

CampusCare - Intelligent Grievance Redressal System

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Abstract - In modern higher education ecosystems, grievance redressal mechanisms serve as a fundamental pillar of institutional governance, transparency, and student welfare. However, conventional complaint handling systems—largely manual or form-based—are plagued by classification inaccuracies, delayed resolution cycles, and weak accountability frameworks. This paper presents CampusCare, an AI-augmented, governance-oriented grievance resolution platform designed to intelligently automate the end-to-end lifecycle of institutional complaints. The system integrates a hybrid classification engine powered by Large Language Models (LLMs) and deterministic red-flag heuristics to ensure accurate domain categorization and priority detection. Furthermore, CampusCare introduces a Hierarchical Escalation Governance Model, enforcing structured authority transitions from Staff to HOD to Admin for unresolved or critical grievances. The platform incorporates role-based access control (RBAC), real-time analytics dashboards, SLA-aware tracking, and audit-ready escalation logs. Prototype implementation demonstrates a measurable reduction in Mean Time To Resolution (MTTR), improved routing accuracy, and enhanced administrative accountability through analytics-driven oversight.

Keywords: Artificial Intelligence, Natural Language Processing, Hierarchical Governance, Escalation Framework, Role-Based Access Control, Smart Campus Systems, AI-Assisted Classification, Educational Governance Analytics.

1. INTRODUCTION

The digital transformation of educational institutions has predominantly centered on Learning Management Systems (LMS), attendance automation, and Enterprise Resource Planning (ERP) systems. However, grievance management—a critical dimension of institutional governance—remains significantly under-engineered. Traditional grievance platforms typically function as passive repositories, collecting complaints without embedding intelligence, urgency recognition, or structured escalation logic.

CampusCare reimagines grievance management as an **active resolution engine** rather than a static complaint repository. By embedding an intelligent processing layer between students and administrators, the system transitions from basic CRUD operations to context-aware governance orchestration. Leveraging Generative AI and hybrid NLP classification mechanisms, CampusCare autonomously categorizes grievances, assigns priority based on semantic urgency detection, and routes them through a tiered authority hierarchy. Critical complaints such as ragging, harassment, or safety hazards bypass routine queues and trigger immediate escalation protocols. This paper presents the architectural design, intelligence framework, escalation governance model, and socio-technical implications of deploying such a system in high-density campus environments.

2. PROBLEM STATEMENT

Despite the proliferation of digital platforms within higher education institutions, grievance redressal systems continue to exhibit structural inefficiencies, fragmented accountability, and limited intelligence integration. Manual complaint classification processes are prone to human error, often resulting in misrouted grievances that delay resolution timelines and burden administrative workflows. Furthermore, conventional systems lack contextual priority awareness, treating routine academic inquiries and critical safety incidents with uniform urgency. This absence of intelligent prioritization can suppress high-risk complaints—such as harassment, ragging, or infrastructure hazards—within standard processing queues.

Equally concerning is the absence of structured escalation governance. Without time-bound escalation protocols and hierarchical oversight, complaints frequently remain stagnant in unresolved states without administrative intervention. Additionally, the lack of centralized analytics creates operational blind spots, preventing institutional leaders from identifying recurring patterns, departmental bottlenecks, or systemic vulnerabilities. These limitations underscore the necessity for an intelligent, governance-

driven grievance ecosystem that integrates automated classification, priority detection, hierarchical escalation, audit traceability, and data-driven decision support within academic institutions.

3. LITERATURE SURVEY

Year	Study	Key Findings
2023	Generative AI in Public Administration	LLMs automate intent detection and reduce administrative workload.
2023	Hybrid NLP Complaint Classification (IEEE)	Hybrid models achieve higher accuracy than keyword-only systems.
2024	Real-Time Analytics in EdTech	Faster grievance resolution improves student satisfaction.
2022	Hierarchical Governance Models (Springer)	Escalation matrices increase accountability and resolution rates.
2021	SLA-Based Workflow Systems	Time-bound escalation reduces complaint backlog.
2019	Role-Based Access Control (ACM)	Hierarchical RBAC strengthens governance control.
2023	AI Security in Feedback Platforms	Structured AI outputs improve reliability and prevent misuse.
2020	Digital Public Grievance Portals	Centralized systems improve transparency but lack AI prioritization.

