Blockchain Frontier Technology (B-Front)
Vol. 2 No. 2 January 2023

P-ISSN: 2808-0831
E-ISSN: 2808-0009

Blockchain and IoT Technology Transformation in Indonesian Education

Ajay Supriadi[1], Muhammad Faiz Iqbal[2], Alva Nandana Pratista[3], Diaz Mauludin Sriyono[4], Dheaka Jaya Buanasari[5]
Technical Information, University of Raharja[1]
Software Engineering, University of Raharja[2]
Information Systems, University of Raharja[3,4,5]

e-mail: ajay.supriadi@raharja.info, faiz.iqbal@raharja.info, nandana@raharja.info, diaz.mauludin@raharja.info, dheaka@raharja.info

Author Notification
01 January 2023
Final Revised
04 January 2023
Published
05 January 2023

Supriadi, A., Iqbal, M. F., Pratista, A. N., Sriyono, D. M., & Buanasari, D. J. (2022). Blockchain and IoT Technology Transformation in Indonesian Education. Blockchain Frontier Technology, 2(2), 44–53.
DOI: https://doi.org/10.34306/bfront.v2i2.208

Abstract

Every area of life has been touched by technology, and the education industry is no different. Recently, there have been seismic shifts. Teachers and students used a blackboard technique in the traditional classroom teaching-learning process. But this process' characteristics have changed during the last few years. Technology has snuck in and significantly improved it. On the one hand, whereas in conventional classrooms the players were the teachers, the students, and the books, in the modern classroom the players are the teachers, the students, robots, the e-books, the laptops, and the books. With the help of e-lectures and tutorials, the teaching-learning process can now transcend geographical borders in classrooms. For the process, a vast amount of information is easily available. Additionally, the current situation shows a change from "Teacher-centered" to "Student Centric". However, the focus of this article is on utilizing the applications of Blockchain and IoT in the sector and identifying the areas where they prove to be advantageous. Several technologies have been major actors in modernizing the education industry. To comprehend and determine how these technologies offer a solution to significant educational difficulties, a thorough literature review must be conducted. The teaching and learning process needs to be understood in light of a variety of factors, including changes to the participants, the process itself, the results that are produced, and others. It is also necessary to identify the related difficulties. A thorough examination of these enables us to draw the conclusion that they can revolutionize education for the better in the future. Blockchain, in particular, is still relatively new, but because of the advantages it offers, further study and adoption will undoubtedly alter the teaching-learning process.

Keywords: *Blockchain, IoT, Education, E-Learning, Customized Lecture Plans.*

1. Introduction

The teaching-learning process has the potential to change thanks to the power of technology. In conventional classrooms, professors impart knowledge while pupils learn it. There has been a paradigm shift in the classroom of today [1]. Thanks to advancements in technology, the entire process is bidirectional. It has altered the learning environment (both physically and online), introducing new teaching-learning models and methods while accommodating altered stakeholder relationships. IoT, Blockchain, AI, and cloud computing

are some of these technologies in education [2]. The driving technologies behind the impending digital transformation are those mentioned above. They are acknowledged as facilitators or breakthroughs that can enhance corporate operations, develop fresh business ideas, and transform how today's markets function [3]. Blockchain is a distributed ledger in the digital realm that may store data like a register . In any industry where it is applied, IoT may produce solutions that are user-friendly. In order to get the optimum results, these technologies must be interdependent and coupled. These technologies will eventually converge, as we will see [4]. Blockchain first became popular as a tool for facilitating Bitcoin and Ethereum-based financial transactions. However, over the past few years, it has also found use in other fields, such as supply chain management and maintaining digital identities. Recent studies have looked at how blockchain and IoT can work together to strengthen the infrastructure of IoT devices [5]. The authors outline the advantages of these technologies and present a use-case to explain. Additionally, they discuss how these technologies work best together. This essay explores the possibilities of blockchain technology and the internet of things in education while examining their uses, advantages, and difficulties [6]. The essay is set up like follows: The use of IoT and Blockchain in education is covered in Section 2, which improves the teaching-learning process. It also talks about the added advantages we get from them. The difficulties with these applications are covered in Section 3. The conclusion is given in Section 4, which also lists potential uses for these technologies in the future [7].

