Recent Research Reviews Journal (ISSN: 2583-7079)
https://irojournals.com/rrrj

# A Smart Centralized Grievance Redressal System leveraging Sentiment-Aware Analytics

**Senthamil Selvi R.[1], Agalya G.[2], Gayathri S.[3], Gejalakshmi S.[4]**

Department of Computer Science and Engineering, Saranathan College of Engineering (Autonomous), Tiruchirappalli, India.

**E-mail:** [1]senthamilselvi-cse@saranathan.ac.in, [2]cse251003@saranathan.ac.in, [3]cse251028@saranathan.ac.in, [4]cse251029@saranathan.ac.in

## Abstract

Grievance redressal mechanism plays a major role in providing transparency, accountability, and satisfaction for citizens by integrating modern governance frameworks. Despite the advantages, the existing complaint management tend to face several challenges such as delays, inefficiency in prioritization and monitoring, which lead to the inadequate handling of important issues. This research work proposes a smart centralized grievance redressal system by leveraging sentiment-aware analytics for complaint processing and management. In particular, the proposed framework consists of a centralized complaint repository, sentiment analysis engine, priority classification system, complaint tracking, notifications and analytics for administrators on a single platform. Natural Language Processing is used to process the descriptions of grievances and extract emotions and severity indicators to prioritize complaints based on their urgency. Complaint allocation, role-based access control, and monitoring capabilities of complaints during their lifetime are other features of the proposed system. The results have proved that the proposed framework outperforms traditional methods of grievance management.

**Keywords:** Grievance Redressal System, Sentiment Analysis, Role-Based Access, Text Processing, Data Analytics, Citizen-Centric Governance.


*DOI: https://doi.org/10.36548/rrrj.2026.1.013*
Extended version of article received from **6th International Conference on Artificial Intelligence, 6G Communications and Network Technologies 2026**
*Received: 05.05.2026, received in revised form: 09.06.2026, accepted: 01.07.2026, published: 13.07.2026*

## 1. Introduction

Grievance redressal helps to ensure transparency, accountability, and satisfaction among the customers. Organizations such as the government, local municipalities, educational institutes, and service providers get numerous complaints on a day-to-day basis related to their services, infrastructure, utility issues, and several others. The processing of these grievances has a great influence on the efficiency of the organization. Traditional methods of handling such complaints involve the use of paper-based procedures, slow communication processes, and manual processing.

The rapid growth of digital technology, complaint management systems have been structured for making it easier to register complaints and tracking them. Using the Internet, citizens can register their complaints and also keep track of the full process by using online systems. However, the majority of the existing systems will process the received complaints sequentially no matter how urgently the tone is expressed in the description of the complaints. As such, critical complaints get handled similarly to other routine service requests, it results in the sub-optimal use of resources and delay in generating a resolution for high-priority event.

Recent advances in NLP and sentiment analysis paves way for establishing improved grievance management system. Sentiment analysis is used for obtaining emotional data from text as it helps the system to understand how dissatisfied, urgent, frustrated, and severe the complaint descriptions are. Sentiment analysis improves the process of grievances handling by categorizing the complaints that needs to be escalated automatically depending on their level of urgency and importance; thus, it helps the authorities solve issues that require immediate action.

Another significant challenge faced by many existing systems for handling grievances is that there is no centralized system that can help to monitor complaints. Records of complaints are usually received for different departments, which makes it impossible to assess the performance of each department and make the process transparent. It is thus important to have a system that would be able to handle all these tasks effectively.

To solve the aforementioned challenges, this research study intends to develop a smart centralized grievance redressal system using sentiment aware analytics. In this proposed model, there will be a common platform for submitting complaints, automated prioritization using sentiment analysis, real time monitoring of complaints, department wise allocation of

complaints, and also a dashboard is developed to monitor the data analytics. The description of the complaints is analyzed using NLP techniques and the priority level is then decided based on the intensity and severity factors.

