AI Powered Civic Issue Resolution System in Urban Area

Anuja H. Khandar[1], Abhishek M. Chavan[2], Shailesh V. Bakale[3], Shruti S. Bhakte[4], Utkarsha D. Tamgire[5], Dr. L. K. Gautam[6]

[1] *Student's, Department of Information Technology, Sipna College of Engineering and Technology, Amravati, Maharashtra, India*

[2] *Guide, Associate Professor, Department of Information Technology, Sipna College of Engineering and Technology, Amravati, Maharashtra, India*

***Abstract*- The rapid growth of urban populations and the rising demand for infrastructure have increased the need for efficient systems to manage civic issues. Traditional complaint management approaches often face several challenges, including lack of transparency, slow response times, incorrect classification of complaints, and weak accountability mechanisms. This research proposes a Civic Issue Reporting and Resolution System designed to improve municipal service management through automation and effective record handling. The proposed framework allows citizens to report problems such as damaged roads, waste accumulation, and public safety concerns using structured digital inputs. The system stores complaint data and status updates in a secure blockchain-based environment to ensure transparency and prevent unauthorized modifications. In addition, artificial intelligence techniques are applied to automatically categorize reported issues using probabilistic text classification methods. A hybrid prioritization model combining rule-based logic and predictive analysis is used to determine the urgency of complaints. The system also detects duplicate reports through similar measurement techniques and automatically assigns tasks to the appropriate municipal departments based on a scoring mechanism. Furthermore, the analytics module supports performance evaluation and trend analysis, helping authorities plan maintenance activities more effectively. Overall, the proposed architecture aims to reduce manual effort, improve the accuracy of complaint routing, minimize duplicate reports, and enhance public trust through transparent and secure tracking mechanisms. The study highlights that integrating crowd-sourced reporting with intelligent classification, automated prioritization, and secure record management can significantly improve the efficiency of urban governance systems.**

***Keywords*: Civic Complaint Management; Blockchain Transparency; Issue Classification; Priority Detection; Smart Governance.**

I. INTRODUCTION

The expansion of urban populations has created significant challenges for municipal infrastructure management and public services in modern cities.

Urban residents frequently encounter issues such as damaged roads, water leakage, waste accumulation, malfunctioning streetlights, and other infrastructure-related problems. Efficient management of such issues requires structured mechanisms that allow citizens to report problems while enabling authorities to track and resolve complaints in a timely and transparent manner. Digital civic complaint management systems have therefore become an essential component of smart governance frameworks, as they facilitate real-time communication between citizens and municipal authorities while improving service responsiveness and accountability [1], [3]. Traditional grievance incomplete redressal mechanisms often depend on manual reporting procedures and multiple communication channels. These approaches make it difficult to monitor complaints properly and frequently result in delays, information, and reduced public confidence in government services. Although many digital governance initiatives have introduced online complaint platforms to simplify reporting, several existing systems still lack advanced automation, transparent record management, and efficient mechanisms for prioritizing reported issues [1][9]. Recent developments in smart city technologies highlight the importance of combining citizen participation with decentralized digital systems to improve administrative performance [2][4]. Blockchain-based governance models offer a secure method for managing records while ensuring transparency and traceability of data. Such decentralized systems help prevent unauthorized data

modification and increase accountability within public administration processes [2][10]. Artificial Intelligence (AI) has also become an important component of modern public sector applications. AI techniques are widely used for tasks such as data classification, pattern recognition, and decision support. Research shows that AI-driven complaint categorization can improve the accuracy of issue identification and significantly reduce response times in municipal operations [5][6]. In addition, machine learning-based governance platforms have been proposed to enhance citizen participation and support data-driven public decision-making processes [3]. Despite these technological advancements, many current solutions remain fragmented. Most systems do not fully integrate crowdsourced reporting, automated classification of complaints, duplicate detection, priority evaluation, and transparent progress tracking within a single platform. As a result, urban governance still requires a more comprehensive approach that combines citizen participation with advanced technologies. To address these limitations, this research proposes an integrated system that combines crowdsourced reporting, artificial intelligence, and blockchain-based transparency. The objective of the proposed framework is to improve operational efficiency, strengthen accountability, and enhance public participation in the management of municipal complaints.

