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Crowdsourcing: A Multi-Dimensional Perspective on Applications, Mechanisms, and Emerging Technologies

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Abstract: Crowdsourcing has become a powerful model for solving complex tasks by leveraging human intelligence and emerging technologies. This paper explores its applications in game design, blockchain, hackathons, and education, analyzing key mechanisms and challenges like quality control, security, and worker motivation. It highlights innovations such as blockchain verification, AI automation, and the Social Internet of Things (SIoT) to enhance efficiency. By synthesizing insights from multiple studies, this paper provides a comprehensive view of trends, challenges, and future directions in crowdsourcing.

Keywords: Crowdsourcing, Blockchain, Game Design, Hackathons, Social IoT, AI, Data Quality.

I. INTRODUCTION

Crowdsourcing has emerged as a revolutionary model for solving complex problems by leveraging the collective intel ligence of a distributed workforce. First coined by Jeff Howe in 2006, crowdsourcing allows businesses, researchers, and organizations to outsource tasks traditionally performed by employees to a large, often anonymous, online community. From data labeling in artificial intelligence to game design, blockchain verification, and educational research, crowdsourc ing has proven its value across multiple domains.

With the rise of blockchain technology, the Social Internet of Things (SIoT), and AI-driven automation, crowdsourcing has evolved beyond simple human computation tasks into a secure, decentralized, and scalable approach. However, chal lenges such as data quality, security risks, worker motivation, and scalability remain critical barriers to its widespread adop tion.

This paper explores the multi-dimensional aspects of crowdsourcing, categorizing its applications in game design, blockchain-based systems, hackathons, and education. It ana lyzes the mechanisms that drive crowdsourcing platforms, the challenges they face, and emerging solutions like blockchain verification, AI-powered task automation, and decentralized reputation systems. Finally, this study outlines the future directions of crowdsourcing, highlighting its potential impact on industries and digital economies.

A. Motivation

Crowdsourcing has emerged as a powerful approach to solv ing complex problems by harnessing collective intelligence. It offers scalability, cost efficiency, and innovation, making it valuable across industries. The rise of digital platforms and advancements in AI and blockchain have further enhanced its potential. However, challenges like data quality, worker motivation, and ethical concerns remain. This research aims to explore crowdsourcing models, applications, and future trends to optimize its effectiveness and address existing limitations.

B. Problem Statement

In order to graduate to multiple-choice questions for one semester of online board exams, a minimum of 5000 questions per subject will be necessary to establish a question bank. The process of creating question papers for the exams is quite complex.

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Can you imagine a crowdsourcing model where a large number of anonymous contributors generate questions, thus building a comprehensive question bank? These questions can be reviewed by experts before being finalized for inclusion in the bank. The actual exam papers can then be generated through an automated system. This approach would provide scalability, a variety of question formats, and ongoing content development. Moreover, incorporating blockchain technology could guarantee transparency, traceability, and secure owner ship of the submitted materials.

II. LITERATURE SURVEY

Crowdsourcing has been widely studied across various domains, with researchers exploring its applications, mecha nisms, and emerging challenges. Yuen et al. (2011) [1] provide a comprehensive survey of crowdsourcing systems, catego rizing them based on applications, algorithms, performance, and datasets. The study highlights how crowdsourcing has evolved into a distributed problem-solving model that enables cost effective task execution. It also discusses key challenges, such as worker reliability, data accuracy, and task allocation optimization. This research serves as a fundamental reference for understanding different types of crowdsourcing models, particularly microtasking and contest-based approaches. [2]

Carter et al. (2012) examine the role of crowdsourcing in game design, particularly in generating quests and challenges within digital games. The study highlights how game de velopers leverage crowdsourcing to integrate player-generated content, enhancing user engagement and creativity. It also dis cusses quality control mechanisms that ensure user-generated quests meet game design standards. The paper underscores the potential of crowdsourcing to create dynamic gaming experi ences while addressing challenges such as content moderation, verification, and balancing player contributions. [3]

Wang et al. (2016) introduce the concept of mobile crowd sourcing networks, where mobile devices and social inter actions extend traditional crowdsourcing models. The study highlights how the Social Internet of Things (SIoT) enhances service discovery, task distribution, and data sharing. [4] A reputation-based auction mechanism is proposed to improve the reliability of crowdsourcing participants. This research is particularly relevant in understanding how mobile technology integrates with crowdsourcing to create flexible, large-scale solutions for real-time data collection and problem-solving.

