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Ai-Powered Blockchain Legal Platform for Case Management

Ms.V.Swathilakshmi[1], Vishnu Preethi K[2], Harini C[3], Booja Devi D[4]

[1]Assistant Professor, Department of Computer Science And Engineering, Sri Manakula Vinayagar Engineering College, Madagadipet, Puducherry, India
[2,3,4]UG Student, Department of Computer Science and Engineering, Sri Manakula Vinayagar Engineering College Madagadipet, Puducherry,India

Abstract:
The Indian judicial system faces ongoing problems which result in extended case durations and manual processing work and unsafe data storage methods and restricted public access to legal proceedings. The justice system experiences severe delays because of these issues which prevent public access to court proceedings. The project develops an AI and blockchain-based legal platform to solve existing court problems through its modernization and process streamlining capabilities. The system uses advanced technologies to boost operational efficiency while increasing accountability and citizen participation in the judicial system. The legal assistance system combines Sentence Transformer-based semantic embeddings with a Random Forest classifier to provide secure and intelligent legal support for precise complaint analysis and legal section forecasting. The system provides functionalities for citizens, judges, and administrators while featuring tools for complaint and judgment summary creation and automatic case updates and ongoing case status checks. Sentence Transformers create dense vector representations from textual data which the Random Forest model uses to classify data and recommend appropriate legal provisions. The system uses MetaMask for authentication because it provides a decentralized method of user verification which prevents any tampering. Blockchain technology uses a Proof of Stake (PoS) system to record transactions in a secure and efficient manner. The system improves transparency and data integrity and trustworthiness while reducing the computational requirements needed for operation. The proposed system enhances operational efficiency because it decreases manual tasks while delivering a secure and intelligent system which supports modern judicial processes.

Keywords: AI-based legal automation, Blockchain-based judicial transparency, Hearing management, Citizen engagement.

I. INTRODUCTION

The Indian judicial system, one of the most extensive and complicated legal systems in the world, experiences ongoing problems which obstruct its ability to deliver justice with both speed and clarity. The most critical challenge stems from the extensive accumulation of pending cases, which results in extended periods for case resolution. The delays obstruct citizens who want to seek justice and create a trust gap because some cases require several years or even multiple decades to reach a conclusion. The problem emerges from a need to handle case records through manual processes which consume excessive time and create opportunities for human mistakes to occur. The traditional method of maintaining court records

through physical document storage creates difficulties in retrieving and updating documents while performing cross-referencing tasks demands extensive manual work. The system depends on manual operations which heighten the possibility of documents being lost or misplaced, thus creating difficulties in case control and delaying legal processes. The organization faces two major obstacles which include administrative problems and difficulties in maintaining data security while protecting data integrity. The storage of sensitive case information which contains personal details and evidence and judgments exists in formats which attackers can easily manipulate or access without permission. The absence of effective digital storage systems creates risks for maintaining confidentiality while it also decreases transparent information sharing. The restricted public involvement creates additional complications because most citizens cannot access information about case progress or judicial explanations and they lack proper channels to report complaints or offer feedback. The lack of transparency creates an impression of separation from the justice process which results in decreased faith among citizens in the legal system. The shortage of judges and court personnel together with insufficient legal staff and the increasing number of cases creates delays which force judges to work beyond their capacity and result in errors during the execution of court procedures. The coordination process between police officers and lawyers and litigants frequently experiences interruptions while the judicial system still uses outdated methods for case processing that lack technological advancements. Systemic reforms which include digital record-keeping and workflow automation and secure data storage and public engagement methods shall solve these challenges. The judiciary needs these reforms to establish justice systems which function with better speed and fairness and greater transparency.

a. Proof of Stake (PoS)

Proof of Stake (PoS) operates as a consensus method for blockchain networks which verifies transactions and generates new blocks without needing power-consuming calculations that Proof of Work (PoW) demands. Validators in PoS receive block proposal and validation rights based on their cryptocurrency token backing which they use as stake security. Validators who behave dishonestly face the risk of losing their staked tokens because the stake acts as their financial obligation to maintain proper conduct. Validators in PoS get selected through three different methods which include their stake amount, their stake duration, and the randomization processes which protect the selection process against manipulation. The selected validator begins their work by checking all pending transactions which leads them to produce a new block which they will integrate into the blockchain. Validators create a block which other validators will check and if all validators agree on its contents, they will confirm the block. The system rewards validators with transaction fees and newly minted tokens which encourages them to protect the network. PoS decreases energy demands from PoW because it eliminates the requirement for mining competitions. The system requires validators to safeguard blockchain security because their active participation requires them to protect network integrity. Delegated Proof of Stake (DPoS) allows token holders to select trustworthy delegates who will perform validation duties, which helps to boost efficiency through this system. PoS presents a secure and efficient method of achieving blockchain consensus which has positive effects on the environment.

