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Blockchain-Based System For Handling Academic Records

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***Abstract*—** The Academic Records Blockchain-Based System project is dedicated to establishing an unyielding anti-forgery system for academic documents, including mark sheets, transcripts, diplomas, and certifications. Our unwavering goal is to guarantee the authenticity of academic records, diminish the prevalence of counterfeit certificates, and streamline the document verification process, ultimately saving time and resources for all stakeholders. Through the adept utilization of blockchain, IPFS, and hash functions, we are committed to providing an exceptionally reliable method for verifying the legitimacy of certificates. This groundbreaking initiative centers around three pivotal entities: the Issuer, responsible for creating and issuing electronic certificates (e.g., universities awarding bachelor's degrees), the Verifier, who rigorously authenticates the certificates (e.g., prospective employers conducting background checks), and the Student, who has secure access to the received documents

Keywords— Ethereum Blockchain, Smart Contracts, React, Solidity.

INTRODUCTION

Our project aims to implement an advanced anti-forgery system for academic documents, including mark sheets, transcripts, diplomas, and other certificates. Our goal is to guarantee the authenticity of academic records, reduce counterfeit certificates, and save time and resources for all parties involved in document verification. In today's world, managing academic records can be inefficient and error-prone. However, with the emergence of blockchain technology, we have a promising solution to transform the way academic records are handled. Traditional record-keeping methods are susceptible to errors, delays, and fraud. With the introduction of Ethereum blockchain technology, we are ushering in a new era of transparent, secure, and decentralized record management.

By harnessing the decentralized infrastructure of the Ethereum blockchain, we eliminate the need for centralized intermediaries. This cultivates a trustless ecosystem where transparency and responsibility take precedence. Every transaction and adjustment to academic records is meticulously documented on the blockchain, establishing a clear and traceable audit trail for all parties involved.

By utilizing smart contracts, the IntraPlanetry File System, and Hash Functions, a seamless interaction is enabled among students, educational institutions, and employers. This facilitates real-

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time transfer and validation of academic credentials, improving record management efficiency and reducing the risk of fraud misrepresentation.

Envision a digital ecosystem where academic achievements, certifications, and credentials are securely stored and easily accessible to authorized individuals, all powered by the innovative capabilities of the Ethereum blockchain. Our project seeks to revolutionize the management of academic records, offering a seamless and trustless platform for students, educational institutions, and employers.

By leveraging Ethereum's smart contract functionality, we enable automated and transparent interactions, ensuring the integrity and immutability of academic records throughout their lifecycle. With our system, students can securely store and share their academic achievements in a tamper-proof environment, providing a verifiable and immutable record of their educational journey. Educational institutions can streamline the issuance and verification process of academic credentials, reducing administrative burdens and enhancing trust in the authenticity of records. Furthermore, our Ethereum blockchain-based system prioritizes data privacy and security, employing encryption techniques and access control mechanisms to safeguard sensitive information from unauthorized access or tampering.

LITERATURE REVIEW

An effective anti-forgery system that can be used for academic documents, including mark sheets, transcripts, diplomas, and other certifications, is what the Blockchain-Based system for Handling Academic Records project focuses on to accomplishing.

Bessa, Emanuel E., and Joberto SB Martins. "A blockchain-based educational record repository." arXiv preprint arXiv:1904.00315 (2019).[2] The paper introduces a blockchain-based repository for handling, educational records. It discusses the benefits of using blockchain for safely storing and sharing the academic credentials of the student. The system allows for easy verification of academic records by employers and educational institutions. It proposes a decentralized approach, where students have control over their records and can share them selectively. Overall, the paper highlights the potential of blockchain in revolutionizing the management of educational records.

Palma, Lucas Machado da (2020) The paper "Blockchain-Based Academic Record System" introduces a system for managing academic records using blockchain technology. It highlights the security and transparency benefits of blockchain in this context. The system utilizes smart contracts to automate the verification and issuance of academic credentials. It proposes a decentralized approach to ensure data integrity and accessibility. Overall, the paper showcases the potential of blockchain in transforming the management of academic records.

Alnafrah, Ibrahim, and Suliman Mouselli's paper, "Revitalizing blockchain technology potentials for Smooth Academic Records Management and Verification in Low-income Countries," published in the International Journal of Educational Development in 2021, delves into the potential of Blockchain technology to enhance academic records management in low-income countries. The paper addresses challenges such as document forgery and the absence of centralized systems, proposing a blockchain-based solution for securely storing and verifying academic records. It emphasizes the potential of blockchain to reduce fraud and improve the efficiency of record management. Overall, the paper underscores the transformative impact of blockchain technology on academic records in low-income countries.