2. Iot And Blockchain In Education: Uses And Advantages

In this study, the ideas of business model innovation, blockchain technology, and enterprise blockchain ecosystem are used to support the research. The concepts are covered in the following sections [8].

2.1 IoT in Education

Connected devices with internet access are able to communicate with one another and share data that can be analyzed and processed to reach "intelligent judgments." This results in the "Internet of Things" concept [9]. Kevin Ashton coined the phrase for the first time in 1999. Since then, it has undergone multiple name changes, had more concepts added, and been redefined. It is defined as "anything at all, depending on requirements" by the Internet of Everything (IoE), Internet of Data, Internet of Anything, Internet of People, and Internet of Process [10]. The most well-known of these is the Internet of Everything (IoE), which includes the people, systems, information, and objects that make networked connections dependable and valuable and so produce new and greater capabilities [11]. It connects a variety of gadgets, including laptops, desktop computers, cellphones, wearable tech, and other portable devices. The wearable technology recognizes, adjusts, records the location and the activity being done, and transmits all of its owner's information [12]. These gadgets are based on sensor and wearable technology. The wearable technologies are sensor-based and can collect data that includes one or more of the following: Biological (body-temperature, heart-rate, stress level, oxygen, sleep quality, blood pressure, etc.), Acoustical (volume, pitch, timing, frequency), and Optical Information (brightness, frequency, luminance, e.t.c). For further processing and decision-making, this obtained data is subsequently sent to various processing units. The following interactions could be carried out by these connected devices: machine to machine (M2M), machine to machine (M2M), and human to machine (H2M) (M2M). Intelligent and pervasive IoT solutions are available [13]. In order to enable communication with both the internal and external environment, IoT can be thought of as a physical network that connects objects and devices globally to the Internet Infrastructure. It makes anything at any time, with everyone using networks and services, connectable. Advanced communications and electronics will play a significant role in the tracking and

management of things intelligently in the future [14]. IoT enables professionals to create compact, reasonably priced wireless systems with low power requirements and simple device integration.The hardware, which includes sensors, wearable technology, actuators, and embedded electronics, is made up of three main parts that facilitate seamless communications in the Internet of Things. The Presentation includes graphical tools that can be utilized for a variety of applications, while the Middleware consists of storage and computing capabilities for data analytics. Wireless technologies like RFID (Radio-Frequency Identification), which has been used by businesses, ZigBee, WSN (Wireless Sensor Network), WLAN (Wireless Local Area Network), NFC (Near Field Communication), DSL (Digital Subscriber Line), and others like LTE (Long-Term Evolution) are used for IoT systems communication [15]. Even while the Internet of Things (IoT) has many uses and advantages in the fields of healthcare, education, smart transportation, smart agriculture, and others, there is still more that can be discovered in the near future. IoT can improve teaching and learning in a number of ways. To properly employ the IoT's systems and solutions in education, we must be aware of the possible benefits it may provide. It will change how educational institutions run and function, and it already has. IoT is being used in education as a teaching and research tool. The authors explain how integrating IoT into educational settings promotes interaction between the principal players (teachers and students) and the objects (real and virtual). IoT in the classroom is a fascinating subject, especially as a notion in computer science [16].