The system also integrates role-based access control, notification systems, and feedback evaluation services to ensure transparency and accountability in the process of grievance resolution.

Major contributions of this study are as follows:

- Implementation of a centralized grievance management platform for efficient complaint handling.
- Integration of sentiment-aware analysis to automatically prioritize the complaints.
- Implementation of real-time tracking and notifications relevant to the complaints.
- Deployment of role-based administrative management and department allocation of resources.
- Design of an analytics dashboard for monitoring complaint trends and resolution performance.

The suggested model is built to achieve the goals of making grievance redressal process more effective, increasing citizen's participation, avoiding delays in responding, and creating a foundation for developing an intelligent complaint management system.

## 2. Related Works

The development of digital complaint redressal models has gained a lot of interest due to the increasing need for transparency and efficiency in the government systems. Many research works have been conducted in areas like automatic complaint registration, complaint routing, sentiment analysis, language translation.

GrievanceGrid, proposed by Suganya et al. [1] is an AI-powered multilingual civic complaint resolving platform that enable the users to file their complaints in multiple languages. Complaints submitted are translated to English language by using the AI technology. The obtained text is then classified and routed to relevant departments using

machine learning methods. The work enhanced the accessibility of the tool for users from various linguistic backgrounds and also emphasized the significance of using AI-supported complaints management systems. Xing et al. [2] presented a sentiment-aware analytic framework that includes sentiment information in deep learning models to facilitate decision-making. This study proved the benefits of using sentiment information obtained from textual data in order to increase prediction accuracy and make intelligent decisions. The idea of using sentiment-aware analytics can be adopted in managing grievances to understand the user satisfaction and sense of urgency. Ye et al. [3] created a multimodal sentiment analysis system that uses sentiment-aware pre-training methods to combine textual and visual information. It has been proved that the use of multimodal data can significantly increases the sentiment analysis performance.

iReport, a publicly reported intelligent grievance system proposed by Laxmaiah et al. [4] makes use of cloud vision technology to analyze complaints in terms of images and automatically route the issue to the closest concerned authority. This system helps in real-time complaint tracking and reduces manual involvement. The smart grievance redressal system developed by Joy et al. [5] involves digitized registering and monitoring of complaint using a centralized web-based system. It provides an interaction interface for both citizens and government authorities to track the entire process. A web-based public grievance portal was developed by Kotwal et al. [6] for performing complaint handling and monitoring activities.

The blockchain technology proposed by Jattan et al. [7] develop a grievance redressal system by integrating Ethereum technology. The system also ensures that grievance records are immovable, transparent and secure by placing grievance records on a decentralized ledger. Although the approach enhanced the system reliability, it added some complexities in terms of computation cost and deployment cost. Kandhari et al. [8] proposed a GPS-based complaint redressal system by utilizing geospatial data to determine the geographical location of the complainants. Geospatial data helps to enable a quick distribution of the problem to achieve a faster solution for civic issues related to location. Ray et al. [9] developed a social complaint management system using mobile application. The citizens were able to make complaints through mobile phones and continuously keep track of the status of their grievances being resolved. Finally, Das et al. [10] proposed a decision support grievance redressal system, which uses sentence level sentiment analysis technique to help decision makers resolve complaints effectively.

## 3. Proposed Work

The smart centralized grievance redressal system shown in Figure 1 follows a centralized design for capturing, handling, and managing complaints by citizens. The process starts with a user registering a complaint through the Citizen Portal. Every complaint is characterized by attributes like Complaint ID, User ID, Department Category, Location Details, Complaint Details, Timestamp, and Evidence.

