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Research Paper

PUBLICEDUCHAIN: A FRAMEWORK FOR SHARING STUDENT-OWNED EDUCATIONAL DATA ON PUBLIC BLOCKCHAIN NETWORK

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ABSTRACT— Today, educational data, controlled centrally by educational institutions and administrative units, may be vulnerable to damage caused by natural disasters, political instability, and wars. Simultaneously, challenges arise in accessing this data for educational activities within the framework of exchange programs or lifelong learning. In the literature, there are numerous blockchain-based studies focusing on storing and sharing data in various fields. While several studies exist on blockchain applications for certification, verification, and data sharing in the education sector, a fully decentralized infrastructure has not yet been presented. To address this issue, it is proposed that data control should shift to the hands of students, who are the rightful owners of the data, rather than being solely in the hands of educational institutions. In alignment with the decentralized internet vision, public blockchain networks are considered the most suitable infrastructure for this purpose. To meet this need, a framework named PublicEduChain has been introduced within the scope of this study. PublicEduChain allows students to store their data in smart contracts created on the public Ethereum network, making it possible to share this information with any educational institution and administrative units. Educational institutions can access student data stored in smart contracts on the public Ethereum network through Learning Management System (LMS) applications and

can add data to these contracts. PublicEduChain ensures that data is managed under student ownership within a fully decentralized infrastructure. The practical steps in PublicEduChain, such as creating a smart contract, logging into LMSs with Ethereum IDs, and allowing LMSs to read and write data in the student contract, are explained in detail.

Index Terms – Blockchain, PublicEduChain, Ethereum, smart contracts, decentralized education, Learning Management System (LMS), educational data management, student-owned data, public blockchain, decentralized identity, educational record sharing, lifelong learning, data security.

I. INTRODUCTION

Globalization, the transition to a digital economy and Industry 4.0, the emergence of new professions and the processes of transition to a digital society have also strongly influenced the field of education. The pandemic period has contributed to the transformation of education, significantly expanded the possibility of online learning, and forced people to change their field of activity, improve their digital skills and receive additional education. In the current information age and globalization context, the support of international organizations like Erasmus+ and DAAD has led to a rise in the number of joint education programs and academic mobility initiatives. In these processes, there has also been a great demand for distance education and students are receiving education from different sources. Students who receive education from different sources within the scope of exchange programs or lifelong learning have difficulty in managing their past course and skill knowledge in different educational environments. Due to natural disasters, political instability and wars in countries, education systems and data can be irretrievably destroyed. Refugee students who have been forced to migrate to other countries due to the recent and still ongoing war between Ukraine and Russia face great difficulties. For example, most of the Ukrainian refugee university students in Poland did not have any documents confirming their educational background and Polish universities had to conduct interviews and special exams to assess their level of knowledge. Currently, the education sector is controlled by educational institutions and administrative bodies. Although the current model offers quality, reliability, and knowledge, it is not flexible in terms of time, money, and distance constraints. In addition,

companies that provide lifelong learning and certification services independently of each other and without any standard or quality control continue to grow. All these problems create the need to digitally transform the records of student credits and academic achievements into a flexible, reliable, and decentralized structure. Blockchain is considered the most suitable solution due to its features and services, offering the potential to overcome the aforementioned challenges.

Blockchain technology was first introduced in 2008 in an article published by a person or group with the pseudonym Nakamoto. According to Li et al. blockchain is an emerging technology that covers many computer sciences such as cryptography-based digital signatures and distributed consensus mechanisms. Thanks to its distributed and transparent structure, blockchain technology enables data sharing between peers in an encrypted and secure manner without a central authority. Blockchain, first known as the technology behind digital currencies, has been pioneering innovative solutions in many areas such as finance, supply chain, health, public services, and education in recent years. Blockchain has the potential to provide a connecting infrastructure between formal and informal learning by using it in the field of education, such as storing students' academic records and verifying and validating credits, certificates, and qualifications within the scope of lifelong learning. Alammary et al. presented several potential solutions offered by blockchain in their review study on blockchain applications in education.

In their recommendations for future studies, they emphasized the considerable benefits that blockchain could bring to cooperation and partnerships between educational institutions. They stressed the importance of conducting further research to explore how blockchain can facilitate and enhance collaboration in the future. In a review study on the use of blockchain in education, Loukik et al. highlighted application examples and benefits.

They specifically addressed the challenge of managing and sharing academic records for future studies. The authors proposed a study investigating how academic institutions could leverage blockchain to record various digital badges and share them across a network of other educational institutions, businesses, and relevant government agencies. According to Bhaskar et al, integration research should be conducted in

collaboration with the information technology (IT) sector to further explore the potential use of blockchain technology in education.

