BLOCKCHAIN IN HIGHER EDUCATION: SMART CONTRACT APPLICATION IN CREDIT STUDENT REGISTRATION

BLOCKCHAIN TRONG GIÁO DỤC ĐẠI HỌC: ỨNG DỤNG HỢP ĐỒNG THÔNG MINH TRONG VIỆC ĐĂNG KÝ TÍN CHỈ CHO SINH VIÊN

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Abstract - The research underscores the urgent need to adopt Blockchain technology in higher education to address the prevalent issues of cheating and hacking in student registration systems. These unethical practices negatively impact fairness and integrity within the educational sector. Blockchain and Smart Contracts offer a solution by ensuring secure, tamper-proof recording of academic records, which enhances transparency and operational efficiency. This technology not only prevents fraud in academic evaluations but also improves management by allowing real-time tracking of students' progress and facilitating data sharing with potential employers, thereby enhancing job prospects of post-graduation. The study further substantiates its claims by presenting an empirical model and conducting a SWOT analysis, demonstrating that while the implementation of Blockchain technology promises to enhance educational administration, it also entails significant investment costs.

Key words - Blockchain; Smart Contract; higher education; credit student registration

Tóm tắt - Nghiên cứu nhấn mạnh tính cấp thiết trong việc áp dụng công nghệ Blockchain tại các cơ sở giáo dục đại học, nhằm giải quyết vấn đề về gian lận trong hệ thống đăng ký tín chỉ sinh viên. Giải pháp sử dụng Blockchain và Hợp đồng thông minh bảo đảm việc lưu trữ hồ sơ học tập an toàn, góp phần tăng cường tính minh bạch và hiệu quả hoạt động. Không chỉ hạn chế gian lận trong đánh giá học thuật mà còn cải thiện quản lý bằng cách cho phép theo dõi tiến trình của sinh viên một cách chính xác và thời gian thực, đồng thời tạo điều kiện thuận lợi cho việc chia sẻ thông tin với các nhà tuyển dụng tiềm năng, từ đó mở rộng cơ hội nghề nghiệp sau khi tốt nghiệp. Nghiên cứu cũng bổ sung các bằng chứng thuyết phục qua việc trình bày một mô hình thực nghiệm và thực hiện phân tích SWOT, chỉ ra rằng việc triển khai công nghệ Blockchain mang lại nhiều lợi ích trong việc nâng cao chất lượng quản lý giáo dục, nhưng cũng đòi hỏi một khoản đầu tư không nhỏ.

Từ khóa – Blockchain; hợp đồng thông minh; giáo dục đại học; đăng ký tín chỉ

1. Introduction

In the increasingly digital age, Blockchain technology has become a groundbreaking trend not only in the financial sector but also in many other fields. What is especially important is that its topicality and importance are increasingly emphasized as this technology is widely adopted globally. Blockchain technology represents a revolutionary possibility in the way we view and execute transactions, manage data, and verify information [1]. This possibility is one of the reasons that Blockchain technology has attracted widespread attention not only from the financial industry community but also from many different sectors, including politics, healthcare, and education.

Figure 1. *Statistics of industries, those are most advanced in developing through Blockchain [2]*

Blockchain technology has continuously developed and proven its topicality through application in many important fields. The security and transparency of Blockchain have made it a useful tool for data management and transactions [3]. In many countries, Blockchain has been applied in many fields including education, there has not been a higher education institution applying this model in Vietnam. Therefore, this research will clarify the effectiveness of Blockchain through a hypothetical model when applied to the management system in higher education, then provide recommendations for applying Blockchain technology to education, specifically the credit student registration at higher education institutions.