II. LITERATURE SURVEY

[1] Sukanya G., Priyadarshini J[1] The system uses Natural Language Processing (NLP) and machine learning (ML) techniques to create a deep learning system which predicts judicial outcomes. The system starts its process by gathering legal text data which includes case laws court judgments and pleadings. The

NLP module analyzes these documents which lack structure to extract the semantic and syntactic and contextual features that define legal meaning through legal terms and established legal patterns. The machine learning system uses these features to learn how courts decide cases through historical pattern recognition and trend assessment and correlation detection. The model uses these learned patterns to predict outcomes for new or ongoing cases which helps in decision-making processes. The system enables users to rank cases according to their difficulty or time requirements while it shows past verdicts that match current cases and creates legal documents. The system combines automated textual analysis with predictive modeling to reduce manual work and improve accuracy while speeding up judicial processes which makes it an essential instrument for contemporary legal procedures.***[2] Srivastava S., Jain M., Maurya R [2]*** The security and privacy requirements for sensitive legal data exceed what traditional centralized file-sharing platforms can deliver because their design creates security vulnerabilities through single points of failure and censorship mechanisms. The legal industry has achieved better efficiency and accessibility because of digitized legal documents which benefit all stakeholders including lawyers and courts and clients. The secure management and document integrity and authenticity verification process presents major difficulties for this document management system. The Blockchain-Based eVault for Legal Documents system uses blockchain technology to create its secure document management system. The eVault serves as a secure decentralized system for storing legal documents which protects against both unauthorized access and fraud and tampering risks. Blockchain technology guarantees document security by making all stored documents immutable and verifiable while the system records all document actions from upload to access to modification in an open ledger system. The decentralized system provides stakeholders with a document management solution that establishes trust through its system of improved accountability and protection against single points of failure. The proposed eVault creates a strong digital document storage solution for the legal field by using blockchain technology to protect legal documents during their storage and sharing and verification processes. ***[3] Alyas T., Abbas Q., Niazi S., et al [3]*** The process-driven sectors which involve multiple stakeholders need transparent systems which deliver accurate results at scale. The paper presents a judicial case management system which uses blockchain technology and smart contracts, establishing a hybrid private-to-public blockchain system to fulfill existing requirements. The framework enables efficient judicial case management through its secure design which provides complete transparency and protects data integrity. The system operates through multiple blockchains, which use a public blockchain to create transparent access for authorized users to digital events and transactions, while a three-tier private blockchain controls private stakeholder interactions to protect confidential case data. Smart contracts automate case workflows by enforcing predefined rules, which decreases the need for manual work and administrative duties, leading to faster judicial processes. The system uses blockchain as a decentralized and tamper-proof system together with cloud computing to protect case data as secure and verifiable information, which cannot be altered. The hybrid approach enables judicial processes to operate according to their specific operational needs, while maintaining privacy and consistent functioning, which allows for system expansion and effective governance. The framework introduces a contemporary judicial system solution which enhances transparency through digital accountability methods to build stakeholder trust, while enabling more effective and secure technological advancements in case management. ***[4] KS D., Narayan D. N [4]*** The legal system now benefits from Artificial Intelligence (AI), which operates as a transformative technology that has multiple applications across various fields. The judicial system acquired this technology, which creates fundamental improvements for justice delivery through better operational efficiency and judicial

accuracy and public access to justice. AI delivers advantages to legal professionals, including judges and lawyers and court administrators through better decision-making assistance and improved operational processes, which enable them to accomplish more with less effort. AI technology enables users to conduct various tasks, including document review, legal research analysis, contract examination and case outcome prediction, which supports their decision-making process. The automation of these traditionally labor-intensive and error-prone processes not only increases productivity but also reduces the likelihood of human mistakes, which enables courts to handle cases more effectively and deliver justice without delay. AI provides legal services to the public through affordable solutions that offer straightforward user experiences. The judiciary faces ethical challenges from AI implementation, which must undergo thorough examination despite its existing benefits. AI implementation in the legal system faces major obstacles, which include algorithmic bias, lack of transparent operations and accountability mechanisms and the potential to disrupt fair legal processes. Responsible AI usage depends on developing frameworks that establish ethical standards, which support law enforcement and sustain public confidence. The judicial system can modernize through AI technology, which requires ethical frameworks to deliver fair justice and transparent proceedings to all parties involved.***[5] Liu S., Zheng Q [5]*** The research paper suggests using a blockchain-based judicial evidence preservation system to address ongoing problems which stem from low trustworthiness and restricted data exchanges and regulatory oversight in electronic evidence storage and management. The system uses blockchain technology because its characteristics of permanent record creation and open visibility establish trustworthy forensics for electronic evidence authentication through permanent and verifiable on-chain record maintenance. The system uses decentralized off-chain storage with Interplanetary File System (IPFS) to manage extensive data processing needs because it provides secure and dependable and rapid storage capabilities which exceed the blockchain's restricted block storage limitations. The dual on-chain and off-chain system design solves the issue of reduced throughput while enabling judicial bodies to handle evidence management and sharing processes with full efficiency. The framework utilizes smart contracts to handle judicial case registration and authority management and evidence handling and data sharing and case information and regulatory review processes. The smart contract system establishes operational standards which maintain security and legal compliance through automation of processes which require no manual work. The simulation tests demonstrate that the recommended method improves system throughput and stability and operational efficiency, while IPFS transfer speeds provide enough capacity to support judicial data exchange requirements. The blockchain-based framework offers secure and efficient and transparent methods for electronic evidence preservation and management which modern judicial systems need. ***[6] Wu Y., Zhou S., Liu Y., et al [6]*** Legal Judgment Prediction (LJP) has emerged as a critical application of Legal AI, which predicts case outcomes by using factual descriptions from legal cases. LJP functions through its core process which analyzes previous legal cases that share identical case details to determine their impact on future case decisions in national legal systems. The success of judgment predictions depends on how well judges utilize precedents from their legal cases. LJP research has produced multiple solutions which use advanced deep learning techniques to create two main solution types: large language models (LLMs) and domain-specific models. LLMs excel in understanding and generating complex natural language, which enables them to interpret nuanced case descriptions while domain-specific models demonstrate efficiency in learning task-oriented patterns and extracting relevant legal knowledge. The paper introduces the Precedent-Enhanced Legal Judgment Prediction framework (PLJP), which combines LLMs and domain models to create a unified framework for legal judgment prediction. PLJP domain models create

