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Enhancing The Security and Reliability of Online Exam Results Using Blockchain and Biometric Authentication

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Abstract- ***The rapid adoption of online education due to the pandemic has necessitated secure and reliable systems for conducting exams and managing results. This project presents a blockchain-based framework designed to securely manage online classes and exam results. By leveraging decentralized storage and cryptographic hashing, the proposed system ensures data integrity and prevents tampering. Smart contracts, developed using Solidity, facilitate secure data transactions on the blockchain, providing a reliable alternative to traditional centralized databases and mitigating risks of unauthorized data modification. However, the initial system lacks an authentication mechanism for students, which poses significant security concerns. To address this issue, we are incorporating biometric-based authentication to guarantee that only registered students can access their accounts and participate in exams. Additionally, to address the high costs associated with blockchain storage, we will implement a lossless compression algorithm to minimize the size of data stored on the blockchain. This integrated approach not only enhances security and accessibility but also optimizes resource utilization, making the online examination process more efficient and trustworthy in educational settings.***

Indexed Terms - Blockchain, online test, online examination systems, smart contracts, Ethereum, meta mask wallet, learning management systems, LMS, Moodle, centralized ledger database, CLD

I. INTRODUCTION

The COVID-19 pandemic has fundamentally transformed education globally, compelling schools and universities to transition from traditional classroom-based teaching to online learning environments. This shift has been facilitated by advancements in e-learning technologies, which enable the delivery of education through electronic applications and network-enabled platforms [1]. Online education offers several benefits, such as flexibility, accessibility, and scalability, allowing students to continue their learning without geographical or physical constraints [2].

Despite these advantages, the reliance on online education has highlighted significant challenges, particularly in the domain of online examinations. Ensuring the reliability, security, and integrity of online exam results has become a pressing concern for educators and institutions. Traditional methods of managing exams and results are often centralized, making them vulnerable to unauthorized access, data breaches, and tampering [3]. Moreover, the lack of robust authentication mechanisms in existing systems raises concerns about identity verification, leading to potential misuse or fraudulent activities [4].

Blockchain technology has emerged as a promising solution to address these issues. By leveraging its decentralized architecture and cryptographic features, blockchain can ensure data integrity, prevent unauthorized modifications, and enhance transparency in the management of online exam results [5]. Additionally, the incorporation of advanced

authentication mechanisms, such as biometric verification, further strengthens the security framework, ensuring that only authorized individuals can access sensitive information or participate in exams. This proposed model integrates blockchain technology with biometric authentication and data compression techniques to create a secure, reliable, and efficient system for online examinations, addressing the evolving needs of educational institutions in a post-pandemic world.

II. RELATED WORK

The rapid adoption of online education and e-learning systems has introduced significant challenges in ensuring secure, reliable, and tamper-proof examination systems. Numerous studies have explored innovative approaches to address these challenges, with blockchain technology emerging as a promising solution. The literature reveals substantial work focused on improving the reliability, transparency, and efficiency of online exam systems through blockchain-enabled frameworks and related technologies.

A study by Laxmi et al. (2024) [6] emphasizes the importance of reliability in online exam results and introduces blockchain as a key enabler for enhancing trust and transparency in the examination process. The authors highlight how traditional centralized systems are prone to data manipulation and security breaches, which undermine the credibility of online assessments. By leveraging the decentralized and immutable nature of blockchain, the study demonstrates how exam records can be securely stored and verified without the risk of unauthorized alterations. This approach ensures the integrity of exam results and fosters trust among stakeholders, including students, educators, and institutions.

Kadam et al. (2024) [7] propose a blockchain-enabled examination platform designed to provide a secure and scalable solution for academic assessments. The study discusses the implementation of smart contracts to automate key processes, such as candidate verification, exam scheduling, and result dissemination. Smart contracts act as self-executing agreements that eliminate the need for intermediaries, thereby reducing the risk of human error and fraudulent activities. The platform also incorporates real-time monitoring and audit trails, enabling institutions to maintain a high level of accountability and transparency in their examination processes.

