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BLOCKCHAIN IN EDUCATION: POTENCIALS AND CHALLENGES IN ACADEMIC RECORDS AND CERTIFICATIONS

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Abstract

Blockchain in education in today's digital age has paved the way for innovative technologies that have the potential to revolutionize various aspects of life, including the education sector. Blockchain, as one of the leading technological breakthroughs, offers the possibility to transform the way academic recording and certification are done in the education system. This article aims to identify and analyze potential applications of blockchain in education, in relation to academic recording and certification management, as well as highlighting the key challenges to be addressed for successful implementation. The research method used is literature using the theory in accordance with the context of research. Research findings suggest that the potential for blockchain use in education lies mainly in its capacity to provide a safe, transparent, and irrevocable way to store academic records. Using this technology, educational institutions can guarantee the integrity and authenticity of academic documents, facilitate verification processes by third parties, and improve operational efficiency. Furthermore, the adoption of blockchain can strengthen the recognition of academic credentials globally and support the development of new teaching techniques through the reliability and security it provides. However, the adoption of blockchain in the education sector also poses a series of challenges. These include technical barriers related to the necessary infrastructure development, training needs for human resources, issues of privacy and compliance with existing regulations, as well as significant initial costs for implementation. In addition, acceptance from various stakeholders in the education sector should be considered to ensure smooth adoption of technology. To address these challenges and maximize the potential

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of blockchain technology in education, the study suggests strategic steps that include developing supportive regulations, investing in training and capacity-building for faculty and students, pilot projects to test the effectiveness of implementation, and adopting adaptive and flexible approaches by educational institutions. Through collaborative efforts between governments, educational institutions, and industry, blockchain has the potential to transform the way the world views academic registration and certification, making the process more efficient, secure, and globally recognized.
Keywords: Blockchain, Education, Potential, Challenges, Academic Record, Certification.

Introduction

Digital technology developments today are experiencing rapid growth and have a profound impact on various aspects of society, including in the lifestyle of society. The era of digitalization has brought a new way of life that relies heavily on electronic devices. (Anggraeni, R., & Maulani, I. E. 2023). Technology has become a tool that helps meet human needs, enabling ways of communicating, accessing information, and various other activities to be easier and more convenient. This digital transformation has affected not only individuals but also and society as a whole, including education. One of them is blockchain technology. (Mulyana, E., & Saepudin, A. 2006).

Blockchain is a technology that enables the transmission and recording of information in a transparent, secure, and decentralized manner. Blockchain was first developed to support the use of Bitcoin. However, this technology is now increasingly applied in various sectors, including education. (Zheng et al., 2018). The trend in the application of blockchain technology in education is growing rapidly along with the need for data transparency, security, and high levels of accuracy. Blockchain can be seen as a solution to solving this problem in the education sector (Belotti et al., 2019)

Although blockchain is considered a new innovation, its use is not entirely new in some educational contexts. There is a viewpoint that suggests that many aspects of blockchain are related to education, such as building a place needed to store and evaluate student skills, certifications, and portfolios. (Steiu, M. F. 2020).

In recent years, many innovative blockchain projects have been launched in the field of education. Some of these projects have developed systems that allow people to verify their qualifications and skills in a more automated, accurate, and autonomous way, or to democratize and speed up the process of payment of tuition fees through smart contracts. (Guustaaf et al., 2021).

Overall, having a secure, trusted, and decentralized blockchain platform can transform the way education is implemented and generate positive benefits for educational practitioners, students, and blockchain users in all sectors.

Besides, blockchain applications such as academic recording and certification are two very important aspects and involve many parties, such as students, lecturers,

educational institutions, and other stakeholders. Implementing blockchain technology in academic registration and certification processes can provide many benefits, such as improving data security and reliability, minimizing the risk of fraud, and facilitating verification processes. (Kolvenbach et al., 2018).

Today, academic recording and certification in many educational institutions is still heavily dependent on traditional methods that use physical documents and central databases. Centralized data storage like this has some weaknesses, such as vulnerability to manipulation and risk of data loss. In addition, the verification process is often time-consuming and costly (Gräther et al., 2018).