Saleh, Omar S., Osman Ghazali, and Muhammad Ehsan Rana.” Blockchain-based framework for educational certificates verification.” Journal of Critical Reviews (2020).[5] Applications in Document Verification: Trends and Challenges Ghazali critically analyzes the potential of

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Blockchain technology in improving document authentication practices. His research sheds light on the challenges and opportunities associated with implementing Blockchain-based solutions for ensuring document integrity and reliability Rana's study investigates the evolving trends and challenges in utilizing Blockchain for document verification purposes. He provides insights into the emerging applications of Blockchain technology and identifies key challenges hindering its widespread adoption in the document verification landscape.

A. Existing System

Paper-Based Documentation*:* Physical Certificates are like academic credentials, including diplomas, transcripts, and mark sheets, have traditionally been issued in physical, paper format. This method, while long-standing, is dependent on physical materials that must be carefully handled and stored.

Forgery Risks: The reliance on physical documents that makes them vulnerable to forgery and alterations. Counterfeit diplomas and tampered transcripts can be relatively easy to produce with modern technology, posing significant challenges to verifying the authenticity of these documents. Such risks undermine the trust in academic credentials and create barriers to ensuring the integrity of educational achievements.

Centralized Storage: academic records are typically stored within the issuing educational institution's database or physical archives. This centralized approach places the control and maintenance of records squarely on the institution, which must ensure the security, accuracy, and accessibility of the records.

Access and Distribution: When students or graduates need to provide their academic documents for job applications, further education, or other purposes, they must request copies from the institution. This process often involves filling out forms, paying fees, and waiting for the institution to process the request. This can lead to delays and inefficiencies, particularly if the institution has a high volume of such requests or if the records are archived in a less accessible manner.

Manual Verfication Process: Employers, other educational institutions, or credential evaluators often need to verify the authenticity of academic documents. This process typically requires them to contact the issuing institution directly, either through written correspondence, phone calls, or emails, to confirm the details of the provided credentials. The manual nature of this verification process is time-consuming and resource-intensive, as it relies on the responsiveness and efficiency of the institution's administrative processes.

Lack of Transparency: The current system lacks a streamlined method for direct verification. Without a centralized database accessible to authorized parties, verifiers must depend on the issuing institution to authenticate each document. This dependency can lead to delays, especially if there are discrepancies or if the institution is slow to respond. Furthermore, the absence of a transparent, standardized verification system can result in uncertainties, making it difficult to ensure the credibility of the documents promptly.

B. Proposed System

The proposed approach outlined here leverages cutting-edge blockchain technology, InterPlanetary File System (IPFS), and cryptographic hash functions to establish a robust, efficient, and transparent framework for creating, storing, and validating academic credentials such as diplomas, transcripts, and certificates. This transformative approach is designed to combat the pervasive challenges of forgery and counterfeiting in academic certifications, ensuring document authenticity and simplifying verification process. The system architecture delineates three pivotal roles: the issuer, responsible for generating and dispensing electronic certificates (e.g., a university issuing graduation diplomas); the verifier, typically an employer or individual seeking to authenticate a student's credentials (e.g., an employer conducting a background check); and the student, the recipient of the certificate with access limited to their own issued documents.

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METHODOLOGY

Workflow and Architecture Design: Excalidraw and Draw.io are powerful tools for visualizing and designing the workflow and architecture of complex systems, such as the Ethereum Blockchain-Based System for Handling Academic Records. Below is an elaboration on how these tools can be used to design and communicate the system's workflow and architecture.

Excalidraw: Excalidraw is an open-source whiteboard tool that allows for real-time collaboration and sketching. It is particularly useful for the early stages of workflow design where the focus is on brainstorming and rapidly iterating ideas.

Draw.io: Draw.io (now known as diagrams.net) is a versatile diagramming tool that integrates with various platforms, including Google Drive and GitHub. It is well-suited for creating more polished and detailed diagrams that can be used in technical documentation and presentations.

React.js and Related Packages: React.js, a powerful JavaScript library developed by Facebook, is the foundation for creating dynamic user interfaces. With its ability to build reusable UI components and efficiently manage state, React.js uses a virtual DOM to optimize rendering performance. Redux, a robust state management tool for JavaScript applications, simplifies the maintenance and debugging of complex state logic by centralizing the application's state. Additionally, React Router, a specialized library for routing in React applications, seamlessly navigates between components or pages within a single-page application (SPA) by synchronizing the UI with the URL. Axios, a widely-used JavaScript library, streamlines the process of making HTTP requests from the browser, providing a simple and intuitive API for AJAX requests and enhancing data retrieval from servers and APIs within React applications. Lastly, styled-components, a CSS-in-JS library, promote component-based styling and scoped CSS, offering a simplified approach to managing styles in large-scale React applications.

