

Blockchain Based Complaint Management System

G Geetha Devi¹, Mahitha Poreddy², Bommyreddy Mokshitha³, Padmini Kondapalli⁴

¹Assistant Professor; Department Of Information Technology Bhoj Reddy Engineering College For Women Hyderabad India.

^{2,3,4}B.Tech Students; Department Of Information Technology Bhoj Reddy Engineering College For Women Hyderabad India.

Mail Id; mahithareddy729@gmail.com², pkondapalli05@gmail.com⁴, bommyreddymokshitha@gmail.com³

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ABSTRACT

In the modern digital era, the need for a transparent, secure, and accountable complaint-handling framework has become increasingly critical for enhancing public trust and ensuring efficient grievance resolution. Conventional complaint management systems are predominantly centralized and manual, making them vulnerable to issues such as data manipulation, delayed processing, lack of transparency, and insufficient audit mechanisms. These limitations often result in inefficiency, reduced accountability, and user dissatisfaction. To address these challenges, this paper presents a decentralized and intelligent Complaint Management System that integrates Blockchain technology with Artificial Intelligence (AI). The blockchain component ensures immutability, transparency, and security by maintaining a tamper-resistant distributed ledger of complaint records. This enables reliable tracking and verification throughout the complaint lifecycle. Simultaneously, AI techniques are utilized to automate complaint classification, predict priority levels, and identify duplicate or fraudulent submissions before storing metadata on the blockchain. The proposed system enhances trust, reduces administrative overhead, and improves response efficiency by combining decentralized storage with intelligent data processing. This approach offers a scalable and secure solution for modern grievance redressal systems in public and organizational domains.

Keywords: Blockchain, Artificial Intelligence, Complaint Management System, Smart Contracts, IPFS, Decentralized Ledger, Transparency, Grievance Redressal, Secure Storage

INTRODUCTION

Effective complaint management plays a vital role in maintaining transparency, accountability, and service quality within public institutions, universities, and organizations. However, traditional grievance-handling mechanisms are often inefficient, relying on manual processes and centralized infrastructures. These systems are prone to challenges such as data tampering, delayed responses, loss of records, and limited visibility for users. Consequently, these shortcomings reduce public confidence and increase the operational burden on administrative bodies. To overcome these limitations, this work proposes a Complaint Management System based on Blockchain and Artificial Intelligence technologies. Blockchain introduces a decentralized and immutable data structure that securely records complaint metadata using cryptographic techniques. Once stored, the data cannot be altered or removed, ensuring integrity and traceability throughout the complaint lifecycle. In addition, Artificial Intelligence is incorporated to enhance system intelligence and efficiency. AI models are used to analyze complaint content, automatically categorize issues, detect duplicate or

misleading submissions, and assist in prioritizing cases. This reduces manual effort and enables faster and more accurate grievance handling.

Purpose of the Project

The primary objective of this project is to design and implement a secure, transparent, and efficient complaint management system by leveraging Blockchain and Artificial Intelligence. The system aims to eliminate key issues in conventional approaches, including lack of transparency, susceptibility to data manipulation, delayed processing, and unreliable validation of submitted evidence.

By utilizing blockchain technology, complaint records are stored in a decentralized and tamper-resistant manner, ensuring that no unauthorized modifications can occur. This establishes a reliable audit trail and enhances trust among users. Furthermore, AI-based validation mechanisms improve the authenticity and relevance of submitted complaints, enabling efficient and accurate grievance resolution.

Existing System

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Current complaint management systems typically operate on centralized architectures managed by government or organizational servers. While these systems provide basic functionality for complaint registration and tracking, they suffer from several limitations. The centralized design restricts transparency and makes it difficult for users to independently verify the status or history of their complaints.

Additionally, such systems are vulnerable to data manipulation, as internal access may allow unauthorized modifications or deletions. The absence of automated validation mechanisms results in reliance on manual verification processes, which are often slow and inefficient. Furthermore, there is no robust method to ensure the authenticity of submitted evidence, increasing the risk of false or misleading complaints.

Proposed System

The proposed Blockchain-Based Complaint Management System is designed to provide a secure, decentralized, and transparent platform for grievance handling. The system incorporates role-based dashboards for users and authorities, enabling efficient interaction and complaint management.