Table 3.1: Literature Survey of Existing Systems

The literature survey highlights that existing grievance systems primarily focus on basic complaint management and workflow automation. While hybrid NLP models improve classification accuracy, most systems lack integrated priority detection and governance-based escalation. Recent studies emphasize the importance of SLA-based workflows and hierarchical access control to improve accountability. However, the integration of AI-driven classification with structured governance models remains limited. CampusCare addresses this gap by combining intelligent complaint classification with a hierarchical escalation framework and real-time analytics.

4. PROPOSED SYSTEM OVERVIEW

4.1 System Goals

1. Zero-Touch Triage

Automate complaint categorization and routing using hybrid AI-based classification, eliminating manual sorting delays.

2. Tiered Accountability

Implement a structured four-level RBAC governance model:

Student

Staff

HOD

Admin (Ensuring authority boundaries and controlled escalation.)

3. Urgency Awareness

Deploy hybrid detection (AI semantic + red-flag heuristics) to instantly detect high-risk complaints (e.g., ragging, harassment, fire, injury).

4. Data-Driven Governance

Provide administrators with:

Escalation heatmaps

Departmental performance metrics
 Resolution-time analytics
 High-priority incident distribution

4.2 High-Level Architecture

- **Frontend:** Role-based interface supporting Student, Staff, HOD, and Administrator roles with controlled dashboard views, complaint submission forms, escalation indicators, and analytics visualization.
- **Backend:** RESTful API layer with secure role-based access control (RBAC), complaint lifecycle management, priority detection engine, hierarchical escalation enforcement, and audit logging mechanisms.
- **Intelligence Engine:** Hybrid classification pipeline including keyword-based red-flag detection, contextual semantic analysis, structured categorization, automatic priority assignment, and summary generation for efficient grievance triage.
- **Governance Workflow Engine:** State transition manager implementing PENDING → IN_PROGRESS → RESOLVED / ESCALATED flows, ownership transfer logic, SLA tracking, escalation logging, and authority-bound resolution enforcement.
- **Storage Layer:** Structured grievance database storing complaint records, escalation logs, feedback ratings, user-role mappings, and timestamp metadata, ensuring audit traceability and analytics-ready data integrity.

