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 [ijirset@gmail.com](mailto:ijirset@gmail.com)

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# Blockchain-based Competitive Examination System in India: Preventing Paper Leaks and Mitigating Frauds

Anush D Kamble<sup>1</sup>, Deepak A Kamble<sup>2</sup>

Atomic Energy School & Junior College, Mumbai, Maharashtra, India<sup>1</sup>

Bhabha Atomic Research Center, Radiometallurgy Division, Mumbai, Maharashtra, India<sup>2</sup>

**ABSTRACT:** The Indian Education System is plagued with the persistent problem of paper leaks. Acquiring and disseminating exam papers through illegal means before the day of the exam undermines the integrity, and fairness of the examination, and leads people to lose trust and credibility in the system. This paper proposes a tamper-proof blockchain-based examination system to combat this challenge. The key idea of this proposal entails keeping encrypted question papers and student answer scripts on a blockchain network. The immutability of distributed ledger technology (DLT), guarantees that the answer script remains invulnerable to tampering. Additionally, smart contracts can automate identity and access management and deploy question papers at exactly the scheduled time for writing exams to avoid time loss during exams.

**KEYWORDS:** Blockchain, Competitive Examination, Fraud Prevention, India, Smart Contracts, Paper Leak

## I. INTRODUCTION

The prevalence of paper leaks in many competitive examinations in India has been a pressing issue that has plagued the education system for years. The scale and intensity of this problem transcend beyond just the realm of academic integrity, with devastating repercussions for the prospects of lakhs of students. The epicenter of this problem can be traced back to a variety of factors, including widespread corruption, lack of proper security measures, and the immense pressure to succeed in a hyper-competitive environment. The leak of examination papers not only compromises the credibility of the evaluation process but also undermines the faith of students, parents, and institutions in the fairness of the system. It is essential to address this issue comprehensively to ensure a level playing field for all aspiring candidates and to safeguard the integrity of the examination process in India. [2][3]

### Background: Competitive Exam Paper Leak Fraud in India

Recent incidents of paper leaks in high-profile competitive exams, such as the Joint Entrance Examination (JEE), and National Eligibility cum Entrance Test (NEET) have highlighted systemic vulnerabilities and lapses in examination security.

The rampant proliferation of leaked exam papers through social media channels and messaging platforms has exacerbated concerns about the fairness and credibility of the examination process [2]. The following examples illustrate the severity and impact of these incidents:

- According to media reports, in the last 7 years, more than 70 examination papers have been leaked in different states of the country, due to which the careers of more than 1.5 crore youth have been affected [3]
- The investigation revealed that the leaks derailed the schedules of as many as 1.4 crore applicants, who were vying, with the crucial National Eligibility cum Entrance Test (NEET) topping the list of infamy. The Rajasthan Police lodged a series of cases when a NEET p for a little over 1.04 lakh posts [5]
- In 2021, the GSSSB announced recruitment for 186 seats of Head Clerk. The examination was conducted on December 12, 2021, at around 700 centers in the state, in which 88,000 candidates participated. When the news broke that the question papers had already been leaked before the exam for Rs 10 lakh to Rs 15 lakh, the exam was canceled. [4]

- In September 2021, a series of examination paper leaks rocked the country. The paper was allegedly leaked in the state capital Jaipur. Eight people, including three students, were arrested for cutting a Rs 35-lakh deal to obtain the question paper [5]

## II. LITERATURE SURVEY

Many studies have explored the utility of blockchain technology in various fields, particularly for credential verification and record management [1]. However, challenges such as scalability and user adoption hinder the potential of blockchain-based examination systems. This paper builds on existing research by addressing these challenges within the context of competitive examinations in India and providing a detailed implementation framework.

## III. BACKGROUND & TERMINOLOGY

### Blockchain

Blockchain technology operates on a distributed ledger technology. A blockchain comprises many interconnect blocks that store various information (transaction records, a unique cryptographic hash of the preceding block, timestamp, etc). Each participant on the blockchain network, also known as a node, maintains a copy of this ledger. This technique eliminates any vulnerability by making it impossible for an entity to manipulate the data once written without altering all preceding blocks [6].

### Smart Contracts

A smart contract is a code embedded in the blockchain network that autonomously executes the contract terms when certain predefined conditions are satisfied [7]. This autonomy eliminates the need for any intermediary's involvement and gets rid of time loss.

