Indonesian Journal of Electrical Engineering and Computer Science
Vol. 33, No. 3, March 2024, pp. 1793~1801
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v33.i3.pp1793-1801

Analysis and design on acceptance of blockchain based e-voting system

Ambuj Shukla[1], Debani Prasad Mishra[1], Anwesh Pattnaik[1], Surender Reddy Salkuti[2]
[1]Department of Electrical Engineering, International Institute of Information Technology Bhubaneswar, Odisha, India
[2]Department of Railroad and Electrical Engineering, Woosong University, Daejeon, Republic of Korea

Article Info

Article history:

Received Sep 12, 2023
Revised Dec 11, 2023
Accepted Dec 13, 2023

Keywords:

Blockchain
Elections
E-voting
Polling station
Smart contracts
Survey

ABSTRACT

Elections are a critical aspect of democratic governance, providing citizens with the power and right to express their views. A secure voting system with innovative features can improve this process. Blockchain technology is considered a disruptive innovation, and its potential for enhancing the e-voting system is significant. The modern voting system is focusing more on blockchain technology to strengthen and secure the process. Blockchain is a reliable, decentralized database that can offer increased security compared to electronic voting machines (EVMs). This research paper presents a detailed study of the design, smart contracts, evaluation of action, and survey on the acceptance of blockchain-based e-voting systems. It examines the requirements for such a system and provides an understanding of the model. As the acceptance of information technology-based services and products increases, future innovation in the e-voting system may depend on blockchain technology. The survey conducted in this paper explores the differences in opinion based on gender, age, and profession among eligible voters from India regarding the acceptance of blockchain technology-based secure e-voting systems. The analysis of these differences sheds light on the potential for blockchain-based e-voting systems to enhance trust and security in the voting process.

Corresponding Author:

Surender Reddy Salkuti
Department of Railroad and Electrical Engineering, Woosong University
Jayang-dong, Dong-gu, Daejeon, Republic of Korea
Email: surender@wsu.ac.kr

1. INTRODUCTION

Blockchain technology has emerged as a revolutionary technology in recent years [1] due to its ability to provide a secure, transparent and efficient platform for various applications. It has the potential to transform a variety of industries [2], including healthcare [3], finance [4], supply chain management [5], and many more. The adoption of blockchain technology in electronic voting systems can address some of the longstanding challenges associated with traditional voting systems [6], such as ballot tampering [7], voter fraud [8], and low voter turnout [9]. By leveraging the unique features of blockchain, electronic voting systems can provide a more secure [10], transparent [11], efficient [12], and accessible [13] voting experience for citizens. One of the key advantages of blockchain-based e-voting systems is the generation of a unique transaction ID for each vote, which can be used to verify the authenticity of the vote [14]. This helps to prevent ballot tampering and ensures the accuracy of the voting results. By providing a user-friendly interface and allowing for remote voting, blockchain-based e-voting systems can increase voter turnout and make the voting process more convenient for citizens [15]. Several studies have examined the benefits and challenges of blockchain-based electronic voting systems [16]. There have been several successful

implementations of blockchain-based e-voting systems in various countries, such as Switzerland [17], Estonia [18], and South Korea [19]. These implementations have shown promising results in terms of security, efficiency, and accessibility. Vora and Shah [20] a comparative analysis of blockchain-based e-voting systems and traditional voting systems was conducted, demonstrating the potential of blockchain technology to enhance the security and transparency of the voting process. Mihalcea *et al.* [21] conducted an evaluation on the adoption of blockchain technology in e-voting systems. They identified several factors that could impact the acceptance of this technology, including trust, cost, and familiarity with the technology. Zhao *et al.* [22], a study on the reception of blockchain-based e-voting systems among Chinese citizens was conducted and it was found that a majority of respondents were willing to use such systems due to their advantages. However, there are still challenges to be addressed in the adoption of blockchain-based e-voting systems [23]. These include regulatory barriers, technical limitations, and public perception of the technology [24]. Addressing these challenges will be crucial in the widespread adoption of blockchain-based e-voting systems in the future. This paper aims to create, design, and analyze a blockchain-based e-voting system and explore its acceptance through a survey. By surveying eligible voters in India, we aim to identify the factors that could impact the adoption and acceptance of blockchain technology-based e-voting systems. The evaluation of the reception of blockchain-based e-voting systems through surveying provides a deeper understanding of the factors that could affect the adoption and acceptance of such systems [25]. This approach allows for the identification of crucial factors such as security, transparency, ease of use, and familiarity with the technology. In conclusion, the use of blockchain technology has the potential to provide a secure and transparent platform for e-voting systems. The results of this study will provide valuable insights into the potential of blockchain technology to enhance the security and transparency of the voting process and its potential to be adopted as a reliable e-voting system in the future.