The scalability of blockchain-based systems for online examinations is further explored by Shakila et al. (2024) [8], who present a framework that integrates blockchain technology with advanced data compression techniques. The study addresses the high storage costs associated with blockchain by introducing a lossless compression algorithm, which significantly reduces the size of data stored on the blockchain without compromising its integrity. This optimization makes blockchain-based solutions more feasible for large-scale deployment in educational settings, where vast amounts of data are generated during examinations. Additionally, the study underscores the importance of maintaining data integrity and security, which are critical for the credibility of online assessments.

Haque et al. (2023) [9] provide a comprehensive meta-analysis of blockchain technology's applications in the educational sector, highlighting its potential to transform traditional examination systems. The study identifies key advancements toward Education 4.0, where technology-driven solutions play a central role in enhancing learning outcomes and administrative processes. Blockchain's ability to provide a decentralized, secure, and tamper-proof record-keeping system is cited as a major advantage, particularly in the context of online examinations. The authors also discuss the integration of blockchain with other emerging technologies, such as artificial intelligence and the Internet of Things, to create holistic and adaptive educational ecosystems.

Farooq et al. (2021) [11] conduct a systematic review of blockchain-based online examination models, identifying common challenges and proposed solutions. The study categorizes these models based on their focus areas, such as security, scalability, and usability. One key finding is the need for robust authentication mechanisms to ensure that only authorized individuals can access the examination system. Biometric authentication emerges as a promising solution, offering a higher level of security compared to traditional password-based methods. The

integration of biometric systems with blockchain further enhances the reliability of online examination platforms, ensuring that exam records are linked to verified identities.

Bucea-Manea-Țiș et al. (2021) [12] highlight the broader implications of blockchain technology in sustainable higher education, emphasizing its potential to create more secure and transparent academic systems. The study discusses the role of blockchain in fostering academic integrity by preventing plagiarism and ensuring the authenticity of certifications and exam results. By providing a decentralized and immutable ledger, blockchain enhances the credibility of academic records and supports institutions in maintaining high ethical standards. The authors also explore the environmental impact of blockchain technology and propose strategies to mitigate its energy consumption, making it a more sustainable solution for educational applications.

Rahmani et al. (2021) [13] examine the integration of blockchain and the Internet of Things (IoT) in e-learning systems during the COVID-19 pandemic. The study highlights how this combination can address critical challenges in online education, such as data security, scalability, and real-time monitoring. Blockchain provides a secure infrastructure for storing and sharing data, while IoT enables seamless connectivity and data exchange among devices. This integrated approach is particularly beneficial for online examination systems, where the reliability and integrity of data are paramount. The authors also discuss the potential of these technologies to support adaptive learning and personalized education, further enhancing the effectiveness of e-learning platforms.

The empirical examination of blockchain's adoption in emerging markets by Chittipaka et al. (2023) [10] provides valuable insights into the factors influencing the implementation of blockchain technology in various sectors, including education. The study applies the Technology-Organization-Environment (TOE) framework to analyze the challenges and opportunities associated with blockchain adoption. Key findings highlight the importance of organizational readiness, regulatory support, and technological infrastructure in ensuring the successful deployment of blockchain-based systems. These insights are particularly relevant for educational institutions seeking to adopt blockchain for online examinations, as they underscore the need for a holistic approach that addresses technical, organizational, and environmental factors.

In conclusion, the literature demonstrates the significant potential of blockchain technology to revolutionize online examination systems by addressing key challenges such as security, transparency, and scalability. Studies emphasize the importance of integrating blockchain with other technologies, such as biometric authentication and data compression, to create comprehensive and efficient solutions. As educational institutions continue to adopt online learning and assessment methods, blockchain-based frameworks offer a reliable and sustainable approach to ensuring the integrity and credibility of exam results. Further research and collaboration among stakeholders are essential to overcome existing barriers and fully realize the benefits of blockchain technology in the educational sector.

