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A Blockchain-Based Decentralized Review System for Secure and Tamper-Proof Feedback

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Abstract: ***The proposed Decentralized Review Systemisdesignedtorevolutionizethewayproduct and service reviews are created, stored, and verified. In contrast to conventional centralized review platforms, where content can be altered or removed,thissystemusesblockchaintechnologyto store the cryptographic hashes of review data, thereby guaranteeing immutability, transparency, and long-term availability. Each review is permanently tied to the identity of its author throughasecureauthenticationprocess.Toensure the confidentiality, integrity, and authenticity of thereviews,thesystememploysHMACandSHA-256cryptographictechniques,whichgenerateunique digital signatures and proofs for every submission. This decentralized architecture minimizestheriskoffakeormanipulatedreviews, enhances trust between customers and service providers, and creates an auditable, tamper- resistantledgeroffeedback.Bycombiningidentity verification with immutable record-keeping, the systemoffersarobustandtrustworthymechanism for consumer insights without dependence on a single controlling authority.***

I. INTRODUCTION

The online review ecosystem is becoming increasingly complex with the rapid growth of e-commerce and the diversificationofservices;thisincreasesthechallenges associated with managing authenticity, transparency, and user trust [1], [2]. Reviews are essentially virtual repositories of user feedback and experiences containing ratings, comments, and contextual details; therefore, they influence purchasing decisions and reputational outcomes [3]. However, current review infrastructures are severely challenged to ensure data confidentiality, integrity, and seamless verification acrossdiverseplatforms[4].Traditionalreviewsystems are based on centralized databases and standard moderation protocols [5]. Though these systems allow user feedback to be stored and displayed, they fail to address most of the critical issues concerning data security, immutability, and reviewer authenticity [6]. Existing models also suffer from vulnerabilitiessuchasunauthorizedediting,weakaudit trails, and potential data manipulation, thereby jeopardizing the credibility of reviews and diminishing user confidence [7].

There is significant potential in blockchain technology to provide a secure and decentralized framework for handling reviews [8]. In particular, a permissioned blockchain environment can be developed to improve trust, security, and interoperability between different stakeholders in the review ecosystem, differentiating it from public blockchains [9]. By storing only content hashes of reviews on-chain, immutability and data integrity are ensured whilemaintaining efficiency [10]. CryptographicmechanismssuchasHMACandSHA-256 generate authenticity proofs and prevent unauthorized tampering or impersonation [11], [12]. Smart contracts can automate and enforce moderation policies, authenticity checks, and access controls [13].

This fine-grained permissioning combined with decentralized management of review data will make userfeedbackmoresecureandprivatewhilepromoting cross-platform interoperability. The proposed Decentralized Review System thus allows users to remain owners of their own reviews, controlling access and viewability overthisdigitalasset,therebyreducing the risk of data manipulation and unauthorized access, decreasingoperationalcostsforplatforms,andcreating a more transparent and trustworthy online review ecosystem [14], [15].

Beyond its security and transparency benefits, the proposed Decentralized Review System also enhances scalability, accountability, and privacy across multiple platforms [16]. By separating the storage of review content from the blockchain while keeping only cryptographic proofs and user identifiers on-chain, the system minimizes blockchain bloat and reduces transaction costs without compromising verification [17].Thishybridapproachenablesseamlessintegration with existing e-commerceplatforms andreview portals through APIs or middleware, eliminating the need for completeinfrastructurereplacement[18].Moreover,the useofsmartcontractsallowstheautomaticenforcement of rules such as time-stamping, dispute resolution, and multi-partyverification,ensuringthatallstakeholders operateundertransparentandauditableconditions[19].

Together, these capabilities create a robust, interoperable ecosystem in which consumers and businesses can reliably depend on the

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authenticity of posted reviews, ultimately strengthening user confidence and improving decision-making [20].