II. LITERATURE REVIEW

Recent advancements in smart city governance highlight the growing role of digital technologies in improving urban service delivery. Decentralized incident reporting platforms enable citizens to actively participate in reporting civic issues, which helps municipal authorities collect real-time information from multiple locations. Research indicates that participatory reporting platforms can substantially enhance service response efficiency and municipal operations. [1], [9]. Furthermore, blockchain-based frameworks have been proposed to enhance transparency and data integrity in civic management systems by maintaining tamper-resistant records of complaints and administrative actions [2], [4]. The implementation of blockchain-based trust systems protects cybersecurity and maintains data integrity while providing better transparency for urban systems [2]. Using blockchain technology together with governance systems creates permanent records of complaints which government organizations must track their current situation to maintain public trust [4], [10]. Artificial intelligence methods are increasingly applied in urban administration to optimize the management of citizen complaints. Machine learning models are widely used to classify citizen complaints, detect patterns in reported data, and assist authorities in decision-making processes. AI-based complaint management platforms can automatically categorize issues and route them to the appropriate municipal departments, thereby reducing manual workload and minimizing response delays [5], [6]. Such intelligent systems also support data-driven governance by enabling authorities to analyze trends and predict recurring infrastructure problems. AI-based systems for analyzing images and text content enable better city responsiveness because they automatically process information submitted by residents [6]. The introduction of structured AI systems for complaint validation and categorization provides organizations with a reliable system which decreases their need for manual review work [8], [13]. Researchers have studied machine learning methods to analyze civic infrastructure systems and to understand their operational functioning on various levels [7]. Automated systems can discover which categories and patterns the reported data contains. Digital grievance redressal systems use streamlined workflow systems together with automated assignment processes to improve public service delivery efficiency [11].

The current urban AI governance discussions show that municipal systems require three essential elements which include transparency and fairness and accountability to function properly [12]. The testing of AI-assisted civic monitoring systems in metropolitan areas shows that these technologies are becoming more widely used through their actual implementation and active pilot programs [14]. The current systems face two major problems because they do not provide secure decentralized record management and they cannot manage intelligent prioritization and duplicate detection through a single system. The existing research shows that blockchain security AI-based classification and digital grievance portals need separate study but researchers have not established a complete system which combines crowdsourced civic issue reporting with resolution processes. The research

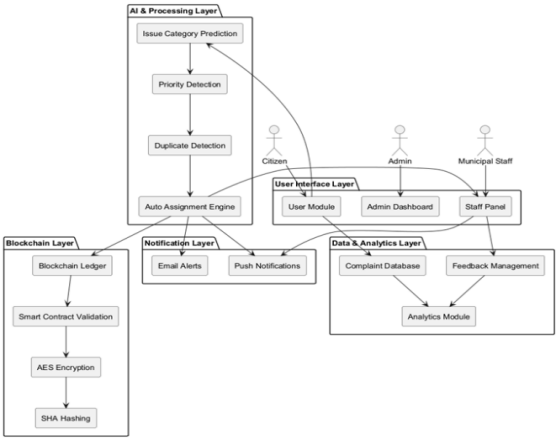
gap exists because the proposed system uses intelligent automation and duplicate detection and priority assessment and automated assignment and transparent tracking functions through a single governance model.

III. MATERIAL AND METHODS

This study proposes a structured and modular framework for a crowdsourced civic issue reporting and resolution system integrating intelligent automation and transparent record management. The research follows a system design–oriented methodology, combining crowdsourced data collection, artificial intelligence techniques, similarity analysis, decentralized record storage, and performance analytics within a unified governance model.

3.1 System Architecture

The architecture of the proposed system follows a multi-layered structure including a User Interaction Layer, an Intelligence Processing Layer, a Blockchain Storage Layer, and an Analytics Layer. The User Interaction Layer enables citizens to submit complaints through structured forms including textual descriptions, location information, and optional multimedia inputs. The Processing Layer applies AI-based algorithms for category prediction, priority detection, duplicate identification, and automated assignment. The Blockchain Layer ensures immutable storage of complaint records and status transitions to enhance transparency and prevent tampering, as suggested in decentralized governance models [2], [4], [10]. The Analytics Layer provides performance monitoring, trend analysis, and decision-support insights for municipal authorities.