A physical document refers to a document that exists in a physical or printed form, such as a letter, contract, book, or other document that can be viewed or retrieved directly. To access information in a physical document, one must search and view the document directly. (SUTOPO, W. F. A. 2017). The advantages of physical documents are their authenticity and ease of reading and processing information. However, there are some weaknesses in using physical documents, such as the difficulty of finding and managing large numbers of documents, the risk of loss, depletion, and the need for large storage space. (Christiani, L. 2020).

Meanwhile, a central database refers to the storage of information in a centralized computer system. This database consists of data sets that are structured and organized into tables, columns, and rows. The information stored in the central database can be accessed and managed using specific software (Rezeki, S. G., & Nasution, M. I. P. 2023).

The advantage of a central database is the ease of searching, managing, and processing information. With the database, users can quickly search and retrieve specific information. In addition, a central database also provides the possibility of better managing and protecting information through user-level access permissions and security settings. However, central databases also have some weaknesses. One of them is the need for a strong technological infrastructure and training to manage and access such databases. Besides, security risks are also an aspect that needs to be considered in managing the central database. (Indrawati et al., 2019).

In practice, many organizations and institutions use a combination of physical documents and central databases. Physical documents are often converted into digital forms through scanning or e-copy processes for more efficient storage and access, while central databases are used to store and manage data that is more structured and accessible through computer systems. (Chandra, A. 2010).

However, with the presence of blockchain technology, the potential to overcome such challenges becomes more likely. In the blockchain, recorded data will be confirmed and verified by multiple parties through distributed processing, thereby enhancing data security and integrity. Moreover, the information will be recorded permanently and unalterable, making it easier to verify in the future. (Chandra, A. 2010).

However, the use of blockchain in education also has its own challenges. Some of the things to pay attention to are data security, the availability of adequate technological infrastructure, as well as legal and regulatory aspects related to the use of blockchain in the context of education.

In this study, it will explore further the potential and challenges that may arise in the use of blockchain in academic recording and certification in the education sector. Implementation of blockchain in education will also be investigated to evaluate success and challenges faced. It is hoped that the results of this research can make an important contribution to the development of a more efficient, transparent, and secure education system through the application of blockchain technology.

Research Method

The research method undertaken in this research is the study of literature. The literature research method is a research approach involving the collection, analysis, and presentation of information from various secondary text sources related to a particular topic (Campbell, 2014; Boddy, 2016). This research method allows to explore research references from trusted sources and conduct in-depth analysis of literary content relevant to the specified research purposes. (Christensen et al., 2011; Lancaster, 2007).

Literature study or literature review is a technique commonly used in academic and scientific research to compile information from a variety of literary sources related to research topics. In the process, the study of literature includes the collection, analysis, and presentation of data found from various literary works relevant to the subject being studied. (Gliner et al., 2011; Bahn & Weatherill, 2013).

Therefore, literary research methods become important in helping researchers to acquire a deep understanding of the current situation and research developments related to the topic being studied.

Result and Discussion

Blockchain Concept

Blockchain or blockchain is a digital technology that started with the idea of creating a virtual currency that is not dependent on a particular bank or financial institution, carried out by someone using a pseudonym named Satoshi Nakamoto in 2008. This concept is meant to address problems in the traditional monetary system, such as inflation and the wave of hacking. (Zheng et al., 2018).

Technically, a blockchain is a data structure consisting of related data blocks organized chronologically (Belotti et al., 2019). Each block is cryptographically connected to the previous block and contains information that is verifiable and unchangeable, such as financial transactions. Adding each new block to the block chain requires verification by the user network, thusining the security and integrity of the data contained in the network (Monrat et al., 2019).

Initially, blockchain technology was only used as a basis for the virtual currency Bitcoin. However, thanks to its ability to ensure data security and authentication, Blockchain technology was later applied in a variety of fields, such as logistics, health, and even elections (Wüst, K., & Gervais, A. 2018). Since then, blockchain has become a global phenomenon that drives innovation and is being integrated into many systems around the world, including education.