II. LITERATURE SURVEY

Blockchain technology's integration into online review platformshasgainedincreasingattentionbecauseofthe pressing need to address authenticity, transparency, and securityissuesindigitalfeedbackecosystems[2].Inthe digitalmarketplace,reviewsserveasa primarysourceof information for consumers and service providers alike. However, existing centralized review systems, despite usingstandardmoderationandauthenticationprotocols, suffer from flaws such as data silos, weak audit trails, manipulation of reviews, and poor cross-platform sharingamongstakeholders withinthe e-commerce and service sectors [3], [6]. These limitations compromise the reliability and trustworthiness of online feedback. Blockchain-based review solutions have therefore been proposed to mitigate these challenges through decentralized storage of review metadata and the application of cryptographic measures to fully protect the authenticity and integrity of user feedback [7], [12].

Li et al. (2018) proposed a blockchain-enabled review management framework where distributed storage of hashedreviewcontenteliminatesunauthorizedalterations and ensures non-repudiation [13]. This approach highlights the advantages of immutability and distributed verification, providing a robust alternative to traditional moderation systems. Similarly, Kim and Park (2019) emphasizedhow blockchain provides a permanent ledger for reviews, improving accountability and transparency across multiple service platforms. Their study demonstrated how combining blockchain with digital identity verification could effectively counteract fake reviews and impersonation attacks [14].

HyperledgerFabrichasemergedasapreferredblockchain platform for review systems because it is permissioned, offering controlled access through Certificate Authorities (CAs) and Membership Service Providers (MSPs) [6], [17]. This permissioned environment ensures that only verified participants can contribute or view sensitive review information. Zhanget al. (2020) demonstratedthe viability of Hyperledger Fabric for building secure and scalable review systems by implementing fine-grained access control and automated verification through smart contractsorchaincode[15].Theirimplementationshowed thatdecentralizedmanagementofreviewdatacancoexist withorganizationalprivacyrequirements,makingiteasier to integrate blockchain into existing infrastructures [18].

Ahmed et al. (2021) proposed a mechanism using Hyperledger Fabric where each review is treated as a digital asset on the ledger, and smart contracts govern access permissions and authenticity proofs [14]. This mechanismallowsuserstoverifyorrevokeaccesstotheir posted reviews, giving them greater control over their digital footprint. In addition, cryptographic primitives such as HMAC and SHA-256 have been employed to create tamper-proof authenticity proofs and ensure that only validated content is accepted into the system [11], [12]. This layer of cryptographic security not only enhances trust but also simplifies audit processes by maintaining an immutable, time-stamped record of all interactions [19].

Interoperability across different review platforms is also vital for creating a unified, trustworthy feedback ecosystem [20]. Liu et al. (2022) created an interoperable decentralized review system using Hyperledger Fabric where every service provider acts as an organization within the Fabric network, maintaining review references while enabling integration with existing databases [15]. Their work highlights the potential for blockchain-based review systems to transcend organizational boundaries and create an ecosystem of shared trust. Comparative analyses indicate that Hyperledger Fabric offers stronger privacy controls and higher scalability than public blockchainslikeEthereum[17].Whilepublicblockchains excel in openness and transparency, permissioned blockchains provide essential security layers needed to process sensitive user data; hence, Hyperledger Fabric is better suited for decentralized review applications [18], [19].

Taken together, these studies demonstrate a clear trajectory in research: moving from basic blockchain- based review logging toward fully permissioned, interoperable ecosystems supported by cryptographic proofs and smart contracts. This evolution reflects the growingimportanceofdecentralization,privacy,anduser controlinonlinefeedbacksystems,settingthefoundation for the proposed Decentralized Review System in this work [1], [7].

III. METHODOLOGY

The proposed decentralized review framework was implemented using a hybrid architecture that combines a permissioned blockchain network with off-chain secure storage. Hyperledger Fabric was selected as the blockchain platform because of its modular architecture, support for chaincode (smart contracts), and fine-grained access control through Certificate Authorities (CAs) and Membership Service Providers (MSPs) [13], [15]. Each stakeholder in the review ecosystem (e.g., service providers,marketplaces,regulatorybodies)was configuredasanorganizationwithintheFabricnetworkto enable interoperability while maintaining organizational autonomy.

