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BLOCKCHAIN BASED CROWDSOURCING PLATFORM FOR QUESTION PAPER GENERATION

Aditi Polkam[1], Rohit Patil[2], Indra Chaudhary[3], Tanya Singh[4], Sneha Deshmukh[5]

[1]Student, Dhole Patil College of Engineering – Pune, Maharashtra, India

[2]Student, Dhole Patil College of Engineering – Pune, Maharashtra, India

[3]Student, Dhole Patil College of Engineering – Pune, Maharashtra, India

[4]Student, Dhole Patil College of Engineering – Pune, Maharashtra, India

[5]Professor, Dhole Patil College of Engineering – Pune, Maharashtra, India

Abstract: This project paper discusses the use of blockchain technology in a crowdsourcing system for the creation of question papers for online and offline exams. The system is designed to provide a diverse set of questions, promote transparency and inclusivity, and automate the generation of question papers. The paper outlines the benefits and drawbacks of traditional question paper setting and crowdsourcing and proposes the use of blockchain technology to achieve decentralization, transparency, and security. The project was developed using the Solidity programming language, which is a high-level programming language used for writing smart contracts on various blockchain platforms. The development frameworks used were Hardhat and Remix IDE, which provide a set of tools for building, testing, and deploying smart contracts. Furthermore, the project was deployed on the Polygon blockchain, which is a Layer-2 scaling solution for Ethereum. This blockchain offers faster transaction processing times and lower fees compared to the Ethereum Mainnet, making it an attractive option for deploying decentralized applications. The Graph Protocol's Subgraph hosted service is used to index the blockchain data and provide a user-friendly interface for querying and analyzing the generated questions.

Keywords – blockchain, crowdsourcing, question bank, smart contracts, IPFS, question paper generation

I. INTRODUCTION

Question paper setting is a crucial part of the education system that has been carried out for decades. The process of setting question papers has evolved over time, but some key steps remain the same. Initially, question papers were set by individual teachers who had expertise in the subject matter by reviewing the syllabus and selecting questions based on the topics covered, often relying on their own experience and intuition to decide what to include. As education systems became more formalized, question paper setting became more standardized. Question papers were then created by a committee of teachers or subject matter experts who would collaborate to create a comprehensive exam that covered all the relevant material. In recent years, technology has had a significant impact on question paper setting. Many schools and universities now use computer programs to generate question papers. These programs can take into account the syllabus, previous year's question papers, and other factors to generate a comprehensive exam. This has made the process faster, more efficient, and more accurate.

A newer and better approach to this involves taking inputs from the community itself which is called crowdsourcing. Crowdsourcing for question paper setting typically involves asking subject matter experts, teachers, or even students, rather anyone to contribute questions that cover specific topics or themes. These questions can then be reviewed and refined by a committee before being included in the final question paper.

Crowdsourcing has several potential benefits for question paper setting.

1. Broad range of topics and perspectives are covered.
2. Identify new and innovative questions that might not have been considered by traditional question paper setters leading to a more engaging and challenging exam that can better test students' understanding of the material.
3. Process is transparent and inclusive. By involving a wider range of stakeholders in the process, it can help to build trust and confidence in the education system.

However, crowdsourcing also has some potential drawbacks:

1. Can be time-consuming to review and refine a large number of questions submitted by a crowd.
2. When a crowdsourced system is highly centralized, decisions about question selection and refinement are made by a small group of individuals. This can limit the diversity of perspectives and expertise that are brought to bear on the question paper setting process. In addition, highly centralized systems may be more vulnerable to bias or errors, as there may be limited oversight or review of the decision-making process.
3. Computer systems are prone to Single Point of Failure and might not be transparent.

These problems can be solved by creating a distributed and decentralized database of questions that is transparent and contributed by a large number of people and approved by subject matter experts. Blockchain technology is based on a decentralized, distributed ledger that records transactions across a network of computers. This makes it a powerful tool for achieving decentralization in crowdsourcing systems, as it allows for a transparent and trustworthy record of contributions and decision-making.