candidate labels, which they use to discover relevant precedents, while LLMs utilize in-context information to perform judgment predictions by linking precedent understanding with judgment decision-making. The framework demonstrates its actual effectiveness through experiments on real-world datasets, which produced superior accuracy and reliability in predicting case results. This approach demonstrates how LLMs can work together with domain-specific models to create a new research pathway, which can extend to other specialized domains that require both task-specific knowledge and advanced language comprehension. ***[7] Goswami D. P., Goswami A. [7]*** The criminal administration field undergoes a significant transformation because of advanced technological integration which creates the new system of Virtual Justice. The system exists as a complete transformation of justice operations which extends beyond its basic legal process digitization. Virtual Justice uses multiple technological solutions which include artificial intelligence case management systems virtual courtrooms online dispute resolution platforms electronic evidence management systems and predictive analytics tools for crime prevention. The new developments enable faster court operations which improve transparency and access to criminal trials while judicial systems can handle more cases without losing their required legal procedures. The evidence collection process and forensic analysis work and decision-support systems that help judges and investigators during difficult cases depend on technology as their main element. The use of technology in criminal administration creates important ethical and legal and procedural challenges which include protecting fairness and privacy rights and stopping algorithmic discrimination and ensuring people receive their lawful rights. Virtual Justice implementation needs a strict system which controls operational speed together with fundamental legal framework requirements to protect justice system values. The technological shift creates both advantages and difficulties which show how digital innovations transform criminal administration while advanced legal systems create future pathways to build a more open and effective justice system. ***[8] Abhishek S., Anas S., et al [8]*** The paper presents a blockchain-based eVault platform as an innovative answer to the perpetual problems which have existed in legal records management through its solution of security issues and transparency deficiencies and access limitations. The research demonstrates that all legal participants, which include lawyers and judges and clients and registrars, require a complete ecosystem, which provides secure and dependable and efficient methods for legal document management. The system operates on Ethereum blockchain technology, which uses smart contracts for access management and document processing and stakeholder communication in a system that guarantees complete security and evidence-based operation. The paper explains how designers created user interfaces which enable users to upload documents and retrieve documents and track document progress and share documents, which results in better workflow efficiency and less administrative work. The eVault platform offers users a document creation and storage feature that enables them to create and safely save legal documents within the system. The platform uses blockchain technology to achieve decentralization and immutability, while its user-centric design protects against common security threats which include unauthorized access and document tampering and system failures. The integrated solution increases the efficiency of legal documentation work while building trust between parties and establishing accountability which leads to better operational results in the legal system. The eVault platform demonstrates a secure and transparent solution for improving legal record management, which leads to digital transformation in judicial operations according to the research paper. ***[9] Chauray M. S., Tiwari A. R [9]*** The research paper examines how Artificial Intelligence (AI) technology currently operates within the Indian criminal justice system, while assessing the resulting legal and ethical problems which emerge from this implementation. The study examines which legal instruments, namely the Information

