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BLOCKCHAIN-BASED ACCESS CONTROL MODEL FOR STUDENT ACADEMIC RECORD WITH AUTHENTICATION

[1] P Ganesh Kumar, [2] P. Akshitha,[3] D.Meghana,[4] V.Mounika

[1]Associate Professor in Department of Information Technology, Bhoj Reddy Engineering College for Women

[2,3,4,]UG Scholars in Department of Information Technology, Bhoj Reddy Engineering College for Women

Abstract

In an era where digital transformation is reshaping education, the secure management of academic records has become increasingly critical. Traditional centralized systems used by educational institutions are prone to data breaches, unauthorized access, and manipulation, thereby compromising the integrity of academic credentials. This project proposes a Blockchain-Based Academic Record Management System that leverages the decentralized and tamper-proof nature of blockchain technology to ensure secure, transparent, and efficient storage and retrieval of academic records. The system aims to provide immutable data storage, streamline the verification of credentials, and enforce strict access control through smart contracts. By eliminating the dependency on centralized servers and enabling real-time, trustless verification, this solution addresses the shortcomings of conventional systems. The proposed framework ensures authenticity, confidentiality, and traceability of records, paving the way for a more secure and efficient academic environment.

I INTRODUCTION

Academic records are vital assets that reflect the educational accomplishments of students and serve as a cornerstone for future academic and professional pursuits. However, the conventional methods adopted by most educational institutions for storing and managing these records rely on centralized databases that are increasingly vulnerable to cyber threats, data corruption, and human errors. These vulnerabilities raise serious concerns regarding the authenticity and security of student credentials. Moreover, verifying academic records typically involves time-consuming manual processes that require significant administrative effort and are susceptible to errors or delays. With the growing demand for secure and rapid verification in both academic and professional domains, the limitations of traditional systems have become more apparent.Blockchain technology, with its decentralized, immutable, and transparent characteristics, presents a transformative solution to these challenges. By distributing data across a network of nodes and employing cryptographic techniques, blockchain can ensure that academic records remain tamper-proof, auditable, and accessible only to authorized users. This paper introduces a Blockchain-Based Academic Record Management System designed to enhance data

security, integrity, and accessibility. The proposed system leverages smart contracts to automate access control and verification processes, ensuring that records can be shared securely with minimal administrative intervention. Through this innovation, institutions can not only protect sensitive academic data from unauthorized manipulation but also streamline the credential verification process for employers, universities, and other stakeholders.By embracing blockchain technology, this project aims to redefine the way academic records are managed, verified, and shared, ensuring a trustworthy and future-proof infrastructure for education systems worldwide.

II LITERATURE SURVEY

With the increasing digitization of academic environments, the need for a secure, reliable, and transparent system for managing educational records has become more pressing than ever. Traditional systems, which rely heavily on centralized storage and manual verification, often suffer from issues such as data breaches, unauthorized access, inefficiencies, and high administrative costs. In response to these challenges, researchers have explored the use of blockchain technology as a potential solution to ensure the integrity and authenticity of academic records. Several noteworthy studies have laid the groundwork for blockchain-based academic record systems, each contributing unique insights and innovations.

Norah Alilwit, in her work on authentication systems, proposed the use of digital identities stored on the blockchain to securely retrieve academic records. Her approach replaces conventional login and verification systems with unique digital IDs, allowing for enhanced data security and easier access to official documents. This system ensures that student records cannot be tampered with and can be accessed only by authorized individuals, significantly reducing the chances of identity theft or fraud. Her research underlines how blockchain can provide a secure foundation for managing not just academic records but also a variety of legal and institutional documents.

Satoki Watanabe and Kenji Saito focused on the efficient verification of documents by introducing a Merkle tree-based method for selective disclosure. Their system allows users to verify specific pieces of data without having to expose or process the entire record. This method is particularly useful in scenarios where only part of a document needs to be verified—such as confirming a degree or grade—without compromising the privacy of the full transcript. Their approach supports lightweight and scalable verification, making it well-suited for large-scale educational systems.

Another significant contribution comes from Joberto S. B. Martins and Emanuel E. Bessa, who developed a blockchain-based educational repository specifically designed for storing transcripts and certificates. Their system offers a

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decentralized way to manage academic documents, eliminating the need for intermediaries and manual processes. By placing academic records on the blockchain, institutions can provide students and employers with immediate access to verified documents, thereby reducing processing times and ensuring data integrity. Their work demonstrates how blockchain can simplify the document-sharing process while maintaining trust between stakeholders.

