RESEARCH & INNOVATION DIVISION
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Justice Aid – AI-Based Law Guidance Chatbot

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In the digital era, the availability of quality and affordable legal information has become a significant challenge due to complex legal language and limited access to legal services. To address this issue, this paper presents an AI-based legal guidance chatbot, JusticeAid, designed to simplify the process of obtaining legal knowledge and provide accessible legal services. This study aims to develop an intelligent system that delivers simplified and accessible legal guidance to users. The proposed system is based on Artificial Intelligence (AI) and Natural Language Processing (NLP) models, including GPT-4, which processes user queries and supports context-driven response generation, generates context-driven responses, and interprets legal texts such as statutes, judicial decisions, and case references. JusticeAid employs a three-layer architecture comprising frontend, backend, and database components to ensure smooth and efficient system operation. During functional testing, system validity in terms of performance and accuracy was evaluated, and usability testing was conducted through user feedback and professional examination of AI-generated content. The obtained test results indicate that the chatbot produces contextually relevant legal responses aligned with Pakistan-specific legal references, with consistent processing speed and reliable document analysis, demonstrating the credibility of the system and its practical applicability. By combining AI with modern web technologies, JusticeAid provides an intuitive and user-friendly interface that assists individuals, students, and legal professionals in understanding the legal domain and making informed decisions.

Keywords: Artificial Intelligence (AI), Natural Language Processing (NLP), Justice Aid, Legal Assistance.

Introduction:

One of the most critical issues in contemporary legal systems is access to justice. Millions of people worldwide continue to face barriers in obtaining timely, affordable, and understandable legal services, despite significant technological advancements. In developing countries such as Pakistan, these challenges are further intensified by fragmented legal databases, complex statutory language, and costly consultation services, which hinder citizens from effectively enforcing their legal rights [1].

With the rapid pace of global digital transformation, the integration of Artificial Intelligence (AI) and Natural Language Processing (NLP) into the justice system has emerged as a promising approach to democratizing access to legal knowledge and enhancing legal literacy [2].

Recent developments in large language models (LLMs) have demonstrated the capacity to interpret, summarize, and contextualize complex legal texts. Through these systems, AI-based legal platforms can provide customized, multilingual, and real-time legal guidance that complements existing legal assistance mechanisms [3].

Such systems not only reduce the cost and time associated with legal research but also promote equitable access to justice for disadvantaged communities, aligning with the objectives outlined in the United Nations Sustainable Development Goal 16: Peace, Justice and Strong Institutions [4].

Although the Pakistani legal system is rich in legal tradition, it continues to face challenges related to accessibility and procedural transparency. Citizens frequently encounter difficulties in obtaining legal documentation, understanding statutory provisions, or securing affordable legal representation [5].

Additionally, rural and semi-urban populations often lack access to digital legal information due to low levels of digital literacy and inadequate technological infrastructure [6].

To address these challenges, there is a need to develop dynamic and context-sensitive solutions that integrate AI within the socio-legal context of Pakistan. In this regard, this paper presents JusticeAid, an AI-based legal guidance chatbot developed to simplify access to legal information in Pakistan. The system is designed to understand user queries, interpret legal documents, and generate contextually relevant legal responses grounded in Pakistan-specific legal references using advanced NLP models. It incorporates a multilingual and user-friendly interface to ensure accessibility for both legal professionals and laypersons. Beyond its immediate practical utility, JusticeAid represents a broader initiative aimed at localizing AI for social empowerment, promoting access to justice as a fundamental right rather than a privilege.

Literature Review:

Artificial Intelligence (AI) has emerged as one of the most transformative technologies within the modern legal ecosystem. Through Natural Language Processing (NLP), Machine Learning (ML), and Large Language Models (LLMs), AI systems are capable of interpreting legal texts, summarizing judicial decisions, and delivering context-aware assistance to users. These capabilities position AI as a significant tool for enhancing access to justice, reducing procedural delays, and improving judicial efficiency.

Laptev and Feyzrakhmanova investigate the application of AI in judicial systems, identifying emerging trends in predictive analytics, NLP, and automated decision-support systems. Their findings confirm that AI enhances court productivity by managing data-intensive legal tasks more efficiently. However, they caution that algorithmic opacity and limited transparency may undermine public trust, emphasizing the need for ethical oversight and mechanisms ensuring human accountability [7].

Norchuk examines the role of AI in improving legal communication for linguistically and geographically marginalized populations. The study concludes that multilingual AI chatbots and automated translation tools can reduce long-standing barriers such as language

limitations, illiteracy, and geographical distance from courts. Nevertheless, Norchuk highlights that digital inequality and infrastructural deficiencies remain significant challenges in developing regions [8].