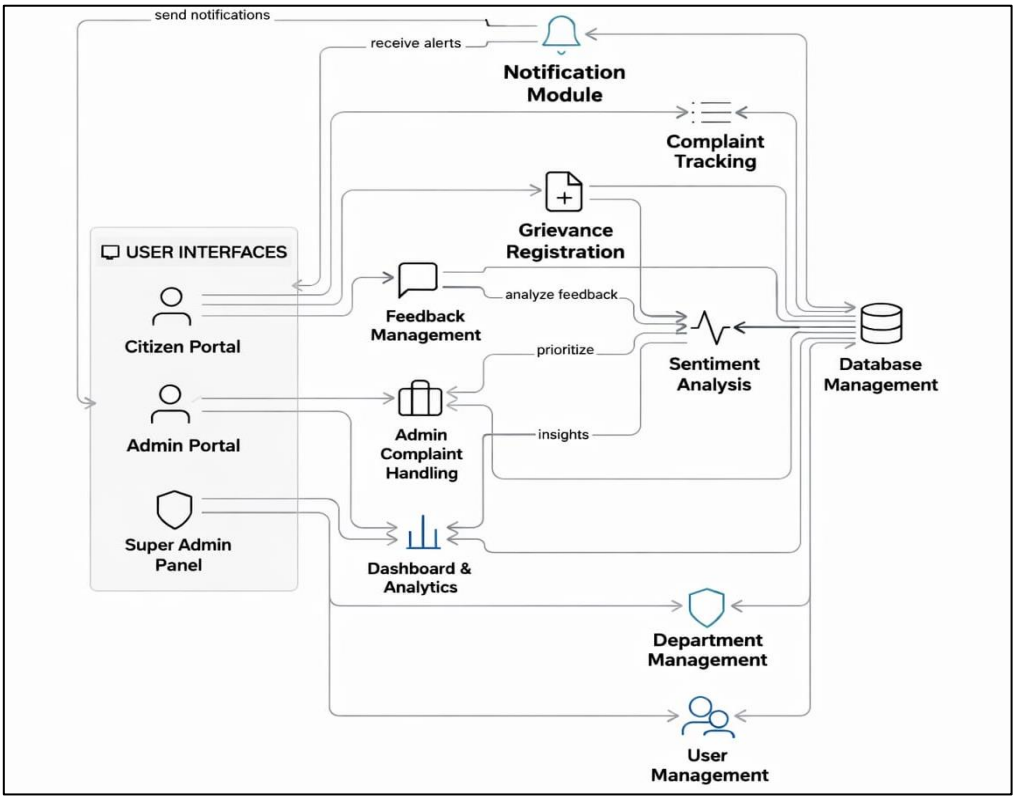


**Figure 1.** Architecture of the proposed smart centralized grievance redressal system

### 3.1 Grievance Registration and Centralized Data Acquisition

This module validates the issuance of complaint on server side, where it checks if all necessary and any required information has been captured accordingly. Post validation, an auto-incremental indexing mechanism identifies a unique Complaint Identification Number (CID). Therefore, this complaint data is then saved in the centralized database management system.

Let

$$G_i = \{CID_i, U_i, D_i, L_i, T_i, E_i\} \quad (1)$$

where $CID_i, U_i, D_i, L_i, T_i$, and $E_i$ denote the complaint ID, user information, complaint description, location details, submission timestamp, and supporting evidence of the $i^{\text{th}}$ grievance, respectively.

The centralized database serves as a shared storage that allows for easy communication between the sentiment analysis, complaint tracking, administrative processing and analytical modules. A centralized architecture of grievance information reduces data duplication and guarantees a uniform overview of each grievance across the lifecycle.

### 3.2 Sentiment Analysis and Priority Score Computation

After registration, the complaint description in text is sent to the sentiment analysis engine for automatic severity determination. The complaint descriptions are unstructured textual data and are converted into machine-readable format by using Natural Language Processing (NLP) techniques.

