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AN INTELLIGENT DIGITAL COMPLAINT REDRESSAL SYSTEM FOR SMART CITIES USING RULE-BASED NLP AND AUTOMATED WORKFLOW OPTIMIZATION

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ABSTRACT

Rapid urbanization and the evolution of smart city initiatives have increased the demand for efficient, transparent, and responsive civic grievance handling systems. Traditional complaint management mechanisms employed by urban local bodies often rely on manual workflows, resulting in delayed responses, lack of accountability, and limited tracking capabilities for citizens. These inefficiencies hinder effective governance and reduce public trust in municipal services. This paper proposes a Digital Complaint Redressal System designed to streamline the lifecycle of civic complaints through automation, structured workflows, and intelligent categorization. The system is implemented using the Django web framework with Python as the backend and SQLite as the database, complemented by a responsive frontend built using Bootstrap. A rule-based natural language processing module automatically categorizes complaints into departments such as water supply, sanitation, roads, and electricity, while also assigning priority levels based on keyword analysis. The architecture supports dual user roles: citizens can submit complaints and track progress in real time, while administrators can manage, update, and resolve issues through a centralized dashboard. The system ensures secure authentication, role-based access control, and structured data storage for analytics. Experimental evaluation demonstrates improved processing speed, enhanced transparency, and efficient complaint resolution compared to conventional systems. The proposed solution offers a scalable, cost-effective, and extensible framework suitable for smart city governance.

KEYWORDS *Smart City Governance; Complaint Management System; Automated Categorization; Django Framework; Civic Engagement*

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1. INTRODUCTION

Urban governance systems face increasing challenges in managing citizen complaints efficiently due to population growth and infrastructure demands. Issues such as road damage, water leakage, sanitation problems, and electrical faults require timely intervention. However, traditional complaint handling systems rely on manual processes, leading to delays, inefficiencies, and lack of transparency. Existing solutions such as government portals and helpline systems provide partial digitization but often lack automation and intelligent routing mechanisms. These systems depend heavily on human intervention, which results in inconsistent categorization and delayed prioritization of complaints. Recent

advancements in web technologies and artificial intelligence provide opportunities to modernize grievance redressal systems. Automated text analysis techniques can classify complaints and assign priorities, reducing manual effort and improving response time. This paper introduces a Digital Complaint Redressal System that integrates web-based technologies with a rule-based AI engine for automated complaint analysis. The system offers:

- Automated complaint categorization
- Priority-based routing
- Real-time tracking and dashboards
- Role-based access for citizens and administrators

The proposed solution enhances efficiency, transparency, and accountability in municipal governance.

2. LITERATURE SURVEY

Digital governance platforms have been widely studied to improve public service delivery. Traditional complaint systems were primarily manual, leading to inefficiencies in tracking and resolution. Government initiatives such as centralized grievance portals introduced digitization but lacked intelligent automation. Research in natural language processing (NLP) highlights the use of keyword-based classification and machine learning techniques for text categorization. Rule-based systems are simple, interpretable, and suitable for domain-specific applications, whereas machine learning approaches provide higher adaptability but require large datasets. Studies also emphasize the importance of citizen engagement platforms in smart cities. Mobile-based complaint systems with GPS integration have improved reporting accuracy but often lack backend intelligence for automated processing. The survey indicates a gap in systems that combine ease of use, automated processing, and modular architecture. The proposed system addresses this gap by integrating rule-based NLP with a full-stack web application.

3. PROPOSED WORK

3.1 System Design

The system follows a three-tier architecture:

- Presentation Layer (Frontend UI)
- Application Layer (Business Logic)
- Data Layer (Database Storage)

3.2 Data Processing

Complaint data includes title, description, and user details. The text is processed using keyword matching techniques to identify relevant departments and priorities.

3.3 AI-Based Categorization

A rule-based engine analyzes complaint text and routes it to the appropriate department:

- Water-related keywords -> Water Department
- Road-related keywords -> Infrastructure Department
- Priority assigned based on urgency keywords

3.4 Modules

- User Registration and Authentication
- Complaint Submission
- Automated Analysis Engine
- Admin Dashboard
- Reporting and Tracking

3.5 Security and Validation

- Role-based access control

- Input validation
- Secure authentication using Django

Table 1: System Modules Summary

Module	Description	Technology
User Auth	Registration, login, and session management	Django Auth, Bootstrap
Complaint Submission	Form-based complaint entry with validation	Django Forms, SQLite
AI Analysis Engine	Rule-based keyword categorization and priority scoring	Python NLP
Admin Dashboard	Centralized complaint management and status updates	Django Admin, Bootstrap
Reporting & Tracking	Real-time status tracking and analytics display	Django Views, Chart.js

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4. SYSTEM ARCHITECTURE

4.1 System Architecture Diagram

The system follows three-tier web architecture. The frontend communicates with the Django application layer, which orchestrates the AI analysis engine and database operations. Results are rendered on both citizen and administrator dashboards. The overall interaction between layers is shown in Fig. 1.