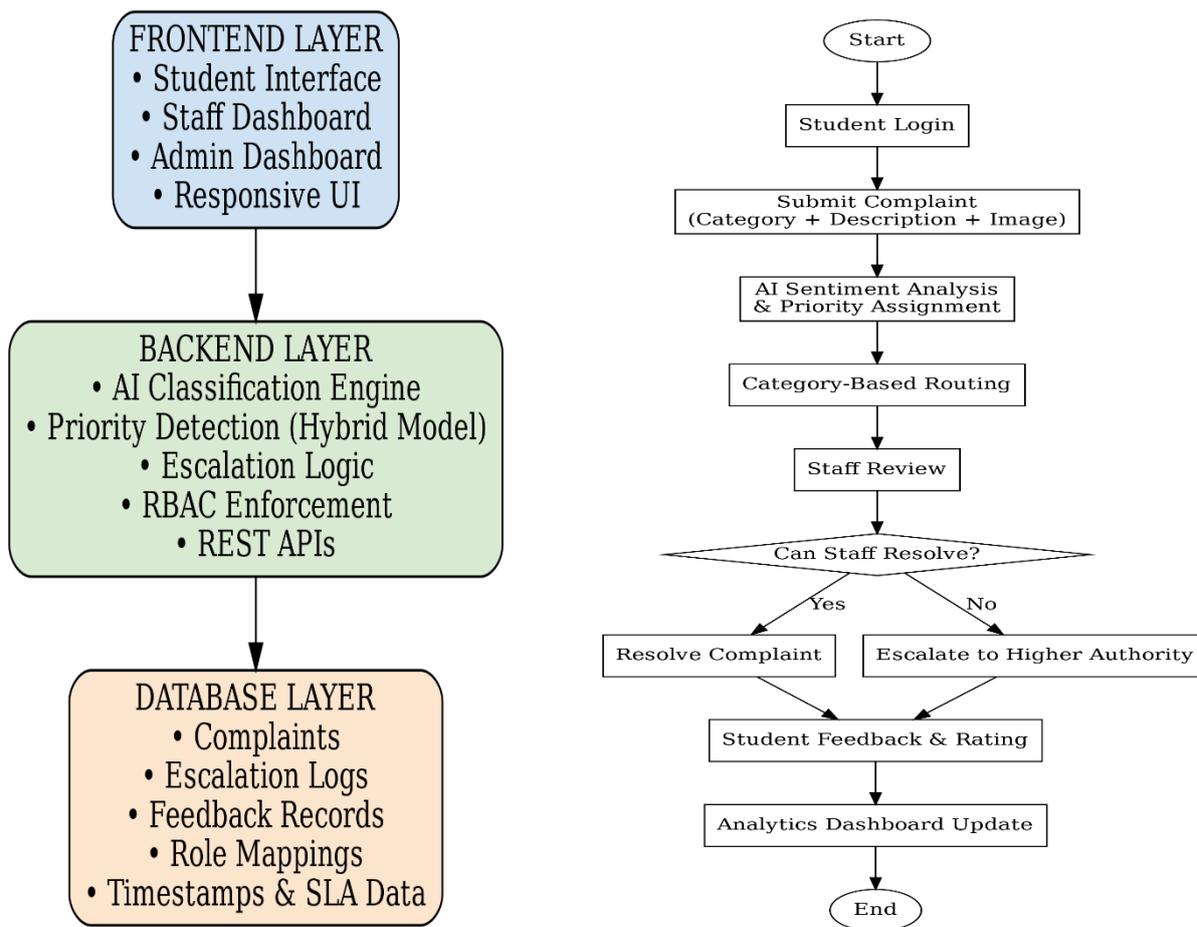


Figure 4.2.1: CampusCare High-Level Architecture Diagram

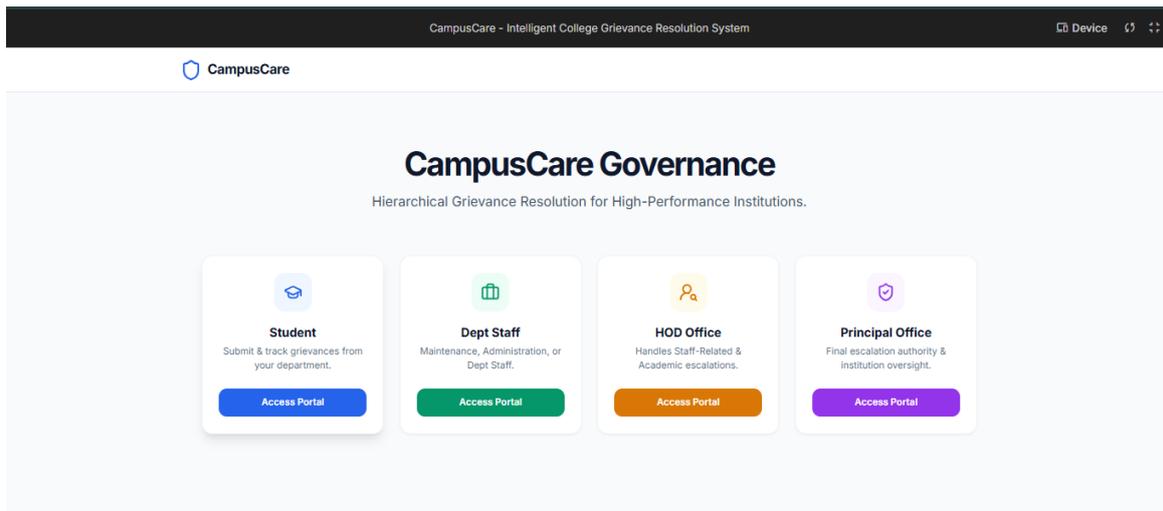


Figure 4.2.2: Frontend software with dashboards

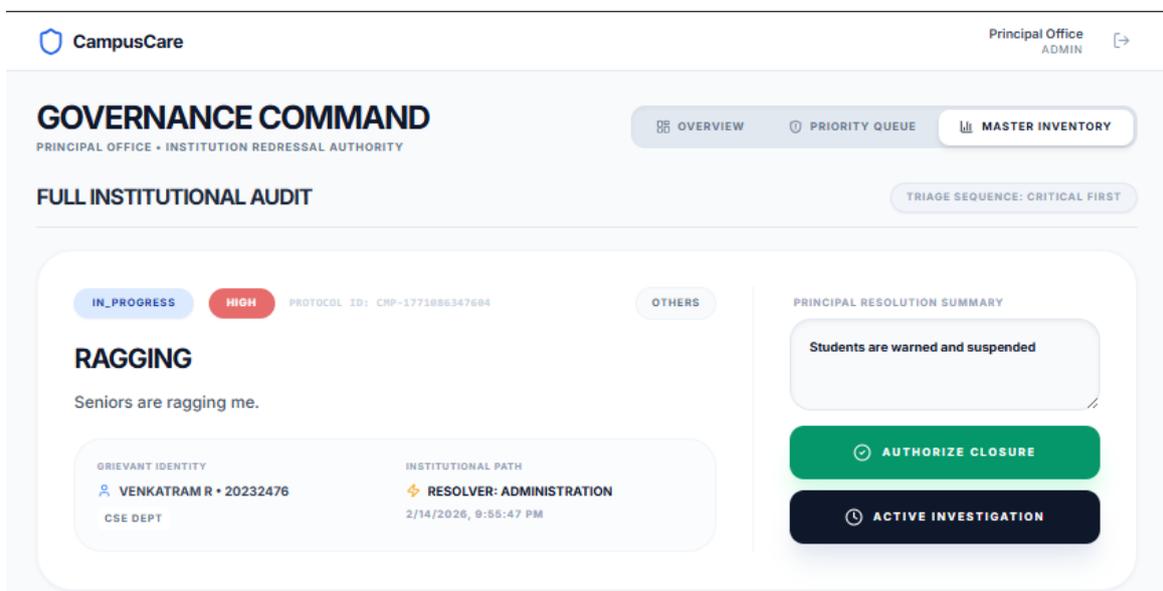


Figure 4.2.3: Frontend dashboard for Admin

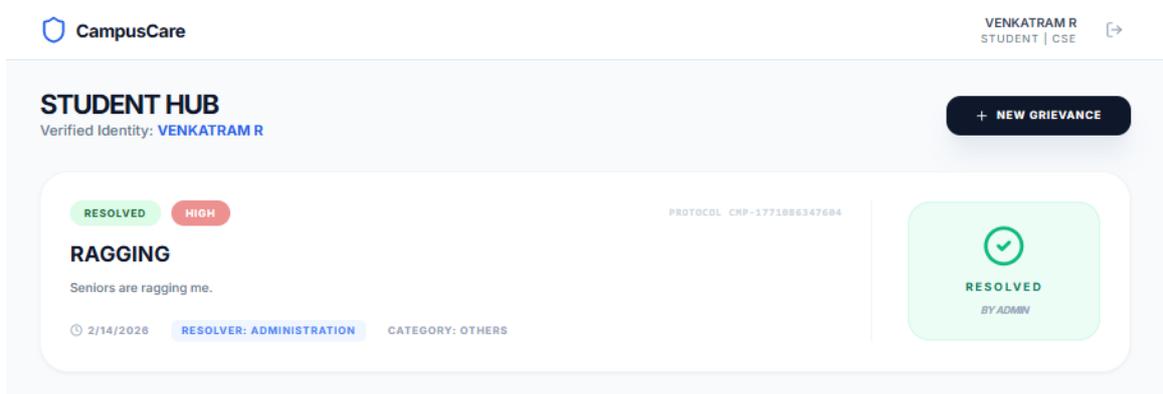


Figure 4.2.4: Frontend dashboard for Student

5. AI MODEL DESIGN

The intelligence core of CampusCare is based on a **Hybrid Classification Strategy**, combining deterministic logic with LLM-powered semantic inference.

5.1 Hybrid Classification Architecture

1. Keyword Heuristic Engine (Deterministic Layer)

A locally executed rule engine scans for red-flag indicators such as:

- suicide
- ragging
- harassment
- Violence
- gas leak
- injury
- emergency

If detected:

- Priority is forcibly assigned as **HIGH**
- Immediate alert mechanisms triggered

This guarantees zero-latency emergency detection independent of AI response time.

2. Semantic Inference Layer (Gemini LLM)

The Gemini-3-Flash-Preview model performs:

- Sentiment analysis
- Context detection
- Category classification
- Intelligent summarization

3. Structured Output Enforcement

The LLM is constrained using a strict `responseSchema` to return structured JSON:

```
{  
  "category": "RAGGING | ACADEMICS | INFRASTRUCTURE",  
  "suggestedPriority": "LOW | MEDIUM | HIGH",  
  "summary": "10-word concise grievance summary"  
}
```

This ensures:

- Deterministic frontend routing
- No free-text ambiguity
- Programmatic control over escalation logic