2. DESIGN

2.1. Architecture and components of the system

The design section of this paper discusses the methods used to create wireframes and mock-ups [26] for the blockchain-based e-voting system. Other techniques used in this process include utilizing prototypes and templates provided by websites such as Dribble, Sneakpeekit, and Balsamiq. Additionally, the poll's structure and front-end framework are presented through the use of HTML, CSS, and Bootstrap, with the process of creating a new poll is also detailed. The NEAR platform, which is the native token on the NEAR protocol decentralized application platform [27], is utilized in this project. To create a NEAR account, the process involves visiting wallet.testnet.near.org, creating an account, copying the given word code, and pasting it into Notepad, using it to pass the Phrase verification test, and finally clicking continue to complete the account creation process. Multiple accounts in ".testnet" format are created to begin with. The npm packages are installed and npm code is used in the code editor to get redirected to the created NEAR account on default browser. These wallets are blockchain accounts and the NEAR tokens are a type of cryptocurrency on the NEAR blockchain. Figure 1. depicts a step in the process of creating a NEAR account.

A text editor, such as microsoft visual studio code (code.visualstudio.com) or Atom, is often used in web development [28] alongside Node.js (nodejs.org) [29] and NPM Package and yarn package manager [30]. To initiate development, 'npm start' or 'yarn start' is run. 'npm i-force' can be used to forcibly install specific requirements. Then, 'npx create-near-app --frontend='react' 'trustballot' is executed in a new terminal section (in the "Research project directory"). In the 'trustballot' folder, 'yarn start' is used for development. A development account is created on a new network with specific access and tokens, and later, smart contracts were deployed on the testnet. The essential 'div' elements are created as needed [31]. The handling of navbar, href, and nav.link with login text, along with the use of container/fluid container using Bootstrap, is also necessary [32]. The 'nav' classname is adjusted to 'mx-left', 'right', or 'auto' accordingly. In the terminal, 'yarn start' is utilized. The condition statement was applied such that if one is logged in, there is redirection to the appropriate tab. A list and link to the original poll were maintained via 'table'. Now, the 'const promptlist=["Poll question"];' was used, such as 'const promptlist = ["Vote your preferred type of government?"];'. This not only benefits the frontend but also contributes to the creation of the homepage under home.js, including the 'Poll list' and 'Poll link' text within the 'table'. By referencing multiple helper functions in utils.js, the initial part of the program focuses on initializing the smart contract, establishing a connection to NEAR testnet, and setting up a wallet-based account. In the config.js tab, configuration using tabs or spaces is employed to connect the application to the mainnet blockchain. Cases used here include production, mainnet, development, testnet, betanet, ci, ci-betanet, local, and test. The 'window.contract' not only establishes a connection to contracts but also relates to 'change and view methods', while 'window.accountID' returns the account ID. At Pollingstation.js, 'export default PollingStation;' was used, and 'div' was added. The 'img src' height is adjusted, styled 'div' is added under

'row', and className is assigned. A 'div' under 'Col' with a new className is centrally aligned, and button "Vote" was added. The same code process is applied for both Candidate1 and Candidate2. For further design, under the NewPolls.js tab, a container, button, and form are imported. Using 'const NewPoll=(props)=>{', the '<form>' Form.Label, Form.Control with reference to CandidateName1URL and Form.Group were added, and the same is repeated for Candidate2. Figures 2 and 3 explain the creation of 'Navbar' and 'Visit poll' page.

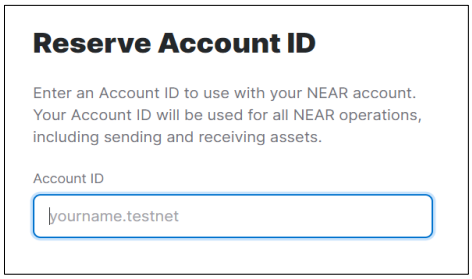

Figure 1. Create NEAR account from "wallet.testnet.near.org"