Rajendran et al. emphasize how conversational AI systems facilitate public interaction with justice institutions. Their research demonstrates that chatbots can assist citizens in filing complaints, drafting preliminary legal documents, and understanding procedural rules. These intelligent systems reduce consultation time and costs, thereby contributing to more transparent and citizen-centered justice delivery [9].

Abuzir analyzes China's Smart Court initiative, in which AI and data analytics are utilized to streamline evidence assessment and verdict prediction. The study demonstrates that predictive modeling reduces procedural delays and enhances judicial consistency—an approach that may serve as a model for the digitization of courts in Pakistan [10].

Raghav et al. explore how predictive analytics can strengthen the rule of law by correlating past verdicts with new cases. The authors note that such tools assist judges in identifying relevant precedents, thereby improving judicial consistency; however, they stress that human oversight remains essential to prevent overreliance on automated decision-support systems [11].

Surya et al. describe India's AI-powered legal chatbot developed for the Department of Justice, which provides legal guidance in multiple regional languages. Their findings demonstrate that localized NLP models significantly reduce information asymmetry, offering practical validation for multilingual systems such as justiceAid [12].

Borgesano et al. introduce the concept of *Justice 5.0*, advocating for human-centered AI integration within justice governance frameworks. Their systematic review of more than 150 studies concludes that transparency, accountability, and inclusivity are fundamental prerequisites for sustainable AI adoption. This perspective reinforces the necessity of participatory design principles in the development of legal-technology solutions [13].

Nastić examines digital justice technologies from a democratization standpoint, demonstrating that AI-driven tools can provide marginalized populations with affordable access to legal information. His analysis concludes that localized AI platforms have significant potential to reduce inequalities in legal participation, aligning closely with the objectives of JusticeAid [14].

Ghoshal emphasizes the necessity of ethical governance in AI-based legal systems. He argues that fairness, explainability, and algorithmic neutrality are essential for building public trust in AI applications. His proposed ethical framework directly supports the development of transparent AI architectures within justice systems, including Pakistan's emerging digital infrastructure [15].

Collectively, these studies suggest that AI-based legal systems can enhance legal communication, automate administrative processes, and extend legal assistance to underserved communities. Despite notable global advancements, most AI implementations remain context-specific and lack adaptation to Pakistan's multilingual and procedurally complex judicial environment. This research gap underscores the significance of JusticeAid as a localized AI chatbot designed to enhance accessibility, inclusivity, and ethical transparency within Pakistan's legal ecosystem.

Objectives:

This research is guided by the following objectives:

To simplify access to legal information by answering user queries, facilitating legal searches, and enabling interactive document analysis.

To provide case-based recommendations, downloadable legal documents, and chat transcripts to deliver deeper contextual insights.

To design an intuitive, user-friendly interface that ensures accessible navigation and seamless interaction for all users, including legal professionals and laypersons.

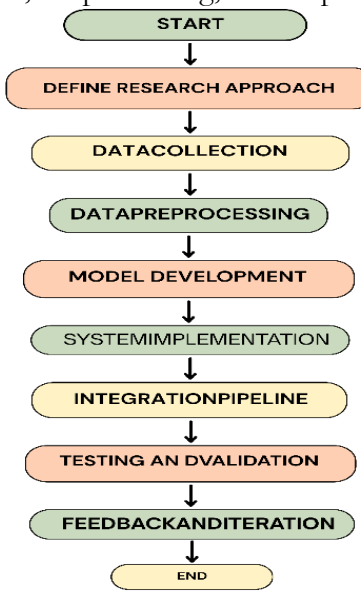
To deliver immediate legal guidance, thereby reducing research time and minimizing the need for preliminary consultations.

Materials and Methods:

JusticeAid is an intelligent legal advice chatbot designed, developed, and validated using a methodology tailored to Pakistan's socio-legal context.

This research adopts a hybrid methodology combining system development and experimental analysis. The development stage focuses on the design and implementation of the JusticeAid platform, such as the design of a three-layer architecture consisting of the presentation layer, application layer, and data layer. This architecture facilitates modular development, scalability, and efficient execution of legal queries.

The development process of the JusticeAid system follows a structured workflow involving data collection, AI processing, and response generation. The overall development process is illustrated in Figure **1**.