### Decentralized Storage (IPFS)

The InterPlanetary File System (IPFS) is a decentralized data repository that allows for peer-to-peer file sharing eliminating the need for any intermediaries. In contrast to a centralized storage system, the IPFS distributes and stores data across multiple blockchain network nodes [8]. IPFS uses content addressing, wherein each file is labeled with a unique cryptographic hash that corresponds to that specific file only. Therefore, it is improbable to tamper with the content without changing the hash or to access it without having the correct decryption keys. These features strengthen data integrity and confidentiality. In our system, IPFS can help circulate exam papers securely and confine their access to authenticated users only.

### Public-Key Cryptography

Public-key cryptography is a cryptographic protocol useful in maintaining secure communication with data encryption. It involves using a pair of interconnected keys: Public and private keys. The public key is publicly accessible to everyone. The private key is confidential, and only known to the owner. The data encoded with the public key can only be decoded with the corresponding private key [9].

### Consensus Mechanism

The consensus mechanism is a protocol used to achieve agreement on a single data value among distributed processes or systems [10]. All the nodes in the blockchain use Consensus mechanisms to validate the authenticity of transactions. Some of the widely adopted consensus mechanisms include Proof of Work (PoW) and Proof of Stake (PoS).

## IV. SYSTEM ARCHITECTURE

### 1. Blockchain Network:

- Blockchain is the backbone of the system. It ensures a tamper-proof system for the storage of sensitive examination-related data including question papers, student submissions, grading records, and results. Each node in the blockchain maintains a copy of the ledger, ensuring data integrity and security [15].

### 2. Smart Contracts:

- Smart contracts are pivotal in automating and securing the examination system's key processes.

- **Functions of Smart Contracts:**
- **Exam Paper Distribution:** Smart contracts handle the secure and timely dissemination of encrypted exam papers to authenticated candidates' digital wallets. This ensures that only authorized candidates can access the exam content.
- **Answer Submission:** The candidate's responses are recorded and uploaded onto the blockchain.
- **Automatic Grading:** Using a set of predefined answer keys, smart contract automatically grades objective questions
- **Result Announcement:** The final results are securely published on the blockchain ensuring transparent dissemination.

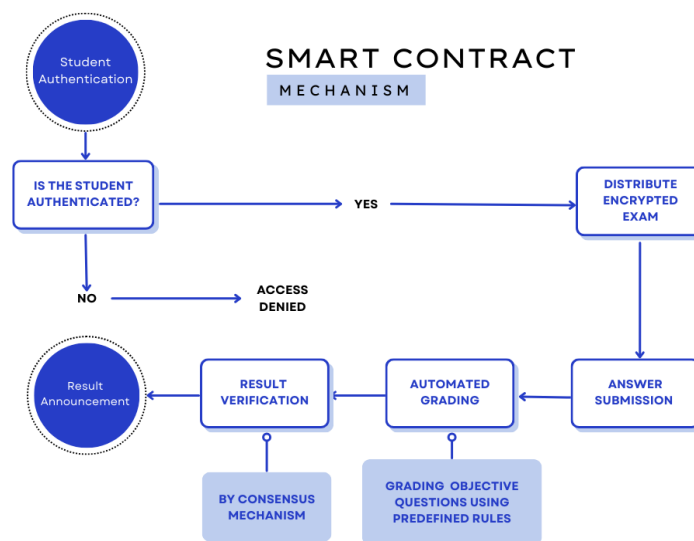


Figure 1: Smart Contract Mechanism

### 3. Identity Management:

- The system utilizes cryptographic techniques like public cryptography and digital signatures to verify the identities of students, examiners, and administrators and help prevent unauthorized exam participation, including proxy testing, and impersonation.
- **Digital Wallets:** Each participant is assigned a digital wallet, which serves as their unique identifier on the blockchain.

### 4. Access Control:

- Access control mechanisms define permissions and access levels for different stakeholders. Smart contracts enforce these permissions, ensuring that only authorized personnel can access or modify specific data.
- The system implements **Role-Based Access Control (RBAC)**, assigning roles such as student, examiner, and administrator, with specific permissions for each role.[16]

### 5. Decentralized Storage:

- The system uses the InterPlanetary File System (IPFS) to store exam questions and student responses securely. IPFS provides decentralized storage, ensuring data integrity and availability.
- **Encryption:** All files stored on IPFS are encrypted to protect sensitive information