Blockchain-based crowd-sourcing has gained attention as a solution to transparency and security concerns on tradi tional crowd-sourcing platforms. One study discusses how blockchain, particularly smart contracts, can create decen tralized frameworks for task management and payment pro cessing. [5] By eliminating intermediaries, blockchain ensures fair and transparent crowdsourcing operations. The study also emphasizes the importance of reputation management systems and consensus mechanisms in preventing fraud and ensuring worker reliability. The integration of decentralized autonomous organizations (DAOs) is highlighted as a way to manage crowdsourcing tasks without centralized control. [6]

Hackathons and educational research also benefit from crowdsourcing. A study on mega hackathons explores how large-scale crowdsourcing events facilitate open innovation, rapid problem-solving, and industry collaboration. Companies use hackathons to identify talent and generate innovative solutions. Another research paper investigates the role of crowdsourcing in education, comparing traditional student based research with crowdsourced studies. [6] Platforms like Prolific and MTurk provide scalable participant recruitment for educational experiments. However, challenges such as participant engagement and data validity require careful qual ity control. These studies demonstrate how crowdsourcing continues to evolve with emerging technologies, shaping its applications across industries. [7]

Smita R. Chunamari and D. G. Borse have significantly contributed to the fields of cryptography and image secu rity through their research on certificateless key agreement and encrypted image verification. In their 2012 work, they proposed a robust certificateless authenticated key agreement protocol that eliminates the need for traditional Public Key Infrastructure (PKI) by introducing a scheme where each public key corresponds uniquely to a private key. [8] This not only strengthens security but also addresses issues such as key escrow and impersonation, making the protocol suitable for distributed environments like peer-to-peer networks.

In a subsequent 2013 study, the authors developed a secure schematic model for verifying encrypted images using an invariant hash function. This approach enables the authen tication of encrypted images without decryption, preserving privacy and ensuring integrity, which is particularly beneficial in sensitive domains such as medical imaging. By combining encryption with hashing mechanisms that are unaffected by encryption processes, their model ensures data authenticity without compromising confidentiality. [9]

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III. METHODOLOGY

The Crowd-Quest methodology involves developing a crowdsourcing-based question generation system integrated with blockchain technology to ensure transparency, security, and fairness. Contributors submit questions, which are re viewed by experts before being stored in a decentralized question bank. Smart contracts automate verification and ques tion paper generation, ensuring data integrity. The system architecture includes data flow diagrams (DFDs) and class diagrams to define interactions between students, teachers, and the platform. Key technologies include Solidity for smart con tracts, IPFS for decentralized storage, and Polygon blockchain for secure transactions. To assess effectiveness, the study eval uates question quality, system security, and user engagement, comparing the platform to traditional educational systems. This approach provides a scalable, transparent, and secure solution for collaborative question generation in education.

A. System Architecture

The Crowd-Quest system architecture Fig 1 is designed to facilitate a secure, transparent, and decentralized crowdsourc ing platform for question generation and verification using blockchain technology. The architecture consists of multiple layers, including data collection, validation, storage, and dis tribution, ensuring seamless interaction between contributors, reviewers, and students.It incorporates smart contracts to auto mate validation and reward mechanisms, enhancing trust and efficiency. Additionally, the use of AI modules across layers ensures intelligent filtering, categorization, and quality control of the submitted content.

