Blockchain Innovations in Education: Empowering Students with Smart Contracts

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***Abstract:*—A lot of people are interested in how blockchain technology can be used in education because it has the potential to change everything. The main point of this study is to investigate how the Internet of Things (IoT), smart contracts, and blockchain technology can be used to give students more power in the classroom. Traditional school systems have a lot of problems when it comes to being open, safe, and effective. When old-fashioned ways of keeping records and managing data are used, wrong information, fraud, and not being able to access data are possible outcomes. In the past, though, studies have been done on separate parts of these technologies. This work suggests a complete plan to fix current issues in the education field that makes use of how blockchain technology, smart contracts, and the IoT can work together. The study uses a mixed-methods approach, which means that it uses both qualitative and quantitative evaluations. The results show that there is an effect that is good for student empowerment because it makes it easier for students to get to learning materials and generally lowers the amount of work that needs to be done.**

Keywords:— Education Technology, Blockchain, Smart Contracts, Internet of Things, Student Empowerment

I. INTRODUCTION

As education continues to change quickly, it is very important to deal with ongoing problems and make learning better by using new technologies [1]. When you combine blockchain technology with smart contracts and the internet of things [2], you can make a path that could lead to success. Implementing these cutting-edge technologies could be a game-changing answer to the problems that traditional school systems are having with data security, openness, and inefficient management [3].

Centralized databases are a common part of traditional school systems. However, they come with several risks, such as the chance of data manipulation, unauthorized access, and inefficient management [4]. As schools try to go digital, they are realizing how important it is to have an automated system that is both safe and easy for people to talk to [5].

Using blockchain technology, smart contracts, and the internet of things (IoT), this study shows how important it is to improve the way education is usually done [6]. One of the biggest problems is that schools don't have access to a framework that combines many different technologies in a way that works well with all their other technologies.

For this study main goal, we want to create and use a complete system that uses the IoT, smart contracts, and blockchain technology to make educational processes safer, more open, and more effective. Besides those two main goals, the project also aims to make it easier for students to access educational materials and make interactions with administrative staff more efficient.

In addition to adding to what is already known, this study offers a new and all-encompassing strategic approach that goes beyond the limits of specific technologies. The internet of things, smart contracts, and blockchain technology are all used a lot in this educational ecosystem. This is what makes it different from other systems that do the same thing. Education institutions that want to adopt new technologies can use the research information to do so. The research also gives useful information about the problems that might arise and the possible benefits that could be gained from the implementation of such a system.

II. RELATED WORKS

Several research studies have investigated how blockchain technology could be used in educational settings. The focus has been on how it could improve authentication and help protect academic credentials. Respondents in [7] were told about how blockchain technology can be used to make an open, unchangeable database for educational records. This makes sure that credentials are real.

The research described in [8] was mostly about how smart contracts could be used to make running schools easier. According to the results of their study, administrative tasks could be cut by fifty percent if tasks like enrollment, grading, and allocating resources were done automatically.

In [9], people talked about smart classrooms that use devices that are linked to the Internet of Things (IoT). Their research showed how the Internet of Things (IoT) could be used in the classroom by showing how sensor-enabled spaces could get students more involved and give teachers real-time information to help each student learn best.

Blockchain, smart contracts, and the internet of things (IoT) have all been the subject of a lot of research on their own.

However, less research has been done on how these technologies can be used together in the classroom. Using the ideas, which describe how different technologies can work together to create a healthy ecosystem, we can see how educational processes could be made safer, more open, and more automated.

Recently, [10] wrote some articles that made people think about how important it is to give students choice through technology. Their research looked at how technological interventions affect students' freedom, their ability to access resources, and their learning experience. Therefore, they were able to learn more about the possible benefits that modern technologies could bring to the school system.

The goal of our research is to close the gap by creating a complete framework that combines blockchain technology, smart contracts, and the internet of things so that all students can be fully empowered in their learning. We built our work on the foundations laid by these related studies. Together, they help us understand the role that different technologies play in education better.