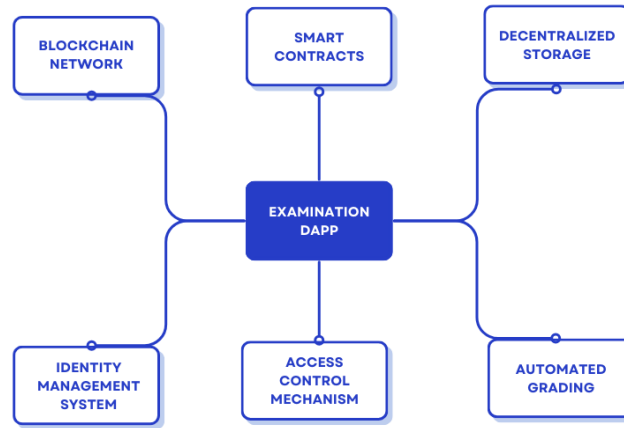


Figure 2: System Components

## V. BLOCKCHAIN TECHNOLOGY SELECTION

The blockchain network will be selected on the following criteria:

- **Security:** The confidentiality of the sensitive examination data should be maintained and reflected in the security features of the blockchain. This includes robust security measures like impenetrability, strong encryption, etc.
- **Scalability:** The rapid surge in the influx of candidates appearing for competitive examinations necessitates scalable-friendly systems. These platforms should be able to accommodate and adapt to such change accordingly.
- **Cost:** The operational costs of such a system should be reasonable and sustainable, considering the potential surge in the number of candidates
- **Access Control and Privacy:** There should be solid safeguards to ensure data privacy. Sensitive examination-related data should only be accessed by authorized personnel to minimize disclosure risks
- Selecting the appropriate blockchain technology is crucial for successfully implementing the proposed system. Three potential blockchain platforms are considered:
- **Ethereum:**
  - Pros:
    - Ethereum is a long-standing and widely adopted blockchain platform equipped with comprehensive smart contract capabilities and a large developer community [11].
    - It offers strong security features that enhance the protection of sensitive examination-related data [12].
  - Cons:
    - High transaction fees and scalability issues can make it difficult to manage high-volume user activity during any particular interval.
- **Polygon:**
  - Pros:
    - Polygon is a blockchain network built on top of Ethereum that provides cost-effective solutions with high scalability, making it suitable for examinations with a large pool of candidates.
    - It also offers low transaction fees with high transaction speed, making it efficient to operate smart contracts [14].
- **Hyperledger Fabric:**
  - Pros:
    - Hyperledger Fabric is a permissioned blockchain platform (not publicly accessible). Data privacy, and access control, are essential for safeguarding examination data confidentiality. modular architecture allows for customizable solutions [13].
    - Its modular architecture offers a high degree of customization, which is crucial for adapting this system to various other exams.

- Cons:
  - Highly complex setup and workflow that requires technical expertise and limits easy integration
- SEI Network
  - Pros:
    - SEI Network is blazingly fast in processing transaction with exceptionally low latency, which is instrumental for simultaneous submissions of exam.
    - Its infrastructure is highly scalable, which is vital for handling heavy-traffic load on the system associated with the surge in number of candidates appearing.
  - Cons:
    - Compared to Ethereum, SEI Network does not have the same level of maturity or developer support, potentially leading to fewer resources or tools.

## VI. WORKFLOW

1. **Initialization Phase:**
  - a. **User Registration Protocol:** Registration of students and examiners begins by creating digital identities and wallets on the blockchain. Both parties require mandatory identity verification using government-issued IDs such as Aadhar, Passport, etc to ensure user authenticity.
  - b. **Examination Content Creation:** On the exam day, the question paper is encrypted to maintain confidentiality and is then uploaded onto a decentralized file storage system such as IPFS. Additionally, an IPFS hash is generated on the blockchain through which the file can be retrieved later.
2. **Distribution Phase:**
  - a. **Cryptographic Distribution Mechanism:** Encrypted exam papers are distributed only to authorized students' wallets, who possess the necessary private keys needed to decrypt the exam paper.
3. **Examination Phase:**
  - a. **Submission Recording Protocol:** Once the exam time is over, answer sheets are automatically submitted via a smart contract, which maintains an immutable record on the blockchain. The contract records the submission time and the content, ensuring a time-stamped record of each student's work.
4. **Evaluation Phase:**
  - a. **Automated Assessment Algorithm:** Smart contracts automatically grade submissions based on predefined answer keys for objective questions.
  - b. **Manual Evaluation Interface:** Subjective questions are manually graded by examiners. The responses are fetched from the IPFS, and evaluated accordingly. The grading is then recorded on the blockchain
  - c. **Result Verification:** Manual verification is conducted by examiners to address any potential discrepancies or errors.
5. **Result Publication Phase:**
  - a. **Result Announcement:** The results are published on the blockchain. This allows students and administrators to securely and transparently access the results through the UI.
  - b. **Grievance Redressal Protocol:** Students can submit appeals if necessary. Administrators review the appeals, and any changes or decisions are updated on the