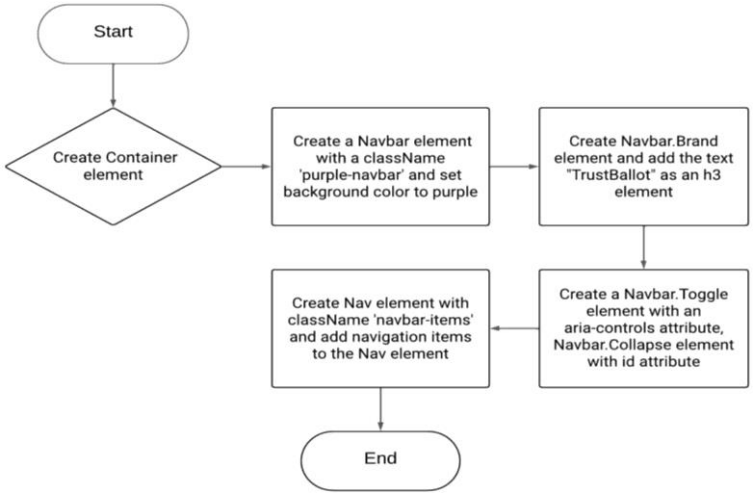

Figure 2. Flowchart explaining design of TrustBallot system's 'Navbar'

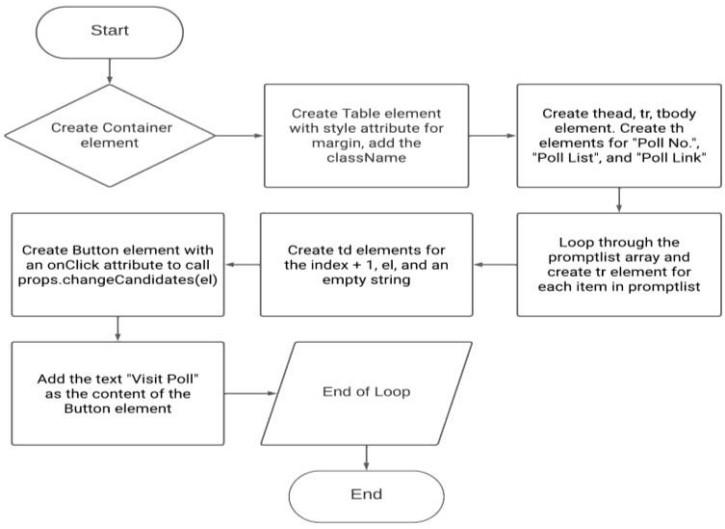

Figure 3. Flowchart explaining design of page with 'Visit poll' button option

2.2. Smart contracts and user experience design

When specific conditions or special purposes are met, programs stored on a blockchain that can run without the need for intermediaries, thereby reducing transaction costs and enhancing information protection, are known as smart contracts [33]. These contracts use array and string properties, where arrays are collections of similar elements, and an example of their declaration syntax is 'int marks [90]', and strings are one-dimensional arrays of characters terminated by a null character, indicating the end of the string. By accessing index.ts in an editor, one can observe the view methods (which does not change the state of the blockchain) and the change methods (which changes the state of the blockchain). The exported functions form part of the smart contract interface, with 'getReading' and 'setReading' used for view methods and Change Methods, respectively. The smart contract implementation involves importing the 'PersistentMap' library, which enables the data structure to function as a map. A variable for a new instance of 'PersistentMap' in which the values are strings, was defined. Additional PersistentMaps can be added for CandidateURL, CandidatePair, PromptArray, and VoteArray. A string array was defined. In utils.js, change methods were implemented, with 'addURL' used to modify the state. Export functions addCandidatePair and addVote, with a condition statement of (VoteArray.contains(Prompt)), were set with values for new value newVal and tempVal. Here, VoteArray.set [prompt, tempArray] was used. The candidate name was returned via CandidateURL.getSome(name), and the index was set for newArray. The export function for recordUser was used with prompt and user as string parameters in parentheses, along with the required "if" condition for userParticipation.contains (prompt). The 'getallPrompt' and 'getVotes' export functions were introduced with the If condition PromptArray containing 'All Arrays' to return the required values. Here, didParticipate, getVotes, and getAllPrompt were added to View Methods, while addURL, addtoPromptArray, and recordUser were added to change methods. Here, Figure 4. depicts the design of the form on the new poll tab, accessible from the new poll option in the navbar.

Figure 4. The "Create new poll" section of TrustBallot system

3. IMPLEMENTATION

In the NewPoll.js tab, an asynchronous function called 'sendToBlockchain' was introduced to handle the asynchronous nature of functions. Additionally, a button with a variant of secondary, primary, danger, or success is displayed with the text "Done" on it, and the <Button onClick={sendToBlockchain}> property was used. The container is styled, and placeholders are used to display text in formats such as 'Candidate 1's Name,' 'Candidate 1's Image address,' and 'Poll question.' In the process of passing information, the asynchronous function 'changeCandidateFunction' was used with the parameter 'prompt' in the format 'async (prompt) => {}.' The 'localStorage.setItem' was used for both candidate cases to store the prompt name and pass name information to the 'Polling station,' enabling the functionality of local storage. In the App.js tab, the 'window.location.replace' function, along with 'href' and 'PollingStation' within parentheses, was used to redirect to the 'Polling station' section. Now, as one gets the "el" containing the name of the prompt observed from the map function, this can be utilized to avoid errors in the '<Button onClick={()=>props.changeCandidate(el)}>visit poll</Button>' function. Hence, the "Visit poll" button appeared along with the other side of the Poll list. Variables like 'VoteCount' were created according to requirements, and a function 'getCandidatePair' returning a string, with an if condition of 'CandidatePair'