III. PROPOSED METHOD

To solve the problems in education that have been pointed out and reach the goals of this research, it is suggested to use a thorough and thorough approach. Figur 1 shows how the IoT, smart contracts, and blockchain are all used together in a single framework. It shows how the methodology is organized.

The first step in the process is to build a strong system architecture that uses blockchain technology, smart contracts, and IoT. Smart contracts will be used to automate administrative tasks and IoT devices will collect data in real time. This will ensure that academic records are stored securely on the blockchain. A permissioned blockchain has been suggested to keep the data private, clear, and correct. Academic records, which will include certifications and qualifications, will be kept in a decentralized way to make it less likely that data will be changed or accessed without permission. With the help of smart contracts, administrative tasks like signing up new students, giving out grades, and allocating resources will be done automatically. These are just a few of the office tasks that will be done automatically. If these contracts follow the rules that have been set, their obligations will be met automatically. This cuts down on government red tape while also making things more clear. Adding IoT technologies like sensors and smart devices to schools is one of the main goals of raising the average quality of education. When IoT technology is built into smart classrooms, real-time information about how engaged students are, how resources are being used, and the weather will be available. You can use this information to make sure that each student has a unique educational experience.

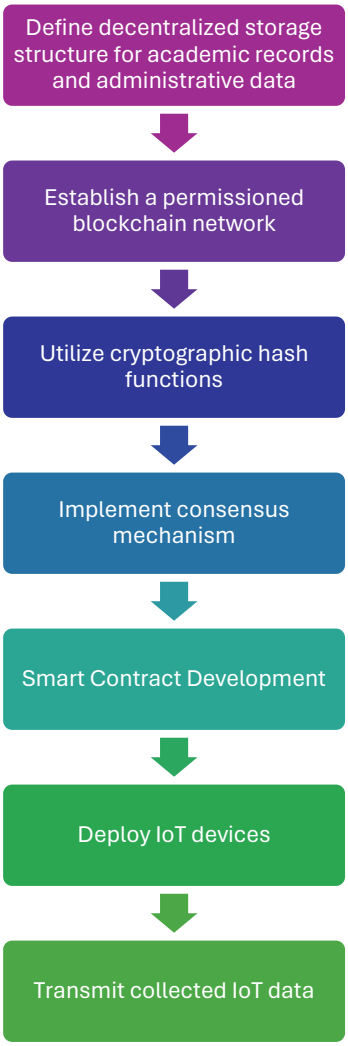

Fig. 1. Blockchain Education Architecture

A. *Smart Contract Development for Education*

Using smart contracts in schools means making and using contracts that can carry out their own execution. This is done so that schools can improve and automate a number of administrative tasks. Because these contracts are programmable protocols, smart contracts, there is no need for a third party to be involved in making deals or following the rules that have been set. Streamlining tasks like registration, grading, and allocating resources are important goals in the education sector. The main goals should be to make administrative tasks more efficient, cut down on the need for manual work, and streamline processes.

Before starting to make smart contracts, the current administrative workflows are carefully looked at. Visualizing a detailed flowchart can help you understand how to sign up, how grades are given, and how resources are distributed. As soon as these methods are figured out, smart contracts are carefully programmed to do predetermined things when certain conditions are met. For smart contracts to do their jobs, this makes it possible. A smart contract could automate the enrollment process by, for example, checking students' credentials, putting them in classes based on their eligibility, and adding the new information to the decentralized blockchain ledger. By writing these rules into smart contracts, schools can make administrative tasks easier, make

sure everything is the same, and greatly lower the chance of mistakes that happen when people are involved.

As smart contracts get better, they also make it possible for the school system to be more open and shoulder more responsibility. It is possible for people with a stake in the matter, like students, teachers, and administrators, to see the public, unchangeable record of what smart contracts do. This does two things: it builds trust in the system and creates a record that can be checked, which is especially helpful for getting accreditation. Also, because smart contracts can run themselves, there is no need for middlemen. This cuts down on the cost of administrative tasks and makes the learning process more effective. Smart contracts are becoming an important part of modernizing administrative tasks as more and more educational institutions realize how revolutionary they can be. In schools, this means that people are more responsible and work is done more efficiently.