3.2 Data Collection and Preprocessing

The complaint dataset mainly includes brief textual descriptions provided by users, responses collected through structured questionnaires, and location-related information. The textual input is processed through several preprocessing operations such as tokenization, stop-word removal, and text normalization. After preprocessing, the Term Frequency–Inverse Document Frequency (TF-IDF) technique is used to transform textual information into numerical vectors that can be processed by machine learning algorithms. In addition, responses obtained from structured questionnaires are converted into categorical and numerical formats so they can be utilized effectively for predicting complaint priority.

3.3 Issue Category Prediction

To enable automatic classification of complaints into predefined categories such as Road, Waste, Water, Streetlight, and Animal-related issues, a probabilistic text classification technique is employed. The Naïve Bayes classifier is selected because of its computational simplicity and proven effectiveness when dealing with short textual data. The model calculates the posterior probability of each category by examining the frequency and distribution of words within the complaint description. This methodology is consistent with AI-enabled governance frameworks that focus on automated complaint classification and efficient service management [5], [8]. The predicted category helps direct the complaint to the appropriate administrative department, thereby reducing the likelihood of manual classification errors.

3.4 Priority Detection Mechanism

The determination of complaint priority is carried out through a hybrid framework that integrates rule-based logic with logistic regression. The rule-based component identifies urgent situations by detecting emergency-related keywords such as accident, fire, or injury, allowing the system to immediately assign a critical priority level. In parallel, logistic regression evaluates structured questionnaire inputs, including parameters such as issue severity, the number of individuals affected, and the duration of the problem. Based on these factors, the system predicts

probability-based priority levels categorized as Low, Medium, High, or Critical. This hybrid approach combines deterministic emergency detection with data-driven analysis, resulting in more consistent and accurate prioritization.

3.5 Duplicate Issue Detection

To reduce redundant submissions and optimize administrative efforts, the system incorporates a mechanism for detecting duplicate complaints. This is achieved using TF-IDF vector representations of complaint descriptions combined with cosine similarity calculations. Each newly submitted complaint is compared with existing complaints within the same geographical region. If the similarity score exceeds a predefined threshold (for instance, 80%), the complaint is marked as a potential duplicate. Similarity-based text comparison techniques have been shown to be effective for identifying repeated civic issue reports in complaint management systems [7], [13].

3.6 Automated Assignment Model

The system incorporates a rule-based scoring mechanism for assigning complaints to appropriate municipal departments or external service teams. The assignment score is calculated based on category relevance, geographic match, and workload balancing. The team with the highest cumulative score receives the complaint. This structured allocation strategy reduces manual intervention and improves operational efficiency, consistent with digital grievance automation approaches [11].

3.7 Blockchain-Based Record Management

To ensure transparency and data integrity, each complaint and its status updates are recorded as blockchain transactions. Each transaction contains timestamp, anonymized reporter identification, category, priority level, and status changes. Cryptographic hashing ensures immutability, while encryption mechanisms protect sensitive information. Blockchain-enabled governance frameworks enhance trust and prevent unauthorized data modification [2], [4], [10].

3.8 Feedback and Performance Analytics

After resolution, the system collects structured citizen feedback regarding satisfaction, response time, and service quality. These responses are stored for analytical evaluation. Performance metrics such as average resolution time, department efficiency, duplicate reduction rate, and priority distribution are computed to support evidence-based decision-making. Analytical dashboards provide insights for preventive maintenance and strategic resource planning.

IV. RESULTS AND DISCUSSION

4.1. Logistic Regression Model- Priority Detection

The proposed Priority Prediction module was evaluated using a synthetically generated, class-balanced dataset comprising 2000 complaint instances distributed equally across four priority levels: Low, Medium, High, and Critical. To simulate real-world reporting ambiguity, 5% controlled label noise was introduced into the dataset. This ensures that model performance reflects practical deployment conditions rather than ideal linear separability.

The Logistic Regression classifier was trained using structured questionnaire-based features including danger level, number of affected individuals, issue duration, service blockage severity, and location sensitivity. Stratified train-test splitting (80:20) was applied to preserve class distribution during evaluation.