containing the prompt, was used. To store the present votes, the asynchronous function ‘getInfo’ with the variable ‘VoteCount’ was set equal to ‘await window.contract.getVotes’ and prompt used to achieve vote count, while ‘changeVote1’ and ‘changeVote2’ were used to update votes for each candidate’s case. Similarly, ‘changeCandidate1Url’ was used for the image's case. To only let buttons remain active till votes were placed, certain ‘disableButton’ was not able to perform action, which even stops the ‘didUserVote’ function, by in a way acting before loading action was used. Functions were used to create and later to update a created variable of vote count for the asynchronous function. The ‘changeVote1’ with ‘voteCount [0]’ and likewise for ‘Vote2’ with ‘[1]’ was done. The process to maintain efficiency while initializing the vote counter for both the candidate's cases was planned. Figure 5 displays the localhost page window once a new poll is created.

Figure 5. Displays localhost page once the new poll is created

4. TESTING AND SIMULATION

After the account is created in “.testnet” format on the NEAR login page at “http://wallet.testnet.near.org” and the phrase test is passed, the user can navigate to the new terminal section in visual studio code and type ‘npm run dev.’ This will redirect the user to the localhost page in the default browser, such as Chrome. To grant access to the user’s account, a new account in “.testnet” format needs to be created. Clicking on “Allow” completes the authentication process. Once the name and image URL for Candidate1 and Candidate2, along with the poll question has been provided, the poll list screen will appear with the TrustBallot navbar logo, designed using front-end methods. Clicking on “Visit poll” will take the user to a multiple-div design-based system with two vote buttons. Clicking the Vote button for the first system will increase the counter for the first candidate by one, while the count for the second candidate remains unchanged. It should be noted that only one vote per account ID is allowed in a poll, and to increase the Vote count, multiple account IDs need to be created. Clicking the “Visit poll” button will display the actual poll, and in this case, Candidate1 was voted for. After voting, the “Vote” button will be disabled for that particular account ID, as visible in Figures 6 and 7, respectively.

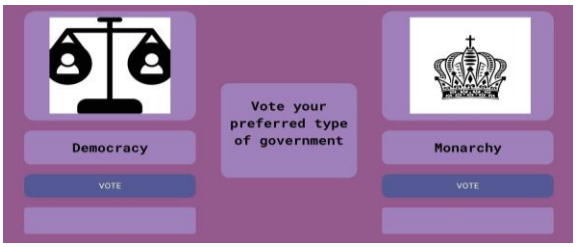

Figure 6. Poll section of the system with active “Vote” buttons

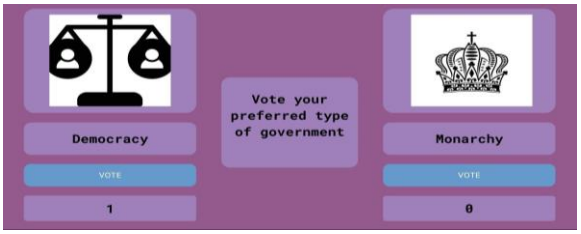

Figure 7. As soon as candidate1 is voted, the vote count for candidate1 gets updated to 1 while it remains none for candidate2. When voting is done, the “Vote” button for that particular accountID gets disabled

5. RESULTS AND ANALYSIS

5.1. Analysis of the simulation results

The simulation of the blockchain-based e-voting system showed that it successfully implemented several features, such as the creation of user accounts in the ".testnet" format, authentication using a passphrase, and the ability to create and participate in polls. The system also enforced the rule of one vote per account ID, which ensures that each user can only vote once. The front-end design of the system was visually appealing, with the TrustBallot navbar logo and the multiple-div design-based system with two Vote buttons. The simulation demonstrated that clicking on the vote button for a particular candidate increased their vote count by one, while the count for the other candidate remained unchanged. Additionally, the "Vote" button was disabled for the account ID that had already cast its vote, ensuring that no duplicate votes were cast. Overall, the simulation results indicate that the blockchain-based e-voting system designed and analyzed in this research paper is functional, secure, and easy to use. The system's ability to prevent voter fraud and ensure fairness in the voting process makes it a promising solution for implementing secure and transparent e-voting systems in the future. Further testing and analysis are needed to assess the system's performance under different scenarios and to identify any additional security concerns.