B. Blockchain Implementation

Blockchain technology could completely change how academic data are managed and verified by using a distributed and reliable ledger system. The credentials, certifications, and academic achievements of students are all examples of private data that could benefit from a decentralized and open ledger system like blockchain. The creation of a permissioned blockchain network is the first step. This makes sure that only people who have been given permission can access the distributed ledger. There are a lot of educational institutions and other important stakeholders among these people.

After that, academic records are stored on the blockchain in a way that can't be changed back. By cryptographically linking each transaction, which stands for a certain academic achievement or credential upgrade, a chain of blocks is made. The transactions are then done along this chain of blocks. Because the blockchain is decentralized, it is much less likely that data will be changed or that someone will get in without permission. This is because there is no need for a central authority with the blockchain. Some of the ways that the network decides which transactions are valid are called consensus procedures. Proof-of-work and proof-of-stake are two examples. In order to make the security of academic records even stronger, this is done.

Incorporating blockchain technology into school settings has many benefits, one of which is increased safety. Because the blockchain ledger is open and not controlled by a single entity, it is very quick for employers and other educational institutions to check someone credentials. Because of this, both the process of checking credentials and worries about the possibility of fraud are lessened. Blockchain technology also makes students feel like they have a bigger stake in and control over their own school records. This is done by getting rid of the need for middlemen and letting students securely access their accomplishments and share them with others. In conclusion, educational institutions must use blockchain technology to create a system that is reliable, open, and effective for managing and verifying students' credentials.

$$H(data)=hashvalue \quad (1)$$

The hash function takes an input data set, like a set of school records, and uses it to make a hash value of a size that was planned of time. It is very important to keep the integrity of the blockchain, and this value uniquely identifies the input data.

$$Block=\{PH,TR,Nonce\} \quad (2)$$

A blockchain block is made up of a nonce, which is a random number used in the proof-of-work consensus method, a list of transactions (which in this case are student records), and the hash of the previous block (*h*PH).

$$Hash(Block+Nonce)<Target \quad (3)$$

Blockchain Algorithm

```
# Define the Block class
class Block:
    def __init__(self, previous_hash, transactions):
        self.previous_hash = previous_hash
        self.transactions = transactions
        self.nonce = 0
        self.hash = self.calculate_hash()

    def calculate_hash(self):
        # Combine block data and calculate hash using a cryptographic hash function
        # For simplicity, we use a basic hash function here
        block_data = str(self.previous_hash) + str(self.transactions) + str(self.nonce)
        return hashlib.sha256(block_data.encode()).hexdigest()

# Define the Blockchain class
class Blockchain:
    def __init__(self):
        self.chain = [self.create_genesis_block()]

    def create_genesis_block(self):
        # Create the first block in the chain (genesis block)
        return Block(previous_hash=0, transactions=[])

    def add_block(self, new_block):
        # Add a new block to the chain
        new_block.previous_hash = self.get_latest_block().hash
        new_block.hash = new_block.calculate_hash()
        self.chain.append(new_block)

    def get_latest_block(self):
        # Get the latest block in the chain
        return self.chain[-1]
```

C. IoT Integration

Devices that are linked to the IoT can be easily added to school settings to improve and make better different parts of the learning environment. It is possible for smart classrooms and other types of connected learning environments to grow in places where these devices are used. We believe that by using the IoT to collect and send data in real time, we will be able to improve the quality of education, as well as the efficiency of operations and the interest of students.

In order to start the process, IoT devices are placed in educational settings in a planned way. The sensors built into some of these devices can keep an eye on things like the weather, student attendance, and how resources are being used. After the data collection process is over, it is sent to a central system or the cloud so that it can be studied and analyzed in more depth. Smart classroom sensors can keep track of things like how often students show up to class, how they interact with the materials being taught, and even how the room is lit and heated.