4.1.1 Experimental Results

The trained model achieved the following performance metrics on the test dataset:

- Accuracy: 95%
- Macro-Averaged Precision: 0.95
- Macro-Averaged Recall: 0.95
- Macro-Averaged F1-Score: 0.95

Class-wise performance analysis revealed:

- Low Priority (Class 0): Precision = 0.95, Recall = 0.95
- Medium Priority (Class 1): Precision = 0.93, Recall = 0.92
- High Priority (Class 2): Precision = 0.95, Recall = 0.96
- Critical Priority (Class 3): Precision = 0.96, Recall = 0.96

Fig.1 : Evaluation Report

Class	Precision	Recall	F1-Score	Support
0	0.98	0.98	0.98	99
1	0.94	0.97	0.96	100
2	0.98	0.94	0.96	103
3	0.96	0.97	0.96	98
Accuracy			0.96	400
Macro Avg	0.97	0.97	0.97	400
Weighted Avg	0.97	0.96	0.97	400

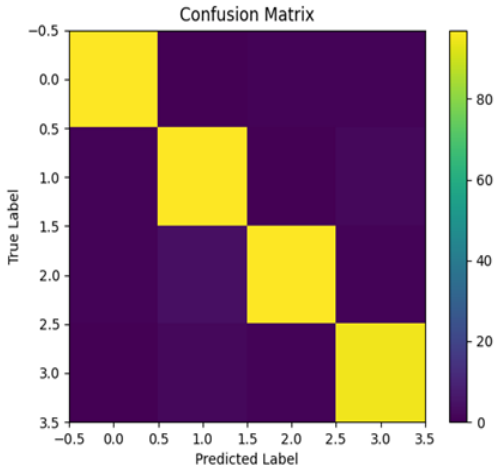


Fig.2. Confusion Matrix

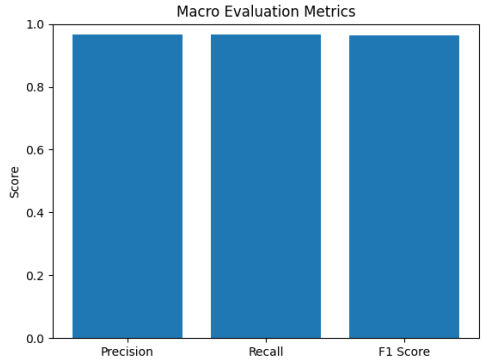


Fig.3. Model Evaluation Matrix

The evaluation results demonstrate stable and balanced classification performance across all priority categories. The slightly lower recall observed for the medium class can be attributed to its intermediate position between Low and High categories, leading to occasional boundary overlap.

4.1.2 Discussion

The experimental analysis confirms that questionnaire-based urgency modeling can effectively support automated prioritization of civic complaints. The Logistic Regression classifier successfully captured linear relationships between severity indicators and urgency levels. The introduction of controlled noise resulted in minor but realistic misclassifications, primarily between adjacent priority classes (Low–Medium and Medium–High). Such behavior reflects practical deployment scenarios where user inputs may contain ambiguity or incomplete information. Importantly, the model maintained strong performance for the Critical class (Recall = 0.96), ensuring that high-risk complaints are reliably detected. In civic governance systems, maintaining high sensitivity for critical cases is essential to prevent delays in emergency response.

The balanced macro and weighted averages confirm that the classifier does not exhibit bias toward any specific priority level. This indicates that the feature encoding strategy and dataset design effectively support multi-class classification. Overall, the results validate the suitability of Logistic Regression for structured urgency prediction in smart civic issue reporting systems. The achieved 95% accuracy under noisy conditions demonstrates robustness, scalability, and practical applicability.

4.2 Naïve Bayes classifier with TF-IDF -(Category Prediction)

The Category Prediction Model was evaluated on a test dataset of 200 civic complaints spanning eight categories: Animal Issues, Drainage, Garbage, Public Safety, Road Issues, Streetlight, Traffic, and Water Supply. To simulate realistic conditions, 5% noise was introduced in the test set, where randomly selected complaints were assigned incorrect categories. This approach mimics real-world user input errors and assesses the model's robustness.