II. RELATED WORK

A. A proposed model for improving the reliability of online exam results using blockchain

In recent times, Learning Management Systems (LMS) have gained significant popularity, particularly due to the COVID-19 pandemic, offering improved effectiveness and efficiency. Within LMS, online exams have emerged as a critical tool for assessing students' performance and understanding of course material, playing a vital role in determining their progression. Ensuring the reliability and transparency of online exam results is imperative.

Any vulnerability, such as hacking, can adversely impact students' grades. Conventional online exam systems often store data centrally in databases like MySQL, making them susceptible to unauthorized access and manipulation.

This paper presents a blockchain-based framework to enable secure and peer-to-peer conduction and evaluation of academic exams. The framework uses hashing techniques to ensure data integrity and employs proof of stake mechanisms for enhanced security. Blockchain's decentralized data storage and cryptographic hashing for each block make it effective in safeguarding data integrity. The paper demonstrates the use of blockchain for developing online exams, storing each question and answer directly on the blockchain.

To achieve this, we have created a module that integrates with the Moodle learning management system. Through a comparative analysis with Moodle's default centralized storage, our module modifies the exam result storage, ensuring secure and tamper-proof data storage on the blockchain.

By leveraging the blockchain, exam data is reliably secured, maintaining integrity, and resisting manipulation. Our results show that data stored on the blockchain is entirely accurate, with no discrepancies compared to Moodle's standard approach. The blockchain network provides a reliable and immutable platform, preventing unauthorized changes to student data. In conclusion, our blockchain-based framework offers a robust solution for enhancing the security and reliability of online exam results.

By harnessing blockchain's decentralized and tamper-proof nature, we ensure data integrity and transparency, providing a more trustworthy assessment of academic performance.

B. *Addressing challenges with Ukrainian refugees through sustainable integration: Response of the educational community in Poland*

The impact of the war on higher education and research in Ukraine is devastating. A great many teachers, researchers and students had to flee ruined universities and research centres. Numerous universities worldwide have demonstrated solidarity with Ukrainian refugees. In an effort to develop effective support strategies, this study identifies specifics of migration from Ukraine caused by the war.

The questionnaire was developed to conduct a survey among 26 Ukrainian faculties recently employed at the University of Information Technology and Management in Rzeszow (Poland). Respondents reported great satisfaction with integration strategies based on perfect intra-university collaboration and comprehensive individual approach.

Four groups of challenges that can be influenced by an intervention at nation-wide, local and institutional levels were identified and then addressed in terms of empirical considerations, firsthand experience and survey findings.

C. *Ethereum-based information system for digital higher education registry and verification of student achievement documents*

Blockchain is a new and modern technology that is gradually being used in various fields due to its ability to decentralize and organize secure and reliable data exchange and storage. One of the related research areas generating increasing interest is the field of education, with particular focus on the digitization and automation of educational management processes and the ability to store and verify digital documents about student progress. The main goal of this study is to develop a platform that creates a unified digital register of students' educational achievements, which is one of the most pressing issues in the field of education, based on the Ethereum blockchain architecture. Blockchain is expensive; therefore, there is a need to consider performance criteria when evaluating any decision made about the technology, especially the most important aspects such as predicting traffic behavior, estimating transaction costs and providing the necessary

indicators of system quality and functionality. However, most research ignores the evaluation of performance indicators, such as throughput, the speed of transactions and the amount of data stored in the Ethereum blockchain database, which are the main evaluation criteria. This paper aims to eliminate this gap by evaluating the performance of the developed platform and by discussing the obtained experimental results. Thus, the main results of this work are the design and deployment of a blockchain platform and the analysis of its transaction costs. We conclude that the proposed blockchain solution is applicable as a system for the accounting and verification of loans and student academic achievements.

D. The future of continuous learning-digital badge and micro credential system using blockchain

Continuous Learning is seen as the key to remain competitive and effective at work. Very often, this also takes place outside the walls of a classroom. Nowadays Digital Badges and micro credentials are pathways to acknowledge and recognize achievements and specific skills of a learner. In this research, the different techniques used in existing blockchain-based educational systems have been reviewed and in the end, a novel web-based digital badge and micro credentials system which helps the learners to acquire the desired skills is proposed. For the Blockchain, Ethereum has been used and to develop the front end ReactJS has been used. A digital badging and micro-credential system consisting of quizzes and digital badges was built with Ethereum blockchain together with ipfs to store the badge image and firebase for examination, registration, and storing courses. The proposed system proved to be very much beneficial and addressed the inherent limitations of traditional learning content management systems (LCMS).

III. PROPOSED METHODOLOGY

The proposed PublicEduChain framework aims to address these challenges by decentralizing educational data management through blockchain technology. By using public Ethereum networks, PublicEduChain allows students to store their educational data in smart contracts, providing them with ownership and control over their information. This decentralized approach mitigates the risks associated with centralized data storage and enhances data security and accessibility.