CSS Preprocessors (Sass, Less): CSS preprocessors expand the capabilities of CSS by introducing features such as variables, mixins, and nesting. Sass (Syntactically Awesome Style Sheets) and less are two popular preprocessors that help enhance the maintainability and organization of CSS code.

CSS Frameworks (Bootstrap, Material-UI): CSS frameworks offer pre-designed UI components and stylesheets that developers can utilize to rapidly build responsive and visually appealing websites. Bootstrap and Material-UI are two widely used frameworks that provide a variety of components, layout systems, and utilities.

Post-CSS: Post-CSS is a tool for transforming CSS using JavaScript plugins. It enables developers to write modern CSS syntax and apply various transformations, such as auto prefixing, minification, and nesting, to improve the compatibility and performance of CSS code.

CSS-in-JS Libraries (Emotion, styled-components): CSS-in-JS libraries allow developers to write CSS directly within JavaScript files. These libraries offer features like scoped styles, dynamic styling, and themes, facilitating improved encapsulation and modularity of styles in React applications.

CSS Grid and Flexbox: CSS Grid and Flexbox are layout mechanisms in CSS that enable developers to easily create complex grid-based or flexible layouts. They provide powerful tools for building responsive and dynamic web designs without heavy reliance on traditional CSS floats or positioning.

Ethereum Test Network: This is a separate Ethereum blockchain environment used for testing purposes. It mimics the main Ethereum network but operates with test Ether, allowing developers to experiment without the risk of using real funds.

Smart Contracts: Solidity Language: Solidity is a high-level programming language used for writing smart contracts on the Ethereum platform. It's specifically designed for creating decentralized applications (dApps) and smart contracts.

Hardhat: Hardhat is a powerful development tool for Ethereum developers. It offers a wide range of features including compilation, testing, and deployment of smart contracts. Developers can write scripts to automate tasks and interact with their contracts during the development process.

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Compilation and Deployment: With Hardhat, developers write Solidity code, compile it into bytecode (the low-level code that Ethereum understands), and then deploy it to the Ethereum test network. Hardhat simplifies this process, providing a seamless workflow for smart contract development and deployment. It also offers built-in support for testing contracts to ensure they function correctly before deployment.
MetaMask: A popular Ethereum wallet that allows users to interact with the Ethereum blockchain and decentralized applications (dApps) directly from their web browser
Blockchain Communication: Ethers.js is an exceptionally powerful JavaScript library that streamlines interaction with the Ethereum blockchain. It provides developers with a high-level API that simplifies the complexity associated with blockchain development. With its comprehensive features and user-friendly design, Ethers.js is an essential tool for creating Ethereum-based applications, including robust systems for managing academic records.
Interacting with IPFS:
IPFS Desktop: A desktop application for interacting with the InterPlanetary File System (IPFS). IPFS is a decentralized storage system that enables storing and sharing of files in a distributed manner across the web. IPFS Desktop provides a user-friendly interface for managing IPFS nodes and interacting with IPFS networks.

IMPLEMENTATION

The Open the project folder in VS Code.
Terminal Setup:
Terminal 1: cd client
Terminal 2: cd server
Terminal 3: cd smart_contracts
Terminal 4: cd smart_contracts
Start IPFS Node Network: Open IPFS Desktop.
Local Blockchain Network Setup:
Terminal 3: npx hardhat node to start a test blockchain and generate wallet addresses.
Terminal 4: npx hardhat run scripts/deploy.js --network localhost to deploy smart contracts. Copy the deployed contract address.
Environmental Variable Setup:
In the client folder, create/modify .env.local file: REACT_APP_CONTRACT_ADDRESS=address_you_copied.
Metamask Integration: Install and set up the Metamask wallet in the browser.
Import dummy accounts generated by Hardhat into Metamask wallet.
Run the Application:
Terminal 1: npm start to start the frontend.
Terminal 2: npm start to start the backend.

RESULT AND DISCUSSION

The implementation of the blockchain-based system for handling academic records was successfully completed. The system includes a web application with a user-friendly interface for Issuers, Verifiers, and Students. The use of blockchain ensures the security and authenticity of academic documents. The integration of IPFS allows for efficient storage and retrieval of documents. The system was tested locally, demonstrating its functionality and effectiveness in managing and verifying academic records.