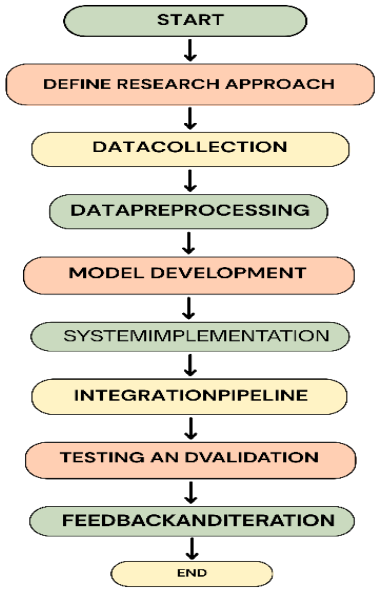


Figure 1. Project development approach flowchart

Research Design:

The project adheres to a system development approach in order to create an AI-driven legal assistance system. Design process entails identification of the problem, system architecture planning, technology selection, system implementation, and evaluation.

The system is designed to address two major challenges of the Pakistani legal environment. First is the fact that a great number of people have limited access to legal advice and legal knowledge. Second, there are complicated terms used in legal documents and statutes, which cannot be comprehended by non-professionals.

Justice Aid tries to overcome these issues by combining Natural Language Processing tools and large language models to process user queries and produce legally relevant answers. Besides the law support in the form of conversation, the site also has document analysis software to enable users to post their legal documents and receive summarized descriptions.

System Architecture:

Justice Aid is implemented based on a three-level architecture that enhances system maintainability, performance, and scalability. The system is separated into three components by the architecture.

The presentation layer is the interface of the system where the users communicate with the system. It enables users to submit legal questions, upload documents, and access legal information via a web-based interface.

The core processing logic of the system resides in the application layer. This layer combines AI models, Natural Language Processing modules, and backend services that perform the task of interpreting user queries and producing responses.

The data layer is responsible for storing and retrieving legal datalegal data such as statutes, legal documents, and user interaction records of users' interaction. MongoDB is the main database since the use of a document-based structure allows storing and retrieving legal data efficiently.

As shown in

Figure 2, the system follows a three-tier architecture consisting of the presentation layer, application layer, and data layer.

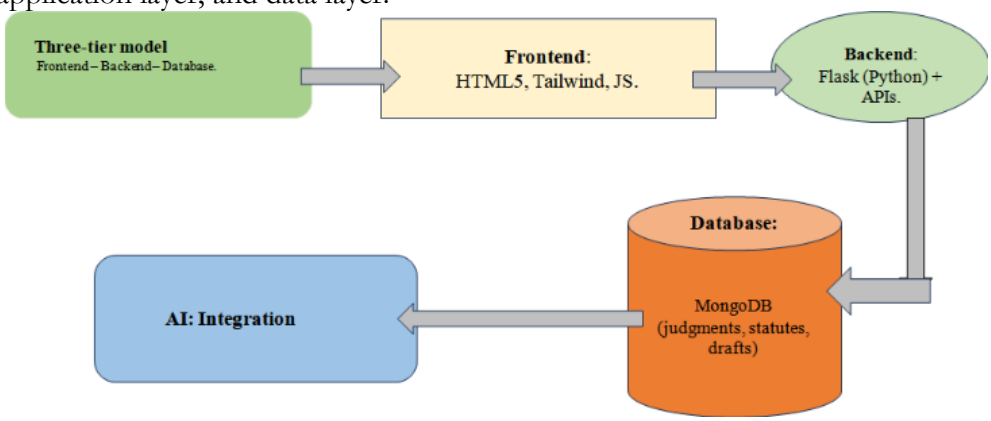


Figure 2. Three Tier Architecture

Data Collection and Preprocessing:

This section outlines the data collection and preprocessing process.

Justice Aid uses legal documents applicable to the Pakistani legal system, including the Pakistan Penal Code, Code of Criminal Procedure, and publicly available case law records. Documents are gathered and grouped to facilitate legal query processing and document analysis services.

Preprocessing includes text cleaning, removal of unnecessary characters, format standardization, and conversion of scanned legal documents into machine-readable text using

Optical Character Recognition (OCR). These steps ensure the information can be effectively analyzed and retrieved by the system.

AI Model Integration:

JusticeAid combines multiple AI models to facilitate answering legal questions and document analysis. The system employs a hybrid intelligent system combining conversational logic with document processing functionalities.

GPT-4: Main conversational model to process user queries, interpret context, and generate responses based on Pakistani legal guidelines. Controlled prompting ensures relevance to legal sources.

Google Gemini: Processes uploaded legal documents for extraction, summarization, and interpretation of content.

Communication between AI models and the backend occurs within a secure API pipeline, ensuring stable communication between the web interface, backend services, and AI modules.

System Implementation:

Justice Aid is a web-based system integrating frontend, backend, and database components.