Thus it can be concluded that, Blockchain is a technology that enables data storage and management in a decentralized, transparent, and secure manner. Blockchain can be considered a digital ledger that records and manages transactions or other records in blocks that are connected chronologically and distributed across various computers or nodes within the network. (Bashir, I. 2017).

Each block in the blockchain contains a number of transactions or other information that is verified and encrypted. Each block also has a cryptographic link to the previous block, forming a chain of blocks that cannot be changed. Thus, any transaction or change within the blockchain must go through a validation process involving the consensus of most nodes in the network, thus ensuring the security, integrity, and accuracy of the data in it. (Dinh et al., 2018).

The uniqueness of blockchain lies in its decentralized nature. There is no single authority that controls or has full ownership of the blockchain. Instead, all the nodes in the network have a complete copy of the blockchain, and they work together to verify and store data. This makes the blockchain not easy to counterfeit or manipulate, and allows any transaction to be carried out directly between two parties without the involvement of third parties, such as banks or financial institutions. (Swan, M. 2015).

Blockchain applications are not limited to digital currencies, like Bitcoin, but are also used in a variety of applications and industries, such as logistics, banking, health, human resources, and more. Blockchain has the potential to improve security, efficiency, and reliability in various aspects of life and business. (Guo, H., & Yu, X. 2022).

In short, blockchain is a technology that enables data storage and management in a decentralized, transparent, and secure manner through the use of chronologically connected blocks and verified by a network of cooperating nodes.

In education, blockchain technology has provided solutions to problems related to qualification validation, academic data, payments, security, and identity management. Although still in the development phase, the potential of blockchain in supporting innovation in the world of education is very promising (Gräther et al., 2018).

Academic Recordings Using Blockchain

Academic recording is the process of making and keeping records of an individual's academic data, including information about academic achievement, courses taken, degrees earned, and so on. In the context of education, academic records are

important to ensure that information related to individual academic progress and achievement is documented. (Strage, A. 2004).

Academic records can involve various aspects, such as: 1) Personal information: Including name, identity number, and contact information of a student or student. 2) Schedule: Information about lecture schedules, dates and times of exams, as well as other academic activities. 3)Academic transcripts: A record of course scores completed and academic achievements. 4)Certificates and degrees: Information on certificates or degrees obtained after completing a particular academic program. 5)Academical experience: Information concerning participation in research, project, or other akademic event. 6)Personal records: Records made by a student/student about challenges, successes, or personal experiences during the course of lectures. (Parack et al., 2012; Mueen, A., Zafar, B., & Manzoor, U. 2016).

These academic records are useful in a number of ways. First, they can be used to monitor and improve individual academic progress. Moreover, they also provide the data needed in the process of recognition of academic qualifications, whether for the purposes of employment, the selection process, or continuing studies to a higher level. In addition, academic recording also facilitates educational institutions in managing student or student data efficiently.

In the digital age, blockchain technology can be used to increase security and transparency in academic records. By using blockchain, academic records can be kept securely, unmanipulated, and verified by stakeholders. Thus, the blockchain used to record and store academic data can be transparent, secure, and verifiable. Here are some of the advantages of academic recording using blockchain technology: 1) Security and Imutability: The academic data recorded in the blockchain is immutable (unchangeable) and resistant to counterfeiting. It ensures that student academic track records will not be abused or manipulated. 2) Transparency: Academic records on the blockchain are accessible to stakeholders, such as educational institutions, prospective employers, or students themselves. This ensures transparency and honesty about one's academic achievement. 3) Verification and Authenticity: Academic data recorded on the blockchain can be easily authenticated. For example, degrees, certifications, or other qualifications can be verified directly through the blockchain to prevent fraud. 4) Update and Transfer: Blockchain enables the update or addition of academic data in a transparent manner. For example, if a student completes an additional degree or training course, their academic records can be updated easily and transparently. 5) Private Access and Secure Data: Students can have exclusive access to their academic records using their own private key, while restrictions on access or data changes can be determined by a system that allows for secure data management. (Bakri et al., 2023; Haryani, et al., 2023; Qin et al., 2023).