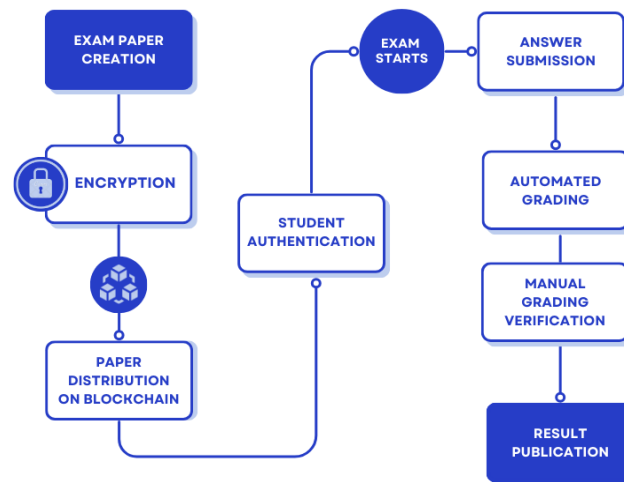


Figure 3: Workflow of Examination Process

## VII. DICUSSION

### Implementation in India

The proposed system is designed to fit the context of competitive examinations in India. The steps for implementation include:

- **System Setup:** Establishing the blockchain network, configuring nodes, and deploying smart contracts.
- **Stakeholder Training:** Educating students, examiners, and administrators on using the system.
- **Mock Examinations:** Conducting trial runs to test the system's functionality and user interface.

### Expected Results and Analysis

The implementation of a blockchain-based examination system is expected to enhance the security, transparency, and trustworthiness of the examination process. By recording all activities on an immutable ledger, the system ensures that exam papers cannot be leaked or tampered with and that grading is fair and transparent [17]. Moreover, this system is more cost-effective than the currently used traditional methods like CBT or Pen Paper based Tests, particularly in India where there is a large pool of candidates appearing for competitive exam. This cost efficiency is achieved through smart contracts which automate key processes like identity verification, exam distribution and grading, reducing the potential for human error. An analysis of similar implementations in other sectors signifies that blockchain technology can significantly improve the integrity and reliability of critical processes [18] [19].

While the proposed blockchain-based examination system offers numerous advantages, it also faces several drawbacks and challenges that must be addressed:

#### 1. Scalability:

- a. In the present day, blockchain technologies struggle to scale and operate effectively. This problem of scalability has a direct negative consequence on transaction processing times and higher costs with a rapid influx in the pool of candidates for appearing for examinations.
- b. **Solution:** Implementing Layer 2 solutions or alternative scalable blockchain platforms may help mitigate this issue.

#### 2. User Adoption:

- a. The technical complexity and resistance to change from traditional systems (such as the CBT Test or Pen-Paper Test) can significantly hamper the adoption of blockchain technology
- b. **Solution:** Awareness programs and pilot testing can change public perception and increase adoption.

### 3. Regulatory and Legal Issues:

- a. **Challenge:** Blockchain technology operates in a regulatory grey area in many regions, including India, potentially leading to legal challenges.
- b. **Solution:** Working closely with regulators to ensure compliance and advocating for clear legal frameworks governing blockchain use in education.

### 4. Interoperability:

- a. **Challenge:** Integrating the blockchain-based system with existing educational infrastructure and databases can be complex.
- b. **Solution:** Designing the system with interoperability in mind and using standardized APIs can facilitate seamless integration.

## VIII. CONCLUSION

Cooperative efforts from all parties including law enforcement agencies, examination authorities, and policymakers are required to address the plague of paper leaks and exam fraud. Innovative solutions like the proposed blockchain-based examination system offer multifaceted features to safeguard the integrity of competitive exams and uphold the principles of fairness and transparency in India's education system.

By harnessing the capabilities of blockchain technology, the proposed examination system offers a robust solution to combat paper leaks and fraudulent activities in competitive exams, thereby restoring trust and credibility in the examination process.

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