5.2. Survey results and analysis

The innovation in information technology has led to the development of new and advanced methods for casting votes during elections. Blockchain-based e-voting systems offer better security and are more cost-effective, accessible and efficient compared to electronic voting. In India, the world's largest democracy, citizens above the age of 18 are eligible to vote. The election commission is responsible for setting the date and time of the election process, preparing an electoral roll and recording votes on electronic voting machines (EVMs) balloting unit. With the growth of information technology, blockchain-based e-voting systems have emerged as a potential solution with higher privacy, verifiability and convenience due to the generation of voter hash, unique transaction ID and user-friendly interface. The author of this paper conducted a survey to capture the opinions of people from various parts of India regarding the acceptance of blockchain technology-based e-voting systems. The survey recorded the views of 159 eligible Indian voters from different age groups, genders, regions and industries. Based on these categories, the opinions of eligible voters regarding their acceptance of blockchain technology-based e-voting systems or lack thereof were classified and represented in graphical form. The survey data reveals that the relationship between intention to accept blockchain technology-based e-voting systems and factors such as age, gender, region and industry varies significantly. The acceptance of blockchain technology-based e-voting systems within the female gender is found to be lower compared to male, which could be due to the lesser engagement of females in blockchain-related activities and lack of exposure and awareness, as shown in the graph in Figure 8. The age range of 18 to 41 years displays higher acceptance of blockchain technology-based e-voting systems due to the more technologically aware and tech-savvy generation, as depicted in the graph in Figure 9. The technology industry, closely associated with blockchain technology, has the highest percentage of acceptance, followed by education, finance and business sectors. Students have a higher acceptance rate due to higher awareness among tech-savvy generations. The lower acceptance among "Housewives" can be attributed to the same reason: lack of awareness observed in females compared to male regarding blockchain-based e-voting systems, as displayed in the graph in Figure 10.