IoT may also be used to learn programming languages better. This offers a positive route leading to notable accomplishments demonstrated by the disabled. Additionally, such a disabled student could not feel comfortable in the well-lit learning environment or in other types of environmental circumstances (say v low temperature of the room, etc) [17]. IoT makes it possible to modify the space to suit the user's preferences. IoT makes it simple to track how many devices are being used in a classroom. IoT-connected devices have the ability to be set to automatically create use and performance reports for the school staff and teachers. The teachers can then evaluate how well each student is using the tools, such as tablets, laptops, etc. Additionally, sensors that detect motion and occupancy will offer vital data on how efficiently a space—particularly a classroom, lab, or library—has been utilized. If these indicators do not indicate a positive analysis, then different techniques or tools might be applied to entertain a learner as they learn. IoT in education can improve learning by making it more interesting and enjoyable [18]. A worldwide educational situation is made possible by innovative approaches, game-based learning, interactive sessions, and readily available smart goods. Virtual reality and augmented reality can be used to accomplish and support these. Both rely on portable devices, wearable glasses, a workbench that can display 3D items onto a table, and a number of spatial gadgets that imitate virtual objects in the real world while giving us the impression that we are actually touching or feeling them [19]. The authors rely on multi-modal learning analytics and IoT devices to boost learner engagement. Results of an experiment carried out in a classroom show greater motivation and learning capacity. B-Schools have been researched, and a model has been developed that guarantees student satisfaction by assessing the factors that determine an efficient teaching-learning process. Any field, including education, becomes increasingly dependent on security. Since there are so many students, keeping track of their whereabouts and activities is crucial. We have all seen shootings and homicides in schools and other places of higher learning. Monitoring student behavior also becomes a critical consideration. The management and personnel are now responsible for keeping track of them. IoT can offer ways to guarantee safety. The classrooms, laboratories, libraries, and all other areas of the school may be furnished with the tools required for the same. Some IoT solutions that can reduce the security risk linked with student lives include emergency indicators, location trackers, wifi clocks, audio enhancers, cameras, etc [20].

When a kid faces a threat anywhere in the school, wearable gadgets can be equipped with alarm buttons that can be activated to alert the authorities. If an elevator provides a risk but is not operated by a person, this could also be legally challenged. Although there are rules

that must be observed when using lifts, in practice, some institutions do not, putting the students at risk. When some hostile behavior is found inside the institution, special emergency alert tones and live briefings can also be helpful [21]. IoT can speed up time-consuming tasks like attendance tracking. Particularly useful for tracking attendance are RFID tags. A reliable method can cut down on the workload, time spent creating sheets, and human mistakes as well. However, IoT systems can automatically create and track attendance while also keeping parents and guardians informed of students' whereabouts. There are some further IoT applications in educational settings that use IoT and other technologies. The Internet of Things is used in task-based learning. IoT has changed from a knowledge-transfer approach to one that is more collaborative and shareable. Connected systems will allow students to self-learn from the activities given to them in task-based learning [22]. It also fosters a sense of unity among them. Additionally, this lessens the teacher's workload in terms of ongoing student observation. Additionally, it aids in the learning process in which teachers help students learn. Feedback, automatic classroom monitoring, and feedback are all made possible by IoT solutions. By alerting the teachers when assistance is needed, this also keeps a pupil in regular contact with the teachers. The effective use of IoT, communication, and practical language applications that enable task-based learning for young children are discussed in this study. The major goal of this essay is to inspire pupils to pursue language learning. Realistic, inviting, and suitable learning scenarios for second language acquisition through chat are developed. Then, performances are evaluated using metrics [23]. IoT may be effectively used for feedback analysis. Feedback from students refers to the caliber of lectures. The feedback that is given to teachers helps them understand their teaching and communication methods, material delivery, subject matter, teaching style, and other factors better, which allows them to work on improving these aspects of their performance [24]. The authors suggest a learning environment that can use sensors to observe and track students' responses while class is in session. Such a monitoring and response system has been found to be successful in raising the caliber of a lecture and the students' level of comprehension. IoT can be used to assess student performance, which the instructors can utilize to determine how much attention each student needs through effective analysis [25]. Based on the information gathered through IoT systems, lecture plans, assignments, formative assessments, and performance evaluations should all be designed with the student in mind. In order to improve the delivery and management of lessons in smart societies, the study presents a personalized Teaching & Learning (UTiLearn) Framework in an e-learning environment that makes use of IoT, Big Data, and Deep Learning. The teaching-learning process can be tailored to the student's level and capacity of retention and absorption by analyzing the recorded data. Learning is tough for the disabled. Technology advancements have frequently fallen short in helping pupils with disabilities. However, IoT works well for them. Students who are hard of hearing can use tools like laptops and connected gloves that translate sign language into speech and subsequently into written form. They can act, learn, and perform like any other student thanks to these innovations. regarding their child's absence or presence in the institution. Sending SMS or emails to registered data kept by the school or college can do this. Smartphone NFC technology is used to track student attendance. Additionally, smart education, smart homes, and smart transportation are the new standard. An intelligent environment is a crucial component of these. With the use of sensors, "Smart Environment" monitors, regulates, and optimizes the environment by tracking temperature, humidity, airflow, and other factors. Depending on the number of people using the room and the HVAC setting (heating, ventilation, and air conditioning), the lighting and HVAC settings can be changed. The method that they are used should also be taken into consideration while making these alterations. Different from a dancing studio or an auditorium is a lab need. These features are planned and effectively employed to cut down on energy waste, which results in significant cost savings. Depending on whether an IoT solution is being utilized for a classroom environment or a campus, Smart Classroom or Smart Campus both include all the functions stated above. In