Technology Act of 2000 and the Indian Penal Code of 1860, can serve to control AI technology use in the legal sector, law enforcement agencies, judicial systems, and prison management. The paper demonstrates that multiple stakeholders need to work together as it shows how legal professionals and policymakers and technologists need to work together to establish AI usage that follows responsible and ethical practices. The study uses a qualitative research method to investigate how AI technology currently operates in Indian criminal justice organizations while studying which laws currently exist to regulate its use. The research evaluates how High Courts and Supreme Court of India supervise AI system usage in legal and ethical standards compliance through their tracking of AI system deployment. The analysis identifies significant gaps because dedicated legislation for AI in criminal justice does not exist at the present time, although existing laws offer some limited regulatory direction. The main obstacles include problems that arise from algorithmic bias and difficulties in achieving fairness and transparency and accountability for AI systems which make automated decisions. The study demonstrates that organizations need to construct strong governance systems together with ethical standards which will direct AI system deployment to accomplish two goals. Technological advancements should improve operational efficiency and effectiveness of the criminal justice system while protecting the rights of all stakeholders and maintaining fairness and trust within the system.***[10] G. Sukanya, J. Priyadarshini [10]***The legal industry which has traditionally been slow to adopt digital technologies has experienced transformation through the implementation of Artificial Intelligence (AI) and Natural Language Processing (NLP) technologies. The judiciary system requires technological advances to increase its adjudication and legal decision-making abilities because the case backlog worsens with population growth. Legal Judgment Prediction (LJP) functions as a text classification and prediction task that depends on accurate textual representation to support its subsequent activities. The encoding models establish fundamental methods to gather syntax information and semantic data and contextual details yet their effectiveness differs based on the particular dataset and specific task requirements. The model selection process becomes difficult because multiple machine learning (ML) metrics including traditional ML and deep learning (DL) metrics need assessment before choosing the appropriate model. The research gap in this study gets resolved through the examination of 12 ML models and 10 DL models that use two embedding methods to analyze real-time criminal case data from the Madras High Court via Manupatra. The study finds that Support Vector Machines combined with Logistic Regression and SGD with Doc2Vec embeddings plus shallow neural networks achieve good performance while Transformer models need self-attention mechanisms to handle long sequences but encounter difficulties with real-time datasets. The paper presents a hybrid CNN-Transformer model for binary judgment prediction which surpasses standard detection methods by achieving superior precision, recall, and accuracy. The work presents methods for selecting models and evaluating their performance while indicating research pathways that lead to future studies on AI applications for legal judgment prediction.

III. PROPOSED SYSTEM

The proposed system operates as a secure legal assistance platform which uses advanced AI and blockchain technology to enhance judicial processes. The system uses Sentence Transformer-based semantic embeddings together with a Random Forest classifier to process user complaints and identify the corresponding legal sections through predictive analysis. The system transforms complaint text into vector representations which capture all contextual meanings when citizens submit their complaints. The system enables different user roles through its multiple access points which serve citizens judges and

administrators to facilitate efficient processing and case tracking and judicial decision processes. The system enhances usability and transparent operations through its features which include automated notifications and real-time case updates and complaint and judgment summaries. The system implements MetaMask authentication to establish secure user verification through decentralized methods which deliver counterfeit-proof verification results. The system uses blockchain technology with a Proof of Stake (PoS) mechanism to create a secure storage solution for transaction records which maintains data integrity and establishes trust between parties.

a. Input Embedding Layer

The Input Embedding Layer serves as the essential component which enables the system to convert user complaints into an analytical format used by intelligent systems. When a citizen submits a complaint, the system first processes the textual data by breaking it down into smaller components which include words and subwords. The system converts each token into a numerical vector through the application of pre-trained Sentence Transformer model embeddings. The system uses positional encoding together with the embeddings to maintain sentence structure and word order. The system requires this understanding to process both the meanings of words and their specific order in the complaint. The formula produces the final token representation through its calculation method.

$$\mathbf{z}_i = \mathbf{x}_i + PE_i$$

The combined embeddings move to the deeper layers which perform semantic analysis and legal section prediction to achieve accurate context-based user complaint interpretation.

b. Transformer Encoder Layer

The Sentence Transformer model uses the Transformer Encoder Layer as its main component to extract word relationships from sentence structures. The system processes input embeddings through self-attention which enables each word to concentrate on important words throughout the sequence. The model achieves better understanding of context dependencies and semantic meaning through this approach. The encoder structure contains several layers which include multi-head self-attention mechanisms that connect to feed-forward neural networks in each layer.

The core function of this layer operates through scaled dot-product attention which is defined as:

$$\text{Attention}(Q, K, V) = \text{softmax}\left(\frac{QK^T}{\sqrt{d_k}}\right)V$$

The formula uses Q and K and V matrices which are created from the input embeddings to calculate attention scores which determine how much attention each word should give to other words in the sentence. The attention layer output goes through a feed-forward network and normalization layers which enhance system performance and stability..

c. Pooling Layer

$$\mathbf{s} = \frac{1}{n}\sum_{i=1}^{n}\mathbf{z}_i$$

The Sentence Transformer architecture uses its Pooling Layer to transform Transformer Encoder output which consists of token-level embeddings into a single constant-length vector that represents the complete sentence. The process creates a complete sentence representation which serves the needs of subsequent tasks that include similarity assessment and classification. The system uses pooling to create a single vector that captures the complete meaning of a complaint which then serves as input for predicting legal

sections. The technique of mean pooling stands as the most frequently used method which calculates the average value of all token embeddings. The mathematical representation of the process is shown as:
The pooled vector of the sentence shows its overall meaning which allows semantic matching with precise classification results. The n tokens of the document use their respective token embeddings zi to create a document representation.

d. Architecture Diagram

The proposed system uses a multi-layered framework which combines user interaction with artificial intelligence and blockchain technologies to deliver secure and intelligent legal assistance. The system user layer enables three roles, which include citizen, judge, and admin, to access the system through web and mobile interfaces for complaint submission and case tracking and notification receipt. The authentication layer uses MetaMask to provide decentralized and secure user verification, ensuring tamper-proof access. The core application layer processes complaint data through multiple modules, including complaint submission, legal section prediction, document summarization, and notification services. The prediction engine uses Sentence Transformers to create semantic embeddings, which the Random Forest model uses to classify legal sections that match the computer program's output.