In a crowdsourcing system that uses blockchain technology, all contributions, including questions submitted by participants and decisions made by reviewers, are recorded on the blockchain ledger. This creates a transparent and auditable record of the question paper setting process, which can help to build trust and confidence in the system. Blockchain technology also provides a high degree of security and immutability, as each block in the chain is linked to the previous block and cannot be altered without consensus from the network. This can help to prevent fraud, errors, or tampering with the question paper setting process.

In addition, blockchain technology allows for greater accountability and incentivization of participants. Smart contracts, which are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code, can be used to automatically distribute rewards to contributors based on their contributions to the system. This can help to motivate participants to contribute high-quality questions and engage more deeply with the question paper setting process.

II. LITERATURE REVIEW

Crowdsourcing has emerged as a popular method for outsourcing tasks to a large group of individuals. Its utilization spans various domains, including software development, data annotation, and more recently, question paper generation. In their research paper titled 'Crowdsourcing System Based on Blockchain' [1], Lin and Zhang present a comprehensive review of blockchain-based crowdsourcing systems. The authors delve into the existing literature concerning the application of blockchain in crowdsourcing and highlight the distinct challenges associated with these systems. They also explore the potential of blockchain technology in the realm of crowdsourcing. As a solution for decentralized storage, the authors propose the use of Inter Planetary File System (IPFS).

Quadratic voting, a collective decision-making process used to count votes during dispute resolutions, is also discussed in the paper. By providing a complete design of a decentralized crowdsourcing system that can withstand network attacks and mitigate single points of failure, the authors contribute to the existing body of knowledge in this area.

Question paper generation presents a complex task that necessitates a comprehensive understanding of diverse subjects, as well as the ability to create relevant and challenging questions. Although several question paper generation systems already exist, they often require substantial human involvement, leading to increased costs and time requirements. Addressing this concern, Hu, Chen, and Lin propose a method in their paper titled 'Designing a Restful Question Bank Service in Cloud' [2]. Their approach involves designing a question bank hosted in the cloud, allowing users to access these resources seamlessly under any circumstances.

While blockchain's decentralized nature makes it highly resistant to fraud and censorship, the increasing costs associated with resource utilization and storage pose a significant challenge. To address this issue and ensure distributed and decentralized storage that remains accessible at all times, Steichen, Fiz, Norvill, Shbair, and State propose a solution in their paper 'Blockchain-Based, Decentralized Access Control for IPFS' [5]. Their proposal involves leveraging the Inter Planetary File System (IPFS) to overcome cost-related concerns. IPFS stores files across a peer-to-peer network of IPFS nodes and generates a Content Identifier (CID), which can be stored on the blockchain and mapped to the file's owner. This approach caters to the requirements of blockchain applications that necessitate the sharing of large files.

III. METHODOLOGY

In this project, our major goal was to be able to formulate an auto-generated question bank with any type of questions for a semester of online/offline exams for each subject. Question banks to be duplication-free, and have a strong dispute resolution system for approval of any question. The team developed a blockchain-based crowdsourcing system to automate the question paper generation process. This system was implemented using the Solidity programming language, deployed on the Polygon blockchain, and data was indexed using The Graph Protocol's Subgraph hosted service. The frontend was developed using Next.js and moderator submitted proofs were stored on a decentralized database called IPFS.

To begin the development process, we conducted an extensive literature review to gain an understanding of the current state-of-the-art in crowdsourcing and blockchain technologies. This involved reviewing academic papers, technical documentation, and existing systems that have been developed in this area. Next, we conducted a requirements analysis to identify the key features and functionalities that our system needed to incorporate. This involved consulting with domain experts and stakeholders to understand their needs and expectations.