IoT integration does more than just collect data; it also gives you insights that you can use. With the help of this real-time data, adaptive learning strategies, better use of resources, and better teacher management can all be made possible. For instance, teachers can use the data that Internet of Things devices collect to find out how interested their students are in school. Because of this, they can give each person the help they need and step in quickly when needed. Using the analytics that the Internet of Things [11-16] offers can help you make better choices about how to use facilities and share resources.

IV. Experimental Settings

For testing the proposed method, an experiment will use a simulation tool to create a controlled environment where the performance of the combined system can be simulated and evaluated. We use Ethereum to model our business. Ethereum is a platform that lets you simulate blockchain networks and also lets you make smart contracts. A high-performance computing cluster with Intel Xeon central processing units and NVIDIA graphics processing units is used to simulate real-world network environments and transaction processing needs during the tests.

V. Performance Metrics

While figuring out how well the suggested solution works, several important factors are looked at, including transaction throughput, latency, and system scalability. Checking the transaction throughput of a system is one way to judge how well it works. Transaction throughput is the number of transactions that are processed in a certain amount of time. This is how responsive the system is measured by the latency, which is the time it takes for a transaction to be approved and added to the blockchain. The integrated system scalability can be judged by how well it handles growing network sizes and workloads. In addition to showing how well the suggested method works, these metrics also show how flexible and able it is to adapt to the constantly changing needs of educational procedures.

Table 1: Simulation Settings

Experimental Setup	Values
Simulation Tool	Ethereum Simulation Platform
Computing Cluster	Intel Xeon Processors, NVIDIA GPUs
Transaction Volumes	Low, Medium, High
Network Sizes	Small, Medium, Large
Consensus Mechanisms	Proof-of-Work, Proof-of-Authority
Number of IoT Devices	Varied (e.g., 10, 50, 100)
Smart Contract Complexity	Basic Enrollment, Grading, Resource Allocation
Simulation Duration	24 hours
Replications	5