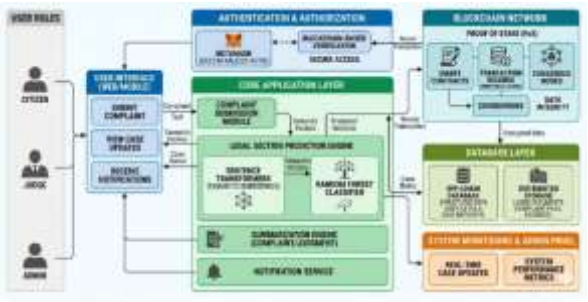


Fig 1.1 Architecture Diagram

The prediction engine uses Sentence Transformers to create semantic embeddings which a Random Forest model uses to determine applicable legal sections. The blockchain layer which operates through Proof of Stake (PoS) controls smart contracts and transaction records and consensus nodes to deliver secure storage and data integrity and transparent access to case-related transactions. The database layer provides off-chain storage for structured data and distributed storage for large files which include evidence documents.

e. User Interface Module

The User Interface Module functions as the main user connection point which establishes interaction between users and the system. The system functions as a web-based and mobile-accessible interface which serves three user categories: citizens, judges, and administrators. Citizens can submit complaints and upload evidence while they track case progress and receive notifications. Judges can review their assigned cases which include access to summarized complaints and evidence materials and the ability to change case statuses and render judgments. Administrators can observe system operations while they control user accounts and track the distribution of cases. The interface design enables users to navigate the system easily while maintaining accessibility to users who lack technical expertise. The system provides users with continuous updates which show them the status of case developments and hearing times and crucial system notifications. The module connects with backend services to enable efficient data exchange between AI engines and blockchain storage components. The system includes session management functions together with encrypted communication methods to ensure user data remains secure.

f. Authentication Module

The Authentication Module uses decentralized identity verification to provide secure and reliable system access for users. The system uses MetaMask for blockchain authentication which removes the requirement for username-password authentication. Users authenticate themselves by using their digital wallets which generate cryptographic signatures for identity verification purposes. The system protects against common security threats through its design which stops password theft and phishing attacks and unauthorized entry. The module provides system access to verified users who include citizens judges and administrators according to their assigned system functions. The system establishes secure session management with role-based access control which restricts user activities to their allocated permissions. The system achieves identity management security through blockchain-based verification which establishes trust between all system users. The authentication process provides users with a simple experience that requires little effort to achieve their security protection needs. The module protects sensitive legal information while confirming that only authenticated users with authorization rights can access the system's protected functions.

g. Complaint Submission Module

The Complaint Submission Module operates as a system which collects all user complaints and handles their complete processing and subsequent management. Citizens can input detailed descriptions of their issues, upload supporting documents or evidence, and submit cases through the system interface. The module starts its work by preprocessing complaint text through a three-step process which includes cleaning and structuring and preparing the material for AI engine analysis. The system captures all essential data elements in standardized formats which results in improved consistency and accuracy for subsequent processing tasks. The module assigns unique case IDs and timestamps and user information to all incoming complaints to establish a complete tracking system. The system checks all input data to ensure that users submit their information in complete and correct formats. The Legal Section Prediction Module receives complaint cases after the processing stage is completed. The system sends notifications to judges and administrators whenever new cases get submitted to the system. The system achieves three objectives by automating the process which handles complaint intake and preprocessing because it reduces manual work and decreases mistakes and maintains effective case data processing from the beginning point.

h. Legal Section Prediction Module

The prediction module for legal sections functions as the primary intelligence unit within the system. The system uses Natural Language Processing tools which analyze complaints to identify suitable legal sections for their resolution. The module uses Sentence Transformers to create dense semantic embeddings from textual complaints which preserve their contextual meaning. A Random Forest classifier processes these embeddings to forecast which legal provisions will apply based on identified patterns. The system achieves higher accuracy and reliability through its combination of deep semantic understanding and strong machine learning methods. The module provides legal recommendations based on complaint understanding which includes both intent and context information, unlike conventional systems that rely on keyword matching. The system helps judges and legal professionals because it cuts down their need for manual case evaluation work. The module can acquire new legal knowledge through training which enables it to adjust to changing legal requirements..