Educational institutions can interact with student data through Learning Management System (LMS) applications, which can read from and write to these smart contracts. This

system facilitates seamless data sharing, reduces the risk of data loss, and supports more flexible and secure educational exchanges and lifelong learning opportunities.

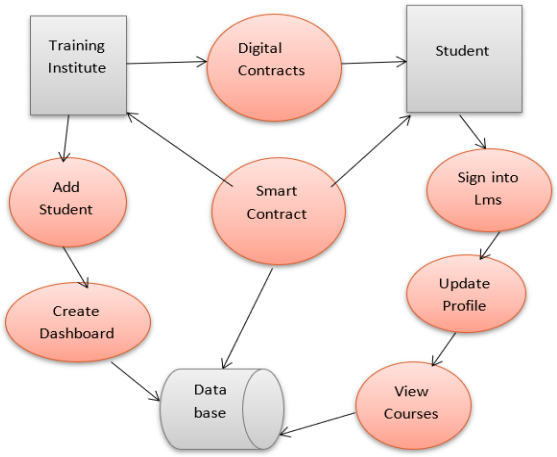
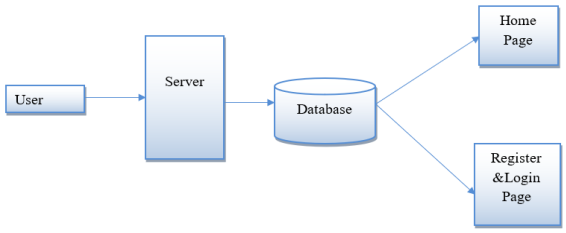


Fig. 1: System Overview

1. User Interface Design

To connect with server user must give their username and password then only they can able to connect the server. If the user already exits directly can login into the server else user must register their details such as username, password, Email id, City and Country into the server. Database will create the account for the entire user to maintain upload and download rate. Name will be set as user id. Logging in is usually used to enter a specific page. It will search the query and display the query.

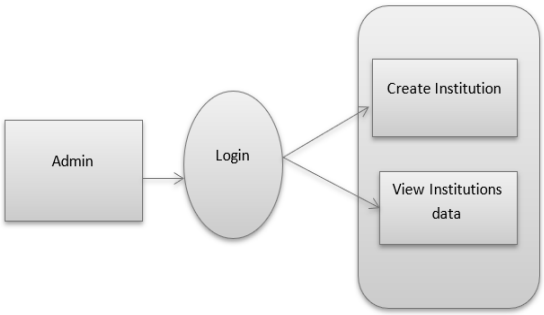


2. Smart Contract

Smart contracts are typically used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss. They can also automate a workflow, triggering the next action when predetermined conditions are met.

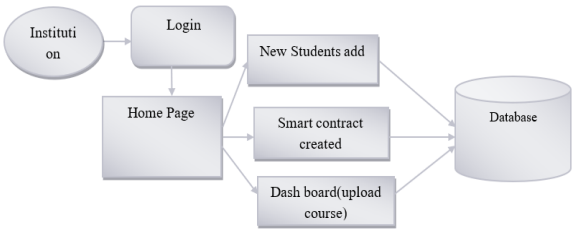
3. Admin

This is the third module in our project is Admin. Here admin will login with his password and Id who has created by the training educations. After admin login directly will navigate into admin home page. The purpose of admin is to add or create institutions and control instutions data.



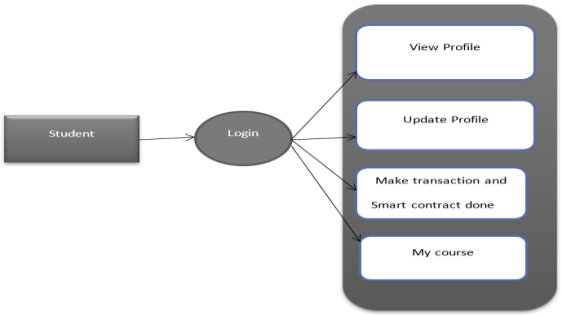
4. Educational Institutions

This is the fourth module in our project is educational institutions. Here institutions will login with hospital id and password. After login it will directly navigate home page there we can add students for course training and when they accept student immediately smart contract will be created and course data will be started.



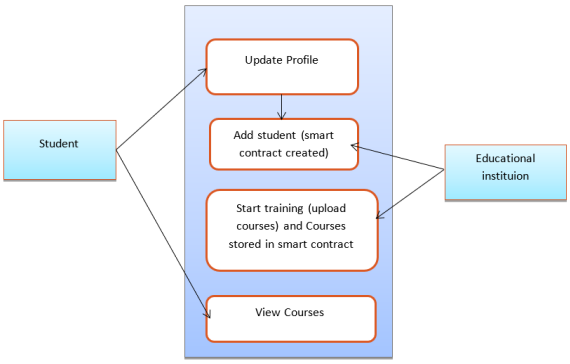
5. Student

This is the Fifth module in our project is Student. The student logging into the LMS application with their Ethereum account can update the address of the smart contract along with their profile information. The LMS application should have the capability to read the educational data stored in this smart contract and write data to this contract when necessary.