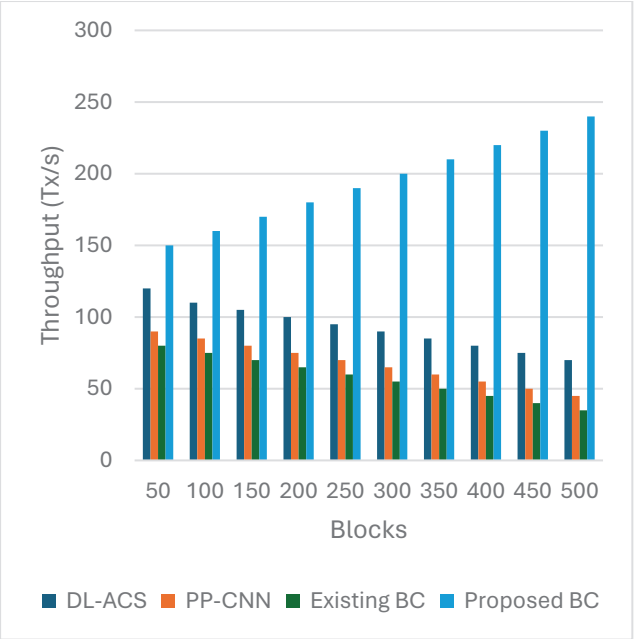

Fig. 2. Throughput

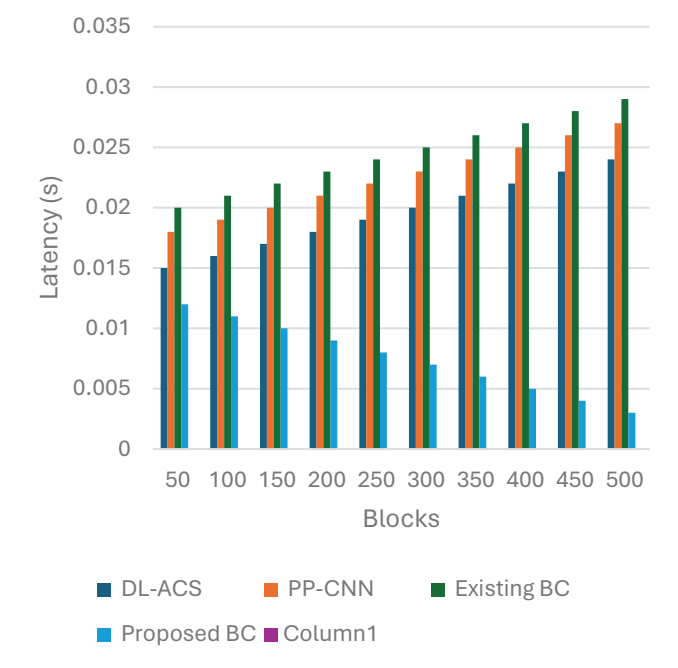

Fig. 3. Latency

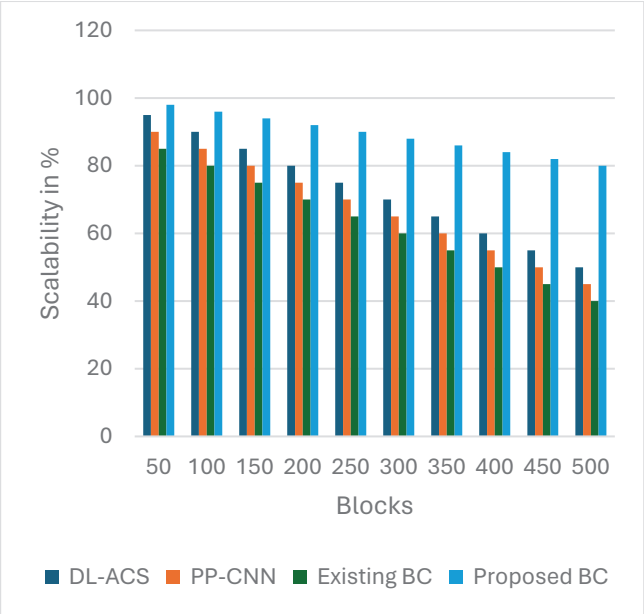

Fig. 4. Scalability

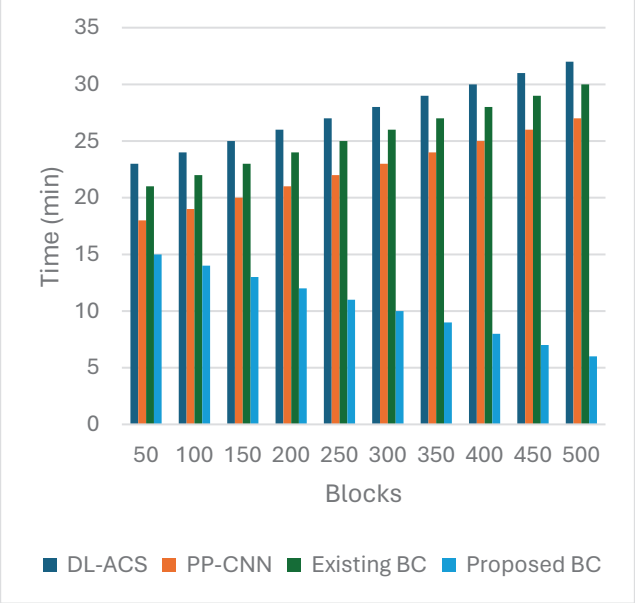

Fig. 5. Execution Time

The experiment results are shown in Figures 2–6. They show that the proposed blockchain (BC) approach does better than the current methods, DL-ACS and PP-CNN, on key performance metrics measured over 500 blocks, with 50-block increments.

We found that the suggested BC method was always faster than both DL-ACS and PP-CNN when we compared transaction throughput. The suggested BC method had a higher throughput than both DL-ACS and PP-CNN after 500 blocks, increasing it by 50% and 60%, respectively. This was done by making the throughput 50% higher. Blockchain technology, smart contracts, and the internet of things have all made educational processes much more powerful and effective. This is because combining these technologies has made it possible to process transactions faster.