Patrick C. K. Hung and his colleagues proposed a permissioned blockchain model where students have control over their own records and can share them with institutions or organizations as needed. In this system, a designated coordinator verifies and approves all records before they are added to the blockchain, ensuring that only accurate and authentic data is stored. Their solution not only enhances security but also supports applications for scholarships and job opportunities by making the verification process faster and more reliable. This model emphasizes both access control and trust, which are essential in academic environments.

Lastly, Omar Musa and his team introduced a decentralized authentication system that utilizes the immutability of blockchain to prevent unauthorized changes to stored data. Their model removes the need for a central authority, reducing the risk of a single point of failure. By storing records across a distributed ledger, their system ensures that once a record is uploaded, it cannot be altered or deleted, thus preserving its authenticity. This approach offers a robust alternative to traditional centralized authentication models, especially in situations where trust and security are critical.

III EXISTING SYSTEM

Currently, most educational institutions rely on centralized databases to store and manage student academic records. While these systems are widely used, they come with several significant drawbacks. Centralized databases are vulnerable to cyberattacks such as data breaches, unauthorized access, and injection attacks, which can compromise sensitive student information. Furthermore, many institutions still depend on physical documents for verification, a process that is both time-consuming and susceptible to damage, loss, or forgery.

Another major issue with centralized systems is the presence of a single point of failure. If the central server experiences downtime due to hardware failure, cyberattacks, or natural disasters, access to student records can be interrupted, potentially disrupting administrative and academic processes. This central dependency not only risks data integrity but also limits the system's scalability and resilience. As a result, there is a growing need for more secure, reliable, and efficient alternatives to traditional record management systems.

IV PROBLEM STATEMENT

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Educational institutions predominantly rely on centralized servers to store and manage student academic records. While this approach is widely used, it exposes sensitive data to various security risks, including breaches and unauthorized tampering. Moreover, traditional methods for verifying student credentials are often slow, resource-intensive, and dependent on manual checks, which can lead to inefficiencies and delays. The absence of a transparent and tamper-proof mechanism further complicates efforts to ensure the authenticity and integrity of academic records, making it difficult to fully trust the system.

V OBJECTIVE

The primary goal of this project is to develop a blockchain-based Academic Record Management System that enhances the security, transparency, and efficiency of academic data handling. By decentralizing storage and utilizing blockchain's immutable ledger, the system aims to provide a robust, tamper-resistant platform for securely maintaining academic records. This solution will simplify and accelerate the verification process, enabling quick and reliable authentication of student achievements. Additionally, the system will incorporate strong access control measures to ensure that only authorized users can view or modify records. Ultimately, the project seeks to safeguard the integrity, confidentiality, and authenticity of academic data, while minimizing the vulnerabilities and limitations inherent in traditional centralized systems.

VI PROPOSED SYSTEM

The proposed system aims to tackle the common problems faced by traditional centralized academic record management by using blockchain technology to create a decentralized and secure solution. Unlike centralized databases that are vulnerable to hacks, data tampering, and server failures, this system spreads data across multiple nodes, making it much harder for anyone to alter or lose records. The design consists of three main parts that work together to improve security, transparency, and ease of access. there's the authentication layer. Here, each student's academic records are tied to unique digital keys, which act like a secure digital signature. Whenever someone—like a university or employer—needs to verify a credential, they can do so quickly and safely using these keys. This not only speeds up the whole verification process but also cuts out the need for middlemen, reducing delays and errors. Next is the access control layer, which keeps a detailed, unchangeable log of every action taken on the records. Whether someone views, updates, or shares a record, the system records it on the blockchain. This transparency means it's easy to track who did what and when, preventing unauthorized changes and boosting trust in the system. It also means only approved people can make changes, keeping sensitive information private and safe. Finally, the data storage layer

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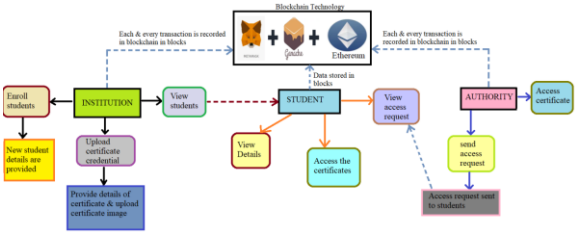
securely holds the records themselves. Instead of storing all the data in one place, the system encrypts the records and spreads them across a network of computers. This makes the records much safer from things like server crashes or cyberattacks, and ensures they're always available when needed. The encryption also protects students' personal information, helping to comply with privacy laws and regulations.

