [Accessed: Jul 5, 2020].

[20] M. Short. "Express JS: A Guide for beginners". Course report.[Online].Available:coursereport.com/blog/what-is-express. [Accessed: Dec 10, 2020].

[21] A. M. Kurian. "Interacting With Ethereum Smart Contracts Through Web3.js". Medium. [Online]. Available:https://medium.com/coinmonks/interacting-withethereum-smart-contracts-through-web3-js-e0efad17977 [Accessed: Mar 21, 2020].

[22] Solidity. "Solidity documentation". [Online]. Available: https://docs.soliditylang.org/en/v0.8.4/ [Accessed: Dec 15, 2020].