#### 3.2.1 Text Preprocessing

Initially, the complaint text undergoes preprocessing operations including:

- Lowercase conversion
- Tokenization
- Stop-word elimination
- Punctuation removal
- Lemmatization

For a complaint text document $C$,

$$C = \{w_1, w_2, w_3, \dots, w_n\} \tag{2}$$

Where, $w_i$ represents the $i^{\text{th}}$ token extracted from the complaint text after preprocessing.

#### 3.2.2 Feature Extraction

The pre-processed tokens are converted into numerical vectors using the TF-IDF feature extraction technique.

The term frequency is computed as:

$$TF(t,d) = \frac{f(t,d)}{\sum_k f(k,d)} \tag{3}$$

Where, $f(t,d)$ is the frequency of term $t$ in document $d$, and $\sum_k f(k,d)$ denotes the total number of terms in document $d$.

The inverse document frequency is calculated as:

$$IDF(t) = \log\left(\frac{N}{n_t}\right) \tag{4}$$

Where, $N$ is the total number of complaint documents and $n_t$ is the number of documents containing the term $t$.

The final TF-IDF representation is:

$$TF - IDF(t,d) = TF(t,d) \times IDF(t) \tag{5}$$

### 3.2.3 Sentiment Scoring

The extracted features are analyzed to determine the emotional polarity of the complaint. The sentiment score is represented as:

$$-1 \leq S \leq 1 \tag{6}$$

Where, $S = -1$ indicates strongly negative sentiment, $S = 0$ represents neutral sentiment, and $S = 1$ denotes strongly positive sentiment.

Negative sentiment values indicate higher dissatisfaction and urgency.

Moreover, severity terms like “emergency,” “accident,” “unsafe,” “dangerous,” and “health risk” are recognized using keyword matching. Each keyword carries a severity weight, which is predefined for it.

The final priority score is computed as:

$$P = \alpha S + \beta K \tag{7}$$

Where, $P$ is the complaint priority score, $S$ is the sentiment score, $K$ is the cumulative severity keyword score, and $\alpha$ and $\beta$ are weighting coefficients satisfying

$$\alpha + \beta = 1 \tag{8}$$

Based on the computed priority score, complaints are classified into:

- High Priority
- Medium Priority
- Low Priority

This mechanism enables automated identification of critical grievances requiring immediate action.

### 3.3 Complaint Tracking and Notification Framework

The complaint tracking system constantly monitors the status of all complaints once they have been assigned priorities. Each complaint goes through predefined stages of workflow:

Each state transition generates an update event that is recorded in the database.

Let

$$S_t = \{s_1, s_2, s_3, \dots, s_n\} \tag{9}$$

Where, $s_i$ denotes the $i^{\text{th}}$ state transition recorded during the grievance lifecycle.

Complaint tracking module fetches the current state of the complaint and reflects its progress to the user through the portal interface.

The notification module operates alongside the tracking framework. Notifications are generated whenever significant events occur, including:

- Complaint registration
- Priority assignment
- Department allocation
- Complaint escalation
- Status updates

- Resolution completion

A notification event can be represented as:

$$N = (CID, E_v, T) \tag{10}$$

Where, $CID$ denotes the complaint identifier, $E_v$ represents the notification event, and $T$ denotes the event timestamp.

Each complaint is assigned a unique identifier number for each respective event. In doing so, it enhances clarity and eliminates possible communication barriers between the citizens and administrative authorities.

### 3.4 Administrative Complaint Processing and Department Allocation

The administrative processing layer obtains prioritized complaints from the sentiment analysis module. The admin portal serves as an interface for evaluating information about complaints, their severity level, available evidences, and past records.

The department management module executes complaint allocation in compliance with their categorization and priority values. Complaint categories comprise the following:

- Water Supply
- Road Maintenance
- Electricity
- Public Health
- Municipal Services

The allocation process can be represented as:

$$D_m = f(C, P) \tag{11}$$

Where, $D_m$ denotes the assigned department, $C$ represents the complaint category, and $P$ is the computed priority score.