2. The application of Blockchain in general

The state of Blockchain implementation in the education sector around the world is reflecting the determination of countries to improve the transparency and efficiency of education systems. Specifically, some pioneering countries such as Estonia, the US, the Netherlands Australia, and other countries (China, Canada, Malta, Latvia, Fiji) [4] have put Blockchain technology into use in education [5]. Estonia, with its Blockchain-based learning management system, has set an example for improving transparency and security in student learning information management. Some universities in the US and the Netherlands have also begun testing the use of
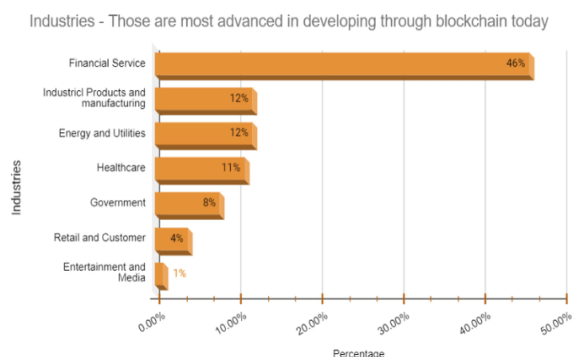
Blockchain to manage degrees and credits, thereby preventing fraud and making it easier for students to verify information. Australia has also joined the race with education related to Blockchain projects. All of these efforts are aimed at the common goal of improving the quality of educational services and ensuring transparency in credit management and student learning information. The application of Blockchain in education is not only a trend but also a potential solution to improve the performance of the global education system.

In Vietnam, Blockchain implementation in the education sector is still in the early stage and there is no official work. Although the potential of this technology to improve transparency and security of academic information is great, delays in adopting new technology and challenges related to regulation and information security is still in question. However, Vietnam can learn from pioneering countries and go further in researching and implementing Blockchain in the field of higher education. This can help improve credit management and student learning information, and also improve the quality of educational services.

The development of Blockchain technology has created an important opportunity to improve credit management and student learning information while minimizing fraud during the enrollment process. The research topic will provide solutions to enhance transparency, security, and efficiency in student credit registration specifically in Danang and Vietnam in general through applying Blockchain in the education system. The findings of this research are expected to contribute to the sustainable development of Vietnam's education system, potentially leading to significant improvements in educational practices and policies shortly especially in the industrial revolution era.

3. Blockchain and Smart Contracts in Education

3.1. Blockchain

Blockchain technology is a ledger that records and stores transaction information. It can be said that this is a database organized into chain links of information blocks (blocks), allowing development and expansion over time. One of the important characteristics of Blockchain is decentralization. Instead of data being stored centrally in a single data center or system, Blockchain distributes information across a network of nodes [6]. More than that, Blockchain provides high security by using encryption and digital signatures to verify the authenticity of data. It also allows transactions to take place directly between two parties without the need for a third-party intermediary. This can help reduce costs and time during the transaction process.

The Application of blockchain technology in higher education has demonstrated numerous benefits, as evidenced by several pioneering initiatives. Starting in 2014, the University of Nicosia implemented blockchain to verify diplomas and accept tuition payments via Bitcoin, marking a significant step forward in educational administration [4]. This technology has since been utilized

to publish all diploma projects on a proprietary platform, enhancing the security and verifiability of academic credentials. Furthermore, global entities like Sony Global Education, in collaboration with IBM, developed a platform in 2016 for managing student performance data, emphasizing blockchain's potential to transform the educational landscape [7]. Effectiveness of blockchain in higher education stems from its inherent properties: decentralized information storage ensures data integrity and distribution; immutable data trails enhance transparency and trust; transaction traceability without alteration promotes security; consensus mechanisms reduce the risk of data manipulation and eliminate the need for intermediaries; and the integration of smart contracts streamlines operations and financial transactions, reducing administrative overheads. Collectively, these features contribute to a more robust, transparent, and efficient management of educational records and processes, positioning blockchain as a key driver in the evolution of higher education systems.

3.2. Smart Contract

The Smart Contracts are contracts written in computer code and operate on a Blockchain or distributed ledger. They automatically validate, process, and enforce contracts based on the terminology written in the code [8]. Smart Contracts can be self-processing and partially or fully self-enforcing. When running on Blockchain, Smart Contracts operate automatically. If the conditions of a contract are met, values are exchanged according to the terms of the contract. Likewise, if the conditions in the contract are not satisfied, operations or payments can be refused even if written in the contract [9] . In today's life, Smart Contracts are being applied in many fields. Many large businesses have researched and applied Smart Contracts in their operations.