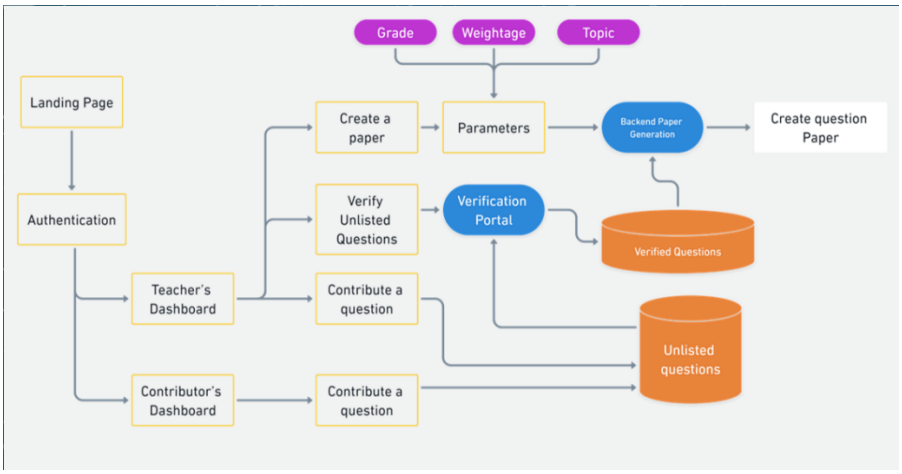

Fig. 1 Sequence Diagram

The system follows a three-layered approach: • Data Processing Layer– Contributors submit questions with relevant metadata (subject, difficulty level), which are stored temporarily for validation. • Validation and Blockchain Layer– Expert reviewers as sess the quality of submitted questions. Verified questions are secured using smart contracts and stored on the blockchain to ensure immutability. • Question Distribution Layer– The approved questions are organized into a dynamic, decentralized question bank, which educators can access for automated question paper generation. The blockchain ensures tamper-proof retrieval of validated questions. The platform utilizes Solidity for smart contracts, IPFS for decentralized storage, and Polygon blockchain for security. The system also includes data flow diagrams (DFDs) to illustrate interactions between students, educators, and the platform. By leveraging blockchain technology, Crowd-Quest guarantees a trustworthy, efficient, and scalable crowdsourcing system for educational assessments.

B. Data Collection and Storage

The Crowd-Quest system follows a structured approach to data collection by allowing contributors to submit questions along with metadata such as subject, difficulty level, and topic category. These submissions are first stored in a temporary validation queue, where expert reviewers assess their quality and relevance. To maintain content accuracy and fairness, only approved questions proceed to permanent storage. This multi-step process ensures that the platform maintains a high standard of question quality while preventing errors or biased content. For secure and tamper-proof storage, the system integrates blockchain technology and InterPlanetary File System (IPFS). Once a question is verified, it is permanently stored on the blockchain using smart contracts, ensuring immutability and transparency. IPFS is used for decentralized storage, assigning each question a unique cryptographic hash, which is referenced on the blockchain. This decentralized approach enhances secu rity, prevents data manipulation, and allows seamless retrieval of verified questions for students and educators. By eliminating reliance on a centralized database, Crowd-Quest ensures data integrity, security, and long-term accessibility.

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C. Data Preprocessing

The data preprocessing phase in Crowd-Quest ensures that submitted questions are clean, structured, and ready for valida tion. Automated checks detect duplicates, grammatical issues, and formatting errors. Natural Language Processing (NLP) is used to categorize questions by subject, difficulty, and topic. Low-quality or unclear submissions are flagged for expert review, where contributors may receive feedback for improvements. As illustrated in Fig. 2, the encryption model outlines the secure pipeline—from question submission and preprocessing to final validation and blockchain storage. This process ensures that only verified, high-quality content is stored, maintaining the reliability and integrity of the Crowd-Quest platform.