Frontend: Developed with HTML5, CSS3, JavaScript, and Tailwind CSS for a responsive interface enabling interaction with the chatbot and uploading of legal documents.

Backend: Implemented using Flask to handle routing, authentication, API communication, AI integration, and document uploads.

Database: The MongoDB database stores user accounts, legal documents, statutes, and chat histories efficiently.

As shown in Figure 3, the backend architecture illustrates communication between Flask services, AI models, and the MongoDB.

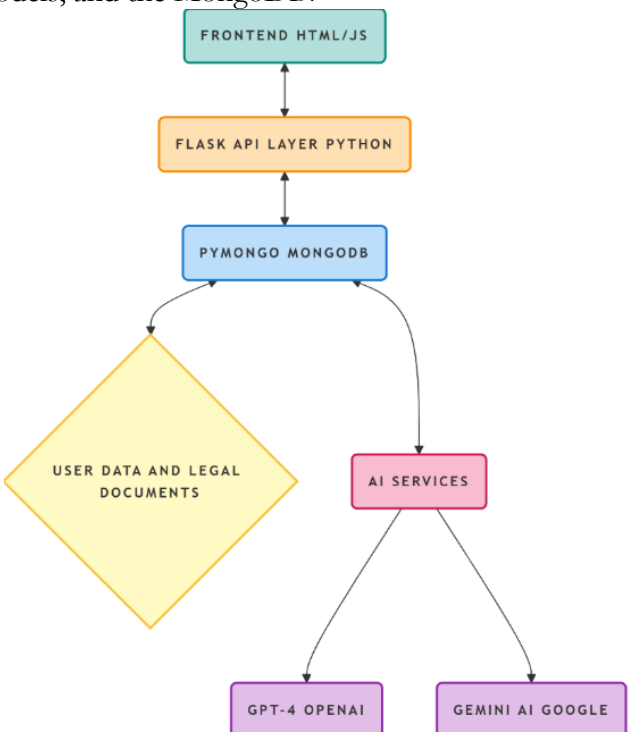


Figure 3. Backend architecture of the JusticeAid system

OCR Interaction and Document Processing:

Users can upload legal documents in several formats, such as PDF files, scanned images, and Microsoft Word files. The system combines several document processing tools to facilitate the use of these formats.

The Py PDF2 library is employed to extract text in digital PDF files. Pytesseract is used to perform Optical Character Recognition (OCR) on scanned documents and images to extract image-based text into a machine-readable format. The python-docx library is used to process Microsoft Word documents.

Such tools enable the system to derive legal information in various document types and transform them into a readable text that could be processed with AI models.

As shown in Figure 4, the MongoDB database architecture organizes legal documents, user accounts, and chat interactions.

Security and Authentication:

Security is an important component of Justice Aid. Authentication mechanisms protect user data and system resources:

Users authenticate via username and password, with bcrypt hashing and salting.

Google OAuth allows secure login with Google accounts.

Sensitive configuration data (API tokens, database credentials) is stored in secure environment variables.

Database access is limited to backend services, with rate limiting to prevent overload or misuse.

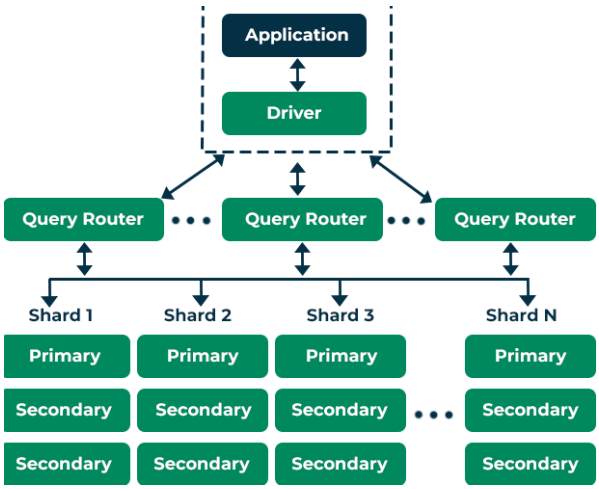


Figure 4. MongoDB Database Architecture

The OCR processing pipeline converts.

As shown in **Figure 5,** the pipeline processes documents to support automated legal analysis.

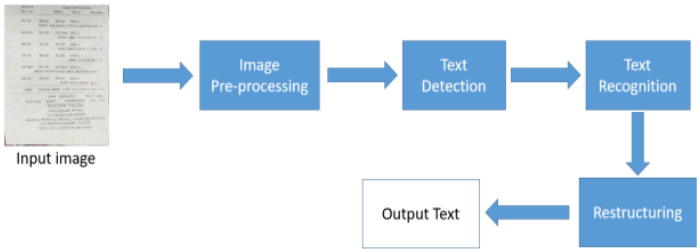


Figure 5. OCR Processing Pipeline.