User-submitted evidence is securely encrypted and stored using decentralized storage solutions such as IPFS, ensuring data confidentiality and availability. The backend, implemented using Flask, manages authentication, encryption, and AI processing tasks. Blockchain platforms like Ethereum or Polygon are utilized to store complaint metadata immutably.

An integrated AI module enhances system reliability by validating complaint content, detecting duplicate entries, and identifying manipulated or suspicious submissions. Separate databases are maintained for optimized performance and efficient complaint tracking.

RELATED WORK

Complaint management has long been a critical function in public administration and organizational governance. Traditional approaches have faced persistent challenges, including lack of transparency, inefficient processing, and vulnerability to data manipulation. Recent advancements in digital technologies have led researchers to explore innovative solutions based on decentralization and automation. Early complaint systems were primarily paper-based, requiring individuals to submit grievances through physical forms or postal services. These methods were inefficient, as complaints could be lost, damaged, or delayed, and there was no effective mechanism for tracking or analysis. With the advent of digital technologies, second-generation systems introduced electronic submissions through emails and basic web interfaces. While these systems improved accessibility and reduced physical storage

requirements, they relied heavily on centralized databases, which introduced risks such as data corruption, unauthorized access, and single points of failure. Subsequent developments led to more advanced web-based platforms with user authentication, complaint tracking, and administrative dashboards. Although these systems enhanced usability and operational efficiency, they still lacked mechanisms for ensuring data integrity, transparency, and independent verification.

Recent research has focused on integrating Blockchain technology to address these issues by providing decentralized and tamper-proof record management. Additionally, Artificial Intelligence has been applied to automate complaint classification, detect anomalies, and improve processing efficiency. These advancements form the foundation for the proposed system, which combines both technologies to create a robust, transparent, and intelligent complaint management framework.

REQUIREMENT ANALYSIS

Functional Requirements

Functional requirements define the core operations that the proposed Complaint Management System must perform to satisfy user needs and system objectives. These requirements describe how the system processes inputs—such as complaint details, user credentials, and uploaded evidence—and transforms them into meaningful outputs like complaint IDs, status updates, and resolution reports. The system is designed to support end-to-end complaint handling, from submission to resolution, while ensuring security, transparency, and efficiency.

The system enables citizens to register complaints by providing relevant details along with multimedia evidence, including images, videos, or documents. To ensure data confidentiality, all submitted information is encrypted before storage and can only be accessed through authorized decryption mechanisms. An integrated Artificial Intelligence module evaluates each complaint to detect manipulated media, irrelevant content, or fraudulent submissions, ensuring only valid complaints proceed further. Additionally, the system records complaint metadata—such as timestamps, categories, and IPFS content identifiers—on a blockchain network, ensuring immutability and protection against tampering. Role-based authentication mechanisms restrict system access based on user roles, including citizens, officers, and administrators. Furthermore, users are provided with real-time tracking capabilities to monitor complaint progress, including verification stages and final resolution updates.

Non-Functional Requirements

Non-functional requirements describe the quality attributes and performance standards that the system

must achieve to ensure reliability and usability. These requirements focus on how effectively the system operates under different conditions rather than what functions it performs.

The system is designed to be highly scalable, capable of handling an increasing number of users and complaint submissions without performance degradation. It ensures fast processing of complaint registration, AI validation, and administrative updates, even during peak usage periods. Security is a critical aspect, with strong encryption techniques, secure authentication protocols, and strict access control mechanisms implemented to safeguard sensitive data. Reliability is maintained by ensuring continuous system availability and preventing data loss, particularly for complaint records and blockchain transactions. The system architecture also supports maintainability, allowing developers to update or enhance functionalities without disrupting ongoing operations. Interoperability is achieved through seamless integration with external systems such as government portals and notification services. Finally, the user interface is designed to be intuitive and user-friendly, enabling individuals with minimal technical expertise to interact with the system efficiently.