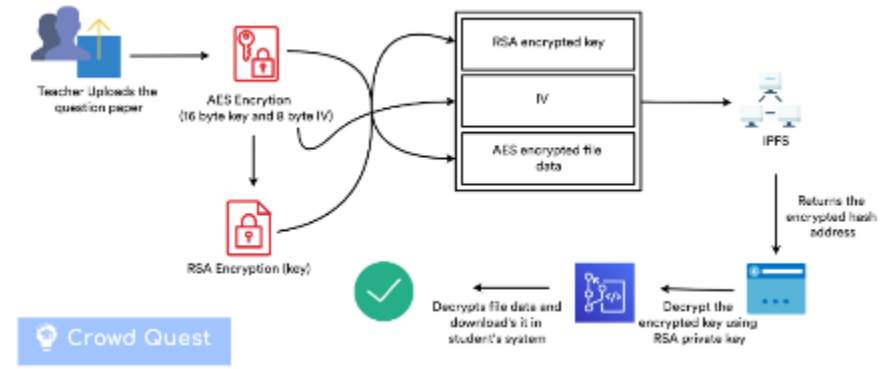

Fig. 2 Encryption Model

D. Blockchain-Based Question Optimization and Verification

• Secure and Immutable Verification: Blockchain ensures transparent and tamper-proof validation of submitted questions.
• Smart Contract Automation: Smart contracts handle auto mated question validation, storing only high-quality and non-redundant questions.
• Decentralized Voting (DAOs): Community-driven voting mechanisms assess relevance and accuracy, preventing biased moderation.
• Collaborative Question Refinement: The system enables contributors to enhance and improve questions collec tively.
• Machine Learning Integration: AI-based ranking models categorize questions based on difficulty, topic, and user preferences.
• Blockchain Oracles for Validation: Oracles fetch real time data for question ranking and validation, ensuring integrity and fairness.

E. Blockchain-Backed Backend API and Smart Contract Integration

The backend API, implemented using FastAPI and Web3.py, serves as the bridge between frontend users, blockchain-based storage, and smart contract execution:
• Decentralized Question Submission and Retrieval: Smart contracts handle secure storage and retrieval of verified questions, ensuring tamper-proof records.
• Immutable Question Auditing: Each submitted question undergoes a hashing process before being stored on the blockchain, preventing duplication or manipulation.
• Automated Reward Mechanism: Contributors are incentivized via blockchain-based token rewards when their questions are accepted through DAO-based voting.
• Smart Contract Execution for Quality Control: Auto mated filters and machine learning algorithms embedded in smart contracts ensure content moderation, eliminating inappropriate or duplicate questions before they are stored.

IV. IMPLEMENTION

A. Blockchain-Enabled Transparency and Security

Blockchain serves as the backbone of the Crowd-Quest system by ensuring immutability, security, and transparency in the question generation process. Every question submitted by contributors is stored as an immutable record on the blockchain, preventing unauthorized modifications or dele tions. This ensures data integrity, making it impossible for any entity to manipulate the stored questions. Additionally, blockchain-based logging mechanisms provide real-time trace ability, allowing stakeholders—students, teachers, and institu tions—to verify the authenticity of submitted questions. Since blockchain operates as a distributed ledger, multiple nodes validate the data, reducing the risk of fraudulent activities. This decentralized approach eliminates the need for a central authority, ensuring fairness and trust in the system.

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B. Smart Contracts for Automated Verification

Smart contracts are self-executing programs that operate based on predefined rules and conditions. In Crowd-Quest, smart contracts automate the question submission, verification, and reward distribution processes. When a contributor submits a question, the smart contract evaluates predefined quality criteria, such as uniqueness, relevance, and difficulty level. If the question meets these conditions, it is automatically approved and stored in the blockchain-based question bank. Otherwise, it is rejected or flagged for expert review. This automation eliminates human bias and speeds up the verifica tion process, reducing manual workload. Additionally, smart contracts ensure that contributors receive fair compensation for accepted questions through a token-based incentive system, further motivating high-quality contributions.