Figure 1, an ideal smart campus is depicted.

Source: researchgate.net

Figure 1. IoT Enabled Smart Campus

2.2 Blockchain for Education

The technology that creates cryptocurrencies is called blockchain, and it is based on the idea of a distributed ledger that uses digital blocks to record transactions and store associated information. It is currently used in finance, where crypto-currencies like Bitcoin, Zerocash, and Ethereum are used. The most popular of these is Bitcoin. Despite being new, blockchain technology is being embraced due to the popularity of Bitcoin, which is being embraced globally. It has the aforementioned applications because it is unchangeable, transparent, safe, and trustworthy for all transactions on the Blockchain network. Due to these benefits, academics from all over the world have used it in a variety of fields, but its potential in education has received particular attention. Blockchain gives its users the ability to conduct transactions through a strong network at a reasonable price. A blockchain-based network has the following qualities: decentralization, reliability, great resistance to change, and scalability. It is based on public key cryptography theory. Each participant in this notion creates two keys—a public key and a private key. Public key can be compared to an email account that is accessible to other network users. The private key is similar to a password in that it is secret and difficult to read. There is a private key for each public key. Let's say A needs to communicate with B. B initially gives A the public key. Then, A transmits B the message that has been encrypted using that public key. Only B has access to the private key needed to

decrypt that message. Blockchain technology also facilitates transactions between A and B in a similar way. A block is created for each transaction to be carried out by securing a predetermined number of nodes. All of the transactions between A and B are included in the block. A digital signature is additionally utilized for reliable authentication. A timestamp value binds every transaction. A new block is generated and linked to the initial block as transactions increase and values are modified. Each participant in the transaction has a copy of the blockchain on their own. Strong cryptographic methods and SHA-256 hash functions prevent any alteration of the original data, and in the event that a third party makes an effort, it will be rejected. Figure 1 depicts a typical Blockchain-based transaction scenario.