III. MATERIALS AND METHODS

The proposed system is a blockchain[4]-based framework designed to securely manage online exam results. Blockchain is a decentralized [15] digital ledger technology that securely records transactions across multiple nodes, ensuring transparency and data integrity. Each transaction is grouped into a block, which is cryptographically linked to the previous block, forming an immutable chain. This structure guarantees that once data is recorded, it cannot be altered or tampered with, enhancing the reliability of exam results. The system facilitates the secure storage and retrieval of exam data, providing a robust alternative to traditional centralized databases. Additionally, it features a user-friendly interface that empowers educators to manage exam results effectively. By leveraging the inherent security and transparency of blockchain [4] technology, the proposed framework addresses critical concerns related to data manipulation and unauthorized access, ultimately fostering trust in the online examination process and improving the overall integrity of educational assessments.

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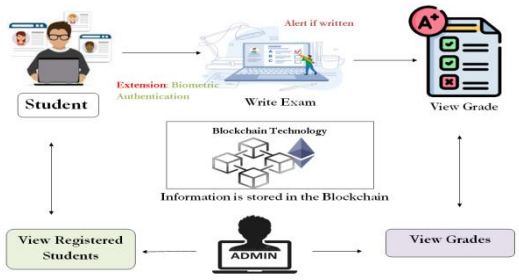

Fig.1 Proposed Architecture

The system architecture depicted in the image (Fig.1) leverages blockchain [4] technology to enhance the reliability and security of online exam results. The process begins with student authentication using biometric information, ensuring that the correct individual is taking the exam. Once completed, the exam data, including answers and grades, is securely stored on the blockchain [4]. This decentralized [15] ledger provides transparency and immutability, preventing tampering and ensuring the accuracy of results. Administrators can view registered students and their grades from the blockchain [4], maintaining a reliable and verifiable record of the entire examination process.

i) Blockchain:

Blockchain[4] technology ensures secure, tamper-proof storage of exam results by leveraging smart contracts. These contracts, written in Solidity, define functions for managing student data and grades. Deployed on the Ethereum [14] network, smart contracts[15] provide a transparent, immutable framework for storing and retrieving data. Once deployed, the contract is associated with a unique address, and Python code interacts with the contract to manage and retrieve data securely, ensuring the integrity of exam results.

ii) Decentralized Ledger:

The decentralized[15] ledger is a key feature of Blockchain[4] technology, where data is distributed across multiple nodes, ensuring redundancy and fault tolerance. This design enhances data availability since even if one node fails, the information remains accessible from other operational nodes. By spreading the data across different locations, the system becomes more secure and reliable. Additionally, decentralization helps in reducing the risks of data tampering, hacking, or unauthorized access, making it an ideal solution for storing sensitive exam results securely and efficiently.

iii) Biometric Authentication:

Biometric authentication provides an added layer of security by using unique physical traits, such as fingerprints or facial recognition, to verify a student's identity. This system ensures that only the registered student can access their account and take exams, preventing impersonation and unauthorized access. The biometric data is securely stored on the blockchain[4], ensuring tamper-proof identification verification. By integrating biometric authentication into the online exam system, the risk of cheating and fraud is significantly reduced, ensuring the integrity of the assessment process.

iv)Implementation:

1. Admin Module

- Login: The admin logs into the system using a predefined username and password.
- View Registered Students: Once logged in, the admin can view a list of all registered students, which includes their details and statuses.
- View Grades: The admin can access the grades of all students, allowing them to monitor academic performance.
- Storage Cost Graph: The admin can view a graph displaying the storage costs for the proposed blockchain[4] and any extensions applied, helping assess financial implications.

2. Student Sign-Up Module

- Registration: Students can register in the application by providing their details and uploading their biometric information. This biometric data is stored on the blockchain [4] for secure identification.

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- Data Storage: Upon successful registration, the student's details, along with their biometric information, are saved in the blockchain [4], ensuring data integrity and security.

