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EXAM-VAULT: Reinventing Examination Security Through Blockchain and Encryption

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Abstract: Secure transmission of examination question papers is critical to maintaining the integrity of academic evaluations. Traditional techniques rely on physical distribution and are prone to paper leaks, unauthorized access, and tampering. EXAM-VAULT proposes a blockchain-based framework for safeguarding question paper delivery using end-to-end encryption and decentralized technology. The system incorporates Ethereum, Hyperledger Fabric, IPFS, RSA encryption, and smart contracts written in Solidity to provide a tamper-proof and auditable solution. ReactJS and Django serve as the frontend and backend, while MetaMask and Firebase are used for authentication and identity verification. By employing RSA encryption and IPFS for document security and decentralized storage, and by storing metadata hashes on blockchain platforms, the system ensures the confidentiality, integrity, and traceability of question papers. This solution is intended for universities, colleges, and certification authorities, eliminating human error and security loopholes.

Keywords: Blockchain, Examination Security, IPFS, Smart Contracts, Ethereum, Hyperledger Fabric, RSA Encryption.

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INTRODUCTION

The credibility of academic and professional examinations is a cornerstone of the education system. However, conventional methods of handling and distributing examination question papers are vulnerable to security threats. Processes involving manual printing, transportation, and storage are susceptible to human error, theft, and unauthorized access, leading to paper leaks that undermine the integrity of the examination process. These breaches not only devalue academic qualifications but also affect institutional reputation. In response, there is a need for a technological overhaul. EXAM-VAULT introduces a secure and transparent framework that leverages blockchain technology, decentralized storage, and cryptographic techniques to ensure the secure transmission of question papers from the Controller of Examinations (COE) to examination centers.

MATERIALS AND METHODS

Several studies have explored blockchain-based examination systems. Existing solutions using Ethereum and IPFS suffer from scalability issues, high gas costs,

and centralized dependencies. Other systems rely heavily on human intervention or are limited in scope. The EXAM-VAULT system addresses these limitations using a multi-layered architecture integrating the frontend, backend, decentralized storage, and blockchain networks.

The frontend is developed using ReactJS, providing role-based dashboards for the COE, teachers, and superintendents. The backend uses Django to handle business logic and API communication. Authentication is managed using MetaMask for secure blockchain interaction. Question papers are encrypted using RSA encryption and stored on IPFS, which generates unique Content Identifiers (CIDs). The system employs a hybrid blockchain model in which Ethereum is used for storing metadata, while Hyperledger Fabric is used for secure communication and auditing. Smart contracts written in Solidity automate workflows and enforce access control.

The workflow includes question paper preparation, RSA encryption, IPFS upload, blockchain recording, anonymous selection by the COE, secure transmission, and final decryption before the examination.

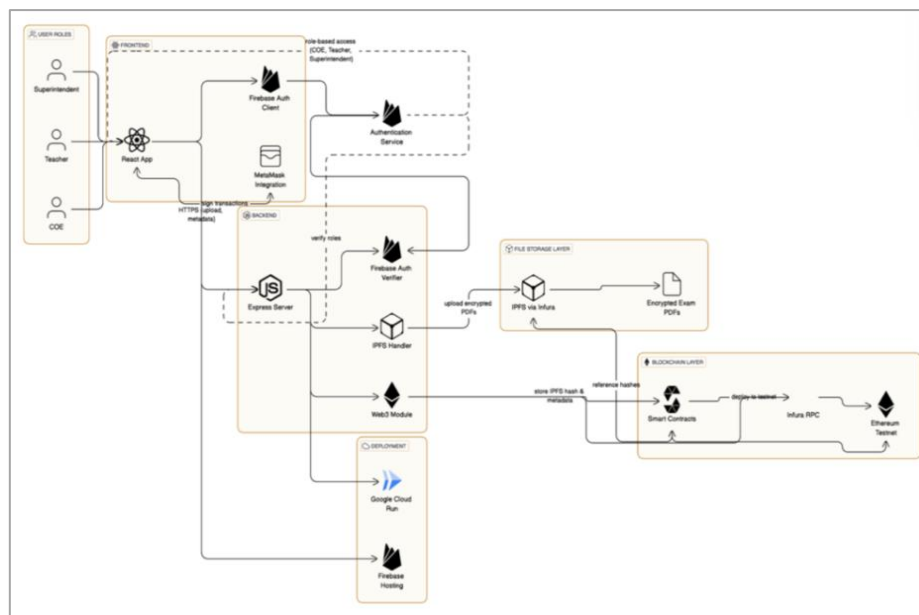


Fig. 1. Architecture of the EXAM-VAULT System.

RESULTS

The **EXAM-VAULT** system ensures secure handling and transmission of examination question papers by eliminating the risks of leakage and tampering. The use of IPFS provides decentralized storage, while blockchain technology ensures immutable records of all transactions. The system enables role-based access control, ensuring that only authorized personnel can access specific functionalities. The hybrid blockchain architecture improves scalability while maintaining a high level of security. Furthermore, the integration of RSA encryption and decentralized storage enhances the confidentiality, integrity, and traceability of examination question papers.

DISCUSSION

Compared with existing systems, **EXAM-VAULT** overcomes major limitations such as centralized storage risks, scalability issues, and high operational costs. The hybrid blockchain model provides both transparency and controlled access. However, challenges such as blockchain transaction costs and scalability still remain. Future improvements may include the adoption of Layer-2 scaling solutions to reduce transaction costs and improve system performance. Additionally, advanced cryptographic techniques, such as multi-party computation, can further strengthen the overall security of the proposed framework.

CONCLUSION

EXAM-VAULT presents a robust and innovative solution to the problem of examination question paper security. By integrating blockchain technology, decentralized storage, and encryption, the system provides a secure, transparent, and tamper-proof framework for examination management. The proposed solution eliminates vulnerabilities associated with

traditional methods and enhances trust in the examination process. Future work includes extending the framework to support the entire examination lifecycle, including answer script evaluation, result processing, and secure archival.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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