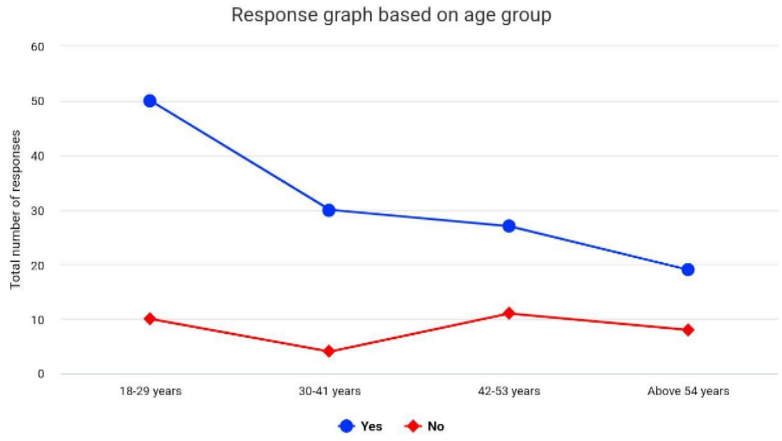

Figure 8. Graph for classification of responses based on gender

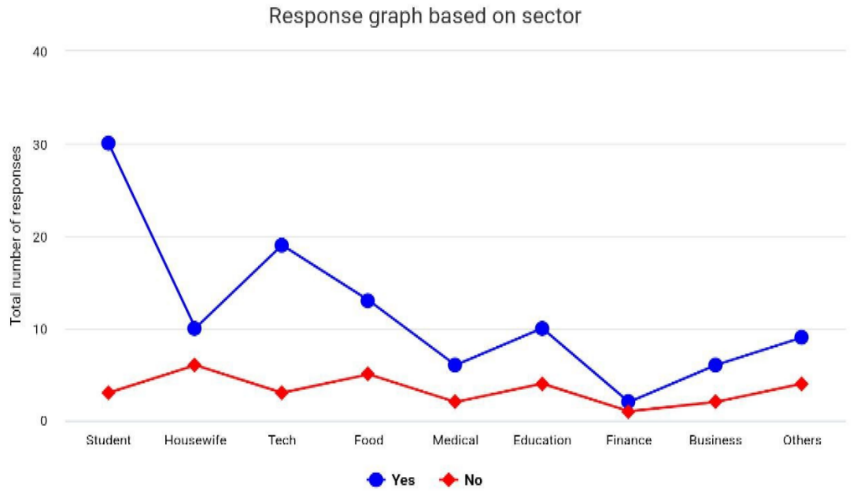

Figure 9. Graph for classification of responses based on age group

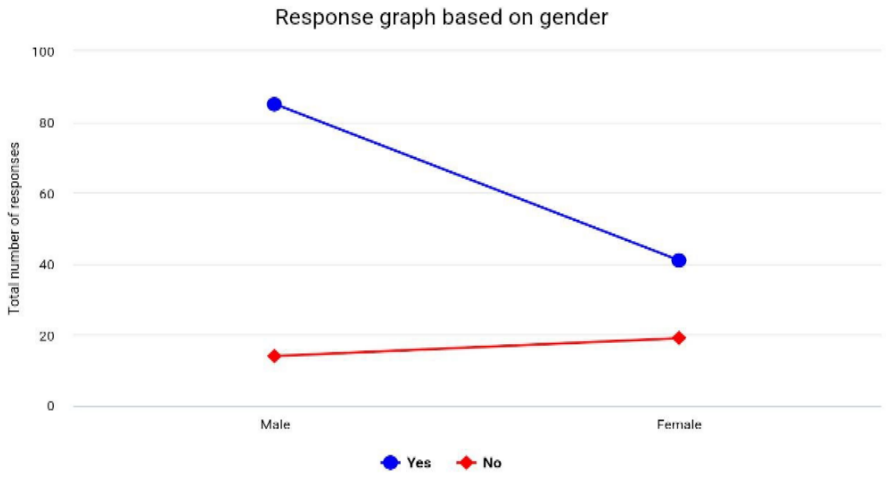

Figure 10. Graph for classification of responses based on profession

6. CONCLUSION

This paper has demonstrated the potential of blockchain technology-based e-voting systems to enhance the efficiency, security, and verifiability of the voting process. By designing and analyzing the model, implementing smart contracts, and conducting a survey on the acceptance of this technology among eligible voters, this paper has contributed to the growing body of research in this field. However, the findings also suggest that there are certain limitations to the data collected, and further research is needed to explore the potential of this technology in other parts of the world and to investigate additional factors that may influence its acceptance. Overall, this paper provides a valuable contribution to the ongoing efforts to enhance the integrity and transparency of the electoral process through innovative and secure technologies such as blockchain-based e-voting systems.

ACKNOWLEDGEMENTS

This research work was supported by “Woosong University’s Academic Research Funding - 2024”.

REFERENCES

[1] S. Nakamoto, “Bitcoin: a peer-to-peer electronic cash system,” in *Proceedings of the 2008 IEEE International Conference on Electronic Commerce Research and Applications*, 2008, pp. 1-7, doi: 10.1109/icec.2008.18.

[2] N. F. Salim, M. A. Wadud, and M. A. Islam, “Blockchain technology for industry 4.0: a systematic literature review,” *Journal of Industrial Integration and Management*, vol. 6, no. 2, pp. 215-244, 2021, doi: 10.1108/JIIM-05-2020-0201.