3. Student Login Module

- Authentication: Students log into the application using their credentials and biometric image. The biometric data is compared with the stored data for authentication.

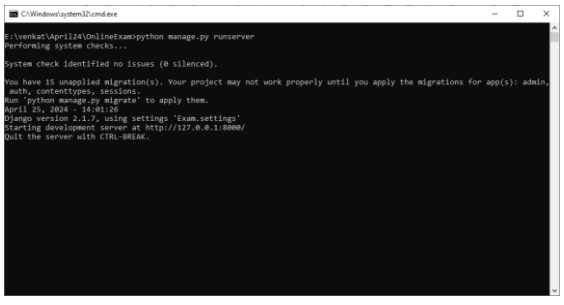
- Write Exam: After logging in, if the student has not already attempted the exam, they are presented with a list of questions. If they have already taken the exam, an error message is displayed. Students answer the multiple-choice questions, and upon completion, the exam data is saved in the blockchain [4], including their answers and grades.

- View Grades: Students can view their grades, which display marks for each question, along with the exam date and the time taken to complete the exam.

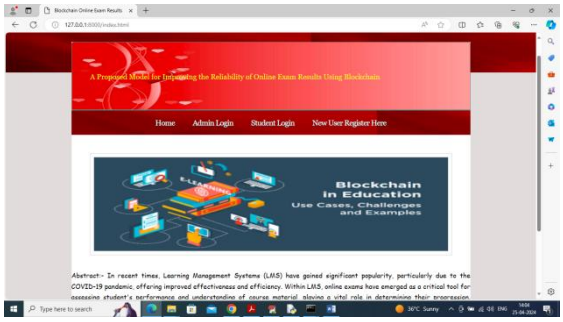
- Duplicate Attempt Prevention: If the same student tries to take the exam again, an alert is shown indicating they have already completed the exam, preventing duplicate submissions.

IV. RESULTS & DISCUSSION

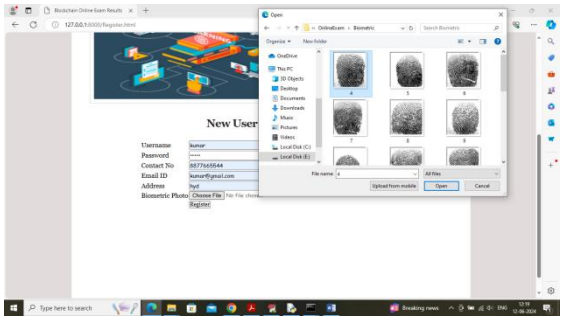
To run project double click on 'run.bat' file to start python server and get below page



In above screen python server started and now open browser and enter URL as http://127.0.0.1:8000/index.html and press enter key to get below page



In above screen click on 'New User Register Here' link to get below page



In above screen user or student entering sign up details and then upload biometric image and then press button to get below page

In above screen student sign up details saved in Blockchain and I am displaying all log details obtained from Blockchain after storage. Above log contains transaction no, block no, hash code and many other details and now click on 'Student Login' link to get below page