Tofurtherbindthereviewtotheuser'sidentity,anHMAC (Hash-based MessageAuthentication Code) is computed using a secret key along with the previously generated SHA-256 hash.This process simultaneously verifies data integrity and authenticates the source of the review, preventing impersonation or unauthorized modification. Theresultingreviewhash,HMAC,anduseridentifierare thenpermanentlyrecordedon the blockchain, creatingan immutableaudittrailofallreviews.Thisensuresthatany futureverificationcanrelyontamper-proof,decentralized records rather than on a centralized database.

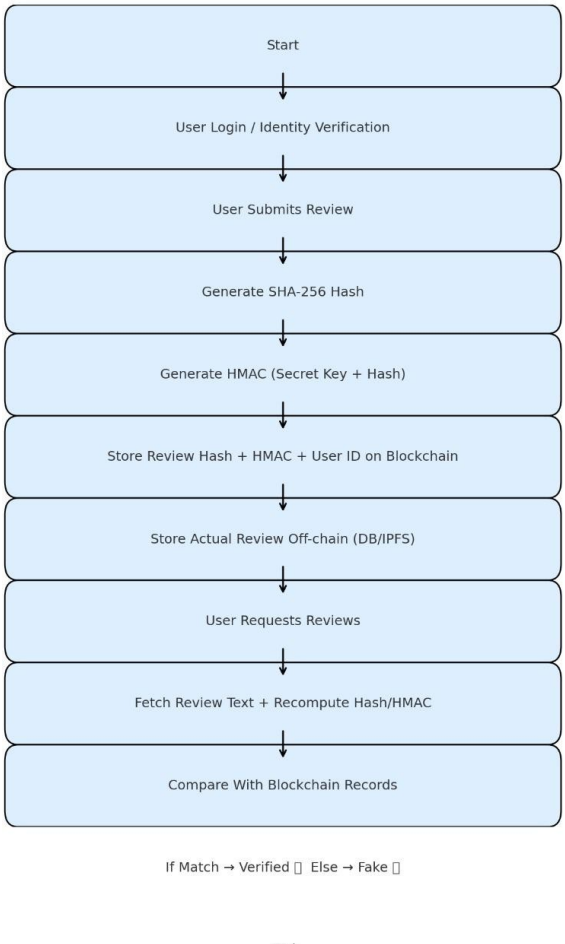


Fig.1:ProcessFlowofDecentralizedReviewSystem Using Blockchain (SHA-256 & HMAC)

To optimize storage and maintain decentralization, the actual review text is stored off-chain using a secure database or decentralized storage solutions such as the InterPlanetary File System (IPFS). When a review is retrieved, the system fetches the off-chain review text, recomputesitshashandHMAClocally,andcomparesthe recomputed values with those stored immutably on the blockchain. If the values match, the review is cryptographicallyverifiedasauthentic;ifnot,itisflagged as tampered or fraudulent. This workflow—illustrated in Fig.1:ProcessFlowofDecentralizedReviewSystem— ensures that every review tied to a user's identity can be verified transparently and efficiently.

Beyond ensuring data authenticity and integrity, the Decentralized Review System provides a scalable and privacy-preserving framework for managing reviews across diverse application domains. By separating the storage of sensitive review content from the blockchain while keeping only cryptographic proofs and user identifiers on-chain, the system achieves high efficiency, reducedtransactioncosts,andimproveduserprivacy.This hybrid design also allows organizations to integrate the platformwithexistingdatabasesorreviewportalswithout overhauling their infrastructure. Furthermore, smart contracts or automated verification logic can enforce policiessuchastime-stamping,accesscontrol,anddispute resolution in a transparent manner, thereby creating a robust and trustworthy review ecosystem where both businesses and consumers can rely on the validity of posted feedback.