***i.* Summarization Module**

The Summarization Module creates short yet significant summaries of legal documents which include both complaints and judgments. The module uses Natural Language Processing methods to extract

important information which it displays in an organized and simple format. Judges can use this system to understand case details better because it provides them with essential information without making them read full case files. The module produces high-quality outputs which maintain the original content through its support of both extractive and abstractive summarization methods. The system helps citizens by delivering straightforward judgment summaries which create better understanding and open access to legal information. Legal professionals benefit from the summarization procedure which decreases their mental workload while increasing their work efficiency and saving time. The system links with other components through its ability to share information with the Legal Section Prediction Module which produces location-specific summaries. The document summarization module enables organizations to manage their extensive legal document collection through automated processes while enhancing user experience.

j. Blockchain Module

The Blockchain Module provides secure and transparent storage of system transactions and records which cannot be altered. The system uses a decentralized blockchain network which employs the Proof of Stake (PoS) mechanism to achieve efficient data validation and storage. All critical actions, such as complaint submission, case updates, and judgment records, are recorded as transactions on the blockchain. Automated processes for case validation and access control execute operations without human involvement through smart contracts. The use of PoS reduces computational overhead and energy consumption through traditional consensus mechanisms while maintaining security and system integrity. The module prevents users from changing or removing data after its initial storage which increases trust in the system. The system enables authorized users to track case transaction histories through its auditability feature which allows them to monitor all case-related activities. The system achieves legal data management security and transparency through blockchain technology which enables secure operations of legal data systems.

k. Admin & Monitoring Module

The Admin and Monitoring Module provides centralized control and oversight of the entire system. The system enables administrators to handle user management through their ability to confirm judge and citizen access while they can also restrict account access and distribute roles correctly. The module allows admins to supervise all active cases while they can designate judges and watch case development through real-time updates. The system includes analytical dashboards which present essential statistics that show total cases and cases handled by each judge and pending cases compared to resolved cases and monthly case trends. The data provides essential support for making choices and enhancing system performance. The module tracks system performance while identifying system faults and maintaining operational efficiency across all system components. The system provides logging and auditing capabilities which enable administrators to track system operations for accountability purposes. Real-time notifications and alerts help admins respond quickly to issues or updates.

IV. RESULT AND DISCUSSION

The proposed system results and discussion demonstrate better legal assistance processes through improved efficiency and accuracy and enhanced security. Sentence Transformer-based semantic embeddings combined with Random Forest classification achieve high accuracy for complaint analysis by using contextual meaning instead of keyword extraction methods. The system successfully detects relevant legal sections through its experimental evaluation which shows improved precision and recall abilities while decreasing misclassification rates to assist judges in their decision-making process. The

summarization module generates brief yet important summaries of complaints and judgments which require less time for manual examination. MetaMask authentication system provides users with secure decentralized verification which removes all dangers that traditional password authentication systems present. Implementation of blockchain technology through Proof of Stake (PoS) enables users to store transaction records securely in an unalterable manner while enhancing system transparency and user trust. The system achieves data integrity through its Proof of Stake (PoS) mechanism which decreases both energy consumption and computational overhead when compared to conventional systems. The system enables citizens to interact with judges and administrators through its multi-role functionality while providing real-time notification and case monitoring capabilities. The system-based communication improvements lead to decreased delays which result in better overall system performance. The admin dashboard delivers important system management insights through its statistical analysis and performance metric functions.

a. Smart Contracts

Smart Contracts are self-executing programs stored on a blockchain that automatically enforce, verify, and execute agreements when predefined conditions are met. The AI and blockchain-based legal platform

$$T_{block} = \frac{1}{\lambda \cdot S_v / S_{total}}$$

uses smart contracts to automate judicial workflows while delivering transparent and secure and accountable legal processes which function without intermediaries. Through their execution of programmed contractual conditions, the system enables multiple stakeholders which include citizens and law students and police personnel and judicial officers to interact without needing to establish trust. A smart contract in this system can handle various legal processes, such as case filing, evidence submission, hearing notifications, and fee management. When a citizen submits a grievance or files a case, the smart contract verifies the submission, logs it on the blockchain, and triggers notifications to relevant judicial officers and parties. The smart contract creates automatic reminder functions during hearing scheduling, which enables case advancement only after all required document submissions and other procedural requirements have been completed.

$$\text{SC}(C) = \begin{cases} \text{Execute Action A}, & \text{if Condition C is true} \\ \text{No Action}, & \text{otherwise} \end{cases}$$

The contract system executes a specific action automatically when the predefined condition C which requires either a case filing or document uploading reaches its true state.Smart contracts also enhance security and transparency by storing every transaction on the blockchain in a tamper-proof manner. The system maintains permanent records of all actions and their results, which enables stakeholders to conduct process audits and confirm compliance with regulations. The proposed platform uses smart contracts which combine automated processes with conditional logic and blockchain security to decrease the need for manual work, decrease operational mistakes, speed up judicial functions, and build trust between all system users, resulting in a legal system that operates with greater efficiency and transparency and accountability.

b. Time efficiency

The Proof-of-Stake (PoS) algorithm is widely recognized for its superior time efficiency compared to traditional Proof-of-Work (PoW) systems. The PoS system chooses its validators through coin ownership and staking, which differentially establishes eligibility criteria compared to the PoW system that requires

miners to solve resource-intensive cryptographic challenges. The deterministic selection process enables faster transaction validation and new block addition to the blockchain through reduced time requirements. The PoS system enables immediate block creation and verification after a validator selection, which removes the need for extended waiting periods that proof-of-work puzzle solutions previously required.
Where:

- S_v is the stake of the selected validator,
- S_{total} is the total staked coins in the network, and
- λ is a network-dependent constant representing block generation rate.