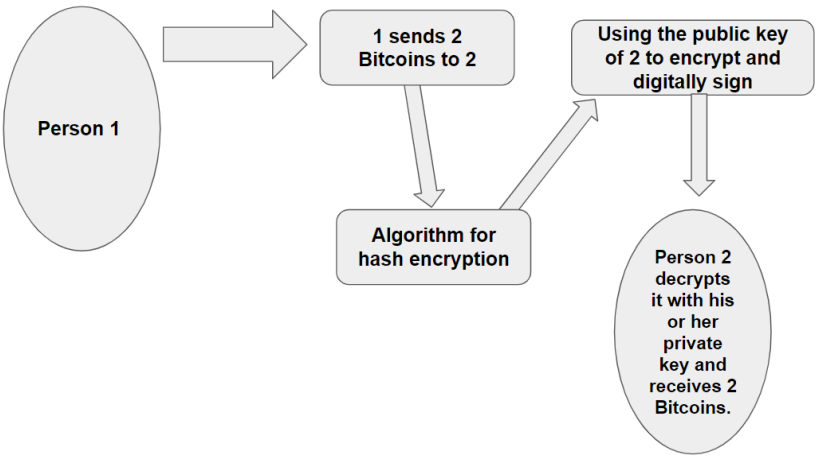

Figure 2. To show a transaction using the Blockchain

applications for teaching. The administration of certificates is the main use of blockchain technology. The management and provision of storage for academic credentials, such as transcripts, certificates, academic records, degrees, etc., is included in this. Blockchains can be used to create one-of-a-kind digital assets that authenticate academic qualifications and certifications. For the same, a great level of trust and secrecy can be offered. The study makes use of Blockchain's decentralized nature to facilitate verification and the issuance of official transcripts. Although the data records will be visible to everyone, only authorized people or organizations are allowed access to and the ability to modify them. In order to provide open infrastructure for the storing, viewing, and verification of blockchain-based credentials management, MIT Media Lab and Learning Machine Co. Universities are renowned for offering teachers and students cloud storage. However, current cloud storage options like Amazon DropBox are rather pricey. The pupils are typically charged extremely expensive tuition fees to cover this expense. Storage costs are reduced through initiatives like Filecoin and SiaCoin. They provide academic institutions with unused storage space in their organizations in return for cryptocurrency. A platform for the same is also created by Sony Global Education. In a larger sense, blockchain can be used to reform the teaching-learning process and monitor its adoption in the industry. Using their ID, each student can be identified specifically.

Additional data, like location, class performance, project evaluation, etc., would also be stored in the block. This would thus improve both the learning experience and the learning outcomes. Fraud detection is another area of application. Any change to the content of the degrees or other documents is much decreased because Blockchain is reliable and secure. On an Ethereum network, a smart contract normally operates. It is a protocol that resembles a

real contract in some ways. It can facilitate the negotiation, implementation, and verification of contract terms and conditions. The fact that it knows who is who allows it to avoid third-party interference and the associated costs. Student rewards based on performance can be given using smart contracts. Instructors can accomplish this with a few easy clicks. This prize may be given in the form of cryptocurrency that can be kept in electronic or virtual wallets. The student is free to use this wallet as necessary. Another noteworthy application is in the area of fair appraisal, particularly in projects and collaborative effort. However, collaborative work has the potential to improve team spirit, foster creative thinking, and foster a sense of cooperation among peers. However, it has a serious drawback. In these tasks, it is frequently seen that one's diligence shows in the finished product, while the lazy ones get the benefits of the team's labor. Together, blockchain and smart contracts can fight this. Each student ID on Blockchain uniquely identifies a block. Each team member submits their work using their unique ID, making it possible to determine how much work each person contributed. Although it would be seen as a single transaction involving the entire team, each node should belong to a different student. The evaluation of each student's performance will then be conducted using the smart contract, with the results being saved in the blocks. Additionally, the concepts they individually employed and their comments can be saved as metadata specific to each student. This would result in an accurate evaluation of the entire project. Utilizing blockchain to improvise student feedback is another application. At the start of a session, a lecture plan would need to be submitted by the instructor. Similar to a smart contract, this would. After then, all classroom instruction would be documented. Smart Contracts would be used to verify that the design and the implementation were consistent. This verification is carried out in accordance with the contract between the teacher and the academic institution, the teacher, and the student. Once finished, digital awards in the form of cryptocurrency can be given to the professors in a similar way as was previously described for students. The relationship between the supervisor and the student in higher education is vital to the success of the scholar's research. The blocks can be used to hold data such as the interaction pattern, the dates on which they interacted, the behavior, and other details. This cannot be changed since both parties would need to agree on a change. A transparent approach like this would make it possible for both sides to take their involvement in the research seriously, improving the research's output and helping society as a whole.

3. Challenges

This section looks at and identifies the challenges that have been faced in incorporating modern technologies into the educational field.