6. Upload

This is the Sixth module is Upload. The process of writing the course data to the smart contract with the address 0xA537C D933Ef5B2Ff097447bC30656149844ff 22f, which the student updated in his profile from the address 0xC6e723eF3f1 3C1cF0C5Df 6F0869676d8e5349 E79'.



IV. EXPERIMENTAL RESULTS AND ANALYSIS

The experimental results show that the proposed PublicEduChain framework enables secure and decentralized

management of student-owned educational records using the Ethereum public blockchain and smart contracts. The system allows seamless data sharing and updating through Learning Management Systems (LMSs) while ensuring data integrity, transparency, and student-controlled access. Experimental evaluation confirms the feasibility of creating smart contracts, authenticating users with Ethereum IDs, and securely reading and writing educational records..

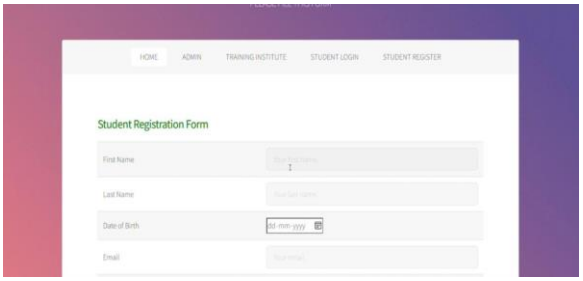


Fig. 2: Registration

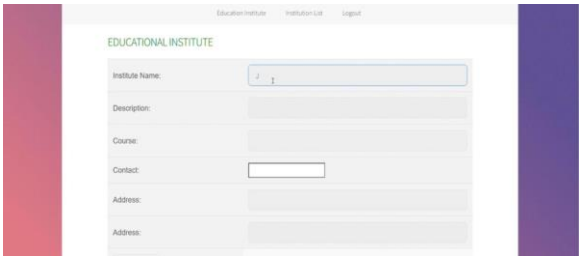


Fig. 3: Educational Institute

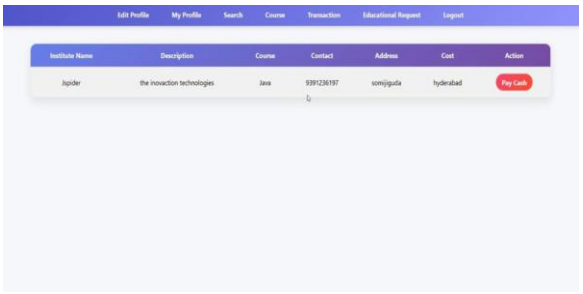


Fig. 4: Pay Cash

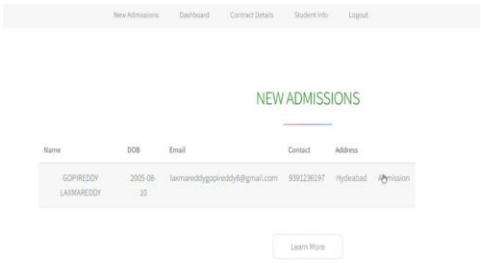


Fig. 5: Admissions

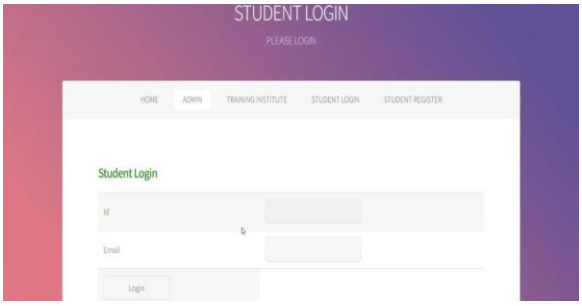


Fig. 6: Student Login

V. CONCLUSION

The PublicEduChain framework offers a transformative approach to managing educational data by shifting control from centralized institutions to the students themselves. By leveraging public blockchain networks like Ethereum, PublicEduChain enables students to store and manage their educational data securely and transparently through smart contracts. This decentralized approach not only mitigates risks associated with natural disasters, political instability, and other threats to centralized systems but also facilitates easier access and sharing of

educational records across institutions. With the ability for educational institutions to interact directly with student data stored on the blockchain, PublicEduChain enhances both the integrity and accessibility of educational information. This innovative framework thus represents a significant step towards a more secure and student-centric model for managing educational records.

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