VII SYSTEM ARCHITECTURE



VIII IMPLEMENTATION

The implementation of this system revolves around several interconnected modules designed to ensure secure, transparent, and efficient management of academic records.

The process begins with **Student Enrollment**, where each student's information is securely recorded on the blockchain. Every student receives a unique blockchain ID that serves as a digital identity, enabling secure and seamless access to their academic records throughout their education. This ID also ensures real-time synchronization with existing institutional databases, reducing the risk of data loss or tampering by decentralizing the information storage.

Next, the **Credential Management** module enables institutions to issue academic credentials that are cryptographically secured and permanently stored on the blockchain. These credentials are immutable, meaning they cannot be altered or forged. Students can share their credentials easily via blockchain-generated links, simplifying verification for employers and other institutions. The system is built to comply with global standards, ensuring these credentials are universally recognized and trusted. Additionally, automated validation reduces manual effort, saving time and improving the reliability of credential issuance.

To safeguard the authenticity of data and transactions, the system incorporates a **Data Authentication** module that uses Ethereum-based smart contracts. These contracts verify user identities and transaction legitimacy with cryptographic precision, ensuring only authorized users can access or modify records. Every transaction is logged immutably on the blockchain, providing a transparent and traceable audit trail. The system also integrates decentralized identity protocols, which give users enhanced control over their personal data and privacy.

The **Access Control** module empowers students with full ownership over their academic records. Students can review and approve or deny access requests, granting permissions for specific time frames when necessary. All access attempts are immutably recorded on the blockchain, creating a

secure and auditable trail that fosters accountability and trust.

For verification purposes, the **Certificate Verification** module enables instant validation of certificates stored on the blockchain. Each certificate is encrypted, timestamped, and stored immutably to guarantee authenticity and prevent forgery. Authorized parties such as institutions and employers can quickly verify credentials using unique blockchain keys, making the verification process faster and more reliable compared to traditional manual checks.

The system also includes a **Record Access** module that offers a user-friendly interface for students and institutions to securely retrieve and view academic records. Real-time data updates maintain consistency across platforms, while advanced search and filtering options help users find specific records efficiently. Role-based access controls ensure that sensitive information is only visible to authorized users. The transparency of blockchain technology allows users to track any changes made to the records, reinforcing trust in the system.

IX RESULTS

The implemented blockchain-based Academic Record Management System demonstrates significant improvements in security, transparency, and efficiency compared to traditional centralized methods. The decentralized architecture successfully eliminates the single point of failure, reducing risks of data loss and tampering. The use of unique blockchain IDs ensures seamless identity management and reliable tracking of student records throughout their academic lifecycle.Credential issuance and verification processes were streamlined through cryptographically secured, immutable records, enabling quick and trustworthy validations by institutions and employers. The Ethereum-based smart contracts effectively authenticated users and transactions, providing a secure and auditable environment with minimal manual intervention.

Access control features empowered students to manage permissions transparently, reinforcing data ownership and privacy. Instant certificate verification using blockchain keys eliminated delays caused by manual checks, significantly improving the responsiveness of verification workflows.The multi-layer blockchain security approach provided robust protection against unauthorized access and cyberattacks, while decentralized data storage enhanced system availability and resilience. The intuitive interface for record access and management allowed users to efficiently retrieve information with role-based permissions, maintaining confidentiality.

X CONCLUSION

This a comprehensive blockchain-based Academic Record Management System designed to overcome the limitations of conventional centralized systems. By leveraging blockchain's decentralized and immutable nature, the system ensures the integrity, confidentiality, and

authenticity of academic records. The modular design, incorporating student enrollment, credential management, data authentication, access control, and certificate verification, provides a seamless and efficient workflow for all stakeholders. The implementation of Ethereum smart contracts and cryptographic techniques ensures secure transactions and user identity verification, while decentralized storage and multi-layered security mechanisms protect against data breaches and system failures. Students gain greater control over their personal academic data, fostering trust and transparency.

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