Testing and Validation:

A number of testing procedures were done to test the reliability and functionality of the JusticeAid system. The testing stage involved functional testing, integration testing, and user-level testing.

Functional testing ensured that the different functional modules of the system, including the AI chatbot, document analysis applications, authentication mechanism, and legal

search functionalities, work properly. Integration testing ensured robust communication between the frontend and backend services, AI models, and the database system.

Additional tests were conducted on edge cases such as invalid inputs, corrupt files, and empty queries to test the stability of the system. These findings demonstrate that JusticeAid is capable of generating dependable legal query processing, accessing pertinent legal information, and interpreting uploaded legal documents at a fair response time.

Results and Discussion:

JusticeAid is an AI-based legal assistance system designed to increase accessibility to Pakistani legal services and information. The evaluation focused on functionality, performance, and usability, utilizing both visual outputs and quantitative test results. Key aspects examined include architecture efficiency, reliability of major features, response accuracy, and overall usability. This section provides a detailed overview of the system architecture and its performance outcomes.

System Architecture Overview:

JusticeAid is developed on a scalable and modular architecture integrating a Flask backend, a responsive web application, and advanced AI algorithms. GPT-4 is employed for interactive legal dialogue, while Gemini handles document retrieval and analysis. MongoDB serves as the primary database.

Key Components:

Frontend: Built using HTML5, Tailwind CSS, and JavaScript, providing a responsive chat interface, document upload tools, tab-based navigation, and session management via local Storage.

Backend: Implemented as a RESTful Flask API, managing user authentication, AI query processing, file parsing, and secure storage. It also supports semantic search of judgments using Sentence Transformer embeddings.

AI Layer: Localized GPT-4 Legal Q&A: Provides context-aware, Pakistan-specific legal guidance.

Gemini 2.5 Flash: Analyzes uploaded documents, performing clause extraction, semantic parsing, and intelligent content summarization.

Document Processing:

Supported Formats: PDF, scanned images (via OCR), DOCX, and plain text files.

Database: MongoDB collections store users, chat sessions, lawyer profiles, statutes, judgments, and uploaded PDFs (using GridFS).

Authentication: Managed through secure email/password login and Google OAuth integration.

Data Flow:

Legal Chat: User messages → Flask API → GPT-4 → Formatted response

Document Q&A: File uploaded → Server extraction → Gemini analysis → Returned answer

Judgment Search: Query embedded → Vector search → Ranked case results

Functional Testing:

Functional testing was conducted for all major modules, including authentication, AI chat, document analysis, lawyer search, and legal database queries. Both unit tests and integration tests were employed to ensure end-to-end workflow stability.

Test Summary: All primary features performed as expected.

Key results include:

Successful user login via email and Google OAuth:

As shown in Figure 6, the Google OAuth login interface enables secure authentication and redirects users to the dashboard after verification. The user is redirected securely to the dashboard after credential validation, enabling personalized access without manual sign-up.

Accurate legal answers with Pakistan-specific citations:

As shown in Figure 7, the AI-powered chatbot responding to a legal query. The system uses OpenAI's GPT-4 model to deliver a Pakistan-specific legal answer, citing relevant sections from the Pakistan Penal Code. This showcases the Chatbot's localization and legal accuracy in delivering context-aware responses.