High-priority complaints are automatically assigned to senior managers in order to decrease response time. Role-Based Access Control (RBAC) is supported by the system. Permissions are assigned depending on users' roles.

The RBAC structure consists of:

1. Citizen
2. Administrator
3. Super Administrator

This access model enhances system security while ensuring operational accountability.

### 3.5 Dashboard Analytics and Feedback Intelligence

The dashboard analytics module automatically collects data related to the operations of the complaints to generate metrics on performance. The information collected includes data on complaints' databases, departments' activities, complaint solving logs, and feedback database.

The key metrics include:

Complaint Resolution Rate

$$CRR = \frac{N_{\text{resolved}}}{N_{\text{total}}} \times 100 \tag{12}$$

Escalation Percentage

$$EP = \frac{N_{\text{escalated}}}{N_{\text{total}}} \times 100 \tag{13}$$

Average Resolution Time

$$ART = \frac{\sum_{i=1}^{N_{\text{resolved}}} RT_i}{N_{\text{resolved}}} \tag{14}$$

Where, $RT_i$ denotes the resolution time of the $i^{\text{th}}$ resolved complaint.

Following the complaints have been resolved, users will be able to rate and provide feedback using the Feedback Management Module. Complaints feedback is also evaluated

using the sentiment analysis module in order to determine satisfaction levels and service problems.

Combining the use of complaint prioritization and analysis based on sentiment, along with feedback analysis, ensures that all the above-mentioned characteristics of the suggested framework are realized.

## 4. Results and Discussion

### 4.1 Complaint Registration and Submission Analysis

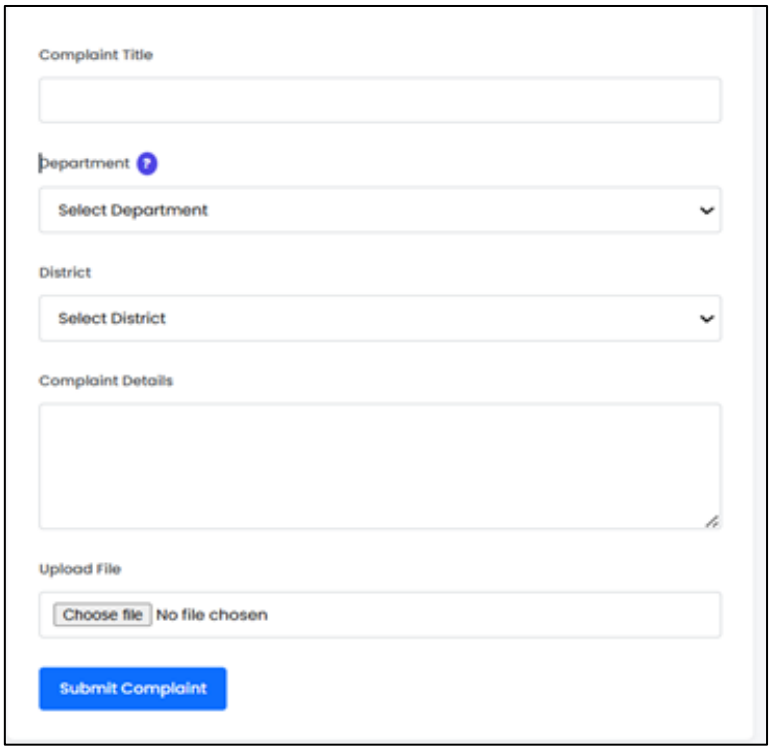


**Figure 2.** Grievance submission and complaint data acquisition

Figure 2 shows the interface for the submission of complaints - proposed grievance redressal system citizens to lodge their complaints using the portal by furnishing these details: complaint title, category of the department, district, and the complaint itself. The interface enables the user to upload pictures, thus helping him to provide photographic evidence.