3.1 IoT in Education

IoT solution implementation for the education industry demands powerful hardware and software. These solutions must be accessed, deployed, and maintained. For this work, a highly qualified technical team is needed. The aforementioned problems are expensive. Unfortunately, the IoT items, their purchase costs, license fees, and additional maintenance fees raise the overall cost to an amount that is out of reach for most people. IoT solution implementation also requires dependable computing platforms as well as powerful data tools and approaches. Additionally, institutions shouldn't use solutions or data storage methods that are too antiquated because they might be unable to support a strong IoT network. Some of these problems have already been fixed. Additionally, the collecting and processing of data by IoT devices exposes it to hacking risks. All stakeholders should place importance on greater data security knowledge. Conscious data use, frequent password changes, device updates, and system checkups are a few precautions that they may take to reduce the risk of cybersecurity concerns brought on by malicious software attempting to access private information. A non-robust framework is the result of weak protocols, policies, and improper documentation. Although sophisticated phishing techniques encouraged people to divulge their private information, 5G will bring about a number of revolutionary improvements in how

we use IoT devices, applications, and solutions. It will alter how IoT is used in every industry, including education. High bandwidth and frequency will create new opportunities and improve accessibility for all sector stakeholders. However, it would also necessitate the installation of numerous base stations. This would multiply the threats as additional bogus stations would appear, bringing new issues that would be undoubtedly challenging to resolve. The authors list a few obstacles, such as spoofing, jamming, and other ones that compromise data integrity. IoT technologies are also beset by a number of ethical issues. The Internet of Things (IoT) is a global architecture that links objects and collects data utilizing wearable technology and other technologies. As a result, it strongly depends on 3G, 4G, sensor technology, and other technologies for this. Educational institutions may use this data improperly to conduct analyses and gain advantages. IoT provides a platform for worldwide sharing, hence IoT-based technologies might not encourage plagiarism and other forms of academic dishonesty. Some of the ethical problems have been covered. High-speed network bandwidth is undoubtedly required for the IoT framework to work correctly, but not everywhere is it feasible. Since education is a fundamental right, outreach can be increased through the use of these technologies. However, there is a gap that needs to be closed in terms of making it accessible with a fast, active Internet connection. IoT for environmental issues largely relies on sensors and wearable technology. This produces a lot of electronic garbage and is harmful to the environment. This paper addresses how IoT can be changed to address its negative impact and transform IoT into Green IoT in order to lessen its effects on the environment. IoT setup and upkeep require experienced personnel. However, it is necessary to train the stakeholders, especially the instructors, in its use. These have been talked about.

3.2 Blockchain in Education

The use of blockchain technology has various advantages. Blockchain still has significant privacy and security vulnerabilities. Data availability and accessibility decline as privacy is protected, especially for websites that rely on user data. It's important to deal with malicious assaults and data leaks brought on by rapid data updates. The blockchain system relies on the use of both public keys and private keys since it employs public-key cryptography. However, public key data is accessible and can be used to identify user data. Private key storage and security are also important concerns that must be addressed. It is common knowledge that each transaction in a blockchain is represented by a single block. As a result, as the number of transactions and users expand, the block size also grows significantly. Additional problems include the handling of data and the poor transaction pace. Because blockchain is still in its infancy, adoption and implementation are expensive. As stated, managing the enormous amounts of data being produced and its storage results in rising costs. The system is difficult to use due to the jargon, complex blockchain environments, lack of clarity, poor usability, and lack of technical understanding among stakeholders. Authorization procedures may become difficult as a result of authorized educational institutions being reluctant to provide their students' credentials. The immutability of blockchain prevents governments from making any modifications to the system's specific policies or to the data that may be needed to preserve law and order.

4. Conclusion

Blockchain, a decentralized digital ledger, has so proven to be secure, trustworthy, and immutable. It can be fully utilized to improve the entire teaching-learning process, provide fair evaluation of both students and teachers, improve performance, motivate both students and teachers by providing them with rewards, manage records, detect fraud, and other things because of these characteristics and its applications in the education sector. These programs, along with a few fresh, creative models and concepts, can open the door to a better future for the education industry. Future study would produce greater findings if the problems with Blockchain were to be solved. Additionally, IoT promises to enhance the

lives of instructors and students. Sensing devices collect data that is used to continuously monitor each student's activities, mood, health, behavior, and contribution to the class. This information enables fair assessment and produces student-centric responses as needed. This study revealed that IoT plays a significant role in enabling an effective and quick teaching-learning process. Although IoT has some limitations that should be overcome, integrated frameworks that incorporate the advantages of both Blockchain and IoT can eventually assist to improve the future of the education industry.