The formula demonstrates that block creation time decreases as validator stake increases because validators with higher stakes will be selected for block creation which leads to constant and effective block production. The proposed AI and blockchain-based legal platform requires time efficiency to operate effectively. Judicial operations depend on quick transaction recording and verification which allows them to handle case filings and evidence submissions and hearing updates effectively. PoS enables all system updates to be processed almost immediately which helps to minimize operational disruptions and maintain steady system performance. The system improves block validation speed which enables automatic notifications and provides instant access to verified records while supporting teamwork between judges and law students and police personnel and citizens. PoS decreases transaction processing delays which speeds up judicial operations and improves platform performance through better system responsiveness and reliability and scalability for managing extensive sensitive legal information.

c. Energy Efficiency

The Proof-of-Stake (PoS) algorithm demonstrates its primary superiority over traditional Proof-of-Work (PoW) systems through its advanced energy efficiency. The process of Proof-of-Work (PoW) requires miners to compete by solving difficult cryptographic puzzles which they need to use for transaction validation and new block creation resulting in extremely high power and computing resource usage. The Proof-of-Stake (PoS) method chooses its validators through an assessment of their cryptocurrency holdings and their willingness to stake those holdings instead of relying on their computational capacity. The blockchain network achieves substantial power reduction because this method of validator selection through deterministic processes eliminates all requirements for energy-consuming mining activities.

The energy consumption in PoS can be estimated using a simplified formula:
Where:

$$E_{PoS} = N_v \cdot P_c \cdot T_{block}$$

- N_v is the number of active validators in the network,
- P_c is the average power consumption per validator node, and
- T_{block} is the block creation interval.

The PcP_cPc value in PoW rises to extremely high levels because of its ongoing requirement for mining operations which use computational resources. The PcP_cPc value decreases for PoS systems because validator nodes only need to perform basic calculations during their block verification process. The energy consumption of PoW networks enables multiple systems to decrease their energy usage by several orders of magnitude. The AI and blockchain-based legal platform needs energy-efficient operations to maintain its ongoing sustainability. The platform needs to track all case filings and hearing updates together with evidence submission records. The PoS system enables blockchain transactions to process through its energy-efficient mechanism which lowers both operational expenses and environmental emissions. The

network uses power-efficient validation to manage its growth, which occurs when more cases and users enter the system, without needing to boost energy consumption. The platform benefits from PoS because its low energy usage delivers both environmentally friendly operation and continuous operational performance, which permits secure judicial record management together with fast blockchain transaction processing for legal procedures.

d. Scalability

The Proof-of-Stake (PoS) algorithm needs scalability to function as a vital element which enables blockchain systems to process more transactions and users plus additional data without losing their operational capacity. The PoS system selects network validators through stake-based selection while Proof-of-Work (PoW) needs energy-consuming mining processes which cause performance limitations when transaction rates increase. The system achieves improved scalability through its design, which enables faster block production and transaction validation processes. The upcoming AI and blockchain-based legal platform needs scalability to handle increasing case filings and legal documents and hearing updates plus user interactions while sustaining quick processing and consensus operations.

The scalability of PoS can be estimated with the formula:

Where:

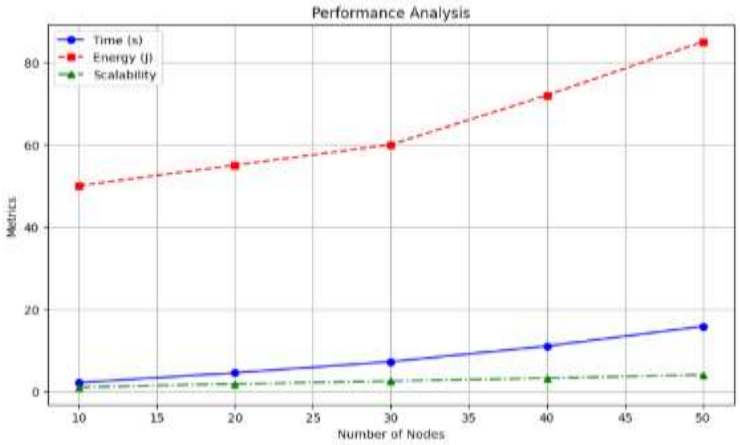
- ***TPS*** is the transactions per second the network can handle,
- N_{blocks} is the number of blocks processed within a time interval,
- $T_{transactions}$ is the average number of transactions per block, and
- T_{block} is the average block generation time.

The network achieves higher TPS through PoS because it eliminates competitive mining which reduces Tblock time. The network gains better scalability through stake-based validator selection which enables new users to join the network without needing computational power. The proposed legal platform supports multiple users including citizens law students police personnel and judicial officers as they use the system to file cases upload evidence and send notifications which need rapid and dependable processing. The blockchain system achieves high scalability through its ability to store increasing quantities of legal data while keeping the system operational. The platform uses PoS to handle high transaction and participant volumes which enables the system to grow for nationwide judicial needs while maintaining speed and reliability and trustworthy performance.

e. Performance analysis

$$TPS = \frac{N_{blocks} \times T_{transactions}}{T_{block}}$$

The PoS metrics graph for the proposed AI and blockchain-based legal platform shows system performance through its three measurement categories which include time efficiency and energy consumption and scalability testing. The time efficiency curve shows that as the stake ratio increases, block creation time decreases, ensuring that case filings, evidence submissions, and hearing updates are recorded quickly and efficiently. The energy consumption curve demonstrates that the system requires minimal energy even as the number of validators grows, showing how PoS technology operates at reduced environmental impact while delivering better performance than conventional Proof-of-Work systems. The scalability curve shows that decreasing block time results in increased transactions per second (TPS), which enables the platform to process additional user requests and legal document submissions and judicial operations without service interruptions.