C. Decentralized and Scalable Storage

Traditional centralized storage solutions pose risks of data breaches, censorship, and single points of failure. To address these issues, Crowd-Quest integrates IPFS (InterPlanetary File System) for decentralized storage of questions and related metadata. IPFS distributes data across a peer-to-peer network, making it more resilient, scalable, and secure. This ensures that questions remain accessible even if some nodes in the network go offline. Unlike conventional cloud-based storage, which relies on a centralized authority, IPFS leverages a content addressed system, meaning each file has a unique crypto graphic hash. This approach ensures tamper-proof storage, reduces redundancy, and optimizes retrieval efficiency. Fur thermore, blockchain stores the hash references to questions, enhancing security without overwhelming the blockchain with excessive data storage.

D. AI-Driven Question Optimization and Categorization

AI in the Crowd-Quest system plays a key role in optimizing, categorizing, and ranking crowdsourced questions. It uses NLP to assess clarity, relevance, difficulty, and unique ness, while flagging errors or ambiguities. AI categorizes questions by subject and complexity, enables personalized recommendations, detects duplicates and offensive content, and ensures originality through plagiarism checks. It also auto-generates tags, predicts question engagement, and verifies answer accuracy. Combined with blockchain, AI enhances the system's efficiency, security, and credibility.

V. RESULT AND DISCUSSION

In this section, the results and outcomes of the CrowdQuest system are presented. The system is designed to automate the generation of question papers from a crowdsourced question bank and securely distribute them using blockchain technol ogy. The key outputs include the ability to generate question papers in real-time based on user inputs, encrypt the papers for secure distribution, and verify the authenticity of the questions through a vetting process. These outputs demonstrate the system's efficiency and security, ensuring that the generated question papers are both reliable and tamper-proof. Detailed descriptions of each output are provided below, along with relevant visuals and analysis to support the findings.

Fig. 3. Homepage

In Fig 3, A clean and responsive homepage designed for ease of access and usability. It offers quick navigation for con tributors and experts, provides multilingual support, displays live statistics, and showcases a minimalistic yet informative interface. The homepage serves as the central gateway to the CrowdQuest platform, ensuring users are welcomed with clarity, security awareness, and simple onboarding option.

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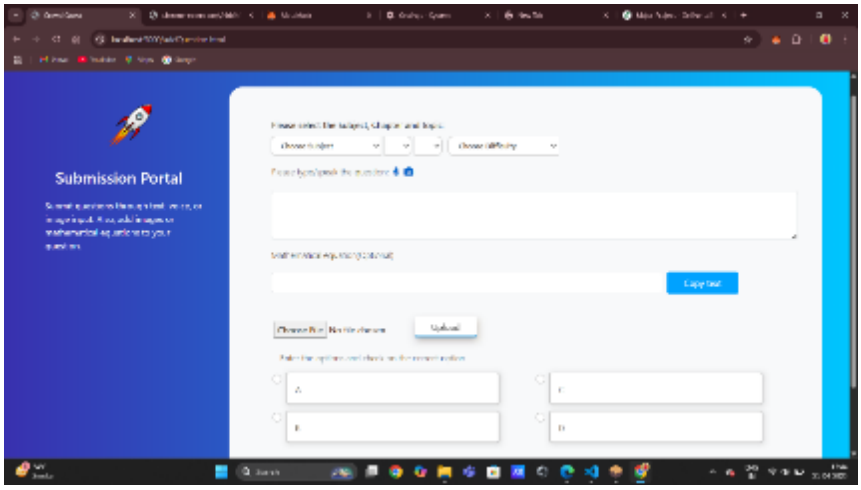

Fig. 4. Question to submit

This figure 4 shows an interface where contributors can easily type or upload questions in various formats for sub mission. The user-friendly design ensures efficient question entry, followed by review and approval.