[3] N. S. Alhadidi, S. Iqbal, and H. Shafique, "A comprehensive survey of blockchain in healthcare: opportunities and challenges," *Journal of Medical Systems*, vol. 44, no. 8, pp. 157-183, 2020, doi: 10.1007/s10916-020-1548-4.
[4] T. M. Khan, R. Z. R. Shah, R. R. Y. Shah, A. I. Khan, and S. B. Shah, "Blockchain technology: a review of its applications in the finance sector," in *Proceedings of the 2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)*, Sukkur, Pakistan, 2019, pp. 1-5, doi: 10.1109/iCoMET.2019.8853387.
[5] A. A. Kuchkovsky, A. A. Guskov, and P. A. Kuchkovskaya, "Blockchain technology as a tool for ensuring the security of supply chains," in *Proceedings of the 2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, 2019, pp. 722-726, doi: 10.1109/IEEM44572.2019.8978704.
[6] "Election technology: the inadequacies of current voting systems," *Computer*, 2011.
[7] E. Luiijf and E. Veenendaal, "Detecting election fraud: a review of computer-based approaches," *IEEE Security & Privacy*, vol. 13, no. 1, pp. 20-27, Jan/Feb. 2015, doi: 10.1109/MSP.2014.191.
[8] R. L. Rivest, "The problem of detecting voter impersonation," *IEEE Security & Privacy*, vol. 16, no. 6, pp. 88-90, Nov./Dec. 2018, doi: 10.1109/MSP.2018.2875256.
[9] R. Krimmer, "Electronic voting and low voter turnout: an empirical evaluation of mandatory voting," *IEEE Annals of the History of Computing*, vol. 41, no. 1, pp. 66-80, Jan.-Mar. 2019, doi: 10.1109/MAHC.2018.2881675.
[10] M. Iqbal, S. Raza, and A. Ali, "A secure and transparent e-voting system using blockchain and NEAR protocol," in *Proceedings of the 2021 9th International Conference on Information Technology Convergence and Services (ITCS)*, Jeju, Korea, 2021, pp. 1-5, doi: 10.1109/ITCS51787.2021.9474702.
[11] N. Ur Rehman, W. Liaqat, and M. A. Qureshi, "A transparent e-voting system based on the NEAR blockchain," in *2021 IEEE International Conference on Intelligent Sustainable Systems (ICISS)*, 2021, pp. 757-762, doi: 10.1109/ICISS51646.2021.9453134.
[12] A. D. Bintang and R. S. Kusumawardani, "Efficient and secure e-voting system using blockchain and NEAR protocol," in *2021 International Seminar on Intelligent Technology and Its Application (ISITIA)*, Surabaya, Indonesia, 2021, pp. 1-5, doi: 10.1109/ISITIA53675.2021.9489813.
[13] J. Kim, D. Choi, and J. Park, "Design of an accessible Blockchain-based e-voting system using NEAR protocol," in *Proceedings of the 2021 IEEE International Conference on Blockchain and Cryptocurrency (ICBC)*, Toronto, Canada, 2021, pp. 99-104, doi: 10.1109/ICBC49986.2021.00022.
[14] J. A. Emenogu, N. N. Nkwocha, and C. I. Ani, "A blockchain-based electronic voting system with transparency and authenticity," *International Journal of Advanced Computer Science and Applications*, vol. 11, no. 3, pp. 9-16, Mar. 2020, doi: 10.14569/IJACSA.2020.0110302.
[15] Y. Cui, Z. Zhang, and W. Wang, "A secure and convenient blockchain-based voting system," in *Proceedings of the 2021 International Conference on Electronics, Communications and Information Technology (ECIT)*, Nanjing, China, 2021, pp. 1-6, doi: 10.1109/ECIT53397.2021.9473488.
[16] S. K. Shukla, S. Garg, and A. K. Jaiswal, "Blockchain-based secure voting system for the NEAR protocol: Issues and challenges," in *Proceedings of the 2021 3rd International Conference on Computing Methodologies and Communication (ICCMC)*, Erode, India, 2021, pp. 1-5, doi: 10.1109/ICCMC51580.2021.9485301.
[17] G. Zavattaro, S. Battistoni, and F. De Gasperis, "Towards blockchain-based e-voting in Switzerland: a critical assessment," in *Proceedings of the 2019 IEEE International Conference on Blockchain and Cryptocurrency (ICBC)*, Seoul, South Korea, 2019, pp. 300-306, doi: 10.1109/BLOC.2019.8751284.
[18] V. Kupreev and A. Novikov, "Blockchain technology for secure e-voting in Estonia," in *Proceedings of the 2017 IEEE 3rd International Conference on Cybernetics (CYBCONF)*, Exeter, UK, 2017, pp. 1-6, doi: 10.1109/CYBConf.2017.7985786.
[19] H. J. Kim, H. Lim, and H. Lee, "A blockchain-based e-voting system for fair and transparent voting in South Korea," *Journal of Supercomputing*, vol. 76, no. 3, pp. 2503-2521, 2020, doi: 10.1007/s11227-020-03323-1.
[20] A. N. Vora and N. Shah, "A comparative analysis of blockchain-based e-voting system and traditional voting system," in *Proceedings of the 2018 IEEE International Conference on Advanced Communication Control and Computing Technologies*, pp. 870-875, 2018, doi: 10.1109/ICACCCT.2018.8759671.
[21] R. G. Mihalcea, M. Dascalu, and D. Popescu, "A comprehensive approach to evaluating blockchain technology adoption in e-voting systems," in *Proceedings of the 2018 IEEE 16th International Conference on Dependable, Autonomic and Secure Computing*, pp. 262-267, 2018, doi: 10.1109/DASC/PiCom/DataCom/CyberSciTec.2018.00050.
[22] Z. Zhao, L. Tang, and G. Peng, "Understanding the reception of blockchain-based e-voting systems among Chinese citizens," *Telematics and Informatics*, vol. 54, p. 101445, 2020, doi: 10.1016/j.tele.2020.101445.
[23] K. M. Khan, J. Arshad, and M. M. Khan, "Investigating performance constraints for blockchain-based secure e-voting system," *Future Generation Computer Systems*, vol. 116, pp. 467-479, 2021, doi: 10.1016/j.future.2020.09.022.
[24] N. Kshetri and J. Voas, "Blockchain-enabled e-voting: the potential of the technology and its adoption barriers," *Government Information Quarterly*, vol. 35, no. 4, pp. 624-632, 2018, doi: 10.1016/j.giq.2018.10.003.
[25] G. Sakharkar and J. Motwani, "Factors affecting the adoption of blockchain-based e-voting systems: a review," in *2019 International Conference on Communication and Signal Processing (ICCSP)*, pp. 185-190, IEEE, 2019, doi: 10.1109/ICCSP.2019.8698208.
[26] M. Tomitsch, S. Viller, and P. Olivier, "Enhancing paper prototyping with digital overlays: comparing traditional and modern tools for sketching interfaces," *International Journal of Human-Computer Studies*, vol. 102, pp. 62-73, 2017, doi: 10.1016/j.ijhcs.2017.02.003.
[27] A. Mallya, M. Bronstein, X. Li, and C. Cachin, "NEAR protocol: a sharded, developer-friendly, proof-of-stake public blockchain," *arXiv preprint arXiv:2010.11487*, 2020.
[28] X. Liu and W. Zhang, "A comparative study of text editors for programming," in *Proceedings of the 2019 International Conference on Computer Science and Artificial Intelligence (CSAI)*, pp. 455-459, 2019, doi: 10.1145/3368555.3368573.
[29] S. Singh and M. Gupta, "Node.js: an overview and its use in web development," in *Proceedings of the 2016 2nd International Conference on Contemporary Computing and Informatics*, pp. 1305-1310, 2016, doi: 10.1109/IC3I.2016.7877565.
[30] M. Grgić and M. Sikora, "Evaluation of NPM and Yarn package managers for web development," in *Proceedings of the 2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)*, pp. 1569-1573, 2018, doi: 10.23919/MIPRO.2018.8400082.
[31] S. A. Mirhosseini, A. Mesbah, and P. Kruchten, "The impact of DIV-based design patterns on website quality: an empirical study," *IEEE Transactions on Software Engineering*, vol. 41, no. 7, pp. 649-668, 2015, doi: 10.1109/TSE.2014.2373282.
[32] E. Wittern and C. Lutteroth, "A comparative study of CSS frameworks for mobile web development," in *Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers (UbiComp/ISWC)*, pp. 1011-1015, 2018, doi: 10.1145/3267305.3274105.