Computational Resource Requirements

The implementation of the proposed system requires a combination of software and hardware resources to ensure efficient operation. On the software side, the system is developed using Python as the primary programming language, with Visual Studio Code as the development environment. The frontend is built using HTML, CSS, and Bootstrap to provide a responsive and interactive user interface. Artificial Intelligence functionalities are powered by OpenAI-

based language models, while blockchain integration is achieved using the Ethereum platform. Data storage is handled using decentralized technologies such as IPFS through services like Pinata or Web3.Storage. Visualization tools such as Chart.js are used to present analytics and complaint statistics. Additionally, libraries such as Web3.py and cryptographic modules are utilized for blockchain communication and data security. From a hardware perspective, the system requires a processor equivalent to Intel Core i5 or higher, a minimum of 8 GB RAM, and at least 500 GB of storage to support application execution, database operations, and decentralized storage interactions.

Architecture

System Architecture

System architecture defines the overall structure and operational flow of the proposed solution. It provides a high-level representation of how different components interact to achieve system objectives. The architecture is designed to integrate web technologies, artificial intelligence, blockchain, and decentralized storage into a unified framework. The system follows a modular approach, where each component is responsible for a specific functionality, such as user interaction, data processing, storage, and validation. This abstraction ensures flexibility, scalability, and ease of maintenance. The architecture emphasizes secure data flow, ensuring that all complaint information is validated, encrypted, and stored in a tamper-proof environment. It also supports lifecycle management of complaints, from submission to resolution, while maintaining transparency and traceability.

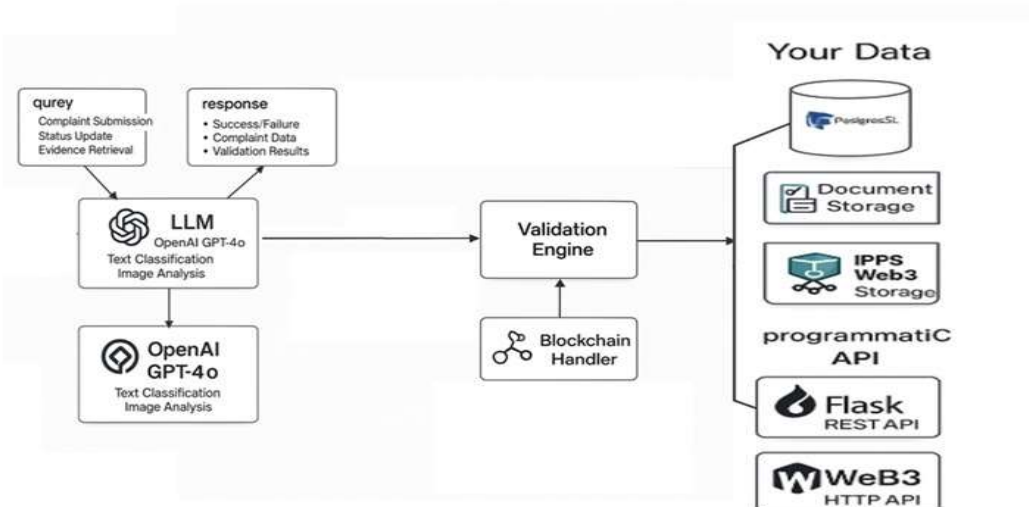


Fig 1; System Architecture

Technical Architecture

The technical architecture focuses on the implementation aspects of the system, detailing how

software and hardware components are integrated to deliver the required functionalities. It provides a comprehensive view of system infrastructure,

including frontend interfaces, backend services, AI modules, blockchain networks, and storage systems. The frontend communicates with the backend through HTTP requests, while the backend processes data, interacts with AI services, and communicates with the blockchain using Web3

libraries. Decentralized storage systems such as IPFS handle file storage, while relational databases manage structured data. This layered architecture ensures efficient communication, scalability, and secure data handling across all components.