Thus, using blockchain for academic records can provide advantages in terms of security, transparency, verification, and private access to academic data. It can help

maintain data integrity, boost public confidence, and facilitate academic processes, from admission to job search.

Certification Using Blockchain

Certification in education refers to the process of assignment or granting an official certificate to individuals who have qualified in a particular area of education or training. This certification indicates that the individual has attained a certain level of competence or expertise recognized by the educational authority or institution concerned. (Liu et al., 2020).

1) Certification Purpose: Certification in education aims to measure and recognize the level of knowledge, skills, and competence of a person in a particular field. With certification, an individual can demonstrate his ability in that field to prospective employers, educational institutions, or the general public. 2) Certification types: There are various types of certification in education, ranging from professional certification for teachers, tutors, or educational administrators, to certifications in areas of skill or specialized expertise such as information technology, foreign languages, or other technical expertise. 3) Certification process: The process to obtain certification can vary depending on the type of certification and the institution concerned. Typically, the certification process involves an examination or assessment that evaluates the knowledge and skills possessed by an individual. 4) Certification Benefits: Obtaining certification in education can provide a number of benefits, such as improving employment opportunities or promotion, increasing confidence and professionalism, giving recognition to abilities, and increasing competitiveness in the labour market. 5) Importance of Certification Validity: It is important to ensure that the certification obtained is valid and recognised by the authorities. Invalid or unrecognized certification can be detrimental to individuals and reduce the value of their competence. (Bowling, A. M., & Ball, A. L. 2018; Darling-Hammond, L. 2002; Gravells, A. 2014).

In an evolving context of education, certification is becoming increasingly important to demonstrate a person's competence and expertise. By obtaining recognized certification, individuals can increase recognition and opportunities in the world of education and the labour market.

Certification using blockchain technology is increasingly in demand in areas such as finance, health, education, and more. With the growing adoption of blockchain technology, obtaining top blockchain certification can help one to prepare itself in securing new career opportunities. There are various blockchain certification programs offered, such as IBM’s Blockchain certification program that includes classes introducing blockchain technology, understanding use cases, distributed application development, project management using the Hyperledger Fabric framework. (Capece et al., 2020).

The use of blockchain technology in certification has several advantages, including: 1) Data security: Blockchain uses sophisticated cryptography and peer-to-peer systems to store information decentralizedly and securely. The data stored in the blockchain is difficult to modify or manipulate, as every transaction has to be verified by a network of distributed nodes. This makes certification on the blockchain more secure and reliable compared to traditional certification documents that can be easily manipulated. 2) Transparency: Transactions on the blockchain are transparent and traceable by all parties involved in the network. Thus, certification in the blockchain has become more open and can be monitored by stakeholders. It can help prevent fraud and build confidence among the parties involved. 3) Efficiency: In traditional certification systems, verification processes often take considerable time and cost. With the use of blockchain, the verification process becomes easier and faster because the certification data is stored in a decentralized database that can be accessed by authorities quickly and accurately. 4) Authentication: Certificates in the blockchain can be accessed using a private key that is owned only by the certificate holder. This facilitates authenticating and validating certificates by the authorities. (Karamachoski et al., 2020; Ghazali, O., & Saleh, O. S. 2018).

With the above advantages, the use of blockchain in certification can provide better and more efficient solutions to authentication, verification, and data management information issues in various areas such as education, health, finance, and others.

Challenges in Adopting Blockchain in Education

Data Security

Adopting blockchain technology in education brings great potential for improving data security, transparency, and efficiency in various aspects such as certificate issuance, academic record retention, and verification of academic achievement. (Steiu, M. F. 2020). However, there are some data security challenges specifically facing the education sector in the implementation of this technology: First, Student Data Privacy. One of the major challenges is how to maintain student data privacy. In the blockchain, transactions or records made become immutable and theoretically accessible by anyone in the network. How to regulate which data is publicly accessible and which should remain private is a critical question (Ma, Y., & Fang, Y. 2020).