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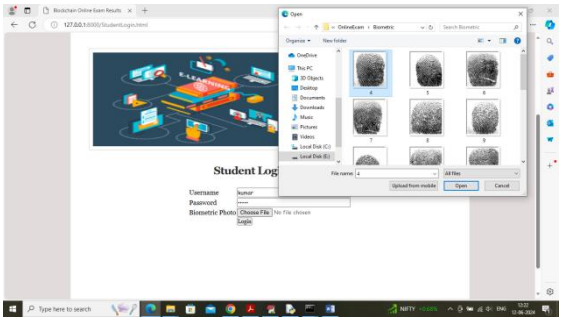
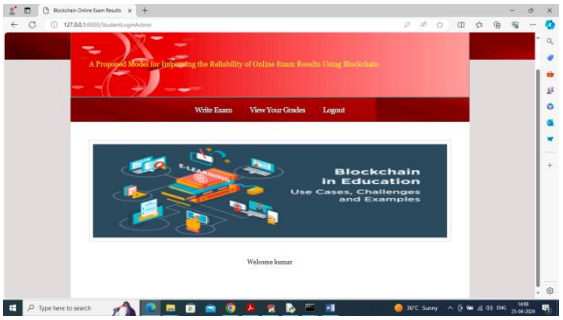
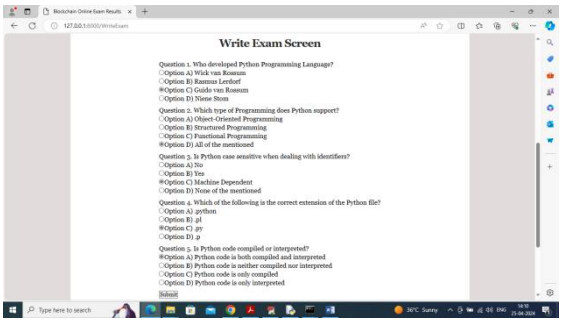


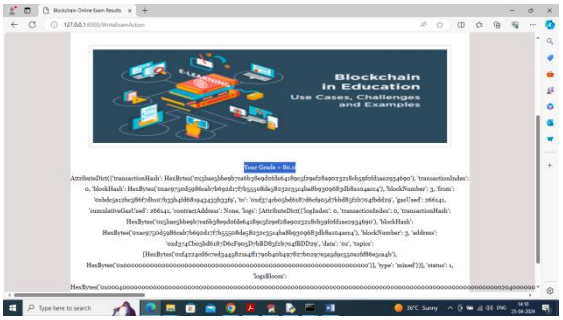
In above screen student is login along with biometric and after login will get below page



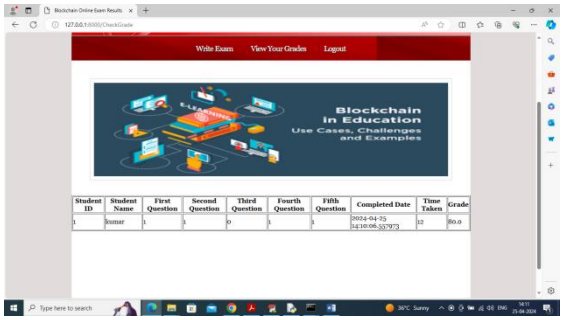
In above screen student can click on 'Write Exam' link to get below page with list of questions



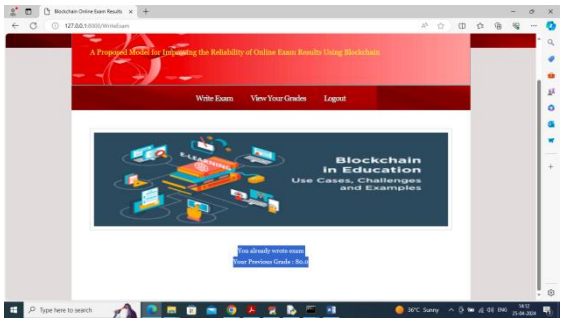
In above screen student will answer multiple choice questions and then press button to get below details



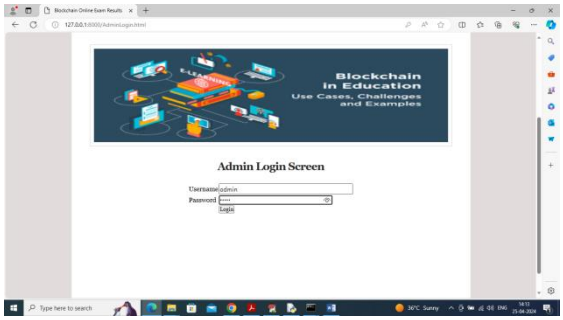
In above screen student got 80% grade and can see all details obtained from Blockchain after exam data storage and now click on 'View Grade' link to view student grade



In above screen student can view marks as 1 if he give correct answer for that question otherwise 0 and then displaying exam date and time taken to write exam along with grade. If same student try to write exam again then will get below alert