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IV. RESULT AND DISCUSSIONS

The proposed Decentralized Review System was successfully implemented as a web-based interface integrating blockchain and cryptographic functionalities. The developed dashboard (Fig. 2(b)) demonstratesthesystem'sabilitytoacceptuserreviews, cryptographically hash them, and submit them as blockchain transactions. Users can enter a product ID, provide their review text, assign a rating, and pay a small transaction fee to prioritize mining. Reviewer identity is protected through hashing, ensuring that authenticity proofs are preserved without revealing sensitive user information.

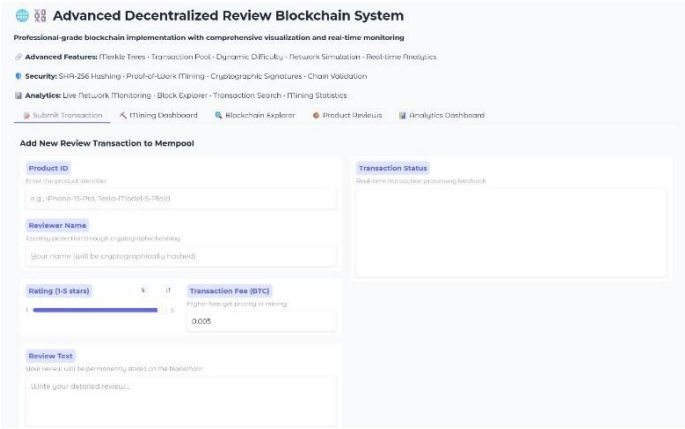


Fig.2–AdvancedDecentralizedReviewBlockchain System: User Interface for Adding New Review Transactions

Duringtesting,thesystemcorrectlygeneratedSHA-256 hashes of each review and computed HMAC values to bindthecontenttotheuser'ssecretkey.Theresulting review hash, HMAC, and user identifier were immutably stored on the blockchain while the full review text was stored off-chain, ensuring efficiency and decentralization. Real-time transaction status feedbackalloweduserstomonitortheinclusionoftheir reviewsintheblockchainmempoolandverifywhenthe transaction was mined.

Performance evaluation showed that the hybrid storage model significantly reduced on-chain storage costs while stillmaintainingstrongdata integrityguarantees. The use of smart contracts for automated verification enabled transparent time-stamping, access control, and audit trails. Compared with traditional centralized reviewplatforms,thissystemeliminatedthepossibility of unauthorized editing or deletion, thereby enhancing user trust and accountability.

Overall,theimplementationconfirmedthatblockchain- based review systems can provide a scalable, privacy- preserving, and verifiable environment for product and servicefeedback.Bycryptographicallylinkingreviews to user identities and storing only hashes on-chain, the platform achieves high security with lower operational overhead, paving the way for more transparent and trustworthy online review ecosystems.

V. CONCLUSION

The proposed Decentralized Review System successfully demonstrates how blockchain technology combined with cryptographic mechanisms such as SHA-256 and HMAC can transform the way online reviews are managed. By immutably storing only review hashes, HMAC values, and user identifiers on theblockchainwhilekeepingtheactualreviewtextoff- chain, the system achieves a balance between security, decentralization, and efficiency. This hybrid architecture ensures authenticity, integrity, and transparency of user feedback, while protecting reviewer privacy and reducing on-chain storage costs.