Second, Regulation and Compliance. Regulations like the GDPR in the European Union demand the right to forget, which means individuals can request the deletion of their personal data. This is not necessarily consistent with the permanent nature of records on the blockchain, which are not designed to be deleted or modified easily. Educational institutions need to find a solution that meets regulatory needs while implementing blockchain (Delgado-von-Eitzen et al., 2020). Third, Regulation and

Compliance. Regulations like GDPR in the European Union demand the right to forget, which means individuals can request the deletion of their personal data. This is not necessarily consistent with the permanent nature of a record on the blockchain, which is not designed to be deleted or modified easily. Educational institutions need to find solutions that meet regulatory needs while implementing blockchain (Rana et al., 2022).

Fourth, storage and key management. Blockchains often require private and public key management. These keys allow access to data associated with the digital identity of the user. Errors in storing or managing these keys can result in loss of access to the data or even theft of data (Delgado-von-Eitzen et al., 2020).

Fifth, storage and key management. Blockchains often require private and public key management. These keys allow access to data associated with the digital identity of the user. Errors in storing or managing these keys can result in loss of access to the data or even theft of data (Delgado-von-Eitzen et al., 2020).

Sixth, scalability issues. Although some blockchain solutions offer great scalability potential, the education sector may still face the challenge of implementing these solutions on a large scale. Considerations about how blockchain will manage large volumes of data from many educational institutions are still the subject of discussion (Mohammad, A., & Vargas, S. 2022).

Seventh, infrastructure readiness. Many educational institutions, especially in developing countries, may not have enough IT infrastructure to adopt blockchain technology. Besides, the lack of understanding and preparedness of IT staff and teachers can be an obstacle. (Holotescu, C. 2018).

Eight, attack on the network. Although the blockchain is known for its security, the blockchain system is not completely immune to attacks, such as 51% attacks on decentralized blockchain networks, where attackers gain majority control over the network and can manipulate data. (Mohammad, A., & Vargas, S. 2022).

In the end, the adoption of blockchain in education promises many advantages, but requires a careful and innovative approach to data security challenges.

Infrastructure Availability

Availability of infrastructure is one of the key components in the application of blockchain technology in the education sector. Such infrastructure includes not only the necessary hardware and software, but also human resources, regulation, and institutional support.

Infrastructure Challenges in Blockchain Application in Education: 1) Hardware and Bandwidth. To run a node or participate in a blockchain, it requires a computer with specific specifications capable of storing a complete copy of the blockchain (for full nodes) and having a stable internet connection as well as sufficient bandwidth to be able to continuously synchronize with the network. 2) Data storage. Blockchains may require a large storage capacity especially if the blockchain is used to store permanent

records such as academic transcripts or certificates. The existing infrastructure must be able to handle that ever-increasing volume of data. 3) Human Resources. Deep understanding of blockchain is still limited among educational practitioners and IT personnel in many institutions. The availability of human resources capable of managing and leveraging the blockchain is essential. Integration of blockchain technology with existing information systems (such as Education Management Information Systems or Learning Management Systems) is a significant challenge. Old systems must be able to communicate with the blockchain or need to be adapted to ensure smooth interaction. 5) Institutional and cultural support. Blockchain application requires support from all levels in an educational institution, as well as changes in organizational culture to adopt new technologies and implement them effectively. 6) Application fees. The acquisition, implementation, and maintenance of blockchain infrastructure could require huge financial investments, something that could be a challenge for educational institutions with limited budgets. 7) Regulation and Compliance. In accordance with existing regulations, the necessary infrastructure must comply with data security and privacy standards set by laws such as the GDPR in the European Union or local regulations. 8) Security and Maintenance. The infrastructure used for blockchain must be secure against cyber attacks, and there must be a system for sustained maintenance and updating (Holotescu, C. 2018; Ma, Y., & Fang, Y. 2020) The proper installation and utilization of infrastructure is crucial to the successful adoption of blockchain in the education sector, ensuring the security, smoothness, and continuity of educational activities in an ever-expanding digital environment.