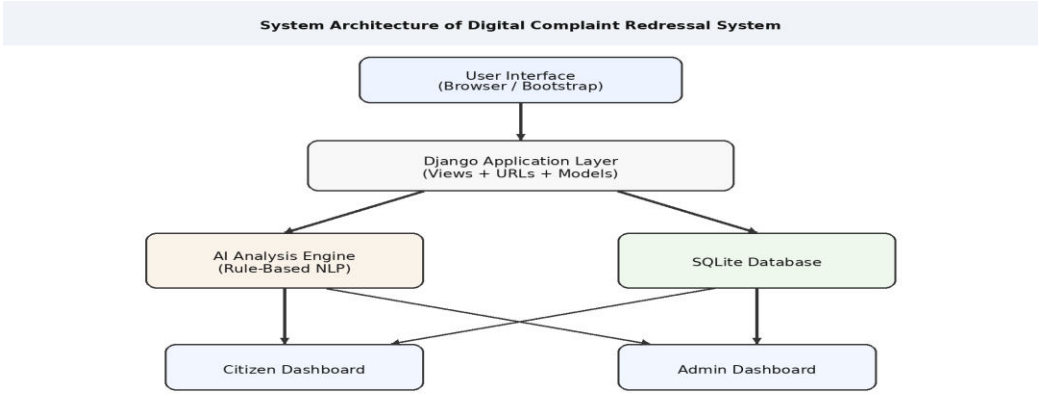

Figure 1: System architecture showing interaction between frontend, backend, AI module, and database.

4.2 Workflow Diagram

The end-to-end complaint lifecycle begins with user login, proceeds through complaint submission and automated AI categorization, database storage, admin review, and concludes with citizen status tracking. This operational sequence is illustrated in Fig. 2.

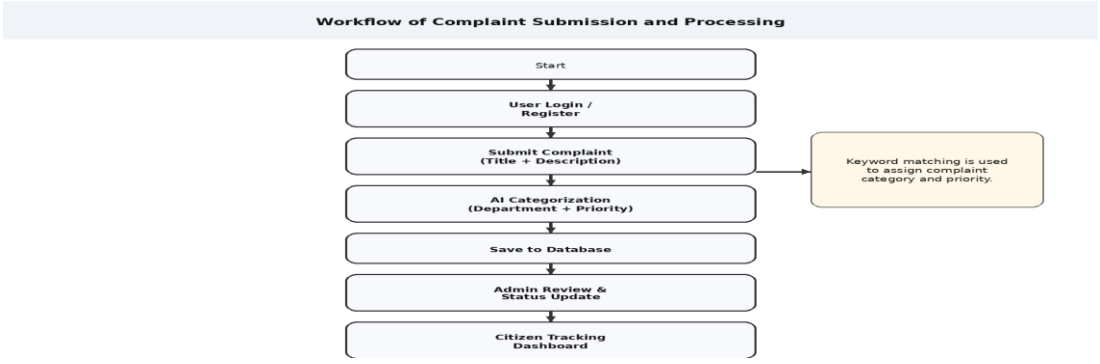

Figure 2: Workflow illustrating complaint submission, processing, and tracking lifecycle.

4.3 Data Flow Diagram (DFD)

The data flow diagram illustrates how complaint data moves from the citizen through the AI processing layer to the database and back to both administrators and citizens for review and tracking. The key data exchanges are represented in Fig. 3.