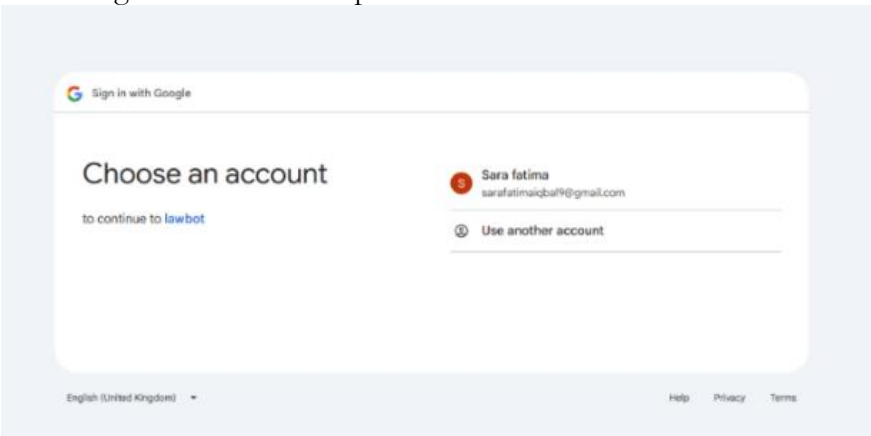


Figure 6. Google OAuth login screen

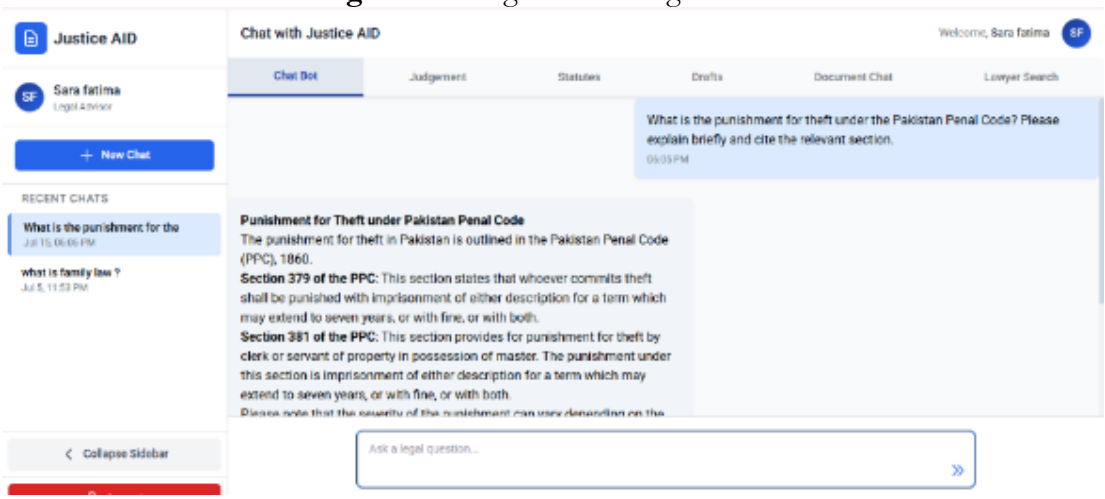


Figure 7. Chat response with GPT-4 citing the Pakistan Penal Code

Document Upload and AI-Based Legal Question Answering

Reliable extraction and analysis of PDF, DOCX, and OCR-based content

As shown in Figure 8, the document upload feature which the user to submit a legal document (e.g., contract, notice) in PDF format. The system extracts text using OCR or direct parsing and forwards it to Gemini AI, which then returns a targeted answer to a user-specific legal query based on the document content.

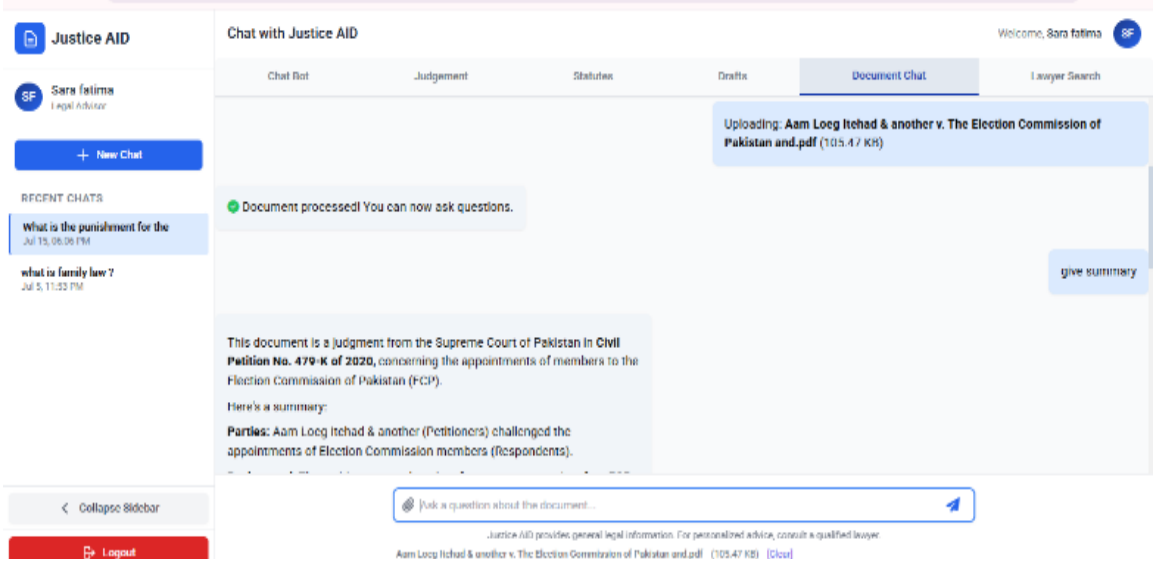


Figure 8. Uploaded PDF → Gemini Q&A flow

Effective lawyer filtering by city and specialization:

As shown in Figure 9, the lawyer search interface enables users to apply filters such as specialization and city to find relevant legal professionals. The correct lawyer profiles are shown based on the selected filters, helping users connect with qualified lawyers in their desired location.