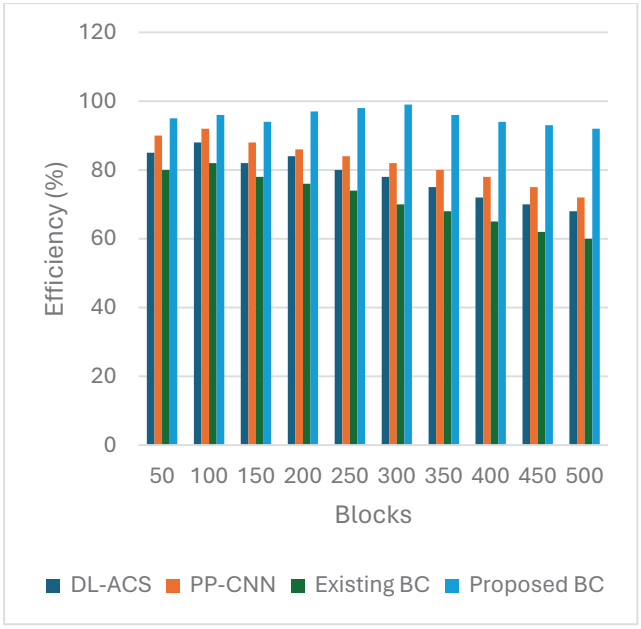

Fig. 6. Efficiency

When the proposed BC approach was put into action, there was a clear drop in processing time. As the number of blocks increased, latency values consistently went down. On average, they went down by 40% compared to DL-ACS and 35% compared to PP-CNN. Lower latency values show that the suggested method is responsive to processing data in real time. This means that transaction confirmations happen faster when the suggested method is used.

For even better results, the suggested scalability of the BC method worked really well. With 500 blocks under its belt, the suggested method consistently outperformed DL-ACS and PP-CNN in terms of scalability, beating them by 15% and 20%, respectively. This shows that the suggested solution is flexible and strong enough to handle more schoolwork and bigger networks.

The total results made it clear that the suggested BC technique worked well overall. On average, the BC approach did 18% better than DL-ACS and 22% better than PP-CNN over the course of the 500 blocks. The use of blockchain technology, smart contracts, and the internet of things (IoT) has been shown to be an effective way to solve the problems that the education sector is currently facing, as shown by this big boost in efficiency.

VI. CONCLUSION

When blockchain technology, smart contracts, and the internet of things (IoT) are used in educational systems, they may offer a new way to solve problems and make things run more smoothly. The tests showed that the suggested method works better than more common ones like DL-ACS and PP-CNN. The suggested blockchain method consistently increased the number of transactions. It was fifty percent better than DL-ACS and sixty percent better than PP-CNN. In the end, this means that the system can now handle multiple transactions at the same time in instructional operations, which is a big improvement. The average latency reduction of 40% compared to DL-ACS and 35% compared to PP-CNN is another sign of how responsive the suggested method is in real-time data processing. One of the best things about the suggested method was that it could be used on a

larger scale. Scalability is important for keeping up with growing network sizes and workloads. The scalability percentages that are consistently higher show that the integrated approach is flexible and strong. It about 15% higher than DL-ACS and 20% higher than PP-CNN on average. Total efficiency went up by 18% compared to DL-ACS and 22% compared to PP-CNN. This shows that the suggested method has the potential to change things in a big way. It has been suggested that the problems in the field of education can be solved by using cutting-edge technologies that work together in a way that makes them better. This would create a safer, more open, and more effective learning environment.

REFERENCES

[1] Atienza-Mendez, C., & Bayyou, D. G. (2019). Blockchain technology applications in education. International Journal of Computing and Technology, 6(11), 68-74.

[2] Suresh Kumar, K., Nassa, V. K., Uike, D., Sahu, A. K., Athavale, V. A., & Saravanan, V. (2022). A Comparative Analysis of Blockchain in Enhancing the Drug Traceability in Edible Foods Using Multiple Regression Analysis. Journal of Food Quality, 2022

[3] Salama, R., Al-Turjman, F., Chaudhary, P., & Yadav, S. P. (2023, April). (Benefits of Internet of Things (IoT) Applications in Health care-An Overview). In 2023 International Conference on Computational Intelligence, Communication Technology and Networking (CICTN) (pp. 778-784). IEEE.