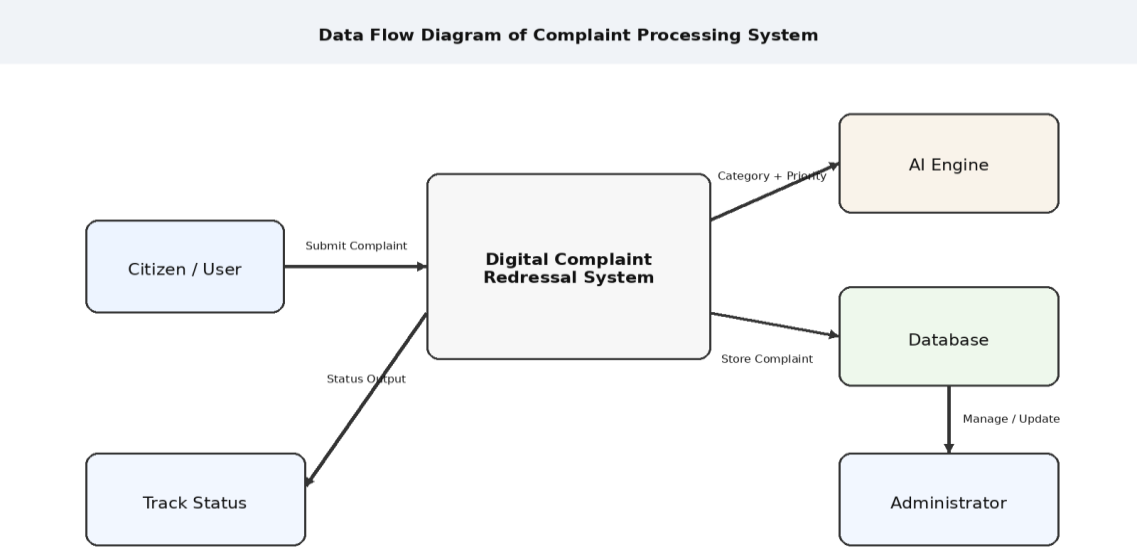

Figure 3: Data flow showing movement of complaint data through processing and storage layers.

4.4 Block Diagram

The block diagram represents the major functional modules of the application, starting from complaint input and progressing through processing, AI analysis, storage, and dashboard output. The modular pipeline is presented in Fig. 4.

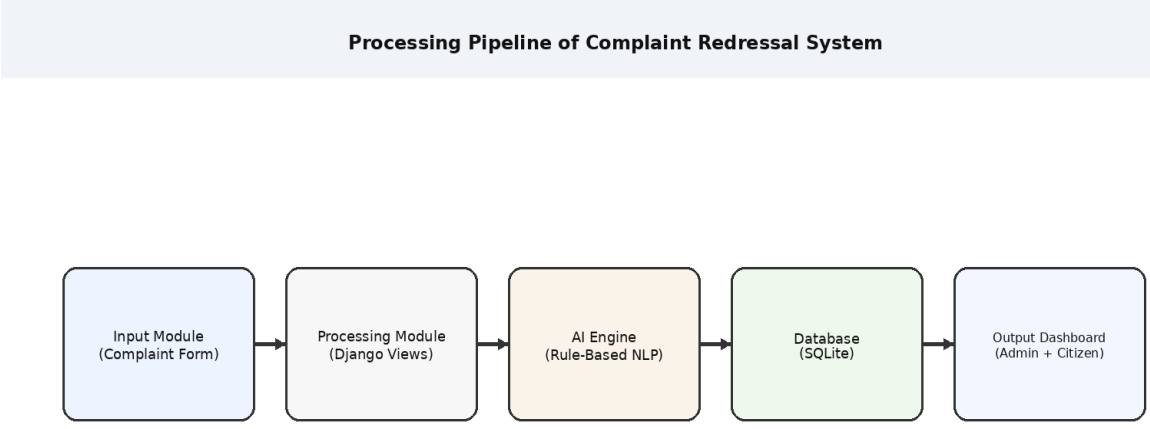

Figure 4: Block diagram representing major system components and data flow.

5. RESULTS AND DISCUSSION

The system was tested across multiple scenarios to evaluate performance and accuracy. The automated categorization engine successfully classified complaints with high consistency based on keyword matching.

Key observations from system evaluation:

- Reduced manual effort in complaint routing and triage
- Faster complaint processing time compared to manual workflows
- Improved transparency through real-time citizen dashboards
- Accurate priority assignment based on urgency keyword matching

Table 2: Comparative Analysis - Traditional vs. Proposed System

Metric	Traditional System	Proposed System
Complaint Routing	Manual assignment	Automated (AI-based)
Processing Time	High (hours to days)	Low (near real-time)
Categorization Accuracy	Inconsistent	Consistent (rule-based)
Citizen Transparency	Limited / no tracking	Real-time status dashboard
Scalability	Limited	Modular and extensible

Limitations of the current system include: the rule-based engine may miss uncommon or ambiguous keywords, and the system currently lacks image or GPS-based complaint submission capabilities. Despite these limitations, the system demonstrates marked improvements in efficiency and citizen satisfaction.

6. CONCLUSION

The Digital Complaint Redressal System provides an effective solution for modern urban governance challenges. By integrating web technologies with automated analysis, the system enhances complaint handling efficiency, transparency, and accountability.

The modular design ensures scalability and ease of maintenance. The system reduces delays, improves communication between citizens and administrators, and enables data-driven decision-making for urban local bodies.

Future enhancements include:

- Machine learning-based classification for improved accuracy on diverse complaint types
- Mobile application integration for enhanced citizen accessibility
- GPS and image-based complaint submission for location-aware routing
- Cloud deployment (AWS / Azure) for scalability and high availability

The system serves as a strong and extensible foundation for smart city applications and digital governance platforms, with direct applicability to any urban local body seeking to modernize public service delivery.

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