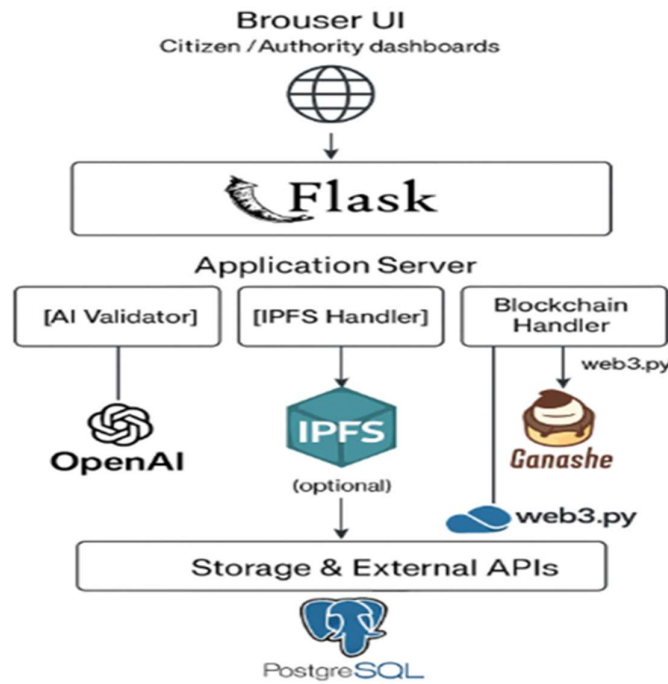


Fig 2 ;Technical Architecture

UML Diagrams

The system design is further represented using Unified Modeling Language (UML) diagrams to visualize system structure and behavior. Use case diagrams illustrate interactions between users and the system, highlighting functionalities such as complaint submission and tracking. Class diagrams represent the static structure of the system, including entities, attributes, and relationships.

Sequence diagrams depict the flow of interactions over time, showing how different components communicate during complaint processing. Activity diagrams model workflows, illustrating the sequence of operations involved in complaint validation, storage, and resolution. Together, these diagrams provide a comprehensive understanding of system functionality and design.

Methodology

The proposed methodology integrates Artificial Intelligence, Blockchain, and decentralized storage to ensure secure and transparent complaint management. The process begins with data collection through a web interface, where users submit complaint details along with supporting evidence. The input data undergoes preprocessing to ensure consistency and validity. AI-based validation

is then applied to analyze the complaint text and associated media, identifying irrelevant or manipulated content. Once validated, complaint data is stored in a relational database, while evidence files are uploaded to IPFS, generating unique content identifiers. To ensure immutability, a cryptographic hash of the complaint metadata is generated and stored on the Ethereum blockchain. This creates a permanent record that prevents unauthorized modifications. The backend interacts with smart contracts to manage blockchain transactions securely. Finally, users and authorities can access complaint information and track progress through dedicated dashboards, ensuring transparency and accountability throughout the process.

System Modules

The system is divided into multiple functional modules to ensure efficient operation. The Citizen Dashboard enables users to submit complaints and track their status in real time. The Authority Dashboard allows officials to review complaints, validate evidence, and update resolution statuses. The Encryption and IPFS Storage Module ensures secure handling of uploaded data by encrypting files before storing them in decentralized storage. The

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Blockchain Module records complaint metadata in an immutable ledger, ensuring transparency and auditability. The AI Verification Module enhances system intelligence by analyzing complaint text and validating multimedia evidence to detect inconsistencies or fraudulent submissions.

IMPLEMENTATION

Technologies Used

The implementation of the system integrates multiple technologies to achieve a secure and scalable solution. The frontend is developed using Bootstrap, which provides responsive design components and improves user experience across devices. The backend is built using the Flask framework, which handles routing, request processing, and session management. Artificial Intelligence functionalities are implemented using OpenAI APIs, enabling advanced text and image analysis for complaint validation. Data storage is managed using PostgreSQL, which ensures consistency and supports complex queries. SQLAlchemy is used as an Object Relational Mapping tool to simplify database interactions. Decentralized storage is implemented using IPFS, with Web3.Storage ensuring long-term availability of uploaded files. Blockchain integration is achieved using Web3.py, which enables communication between the application and