References

[1] H. Purwantih, Z. F. Rahayu, W. Amelia, R. Dwi, and H. M. Bilqis, "Rancang Bangun Sistem Seleksi Rekrutmen Karyawan Dan Guru Berbasis Website Pada Sekolah Citra Bangsa Tangerang," *ADI Bisnis Digit. Interdisiplin J.*, vol. 1, no. 2, pp. 60–70, 2020.

[2] G. G. Wiguna, K. Darkun, and K. Sulistyadi, "SAST & AHP METHOD IN DETERMINING THE BEST STRATEGY OF OFFICE ERGONOMICS PROGRAM IMPROVEMENT TO PREVENT RISK OF MUSCULOSKELETAL DISORDERS AT XYZ COMPANY QATAR," *ADI J. Recent Innov.*, vol. 2, no. 1, pp. 7–14, 2020.

[3] P. A. Sunarya, Q. Aini, A. S. Bein, and P. Nursaputri, "The Implementation Of Viewboard Of The Head Of Department As A Media For Student Information Is Worth Doing Final Research," *ITSDI J. Ed. Vol. 1 No. 1 Oct. 2019*, p. 18, 2019.

[4] R. Hardjosubroto, U. Raharja, N. Anggraini, and W. Yestina, "PENGGALANGAN DANA DIGITAL UNTUK YAYASAN DISABILITAS MELALUI PRODUK UMKM DI ERA 4.0," *ADI Pengabdi. Kpd. Masy.*, vol. 1, no. 1, 2020.

[5] T. Ramadhan, Q. Aini, S. Santoso, A. Badrianto, and R. Supriati, "Analysis of the potential context of Blockchain on the usability of Gamification with Game-Based Learning," *Int. J. Cyber IT Serv. Manag.*, vol. 1, no. 1, pp. 84–100, 2021.

[6] D. Apriani, T. Ramadhan, and E. Astriyani, "Kerja Lapangan Berbasis Website Untuk Sistem Informasi Manajemen Praktek (Studi Sistem Informasi Program Studi Kasus Merdeka Belajar Kampus Merdeka (MBKM) Universitas Raharja," *ADI Bisnis Digit. Interdisiplin J.*, vol. 3, no. 1, pp. 24–29, 2022.

[7] A. Alwiyah and S. Sayyida, "Penerapan E-Learning untuk Meningkatkan Inovasi Creativepreneur Mahasiswa," *ADI Bisnis Digit. Interdisiplin J.*, vol. 1, no. 1, pp. 35–40, 2020.

[8] W. Andriyan and V. Anesti, "Visual Audio Communication Design on the Role of Information Technology on Student Life Style of Universitas Raharja," *ADI J. Recent Innov.*, vol. 2, no. 1, pp. 15–24, 2020.

[9] P. Hendriyati, F. Agustin, U. Rahardja, and T. Ramadhan, "Management Information Systems on Integrated Student and Lecturer Data," *APTISI Trans. Manag.*, vol. 6, no. 1, pp. 1–9, 2022.

[10] R. B. Putra, F. Yeni, H. Fitri, and D. J. Melta, "The Effect Of Board Of Commissioners Ethnic, Family Ownership And The Age Of The Company Towards The Performance Of The Company LQ45 Company Listed In Indonesia Stock Exchange," *ADI J. Recent Innov.*, vol. 1, no. 2 Maret, pp. 85–92, 2020.

[11] T. C. Husnadi, T. Marianti, and T. Ramadhan, "Determination of shareholders' welfare with financing quality as a moderating variable," *APTISI Trans. Manag.*, vol. 6, no. 2, pp. 191–208, 2022.

[12] T. Ramadhan and R. D. Destiani, "Pengetahuan Manajemen Keuangan Bisnis Terhadap Niat Mahasiswa Bisnis Digital dalam Berwirausaha," *ADI Bisnis Digit. Interdisiplin J.*, vol. 3, no. 1, pp. 59–62, 2022.