The graph demonstrates that the proposed system can deliver fast and secure blockchain operations with energy-efficient performance, which enables large-scale adoption, thus making it suitable for national judicial systems.

V. CONCLUSION

The proposed system provides an all-encompassing innovative solution to address the main obstacles that the Indian judicial system faces which include case delays and insufficient transparency and manual inefficiencies and limited public engagement. The system achieves legal process improvements through its use of artificial intelligence techniques and blockchain technology which result in faster and more precise and more dependable outcomes. The system employs Sentence Transformer-based semantic embeddings together with a Random Forest classifier to deliver exact complaint analysis results while making predictions about legal sections through context-aware decision-making support. The system's features which include complaint and judgment summarization and automated notifications and real-time case monitoring enable judicial staff to work more efficiently while decreasing their workload. Secure authentication using MetaMask ensures decentralized and tamper-proof user verification, strengthening system security. The system uses Proof of Stake (PoS) blockchain integration for case transaction storage which remains unchangeable and open to public view, thereby establishing trust between users and the system. The system supports different user roles which enable citizens and judges and administrators to interact with each other. The proposed system needs future development work which will enhance its ability to scale and improve its intelligence while it adapts to real-world conditions. The system will benefit from new capabilities which include advanced deep learning models and transformer technology that will enhance legal reasoning and enable multilingual capabilities to handle regional language complaints. The system can become more accessible to non-technical users through the addition of speech-to-text and voice-based complaint submission systems. The system will achieve better section prediction accuracy through two improvements which include national legal database connection for real-time legal updates. The blockchain layer will gain better capabilities through interoperability features which enable it to establish connections with different government systems. Predictive models which include explainable AI techniques will improve prediction transparency through their ability to provide understandable explanations of results. The upcoming features will deliver judicial decision support through the development of mobile applications which will offer advanced analytics and predictive case outcome modeling tools.

REFERENCE

1. Sukanya, G., & Priyadarshini, J. (2025). Fine Tuned Hybrid Deep Learning Model for Effective Judgment Prediction. Computer Modeling in Engineering & Sciences(CMES),142(3).https://www.techscience.com/CMES/v142n3/58162
2. Srivastava, S., Jain, M., & Maurya, R. (2025). Blockchain Based E-Vault System for Legal Records. In Emerging Trends in Computer Science and Its Application (pp. 568–572). CRC Press.https://www.routledge.com/Emerging-Trends-in-Computer-Science/9781032456583
3. Alyas, T., Abbas, Q., Niazi, S., Alqahtany, S. S., Alghamdi, T., Alzahrani, A., ... & Ibrahim, A. M. (2025). Multi Blockchain Architecture for Judicial Case Management Using Smart Contracts. Scientific Reports,

15(1), 8471.https://www.nature.com/articles/s41598-025-08471-9

4. KS, D., & Narayan, D. N. (2024). Artificial Intelligence in Justice System and Its Ethical and Legal Implications: A Comparative Analysis.https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4774965
5. Liu, S., & Zheng, Q. (2024). A Study of a Blockchain-Based Judicial Evidence Preservation Scheme. Blockchain: Research and Applications, 5(2), 100192.https://doi.org/10.1016/j.bcra.2023.100192
6. Wu, Y., Zhou, S., Liu, Y., Lu, W., Liu, X., Zhang, Y., ... & Kuang, K. (2023). Precedent-Enhanced Legal Judgment Prediction with LLM and Domain-Model Collaboration. arXiv preprint.https://arxiv.org/abs/2310.09241
7. Goswami, D. P., & Goswami, A. (2025). Virtual Justice:

The Role of Technology in Transforming Criminal Administration. SSRN.https://ssrn.com/abstract=5121477

8. Abhishek, S., Anas, S., Anuragav, R., & Sachin, K. (2024). Evault for Legal Records.https://lawfullegal.in/evault-for-legal-records/
9. Chauray, M. S., & Tiwari, A. R. (2023). The Role of Artificial Intelligence in Criminal Justice System. World Bulletin of Management and Law, 43, 19–26.https://scholarexpress.net/index.php/wbml/article/view/2417
10. G. Sukanya & J. Priyadarshini. (2024). Hybrid CNN: An Empirical Analysis of Machine Learning Models for Predicting Legal Judgments. International Journal of Advanced Computer Science and Applications (IJACSA), 15(7).https://thesai.org/Publications/ViewPaper?Volume=15&Issue=7&Code=IJACSA&SerialNo=2