3.3. Recommendation for applying Smart Contract in Credit Student Registration

Blockchain is like a database, a form of storing records of values and transactions and anything can be stored on it. Blockchain offers huge advances in improving transparency when compared to current record-keeping practices in many fields, including education.

First, current higher education environment, credit registration has become an essential part of students. However, this process has encountered many complex problems and caused difficulties for students. There are many cases where students are not eligible to register for a course, but the system still allows registration or registers successfully such as a few days later informing them that registration has not been successful, etc [10]. And Blockchain in general and Smart Contracts in particular can help us solve the above problems.

It can be seen that data entered into the Blockchain cannot be modified, thereby avoiding fraud through disguising transactions and data history. Transactions put into the Blockchain will create a clear history of operations from the starting point, allowing for easy verification and inventory of every transaction or operation. When applied

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to credit registration, Blockchain will help us strictly control student actions on the website system, thereby managing and minimizing the problem of students registered credit who are attacked by scammers (Figure 2).
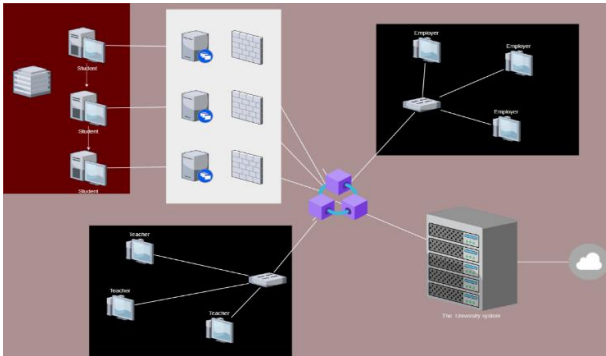

Figure 2. Model Assumption of Blockchain in Education System

Second, thereby eliminating the risk of unauthorized changes, fraud, server errors or crashes [11]. Disobeying terminology during the process of students registering for credit. Specifically, as contracts are archived, new versions are created while previous versions are still stored with correct timestamps on all versions. This not only helps create a more accurate summary of processes, but also helps the school manage the actions taken by students.

Third, if one of the conditions of a contract is not satisfied, the contract will not be performed, this helps students understand the Course Discription, Course Conditions (Prerequisite Course, Conditional Course, Parallel Course), Course Type (Compulsory, Elective, Optional General knowledge), Knowledge Blocs (General knowledge Professional knowledge, Foundation knowledge, Specialized knowledge, Soft and professional skills, Graduation Internship & Thesis) and other important information of Course Syllabus. All of them are shown on the system of course that students can register the potential course without studying prerequisite course.

In addition, when applying Blockchain in general and Smart Contracts in particular, it will help higher education institutes and their staffs manage information data sets more effectively and easily. All data will be stored in the cloud and every student can update their personal profile on the system with their official ID. Thanks to these benefits, the data set is shared with employers to expand job opportunities for students after graduation and help businesses easily find potential candidates.

Here is the Model Assumption of Blockchain in Education System as reseach's findings.

4. SWOT Analysis in the relation between Education and Blockchain

In the analysis of the intersection between education and blockchain technology, the author adopts the SWOT model to provide a comprehensive view of its application in educational systems. By using the SWOT framework, evaluating the Strengths, Weaknesses, Opportunities, and Threats associated with blockchain implementation, the author strategically identifies both the potential advantages and the challenges that may arise. This methodical

approach allows for a balanced assessment, highlighting how blockchain's strengths, such as enhanced security and transparency in student registration, could significantly benefit educational institutions. At the same time, it critically examines the weaknesses and threats, such as high implementation costs and technical complexities, providing a thorough understanding of the practical implications of blockchain technology in the educational sector. This detailed analysis ultimately serves to inform decision-makers about the viability and potential impact of integrating blockchain into educational practices.