Based on the requirements analysis, we designed the architecture of the system, including the smart contracts that would be used to manage the crowdsourcing process, the data structures that would be used to store the generated questions and their metadata, and the user interface that would be used to interact with the system. We finally decided some key objectives our system would achieve:

1. To provide a system with a variety of questions creatively thought by various people.
2. To achieve bias-less dispute resolution in a question paper setting.
3. To automate the generation of a question paper.

Subsequently, we embarked on the implementation phase utilizing the Solidity programming language, along with the Hardhat and Remix IDE development frameworks. Our team diligently wrote and rigorously tested the smart contract while incorporating the essential backend functionality to seamlessly interact with the Polygon blockchain. To benefit from its advantages such as low transaction fees and high scalability, we successfully deployed the system on the Polygon blockchain. To further enhance user experience, we leveraged The Graph Protocol's Subgraph hosted service to efficiently index blockchain data and facilitate seamless querying and analysis of the generated questions. The frontend was then developed using Next.js, enabling us to craft a responsive and interactive user interface with a streamlined API handling process.
This comprehensive approach ensures a robust and user-friendly platform for question generation and access.

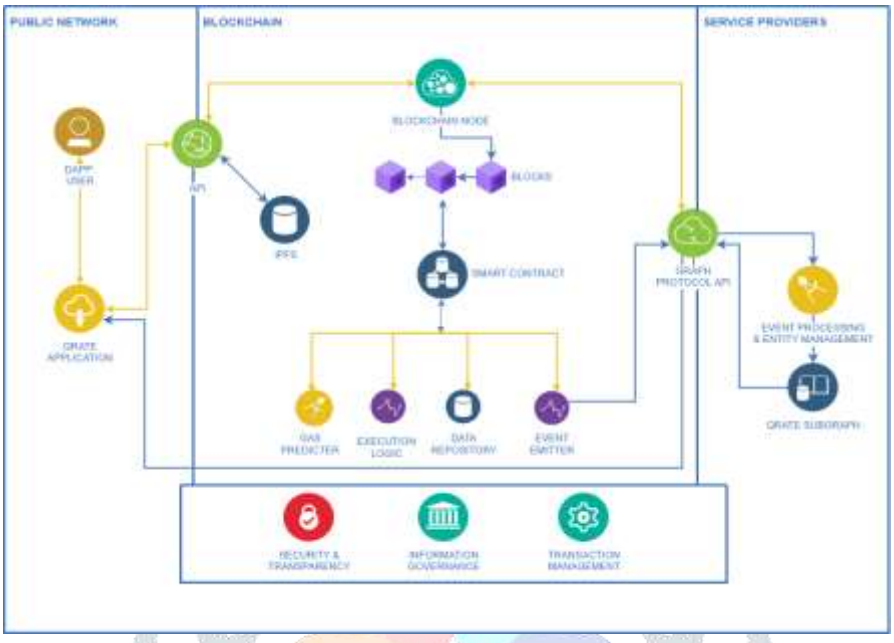

Fig – System Architecture

To evaluate the effectiveness of the system, we conducted a series of tests and user studies to measure its performance, usability, and user satisfaction. The results of these tests and studies were used to identify areas for improvement and to refine the system.

Overall, the methodology used in this project involved a rigorous and iterative approach to software development, incorporating input from domain experts and stakeholders, and leveraging the latest advancements in blockchain and crowdsourcing technologies. The resulting system has the potential to revolutionize the question paper generation process, making it more efficient, reliable, and cost-effective.

Algorithm Developed to Approve or Reject questions

Let X be the total number of moderators for a particular subject.
Let U denote the total number of upvotes received on a question and D denote the total number of downvotes for a question.
Therefore, the total number of votes for each question is equal to U+D.
M is the number of minimum number votes required for a result of the question to be calculated, and T is the threshold (percentage of moderators to agree on a collective decision).
Let S be the status of the question which defaults to PENDING.