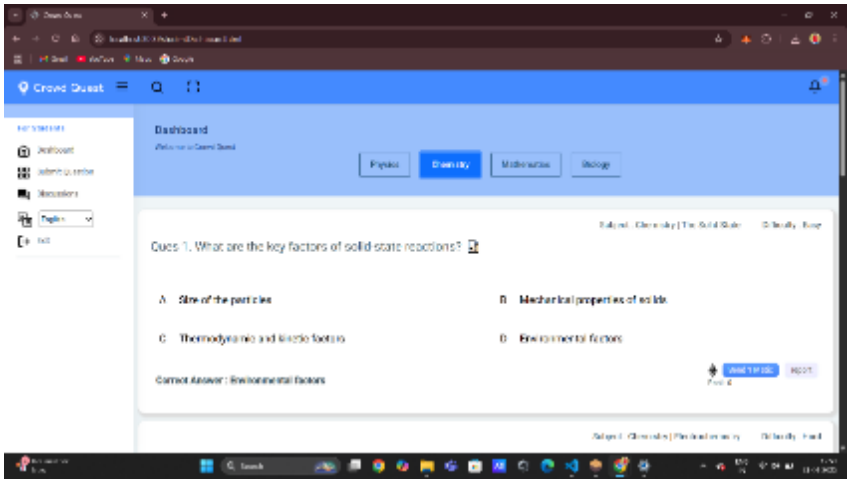

Fig. 5. Question Dashboard

In Fig 5, The Question Dashboard offers a centralized interface to view, filter, and manage submitted questions. It allows users to track status, edit, delete, or search questions, ensuring efficient and transparent oversight.

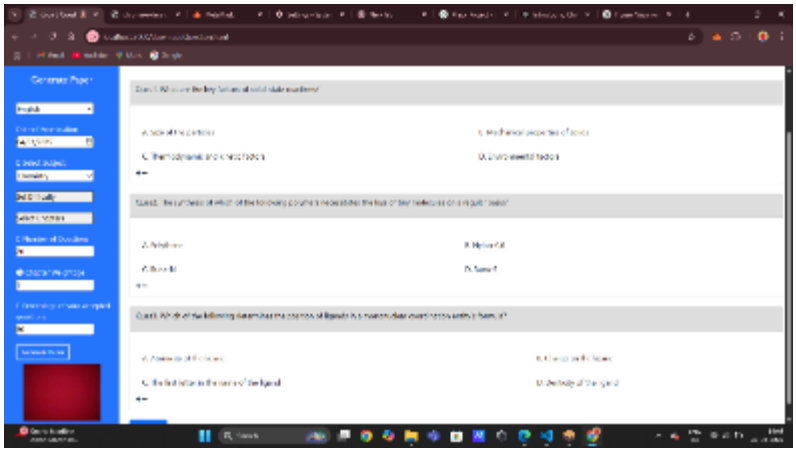

Fig. 6. Generating Question Paper Using Smart Contract

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This figure 6 illustrates the generation of a question paper using a smart contract. The smart contract automates the process, ensuring the paper is generated based on prede-fined criteria. It guarantees security, randomness, and integrity in the paper creation. The blockchain-based approach provides transparency and prevents tampering of the generated question paper.