Table 1. SWOT Analysis in the relation between Education and Blockchain

SWOT ANALYSIS	
Strengths	**Weaknesses**
- *Security*: Blockchain provides a strong and decentralized layer of security, helping to protect students' personal information and academic data from attacks and unauthorized changes. - *Transparency*: Using Blockchain in credit and certificate management helps create high transparency, giving students and schools the ability to verify information quickly and easily. - *Minimize fraud:* Blockchain and Smart Contracts help reduce the risk of fraud in course registration and credit management, ensuring the accuracy of information - *Process automation:* Smart Contracts have the ability to automatically execute processes and transactions, reducing manual work and time required.	- *Delays in implementation*: Implementing new technology such as Blockchain and Smart Contracts can require significant time and resources, especially in educational environments - *Tech literacy*: Understanding of Blockchain and Smart Contracts is limited in the education community, which can be a barrier to adoption; - *High cost:* This is the biggest problem for all higher education institutions.
Opportunities	**Threats**
- *Improve the quality of educational services*: Using Blockchain and Smart Contracts can help educational institutions provide higher quality services, from credit management to certificate verification. - *Increase transparency and trustworthiness:* Increasing transparency and trustworthiness in the education system can create trust from students and parents. - *Scalability and widespread adoption*: Blockchain has the potential to be applied not only in the traditional education system but also in other aspects of education, such as corporate training and online courses.	- *Changes in regulations and policies*: Changes in regulations and legal policies may affect the implementation of Blockchain and Smart Contracts in education. - *Challenges in managing personal data*: Managing students' personal information according to data privacy regulations can face challenges and legal risks. - *Competition and substitution:* Other technologies may emerge and compete with Blockchain and Smart Contracts in improving learning and credit management.

5. Challenges and Opportunities

Applying Blockchain technology and smart contracts in the higher education sector, particularly in course registration, presents a unique set of challenges and opportunities. One significant opportunity is the enhancement of transparency and security. Blockchain's decentralized nature ensures that academic records and course registrations are immutable and transparent, reducing the likelihood of fraudulent activities. Smart contracts can automate and streamline the registration process, making it more efficient by automatically enrolling students once prerequisites are met or fees are paid, thereby minimizing administrative errors and workload.

However, these advancements are not without their challenges. Implementing Blockchain technology requires substantial initial investment and a shift in the existing IT infrastructure, which can be a significant hurdle for institutions with limited resources. There is also the challenge of interoperability between different Blockchain systems, which is crucial for the transferability of academic credits and records across institutions. Additionally, there's a learning curve associated with the adoption of new technologies, requiring training for both administrators and students to effectively navigate the new system.

Privacy concerns represent another challenge, as the transparency of Blockchain could conflict with the need to protect students' personal information. It's essential to find a balance between transparency and privacy, possibly by leveraging Blockchain solutions that offer selective anonymity or permissioned access.

Moreover, a critical consideration in the application of Blockchain and smart contracts within education, particularly in course registration, is the substantial financial investment required. Implementing such cutting-edge technology necessitates a significant upfront cost, including the development or acquisition of the Blockchain infrastructure, training staff and students to adeptly navigate the new system, and ongoing maintenance and updates to ensure security and efficiency. This financial barrier can be particularly daunting for educational institutions that operate with limited budgets or those that must prioritize their expenditures across various needs. The cost factor extends beyond just the initial setup; it encompasses the need for continuous investment in technology updates to keep up with advancements in Blockchain technology and to address any emerging security vulnerabilities. Consequently, while the long-term benefits of enhanced transparency, security, and efficiency are compelling, the immediate financial implications pose a substantial challenge that institutions must carefully consider and plan for. The decision to invest in Blockchain technology for education requires a thorough cost-benefit analysis to ensure that the potential long-term advantages justify the initial financial outlay.

In summary, while Blockchain and smart contracts hold the promise of revolutionizing course registration and the broader educational landscape by making it more secure, efficient, and transparent, they also pose significant challenges that need to be carefully addressed. The successful implementation of these technologies will require not only overcoming technical and financial barriers but also ensuring that the privacy and autonomy of students are safeguarded.