[33] K. Hwang and J. Lee, "Design and implementation of a smart contract-based e-voting system on NEAR protocol," in *Proceedings of the 16th International Conference on Future Information Technology (FutureTech)*, pp. 152-156, 2021, doi: 10.1109/FutureTech51088.2021.9489555.

BIOGRAPHIES OF AUTHORS

Ambuj Shukla is a student of Electrical and Electronics Engineering at the International Institute of Information Technology (IIIT), Bhubaneswar. His areas of interest revolve around web development, including front-end and back-end technologies, responsive design and blockchain technology. Ambuj has led his team to rank among top 30 in Uttishtha 2023 (Udaan 6.0) organized by E-Cell IIM Kashipur, competing with talented teams from IIMs, IITs, NITIE, and others. Furthermore, he led a team that qualified for the grand finale round of the smart bengal hackathon 2023. He can be contacted at email: b320007@iiit-bh.ac.in.

Debani Prasad Mishra received the B.Tech.in Electrical Engineering from the Biju Patnaik University of Technology, Odisha, India, in 2006 and the M.Tech. in power systems from IIT, Delhi, India in 2010. He has beenawarded the Ph.D. degree in power systems from Veer Surendra Sai University of Technology, Odisha, India, in 2019. He is currently serving as Assistant Professor in the Department of Electrical Engineering, International Institute of Information Technology Bhubaneswar, Odisha. His research interests include soft computing techniques application in power system, signal processing and power quality. He can be contacted at email: debani@iiit-bh.ac.in.

Anwesh Pattnaik is a student of Electrical and Electronics Engineering at the International Institute of Information Technology (IIIT) Bhubaneswar. His areas of interest revolve around web development, including front-end and UI technologies, responsive design and SQL technologies. He has been a finalist in Codespire 2023 (Indore), and achieved third rank in the national event that saw a participation of over 530 teams from all over India. He can be contacted at email: b320011@iiit-bh.ac.in.

Surender Reddy Salkuti received the Ph.D. degree in electrical engineering from the Indian Institute of Technology, New Delhi, India, in 2013. He was a Postdoctoral researcher with Howard University, Washington, DC, USA, from 2013 to 2014. He is currently an Associate Professor with the Department of Railroad and Electrical Engineering, Woosong University, Daejeon, South Korea. His current research interests include market clearing, including renewable energy sources, demand response, smart grid development with integration of wind and solar photovoltaic energy sources. He can be contacted at email: surender@wsu.ac.kr.