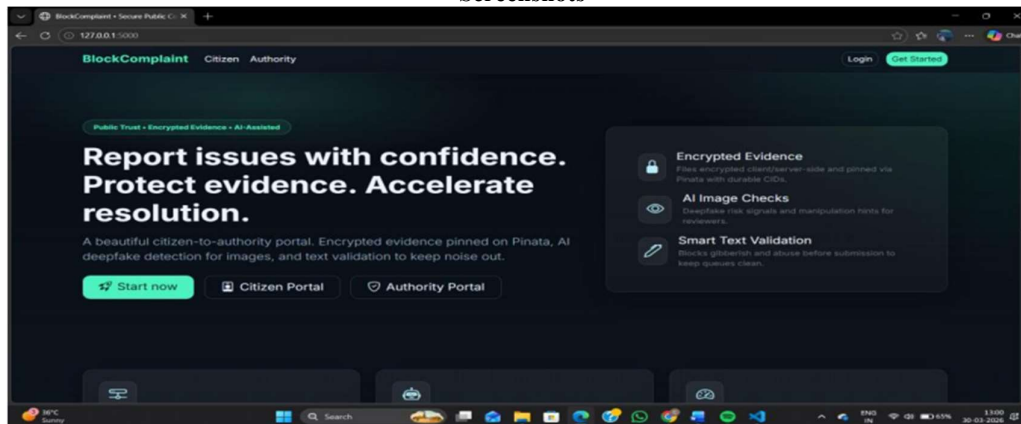
the Ethereum network. Ganache is used as a local blockchain environment for development and testing purposes.

Algorithmic Implementation

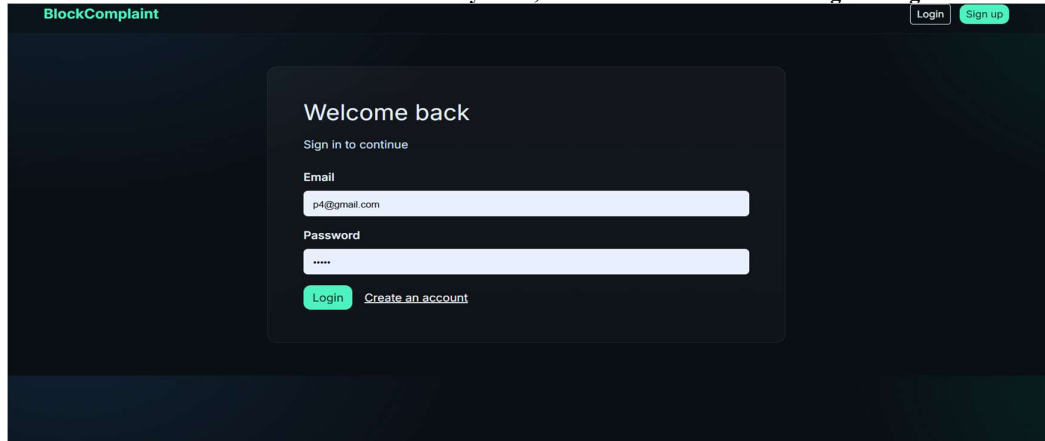
The system incorporates several algorithms to ensure security, validation, and efficiency. A text classification algorithm is used to categorize complaints based on their content, improving routing and prioritization. Image validation techniques analyze uploaded media to detect manipulation or irrelevance.

Cryptographic hashing using SHA-256 ensures data integrity by generating unique hashes for complaint metadata. The Merkle Directed Acyclic Graph structure used in IPFS enables secure and traceable storage of files. Additionally, secure password hashing algorithms such as bcrypt or PBKDF2 protect user credentials by converting them into irreversible encrypted forms. The blockchain service module manages account configuration, transaction handling, and smart contract interaction, ensuring secure storage of complaint records. The complaint classification module processes user input using AI models, extracting relevant categories and ensuring valid classification. These components collectively ensure that the system operates securely, efficiently, and reliably.