1. Start
2. Calculate the total votes for a question i.e. U+D
3. If U+D >= M, then
    a. If (U*100)/X = T, then:
        Set status:=ACCEPTED
    Else if (D*100)/X = T, then:
        Set status:=REJECTED
    End If
    End If
4. End

IV. RESULTS

In this project, we were able to achieve a wide range of contributed questions from different users. These questions were submitted through our platform and were subject to moderator approval. Moderators were approved only by the admin after verifying their qualifications and authenticity through the proofs submitted by them which were securely stored on IPFS for future reference.

Furthermore, we were able to retrieve data easily after indexing it on a graph. This made it easier to analyze and organize the submitted questions according to different topics and categories. The indexed data allowed us to create a form where users could choose from a variety of topics and generate a random customized paper. The customized paper generated by the platform was based on the user's preferred topic. This made it possible for users to get personalized content that matched their specific needs and interests.

Metrics (as of May 16, 2023):
1. Number of unique questions: 90
2. User participation (unique users): 20
3. Question acceptance rate: 42%
4. System reliability and uptime: 99%

Finally, the implementation of a blockchain-based crowdsourcing system for question generation has the potential to revolutionize the way question papers are created and utilized. By leveraging the transparency, immutability, and decentralized nature of blockchain technology, this system ensures the integrity and security of the question bank, while also promoting a collaborative and inclusive approach to knowledge sharing. The involvement of a diverse crowd in contributing questions allows for a wide range of perspectives, expertise, and subject areas to be covered. This not only enhances the quality and comprehensiveness of the question bank but also fosters a sense of community and engagement among contributors. The inclusion of moderators in the vetting process plays a crucial role in maintaining the standards and accuracy of the question bank. Their expertise and oversight help filter out irrelevant or inappropriate questions, ensuring that only high-quality and relevant content is made available for generating question papers. The ability for anyone to generate question papers from the question bank democratizes the examination process, making it accessible to a larger audience. This system empowers educators, examiners, and learners alike, giving them the flexibility to tailor question papers according to their specific needs, while also promoting adaptability to changing educational requirements.

Moreover, the utilization of blockchain technology in this crowdsourcing system enhances transparency and trust in the question generation and selection process. The immutability and auditability of the blockchain ledger ensure that every action taken within the system is traceable and verifiable, minimizing the risk of fraud or tampering.

Advantages of the system:

1. Wide range of unique, creatively thought questions.
2. Efficient dispute resolution through decentralized voting.
3. Tamper-proof storage of question acceptance status.
4. No risk of system downtime due to no Single Point of Failure(SPOF)

Limitations of the system:

1. Slow decision-making speed.
2. Increased cost of transactions on the blockchain.

V. CONCLUSION & FUTURE SCOPE

A blockchain-based crowdsourcing system for question generation and paper creation holds immense potential to transform the traditional educational assessment landscape. It promotes collaboration, inclusivity, and transparency, while empowering educators and learners to actively participate in the knowledge-sharing process. As this technology continues to evolve, it has the capacity to revolutionize the way we approach assessments and examinations, making them more dynamic, relevant, and learner-centered.

To enhance the quality and reliability of the question bank in a blockchain-based crowdsourcing system, several key features can be implemented. Firstly, an algorithm can be integrated to detect and prevent duplicate or copied questions, ensuring the authenticity and uniqueness of user contributions. This algorithm, trained on a large dataset and utilizing natural language processing techniques, enhances the platform's trustworthiness. Secondly, introducing incentives for contributors whose questions are accepted can foster active participation and encourage users to contribute more frequently. By rewarding their efforts, the platform can attract a larger pool of high-quality questions. Lastly, implementing a consensus-based system for selecting new moderators ensures that their values and approaches align with existing moderators. Through a nomination process and discussions or voting among current moderators, a consensus can be reached on the suitability of potential new moderators, ensuring a cohesive and shared vision for effective moderation. These features collectively enhance the platform's reliability, encourage user engagement, and maintain the integrity of the question bank.

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