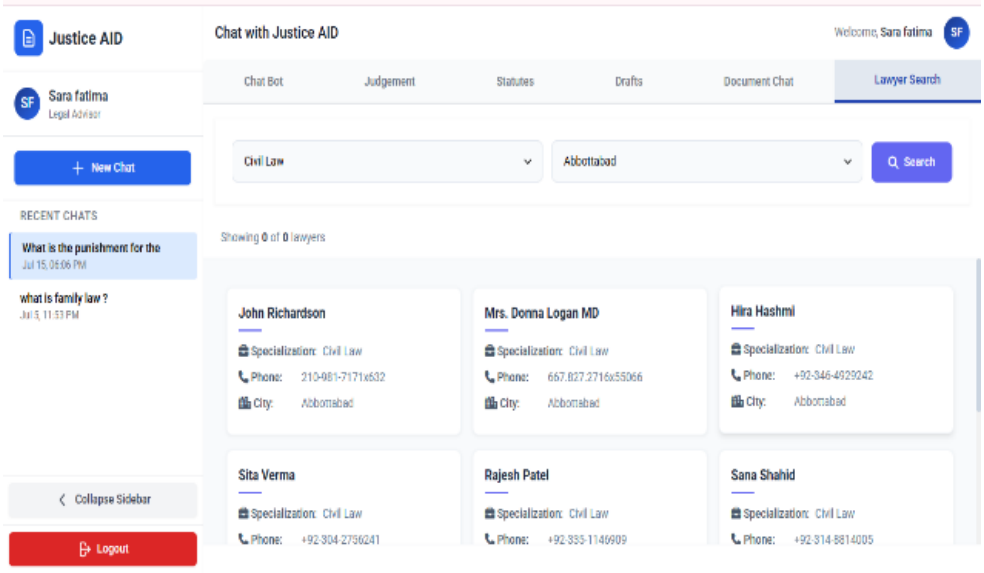


Figure 9. Effective lawyer filtering

Relevant case retrieval via semantic search:

As shown in Figure 10, the judgment search feature is powered by semantic embeddings. The user enters a legal query, and the system retrieves and highlights relevant judgments using natural language understanding rather than just keyword matching, thereby improving search accuracy.

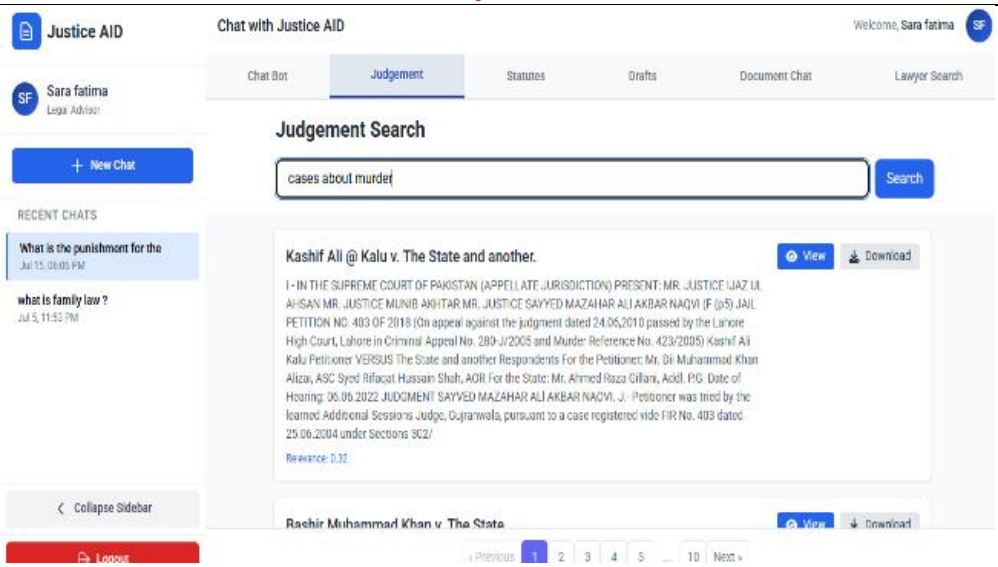


Figure 10. Judgment search with semantic result highlight

Accurate statute search and display:

Fully functional draft viewer and download mechanism

These figures visually confirm that each feature works correctly as intended and that user interactions flow smoothly across modules.