In above screen student will see alert as already wrote exam and now logout and login as admin



In above screen admin is login and after login will get below page

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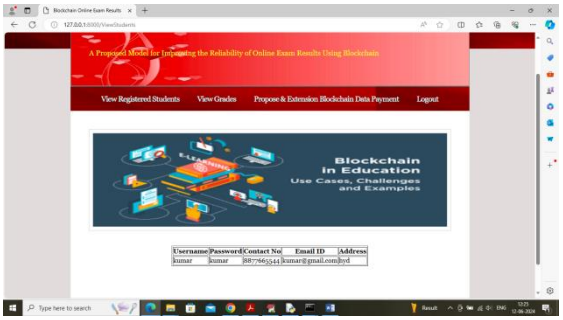
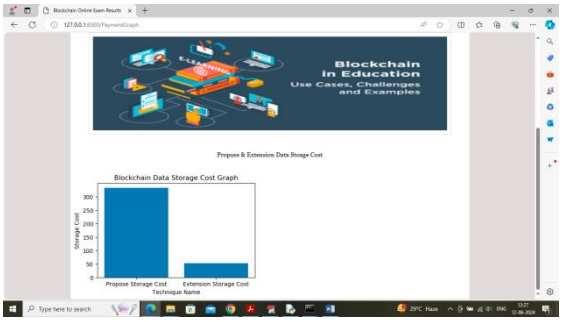
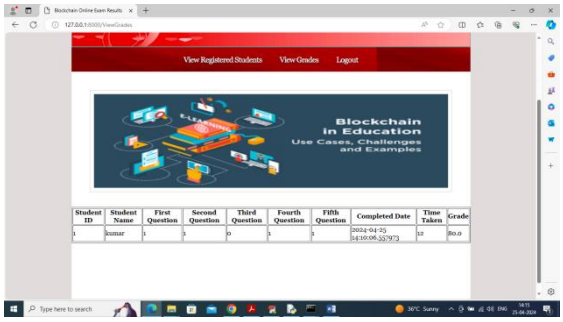
In above screen admin can click on 'View Registered Students' link to get below list of students



In above screen admin can view list of students and now click on 'Propose & Extension Blockchain Data Payment' link to get storage cost graph



In above graph x-axis represents technique name and y-axis represents 'Storage Cost' and in both technique we can see storage cost is reduced in Extension compression storage so by employing extension technique we can reduce Blockchain payment cost. Now click on 'View Grades' link to view grades of all students



In above screen admin can view grades of all students.

CONCLUSION

The project effectively utilizes blockchain technology to create a secure and tamper-proof system for storing examination results and student data, significantly minimizing the risks associated with centralized databases. By employing a decentralized[15] storage approach, it ensures data integrity and availability, eliminating issues related to single points of failure and unauthorized access. Incorporating biometric authentication further enhances security, ensuring that only registered students can log in and participate in examinations. This robust identity verification mechanism helps prevent impersonation, fostering trust in the examination process. Additionally, the implementation of lossless compression algorithms reduces the storage costs associated with blockchain technology, making the system more economically viable for educational institutions while preserving data integrity. The development of an intuitive user interface simplifies registration, login, and examination processes, enhancing user experience and encouraging participation in online assessments. By addressing the limitations of traditional systems, this project delivers a user-friendly and secure online examination platform that promotes transparency and trust in educational assessments, ultimately contributing to a more reliable and efficient online learning environment.

Incorporate AI and machine learning algorithms to analyze student performance data, providing personalized feedback and adaptive learning pathways to enhance educational outcomes. Adapt the project for use in various educational settings, including universities, vocational training centers, and online learning platforms, broadening its impact on the

education sector. Include advanced analytics and reporting features to offer deeper insights into student performance trends, exam integrity, and overall system effectiveness. Ensure compliance with educational regulations and standards, potentially developing a standardized framework for online examinations that can be adopted globally.

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