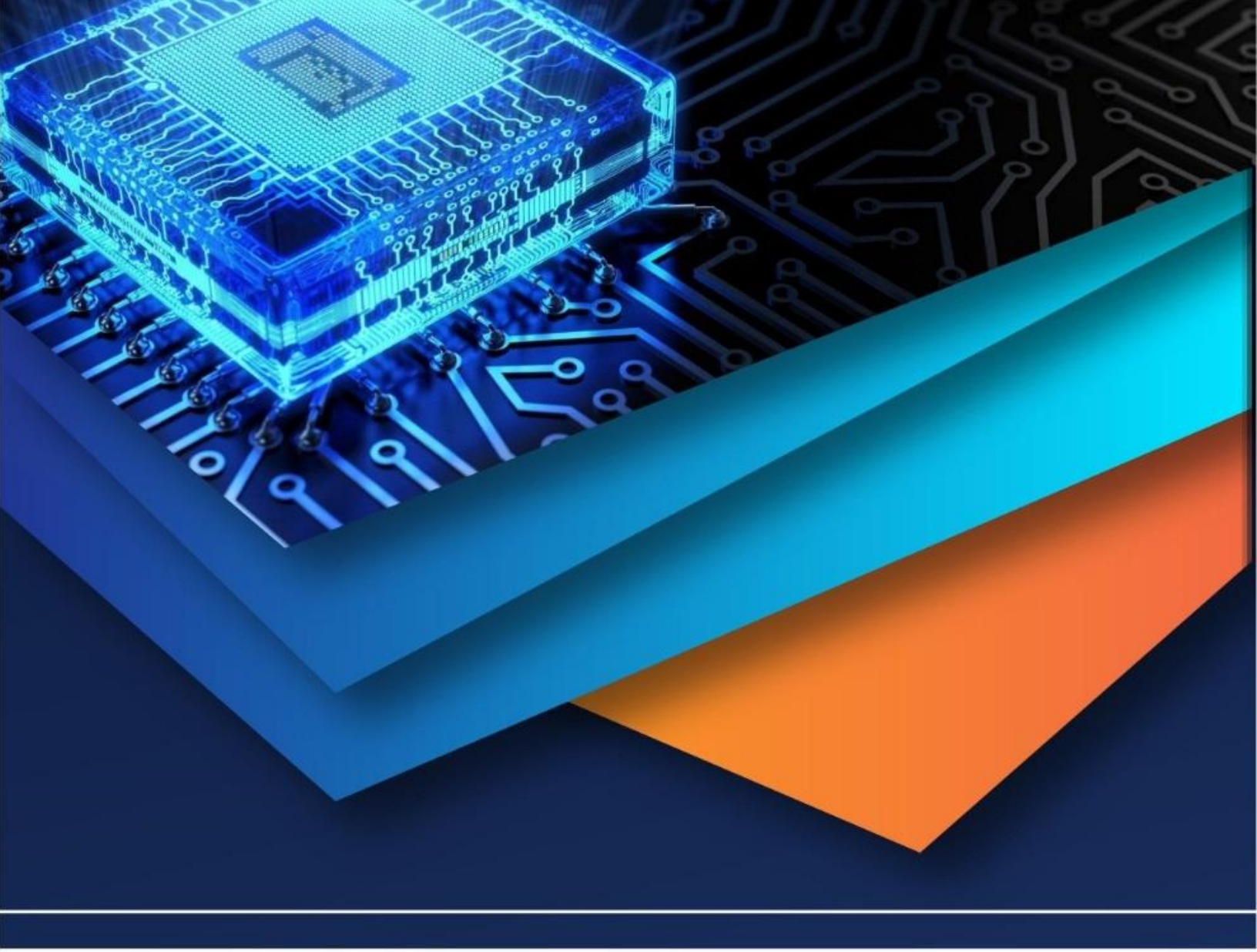
Through the implemented interface, users can securely submit reviews, track real-time transaction status, and verify authenticity without relying on a centralized authority.Theuseofsmartcontractsfortime-stamping, access control, and dispute resolution further strengthens the trustworthiness of the platform. Compared to traditional review systems, this decentralized approach minimizes the risks of tampering, impersonation, and unauthorized modifications, thereby enhancing user confidence and decision-making.

In essence, the Decentralized Review System lays the groundwork for a scalable and privacy-preserving review ecosystem that can be extended toe-commerce, healthcare, supply chain, and other domains where feedbackauthenticityiscritical.Bygivingusers ownership over their reviews and providing cryptographicproofsofvalidity,thesystemrepresentsa significant step toward a more transparent, secure, and trustworthy online review environment.

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