[13] F. P. Oganda, M. Hardini, and T. Ramadhan, "Pengaruh Penggunaan kontrak cerdas pada Cyberpreneurship Sebagai Media Pemasaran dalam Dunia Bisnis," *ADI Bisnis Digit. Interdisiplin J.*, vol. 2, no. 1, pp. 55–64, 2021.

[14] U. Rahardja, Q. Aini, Y. I. Graha, and M. R. Tangkaw, "Gamification Framework Design of Management Education and Development in Industrial Revolution 4.0," *J. Phys. Conf. Ser.*, vol. 1364, no. 1, pp. 0–13, 2019, doi: 10.1088/1742-6596/1364/1/012035.

[15] C. Lukita, M. Hatta, E. P. Harahap, and U. Rahardja, "Crowd funding management platform based on block chain technology using smart contracts," *J. Adv. Res. Dyn. Control Syst.*, vol. 12, no. 2, 2020, doi: 10.5373/JARDCS/V12I2/S20201236.
[16] Q. Aini, A. Anoesyirwan, and Y. Ana, "Effect of Cloud Accounting as income statement on Accountant Performance," *Aptisi Trans. Manag.*, vol. 4, no. 1, pp. 13–21, 2019.
[17] R. Widayanti, U. Rahardja, F. P. Oganda, M. Hardini, and V. T. Devana, "Students Formative Assessment Framework (Faus) Using the Blockchain," in *2021 3rd International Conference on Cybernetics and Intelligent System (ICORIS)*, 2021, pp. 1–6.
[18] N. Lutfiani, F. P. Oganda, C. Lukita, Q. Aini, and U. Rahardja, "Desain dan Metodologi Teknologi Blockchain Untuk Monitoring Manajemen Rantai Pasokan Makanan yang Terdesentralisasi," *InfoTekJar J. Nas. Inform. dan Teknol. Jar.*, vol. 5, no. 1, pp. 18–25, 2020.
[19] A. G. Prawiyogi, A. S. Anwar, M. Yusup, N. Lutfiani, and T. Ramadhan, "Pengembangan Program Studi Bisnis digital bagi pengusaha dengan perangkat lunak lean," *ADI Bisnis Digit. Interdisiplin J.*, vol. 2, no. 2, pp. 52–59, 2021.
[20] J. Leonard, D. Damanik, and O. Amirkhasanah, "Application of Information Session Information System as Media Submission of Final Results Comprehensive Session," *J. Recent Innov.*, vol. 1, no. 1, pp. 62–70, 2020.
[21] H. T. Sukmana, "Prototyping ITSDI Journal Center Menggunakan Tools Invision Untuk Mewujudkan Creative Innovation Soft Skill Di Era Industri 4.0," *ADI Bisnis Digit. Interdisiplin J.*, vol. 1, no. 1, pp. 56–69, 2020.
[22] Q. Aini, A. Badrianto, F. Budiarty, A. Khoirunisa, and U. Rahardja, "Alleviate Fake Diploma Problem In Education Using Block Chain Technology," *J. Adv. Res. Dyn. Control Syst.*, vol. 12, no. 2, pp. 1821–1826, 2020, doi: 10.5373/JARDCS/V12I2/S20201225.
[23] T. Ayuninggati, E. P. Harahap, and R. Junior, "Supply Chain Management, Certificate Management at the Transportation Layer Security in Charge of Security," *Blockchain Front. Technol.*, vol. 1, no. 01, pp. 1–12, 2021.
[24] U. Rahardja, A. N. Hidayanto, T. Hariguna, and Q. Aini, "Design Framework on Tertiary Education System in Indonesia Using Blockchain Technology," *2019 7th Int. Conf. Cyber IT Serv. Manag. CITSM 2019*, pp. 5–8, 2019, doi: 10.1109/CITSM47753.2019.8965380.
[25] P. A. Sunarya, U. Rahardja, L. Sunarya, and M. Hardini, "The Role Of Blockchain As A Security Support For Student Profiles In Technology Education Systems," *InfoTekJar J. Nas. Inform. dan Teknol. Jar.*, vol. 4, no. 2, pp. 13–17, 2020.