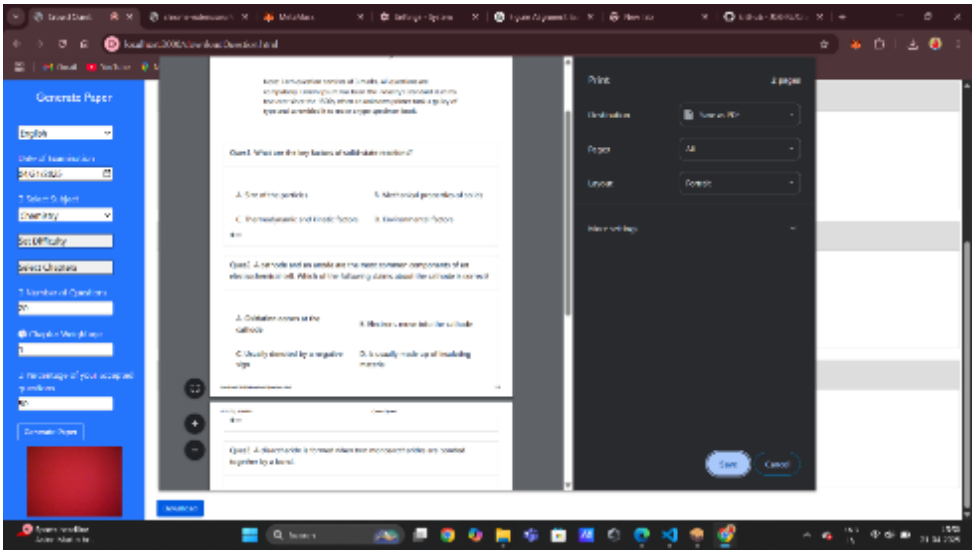

Fig. 7. Download PDF of Paper

This figure 7 illustrates the option to download the question paper as a PDF. The paper, once generated and finalized, can be easily downloaded for printing or distribution. The PDF format ensures that the content is preserved in a secure, non editable form. This feature simplifies the process of accessing the paper for offline use or distribution.

VI. CONCLUSION

The development of CrowdQuest has laid a strong founda tion for transforming traditional assessments through crowd sourcing and blockchain. This phase focused on system design, secure data collection, and creating a transparent, token incentivized question vetting process. The next phase will involve implementation—deploying smart contracts, launching the platform, and conducting real-world testing. With this groundwork, CrowdQuest is set to evolve into a scalable, collaborative, and secure solution for modern educational assessments.

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REFERENCES

[1] Y. Liang, Y. Li, and B.-S. Shin, “Blockchain-based crowdsourcing for human intelligence tasks with dual fairness,” Blockchain: Research and Applications, p. 100213, 2024.

[2] A. Jaribion, S. H. Khajavi, U. J¨ arvihaavisto, I. Nurmi, R. Gustafsson, and J. Holmstr¨om, “Crowdsourcing properties and mechanisms of mega hackathons: The case of junction,” IEEE Transactions on Engineering Management, 2021.

[3] S. Carter, M. Smith, S. Bali, S. Sotiriadis, N. Bessis, and R. Hill, “The use of crowdsourcing to aid quest design in games,” in 2012 Third International Conference on Emerging Intelligent Data and Web Technologies. IEEE, 2012, pp. 302–305.

[4] K. D. Wang, Z. Chen, and C. Wieman, “Can crowdsourcing platforms be useful for educational research?” in Proceedings of the 14th Learning Analytics and Knowledge Conference, 2024, pp. 416–425.

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[5] K. Wang, X. Qi, L. Shu, D.-j. Deng, and J. J. Rodrigues, "Toward trustworthy crowdsourcing in the social internet of things," IEEE Wireless Communications, vol. 23, no. 5, pp. 30–36, 2016.

[6] Y. Yu, S. Liu, L. Guo, P. L. Yeoh, B. Vucetic, and Y. Li, "Crowdr fbc: A distributed fog-blockchains for mobile crowdsourcing reputation management," IEEE Internet of Things Journal, vol. 7, no. 9, pp. 8722 8735, 2020.

[7] M.-C. Yuen, I. King, and K.-S. Leung, "A survey of crowdsourcing sys tems," in 2011 IEEE third international conference on privacy, security, risk and trust and 2011 IEEE third international conference on social computing. IEEE, 2011, pp. 766–773.

[8] S. R. Chunamari and D. Borse, "Secure schematic model for verifying encrypted image using invariant hash function," International Journal of Computer Applications, vol. 975, p. 8887, 2013.

[9] ——, "Robust framework for certificateless authenticated key agreement protocol," in International Conference in Recent Trends in Information Technology and Computer Science (ICRTITCS-2012) Proceedings pub lished in International Journal of Computer Applications (IJCA)(0975 8887), vol. 27. Citeseer, 2012