6. Suggestions

Considering the opportunities and challenges of implementing Blockchain and smart contracts in education, particularly in the context of self-service course registration for students, it is imperative to offer strategic suggestions to not only the Vietnamese government and education department but also to all educational organizations, especially universities and colleges. Firstly, a phased approach to implementation can mitigate financial strain and technical challenges. Starting with pilot projects allows institutions to assess the technology's impact and address any issues on a smaller scale before wider deployment. Collaborative efforts between government bodies, educational institutions, and technology providers are crucial. Such partnerships can facilitate knowledge sharing, reduce costs through shared resources, and ensure the interoperability of systems across different institutions.

Moreover, it's important to establish clear regulatory frameworks and guidelines that support the adoption of Blockchain in education, fostering an environment where innovation can thrive while protecting the interests of all stakeholders. The government and education department should consider providing financial incentives or subsidies to encourage early adoption and offset initial costs for institutions. Capacity building is another critical aspect, with targeted training programs for administrators, educators, and students to ensure they are well-equipped to leverage the new technology effectively.

Additionally, institutions should prioritize privacy and data protection in their Blockchain implementations, possibly by exploring Blockchain architectures that offer privacy features suitable for educational environments. Finally, ongoing evaluation and adaptation are essential, with institutions remaining open to feedback and ready to iterate their approaches based on emerging trends, technological advancements, and the evolving needs of students and educators. By taking a strategic, collaborative, and adaptable approach, the Vietnamese government, education departments, and educational organizations can navigate the complexities of integrating Blockchain technology into education, unlocking its potential benefits while addressing the associated challenges.

7. Conclusion

The application of Blockchain in the field of education brings many significant advantages. Blockchain indeed gives a groundbreaking approach to the education sector, creating a trustworthy and transparent system. Using Blockchain in managing academic records in general and Credit Registration in particular helps authenticate and secure students' personal information, eliminating the risks of falsification and unauthorized modification when applying credit registration. Additionally, the application

of Blockchain in managing student academic records ensures integrity, allowing degrees and certificates to be easily and reliably verified. Furthermore, Blockchain creates a transparent and fair environment in education. Storing learning information and results on Blockchain helps all stakeholders such as student, staff, and academic staff to check and verify the accuracy of data. This helps avoid fraudulent practices and ensures that people are evaluated and ranked based on their true abilities.

In the future, the use of Blockchain will also help optimize the information management and sharing process among stakeholders in the education system, especially with domestic and foreign affiliated education systems. Important information such as academic results, course lists, teaching schedules, teaching contracts, etc can be securely stored and managed without loss or misuse. In particular, information sharing becomes faster and minimizes the process of students' study abroad, graduated students and transfer applications due to Blockchain can help manage student records, degrees, certificates and other academic achievements easily and securely. Through Blockchain, students can store and share their personal records safely and conveniently. At the same time, employers can also check eligibility and review student achievements quickly and reliably.

In the other hand, applying Blockchain in education also poses a number of challenges and limitations, including technology complexity, implementation costs, and the transition process from traditional system to Blockchain system. This requires focus and buy-in from stakeholders for successful implementation. In parallel, to achieve this goal, it is necessary to have the regulations from government and Ministry of Education which jointly propose solutions and create a legal corridor for development and application about Blockchain technology in the field of education.

In conclusion, the integration of Blockchain and smart contracts into the educational sector, especially for facilitating self-service course registration, presents a balanced landscape of significant opportunities and formidable challenges. Enhanced security, transparency, and efficiency stand as major benefits, while financial, technical, interoperability, and privacy concerns pose considerable hurdles. To navigate this landscape, a strategic approach involving phased implementation, collaboration between government, educational institutions, and technology providers, supportive regulatory frameworks, financial incentives, comprehensive training programs, and a strong focus on privacy is essential. Such an approach not only addresses the immediate challenges but also sets a foundation for leveraging Blockchain technology's full potential in revolutionizing educational processes and outcomes. By embracing these strategies, stakeholders can ensure a smooth transition towards a more innovative, secure, and efficient educational system.

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