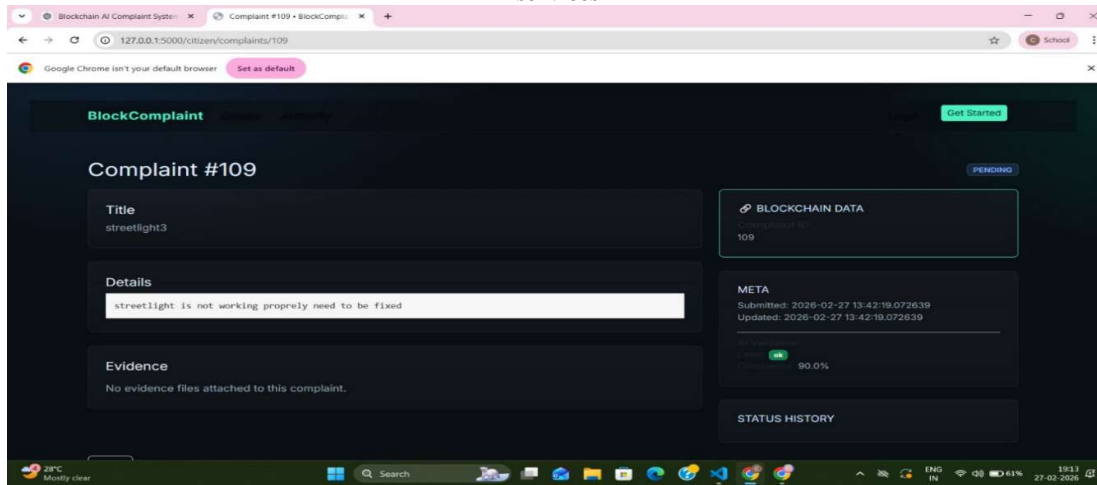
Screenshots



Screenshot 1; Visit the website and click on "Start Now"



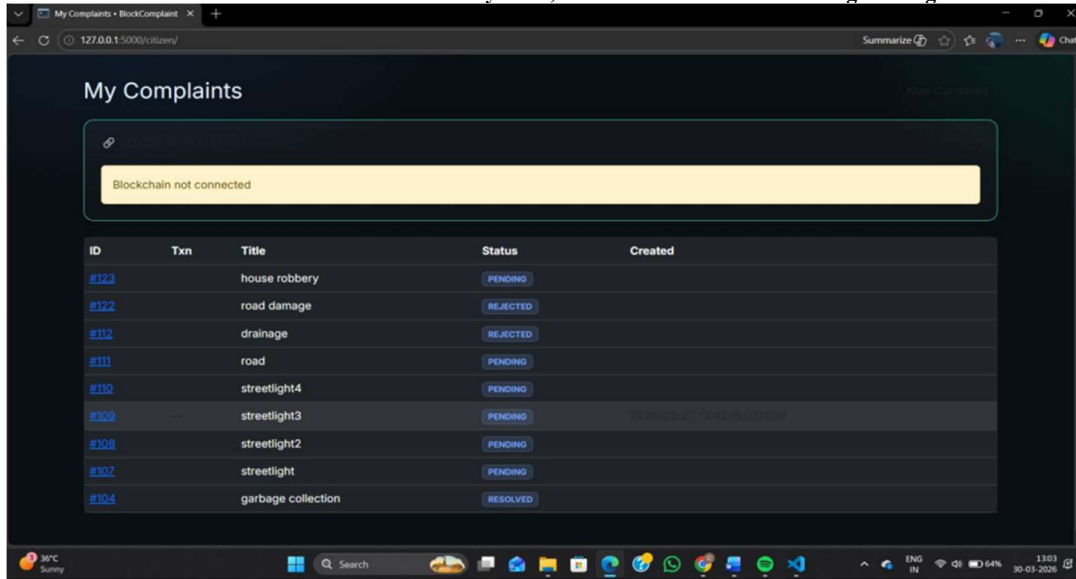
Screenshot 2; Secure login screen allowing users to sign in using credentials before accessing legal services



Screenshot 3; Complaints Register Page

id	citizen_id	title	text	status
73	1	dog issue	am writing to inform y...	pending
74	1	dog issue2	am writing to inform y...	blocked
75	1	dog issue with just te...	am writing to inform y...	pending
76	1	dog issue	am writing to inform y...	pending
77	1	dog issue -test	am writing to inform y...	pending
78	1	dog issue - test	am writing to inform y...	blocked
79	1	dog issue - test final	am writing to inform y...	blocked
80	1	test 10	am writing to inform y...	pending
81	1	dog - bad road	am writing to inform y...	blocked
82	6	House Robbery	On October 12th, while...	under_review
83	6	House Robbery	On October 12th, while...	pending
84	6	House Robbery	On October 12th, while...	pending
85	6	House Robbery	On October 12th, while...	pending
86	6	House Robbery	On October 12th, while...	pending
87	6	House Robbery-video	On October 12th, while...	pending
91	9	Road issue	I am reporting a sever...	under_review
92	6	missing wallet	I would like to report...	pending
93	6	Bag Misplaced	I accidentally left my...	blocked
94	6	Bag Misplaced	I accidentally left my...	rejected