The data provided by the user is validated before saving any complaints in the centralized database with the help of a complaint registration module. On submission a unique invoice identifier is created for reporting the grievance. Soon after, the textual description is

forwarded to the sentiment analysis engine, where a contextual pre-processing including the tokenization, stop-word removal and TF-IDF feature extraction are respectively executed.

Experimental evaluation indicated that the complaint registration and database insertion were performed in less than a few seconds so the user experience was seamless, Moreover, with the use of automated complaint classification, there were reductions in manual categorization and complaints could be forwarded directly to administrative departments.

### 4.2 Sentiment-Based Complaint Prioritization Performance

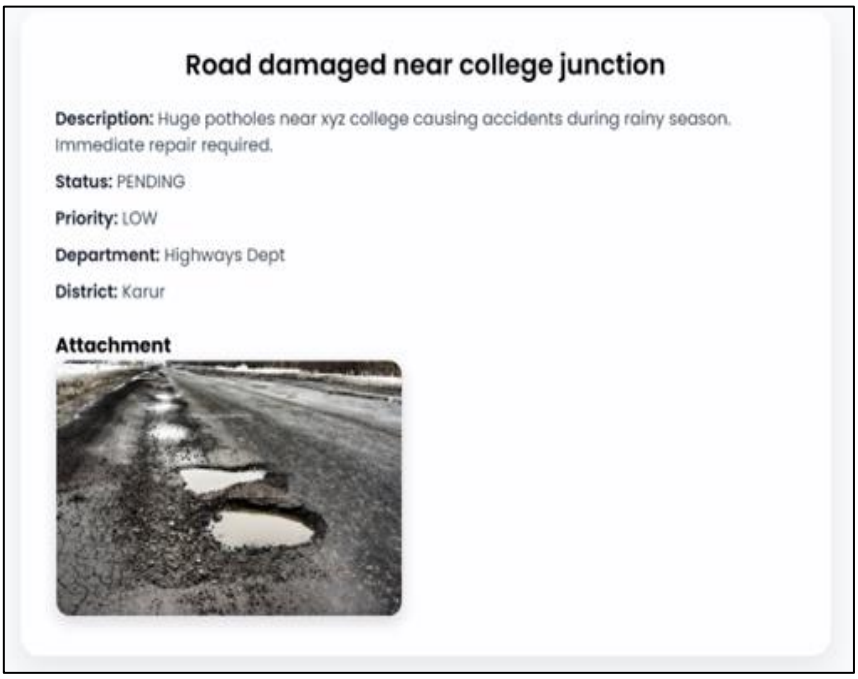


**Figure 3.** Complaint details with priority, status, and supporting evidence

After registration and processing, the detailed complaint view is generated as depicted in Figure 3. It shows the complaints data i.e. title, description, department assigned to resolve the complaint, location details for all 15 complaints status and its priority level.

The sentiment analysis module extracts the text of the complaint and determines which priority category it belongs to base on sentiment words based on emotional intensity and severity. Certain critical terms in complaints like "dangerous", "accident", "water leakage" or any health risk will give those requests a higher priority score than normal service requests.

The mechanism of prioritization proposed for understanding the complaints was successful in segregating these into high, Medium and Low priority based on verbal responses. Complaints graded as high-priority were automatically forwarded to administrators for urgent

consideration while medium- and low-priority complaints proceeded through standard workflows. This automated prioritisation lowered administrative burden and ensured that urgent complaints were handled by without delay.

It provides full visibility across grievance lifecycle as it also shows the current status of processing on complaint detail page. Supporting image evidence also increases complaint verification accuracy and helps departments make the right decisions when solving a problem.