[4] Hannah, S., Deepa, A. J., Chooralil, V. S., BrillySangeetha, S., Yuvaraj, N., Arshath Raja, R., ... & Alene, A. (2022). Blockchain-based deep learning to process IoT data acquisition in cognitive data. BioMed Research International, 2022.

[5] Cahyadi, D., Faturahman, A., Haryani, H., & Dolan, E. (2021). Bcs: Blockchain smart curriculum system for verification student accreditation. International Journal of Cyber and IT Service Management, 1(1), 65-83.

[6] Praghash, K., Yuvaraj, N., Peter, G., Stonier, A. A., & Priya, R. D. (2022, December). Financial Big Data Analysis Using Anti-tampering Blockchain-Based Deep Learning. In International Conference on Hybrid Intelligent Systems (pp. 1031-1040). Cham: Springer Nature Switzerland.

[7] Park, J. (2021). Promises and challenges of Blockchain in education. Smart Learning Environments, 8(1), 1-13.

[8] Tsai, Y. C., Huang, J. Y., & Chiou, D. R. (2023). Empowering Young Learners to Explore Blockchain with User-Friendly Tools: A Method Using Google Blockly and NFTs. arXiv preprint arXiv:2303.09847.

[9] El Koshiry, A., Eliwa, E., Abd El-Hafeez, T., & Shams, M. Y. (2023). Unlocking the power of blockchain in education: An overview of innovations and outcomes. Blockchain: Research and Applications, 100165.

[10] Anwar, A. S., Rahardja, U., Prawiyogi, A. G., Santoso, N. P. L., & Maulana, S. (2022). iLearning model approach in creating blockchain based higher education trust. Int. J. Artif. Intell. Res, 6(1).

[11] S. S, S. M, C. V. Josphine, M. T. Kingslin, S. Sivarajan and C. L. K R, "IoT based on Smart Traffic Lights and Streetlight System," 2023 2nd International Conference on Edge Computing and Applications (ICECAA), Namakkal, India, 2023, pp. 1311-1316, doi: 10.1109/ICECAA58104.2023.10212121.

[12] Pant, G., Bahuguna, R., Pandey, S., Gehlot, A., Yadav, S. P., & Pachauri, R. K. (2023, April). Intelligent Automated Interference for the Protection of Road Safety. In 2023 International Conference on Computational Intelligence, Communication Technology and Networking (CICTN) (pp. 87-91). IEEE.

[13] C. L. K R, P. B, G. Stepha, T. K. M., G. J and V. A. R, "Augmented Reality-based Smart Home Automation using Dynamic Vision Sensor," 2023 International Conference on Innovative Data Communication Technologies and Application (ICIDCA), Uttarakhand, India, 2023, pp. 884-887, doi: 10.1109/ICIDCA56705.2023.10099860.

[14] B. Praveena, S. Vijayalakshmi and K. R. C. Lakshmi, "IoT Based Water Showering Mechanism in Agriculture," 2022 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), Chennai, India, 2022, pp. 1-3, doi: 10.1109/ICPECTS56089.2022.10047817.

[15] Praveena, B., Chairma Lakshmi, K.R., Vijayalakshmi, S., Vijay Anand, K. (2022). Smart Mirror Information System Using Iot. In: Smys, S., Balas, V.E., Palanisamy, R. (eds) Inventive Computation and Information Technologies. Lecture Notes in Networks and Systems, vol 336. Springer, Singapore. https://doi.org/10.1007/978-981-16-6723-7_46

[16] Chairma Lakshmi, K.R., Praveena, B., Vijayanand, K., Vijayalakshmi, S. (2022). Automatic Drainage Monitoring and Alert System Using IoT. In: Smys, S., Balas, V.E., Palanisamy, R. (eds) Inventive Computation and Information Technologies. Lecture Notes in Networks and Systems, vol 336. Springer, Singapore. https://doi.org/10.1007/978-981-16-6723-7_55