Legal and Regulatory Perspective

The implementation of blockchain in the education system has significant legal and regulatory implications and poses many challenges. Legal and Regulatory Challenges in Blockchain Application: 1) Data Privacy Protection. The public blockchain theory means that all transactions and records on such systems can be read and verified by anyone. This may conflict with data privacy laws such as the GDPR in the European Union which demands the protection of personal data. 2) The right to be forgotten. Laws like the GDPR give individuals the 'right to be forget', which means they can ask for their personal data to be deleted. But on the blockchain, data cannot be erased or modified, making it contrary to the law. 3) Responsibility and Data Processing. For article 5 of the GDPR, the decentralized aspects of blockchain obscure the line of responsibility and make it difficult to determine the data controller. 4) Legal interoperability. Blockchains, especially those decentralized, operate across borders and may be subject to many jurisdictions. Differences in laws and their interpretation can lead to conflict and legal uncertainty. 5) Authentication and Electronic Law. There is uncertainty in many jurisdictions regarding the legal acceptance of blockchain

transactions and digital authentications. (Marcoux, R. M., & Vogenberg, F. R. 2016; Jacobsen et al., 2017).

In the end, to ensure that the application of blockchain in education runs smoothly and in line with laws and regulations, an open dialogue and collaboration between education, government and community law is needed.

Preparedness of lecturers and students

The readiness of faculty and students to adopt blockchain in the education system is a key factor in the success of the application of this technology. This readiness is not only related to technical aspects, but also conceptual understanding, readiness to adapt to new methodologies, and the ability to integrate technology into teaching and learning practices (Yusuf, F. 2021). Lecturer readiness, includes; 1) Conceptual understanding: a) Education and Training: Lecturers need training and workshops to understand the basics of blockchain, including data security, trust, transparency, and how these technologies can be used in education; b) Capacity to Integrate Technology: Developing the capacity to incorporate blockchain technology into curricula and teaching materials; c) Change in Teaching Methodology: Teachers must be prepared to adapt their teaching methodology by using blockchain technology to enhance student learning experience. 2) Technical readiness; (a) Tools mastery: Skill in using blockchain-based tools and platforms relevant to the education sector; (b) Resource utilization: Ability to harness and give students access to educational resources about blockchain (Iyer et al., 2022; Bjelobaba et al., 2022).

Student preparedness, including; 1) Awareness and Acceptance: a) Knowledge of Blockchain: Students need to be given a basic awareness of what blockchain is and its potential in a variety of sectors including education; 2) Interest in Learning: Will and desire to learn new technologies and adapt their use in the learning process. 2) Technical readiness: (a) Ability to Use Technology: students must have or have developed the ability to use tools and applications based on blockchain; (b) Active participation: Will to participate in blockchain-based learning systems, including the use of digital credentials and learning management systems (LMS) integrated with blockchain. (Lutfiani et al., 2021; Widayanti et al., 2021).

Provision of resources, learning opportunities, and environmental support will strengthen the readiness of faculty and students in the adoption and utilization of blockchain in the education sector, paving the way for innovation and improved learning quality.

Conclusion

Blockchain's potential in education encompasses several aspects such as high and non-falsification, transparency and ease of verification, operational efficiency, cross-border recognition, and innovation in learning methodologies. Meanwhile,

challenges in Blockchain Implementation include Technical Barriers, Human Resource Preparedness, Privacy and Regulatory Issues, Charges and Investments and Acceptance and Adaptation of Stakeholders. For a step forward, Blockchain technology must co-operate Regulation, SDM Development, Pilot and Trial, and Adaptation and Flexibility.

Overall, blockchain has huge potential to revolutionize academic recording and certification in education. However, its full success depends on the capacity of the education system to address regulatory, technical, and social challenges in order to use these technologies effectively and ethically.

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