Screenshot 4; Complaints stored in database



Screenshot 5; Citizens Complaint Board

TEST CASES

The testing phase was conducted to verify the correctness, reliability, and security of the proposed Blockchain-Based Complaint Management System. Each functional component of the system was evaluated using predefined test scenarios, ensuring that all modules perform as expected under various conditions. The user registration functionality was tested using valid credentials, where the system successfully created a new user account upon form submission. Similarly, the login module authenticated users correctly and redirected them to the appropriate dashboard based on their roles. Complaint submission was validated by providing a title, description, and image, resulting in successful storage of complaint data within the system.

The Artificial Intelligence module was tested using invalid or nonsensical input, where the system effectively identified and rejected such complaints, demonstrating its ability to filter irrelevant content. The evidence upload feature was verified by uploading valid files to IPFS, where unique Content Identifiers (CIDs) were generated and stored correctly. Blockchain integration was tested by submitting complaint metadata, which resulted in successful transaction execution and generation of a transaction hash. Further tests confirmed that users could view real-time complaint status updates, while authorities were able to modify complaint statuses, such as marking them as resolved. Security testing ensured that unauthorized users attempting restricted actions were denied access through role-based authentication. Overall, all test cases produced the expected outcomes, indicating that the system operates reliably and meets its functional requirements.

CONCLUSION

The proposed Blockchain-Based Complaint Management System demonstrates the effective application of emerging technologies to address persistent challenges in grievance redressal processes. By integrating blockchain technology, decentralized storage, and artificial intelligence into a unified platform, the system provides a secure, transparent, and efficient solution for managing complaints. The use of blockchain ensures that all complaint records are immutable, verifiable, and resistant to unauthorized modifications. This significantly enhances transparency and accountability, thereby increasing user trust in the system. Decentralized storage through IPFS further strengthens data reliability by eliminating dependence on centralized servers and ensuring secure handling of multimedia evidence. The incorporation of AI-based validation improves system intelligence by identifying irrelevant, fraudulent, or low-quality submissions before they are processed. This reduces administrative workload and enhances the overall efficiency of complaint handling. Additionally, role-based access control and real-time tracking mechanisms facilitate smooth interaction between users and authorities, ensuring timely updates and resolutions. From an implementation perspective, the project successfully integrates multiple technologies, including web development frameworks, blockchain networks, decentralized storage systems, and AI services. It also addresses practical challenges such as system security, scalability, and performance. Overall, the system achieves its objective of providing a robust and trustworthy complaint management framework suitable for modern governance and organizational environments.

FUTURE SCOPE

The proposed system offers several opportunities for future enhancements that can further improve its functionality, scalability, and real-world applicability. One significant extension involves the integration of advanced smart contracts to automate complaint workflows, including status updates, escalation processes, and resolution validation. These contracts can also enable incentive mechanisms to encourage user participation and ensure fair handling of complaints. Deploying the system on public blockchain networks, such as Ethereum testnets or mainnets, represents another important advancement. This would enhance transparency by allowing public verification of complaint records while improving accessibility and eliminating reliance on local development environments. The development of a mobile application can significantly enhance user engagement by enabling complaint submission through smartphones. Features such as location-based services, real-time notifications, and multimedia capture would improve usability and provide more accurate reporting of issues. Future improvements may also include the incorporation of advanced data analytics to identify complaint trends, enabling authorities to make data-driven decisions. Additionally, support for multiple languages can broaden system accessibility, making it suitable for diverse user groups. Enhancing security measures to handle large-scale deployments and integrating with external government systems can further strengthen the system's effectiveness.

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