### 4.3 Administrative Analytics and System Performance Evaluation

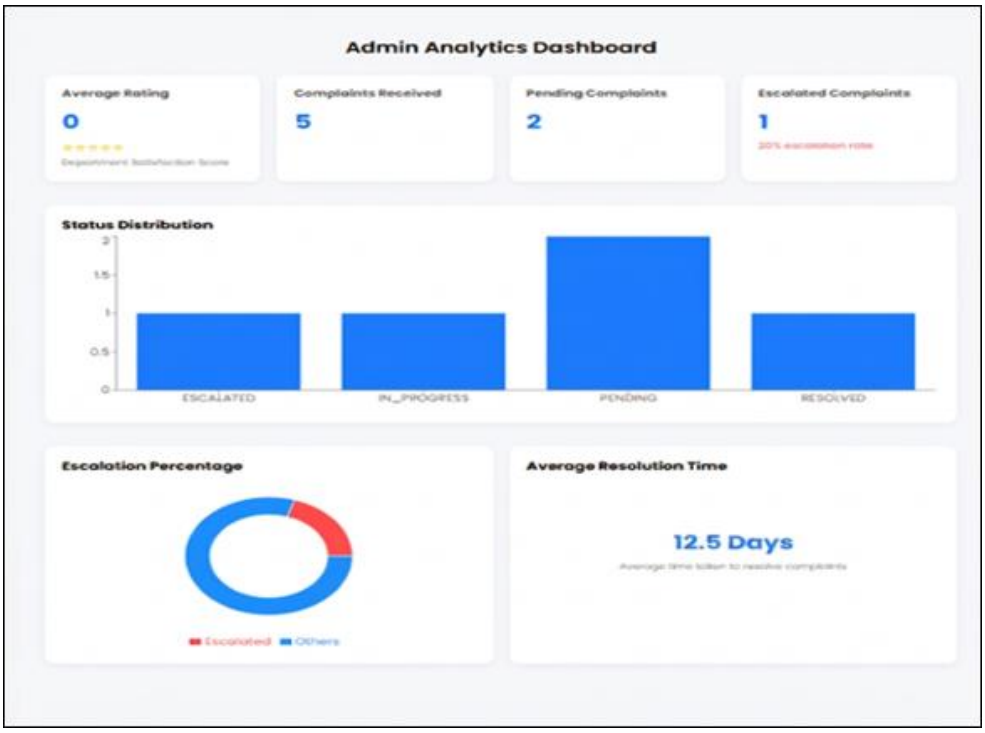


**Figure 4.** Administrative decision support dashboard

The administrative analytics dashboard in Figure 4 provides a real-time summary view of grievance processing. 5 Complaints were acquired in total, which shows the successful store and log of complaints within one software application. Out of these complaints, 2 were unresolved type, 1 complaint was under process, 1 complaint was resolved and there is one reserved for higher administrative decision making.

The dashboard indicates a 20% escalation rate, meaning that only one of the five logged complaints needed to be escalated due to it being more serious than a standard journal entry. The above illustrates how well-suited the sentiment-aware prioritization mechanism is to highlight complaints that need administrative attention.

The graph distribution for various stages of complaints shows that the system can indeed separate complaints based on the workflow stages such as escalated, in process, pending, and resolved. The pending stage had the most concentrated complaints in 2 numbers, while other stages had complaints of one number each.

Mean time for resolving complaints is 12.5 days; this refers to the period spent by the administration in handling the grievance. This enables the management to monitor the speed at which complaints are being processed by the departments.

## 5. Conclusion

Proposed Smart Centralized Grievance Redressal System using Sentiment-Based Analytics enhance the grievance handling process. Based on natural language processing, the system successfully identified urgent complaints and classified them into the highest priority for fast-processing by the administration. The experiment also proved the efficiency of the proposed model in improving the efficiency, transparency, and reliability of the grievance management process. Centralized method has greatly improved the processing of complaints and decision making and makes it an appropriate solution in modern digital governance. The advantages of the model include increased accountability, lower response time, better communication between citizens and authorities. Future research will concentrate on adding multi-language sentiment analysis, predictive analysis of grievances trends, and machine learning models to increase the processing efficiency.

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