4.2.1 Experimental Results

The model achieved the following metrics on the noisy test set:

- Accuracy: 0.95
- Macro-Averaged Precision: 0.94
- Macro-Averaged Recall: 0.94
- Macro-Averaged F1-Score: 0.94

Class-wise performance varied slightly due to noise injection:

Category	Precision	Recall	F1-Score	Support
Animal Issues	0.95	1.00	0.97	19
Drainage	1.00	0.87	0.93	15
Garbage	0.88	0.91	0.89	23

Public Safety	0.89	0.96	0.93	26
Road Issues	1.00	0.91	0.95	33
Streetlight	0.98	1.00	0.99	56
Traffic	0.91	0.83	0.87	12
Water Supply	0.94	1.00	0.97	16

These results indicate that while noise slightly reduced performance compared to the clean dataset (where accuracy was 1.00), the model remained highly effective, maintaining precision and recall above 0.87 for all categories.

4.2.2 Discussion

The results demonstrate that the Naïve Bayes classifier with TF-IDF vectorization is robust to small levels of input noise:

1. Accuracy drops slightly but remains high: The overall 95% accuracy shows the model can correctly categorize most complaints despite minor errors.

2. Category-specific variations: Categories with fewer samples or highly ambiguous text (e.g., Traffic, Drainage, Garbage) show slightly lower recall, reflecting sensitivity to noise.

3. Robustness to mislabeling: The model still correctly identifies the majority of complaints in each category, suggesting good generalization for real-world applications.

Operational significance: In a live civic reporting system, this level of performance ensures that complaints are routed correctly most of the time, reducing administrative workload and speeding up resolution.

Fig.4 Confusion Matrix

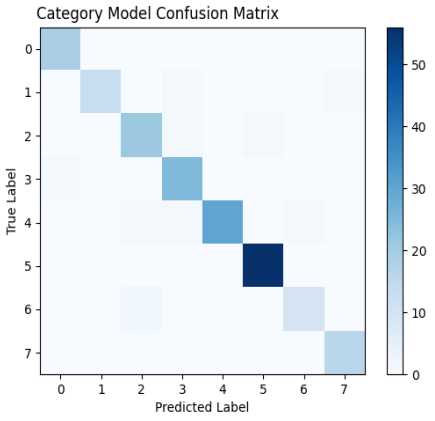
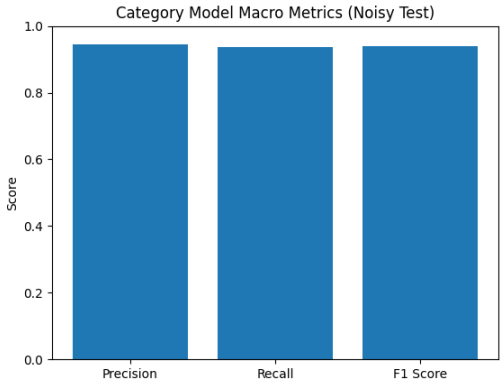


Fig. 5 Model Evaluation Matrix



V.CONCLUSION

This research introduced an AI-based civic issue reporting and resolution framework aimed at improving the transparency and efficiency of municipal complaint handling. By integrating machine learning techniques for complaint categorization and urgency prediction, the system enables automated routing and prioritization of civic issues. The system enables real-time problem reporting by citizens while simultaneously providing analytical insights for municipal authorities. Experimental results demonstrate that intelligent automation can significantly reduce administrative workload and improve response times in urban governance environments. The Category Prediction Model demonstrated high accuracy, which enabled it to classify civic complaints into multiple categories despite the presence of realistic noise. The Priority Prediction Model accurately assigned urgency levels, which ensured that critical issues received prompt resolution. The research demonstrates that AI systems with automated routing and decision support functions can decrease administrative work while helping municipalities respond faster to public needs.

The proposed system achieves efficient civic issue management through its module integration which includes transparent reporting and feedback systems because it helps track accountability while fostering citizen participation and evidence-based decision processes. The system evaluation proves that it maintains operational strength when users introduce small input mistakes, which supports its use in actual smart city environments.

Future work can focus on incorporating multi-language support, real-time NLP-based complaint understanding, and predictive maintenance analytics to further enhance efficiency and scalability. The research shows that AI-driven platforms for civic issue management can improve urban governance while delivering better municipal services.

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