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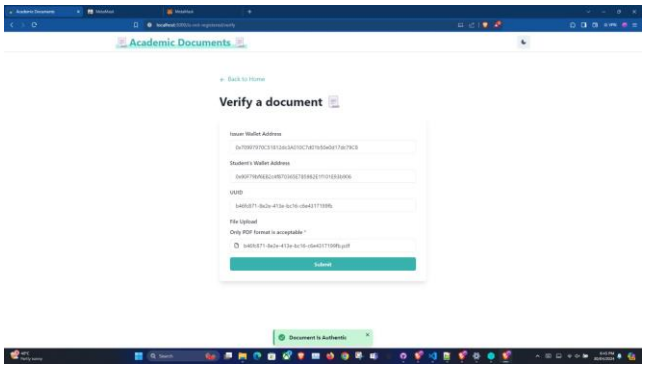
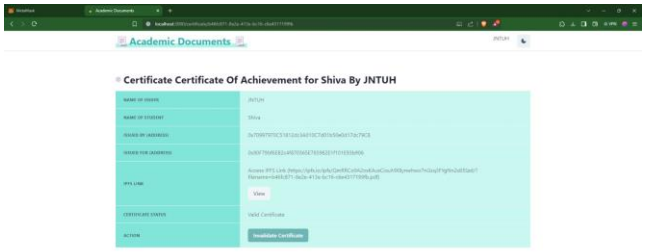
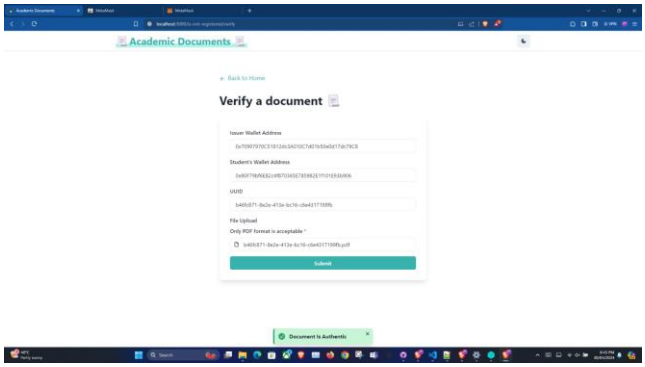


i. Issue Certificate



ii. Issued Certificate Details



iii. Verify Certificate

FUTURE ENHANCEMENTS

Integrating blockchain technology and the InterPlanetary File System (IPFS) for handling academic records offers a robust and secure system, with numerous potential enhancements. Future improvements could include enhanced data privacy and security through zero-knowledge proofs and homomorphic encryption, ensuring that sensitive information remains protected even during processing. Improved interoperability can be achieved with cross-chain compatibility and standardized data formats, facilitating seamless data exchange between educational institutions. Scalability solutions like sharding and Layer 2 technologies will enhance processing power and reduce congestion. Advanced identity management using decentralized identifiers and self-sovereign identity will give users control over their digital identities and personal data. Data accessibility and retrieval can be enhanced with content-addressable storage and integration with decentralized databases like BigchainDB. Smart contracts can automate credential verification and conditional access, reducing administrative overhead and enhancing security. Integrating artificial intelligence can enable predictive analytics for personalized education plans and automated assessment feedback. Decentralized governance structures, such as DAOs, will ensure transparency and community involvement, while compliance with regulations like GDPR and FERPA will be maintained. Enhancements to user experience, including intuitive interfaces and mobile accessibility, will make

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the system more user-friendly. Additionally, broader ecosystem integration with employers and educational technology platforms will streamline processes like hiring and expand the system's functionality and reach.

CONCLUSION

The Ethereum Blockchain-Based System for Handling Academic Records is a significant advancement in academic record management. It utilizes cutting-edge technologies such as blockchain, decentralized storage, and smart contracts to offered a secure, transparent, and efficient solution for managing academic credentials. The system's architecture was carefully designed to leverage the decentralized nature of blockchain technology while addressing the limitations of traditional record management systems. By utilizing the Ethereum blockchain as the underlying infrastructure and implementing smart contracts for logic and rules enforcement, the system ensures transparency, immutability, and trustworthiness of academic records. Furthermore, the system's integration with off-chain storage solutions such as IPFS enhances scalability and efficiency in handling large data associated with academic records, ensuring seamless user experience and data accessibility. In conclusion, the Ethereum Blockchain-Based System for Handling Academic Records represents a paradigm shift in how academic credentials are managed, verified, and shared. By providing a decentralized, secure, and transparent platform, the system empowers individuals and institutions to maintain control over their academic records while promoting integrity, interoperability, and trust in the academic ecosystem. As the project evolves and adoption increases, it has the potential to revolutionize academic record management globally, paving the way for a more efficient, inclusive, and trustworthy credentialing system.

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