As shown in Table 1, the functional test results indicate that all major modules of the JusticeAid platform operate normally. Each test case was executed under normal usage conditions, and the observed results were consistent with the expected results, confirming the reliability and correctness of the implemented functions.

Table 1. Notable Edge Case Handling

Feature	Edge Case	Outcome
Signup	Duplicate email	Returns "Email already exists" error
Chat	Empty input	Alert message shown
Document Upload	Corrupted file	Displays "Upload failed."
Lawyer Search	No matching lawyer	Shows "No results found" UI
Statute Search	Misspelled section number	No result, but it does not crash

Performance Evaluation:

The evaluation of JusticeAid was conducted in terms of response time, document processing efficiency, and search latency. System testing in the local development environment provided quantitative results.

Chat Response Time:

The chatbot's performance in responding to legal queries of different lengths was tested.

As shown in Table 2, because the GPT-4 model performs contextual reasoning, the system responds faster to shorter queries, while longer queries require more processing time.

Table 2. Chatbot Response Time

Query Type	Average Response Time
Short legal query	9.7 seconds
Long legal query	17.6 seconds

Document Processing Performance:

JusticeAid allows various document types such as PDF, DOCX, TXT, and images. The processing time of each document type was determined during testing.

As shown in Table 3, text-based files such as TXT and DOCX are faster to process than scanned documents, since OCR requires additional computational resources to process scanned documents.

Table 2. Document Processing Time

Document Type	Average Processing Time
PDF	1.9 seconds
OCR Scanned PDF	9.5 seconds
Image OCR	3.7 seconds
DOCX	1.8 seconds
TXT	0.3 seconds

Search Performance:

Search latency across various legal information retrieval functions was tested in the system. As shown in Table 4, the lawyer search module returned the fastest results due to a smaller dataset, but the judgment search took longer because of semantic embedding and ranking tasks. Table 3 Search Latency Evaluation

Table 4. Search performance

Search Module	Average Response Time
Judgment Search	1.1 seconds
Statute Search	0.29 seconds
Draft Search	0.45 seconds
Lawyer Search	0.14 seconds

These findings confirm that JusticeAid is efficient in document management and suitable for practical use by users requiring Pakistan-specific legal advice. The system demonstrates a balance between speed, accuracy, and usability, supporting the effectiveness of the hybrid AI architecture and its suitability for real-world use.

Comparison to Existing Legal Chatbots:

To evaluate the proposed JusticeAid system, a comparison was made with existing legal chatbots, including Pakistan Law Bot, LawGPT, NAZ Assist, and Lexa Lawyer. The comparison focuses on key features such as legal information access, case support, document downloads, cost, and language support.

As shown in Table 5, JusticeAid provides additional capabilities such as case study support, document downloads, and chat history, which enhance the accessibility and usability of legal assistance compared to existing chatbots.

Table 4. Comparison between JusticeAid and Existing Legal Chatbots

Feature / Objective	JusticeAid	Pakistan Law Bot	Law GPT	NAZ Assist	Lexa Lawyer
Legal Information Access	Yes	Yes	Yes	Yes	Yes
Case Study Support	Yes	No	Yes	No	Yes
Document Download	Yes	No	Yes	No	Yes
Chat History	Yes	No	No	No	Yes
Ease of Use	High	High	Medium	High	Medium
Instant Responses	Yes	Yes	Yes	Yes	Yes
Cost	Free	Low-cost	Free/Paid	Free	Paid
Language Support	English	English	English	Multilingual	English

Conclusion:

This study presents JusticeAid, an AI-based legal assistance system designed to improve access to legal information within the legal framework of Pakistan. The system

integrates GPT-4 and Google Gemini within a three-tier architecture to provide conversational legal guidance, document analysis, and lawyer discovery through a user-friendly web interface.

Experimental evaluation demonstrated that the chatbot provides reliable legal responses with average response times ranging from 9.7 to 17.6 seconds, while document processing tasks took 0.3 to 9.5 seconds depending on file type. The results indicate that the proposed system effectively supports legal query handling, document interpretation, and legal resource discovery.

Although the system demonstrates promising capabilities, certain limitations remain, including reliance on a static legal database, English-only language support, and the absence of verified lawyer profiles. Future improvements may include integration with real-time legal databases, multilingual support for regional languages, mobile application development, and the incorporation of explainable AI techniques to enhance transparency and trust.

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