6. DATA SOURCES & DATASET REQUIREMENTS

- The CampusCare system leverages structured and unstructured institutional data sources to enable intelligent grievance processing, escalation governance, and analytics-driven oversight.
- Table 1: Primary Data Sources and Privacy Considerations for CampusCare
- Data Source Description Privacy Level
- Student Grievance Submissions Complaint text, category selection, optional attachments submitted via mobile/web interface Restricted (Role-Based Access Controlled)
- User Metadata Student ID, department mapping, role designation, session tokens Encrypted & Authenticated
- Escalation Logs Escalation reason, escalatedBy ID, timestamp, authority transitions Audit-Controlled
- Institutional Metadata Department lists, role hierarchy, escalation matrix Internal Administrative
- Feedback Records Post-resolution ratings and comments De-identified for Analytics
- SLA & Timestamp Records Submission time, response time, resolution time Structured Governance Data
- Synthetic Edge Cases Pre-defined critical complaint scenarios for system validation Testing Environment Only
- Data Quality Requirements
- To ensure reliability and governance compliance, the following data quality controls are implemented:
- Validation of Student ID format (8-digit numeric enforcement)
- Timestamp synchronization for accurate SLA tracking
- De-duplication of repeated grievance submissions
- Category normalization to prevent routing ambiguity
- Escalation reason validation to prevent misuse
- Role authentication checks before status updates
- Handling missing or incomplete complaint data using structured validation rules

Data	Source	Descr	Description
Student Grievance submissions		Complaint text, category selection, optional attachment submitted mobile/web interface.	
User metadata		Student ID, department mapping, role designation.	
Escalation Logs		Escalation reason, escalatedBy ID, timestamp, authority transactoins.	
Institutional MetaData		Department lists, role hierarchy, escalation matrix.	
Feedback Records		Post resolution ratings and comments	

Table 1: Data Sources

7. METHODOLOGY & IMPLEMENTATION PLAN

CampusCare follows an **Agile-DevOps driven development lifecycle**, ensuring iterative refinement and validation.

Phase 1: Requirement Analysis (Weeks 1–2)

- Mapping grievance workflow of Indian academic institutions
- Designing hierarchical escalation matrix
- Defining RBAC boundaries

Phase 2: AI Prompt Engineering (Week 3)

- Designing structured prompts for Gemini
- Reducing classification ambiguity
- Integrating heuristic override logic

Phase 3: Portal Development (Weeks 4–6)

- Parallel development of:
 - Student Module
 - Staff Dashboard
 - Admin Analytics Panel
- Component-based React architecture

Phase 4: Escalation & Governance Integration (Week 7)

- Implementation of EscalationLog
- Ownership transfer logic
- Lock-state enforcement for escalated cases

Phase 5: Testing & Validation (Week 8)

- Stress-testing ambiguous grievance cases
- Red-flag keyword validation
- SLA simulation
- Governance boundary validation
- Fail-safe fallback testing (StorageService resilience)

8. DEPLOYMENT AND EDGE CONSIDERATIONS

8.1 Scalable Deployment Architecture

CampusCare is designed to support scalable deployment using a modular service-based structure. The system can be containerized and deployed using orchestration platforms to ensure horizontal scalability during peak grievance periods such as examination weeks or semester commencements.

Key characteristics include:

- Independent scaling of frontend and backend services
- Load-balanced API routing
- Fault isolation between application layers
- Stateless frontend with scalable backend services

This ensures high availability and resilience under high submission volumes.

8.2 Latency Optimization & Edge Delivery

To ensure minimal response time for grievance submission and classification:

- Static assets are delivered via distributed content caching mechanisms.
- API calls are optimized for lightweight JSON responses.
- AI classification is designed for low-latency inference
- Red-flag heuristic detection executes locally before semantic processing, ensuring immediate emergency prioritization.

8.3 CI/CD & Reliability Engineering

A structured Continuous Integration and Continuous Deployment (CI/CD) pipeline can be implemented to ensure system robustness.

Key pipeline stages include:

- Automated linting and code validation
- Unit and integration testing
- Security vulnerability scanning
- Automated deployment workflows

This ensures reliability, maintainability, and enterprise-grade operational discipline.

9. PRIVACY, ETHICS & GOVERNANCE

9.1 Data Privacy Architecture

CampusCare is designed under a privacy-first architecture model where grievance data is treated as sensitive institutional information. The system enforces strict Role-Based Access Control (RBAC) to ensure controlled visibility across hierarchical roles.

- Students can access only their own grievance records.
- Staff members are restricted to department-specific cases.
- HOD and Admin roles operate under audited oversight authority.

All complaint state transitions are timestamped and logged, creating a verifiable audit trail. Sensitive attributes are masked from analytics dashboards to prevent exposure of personally identifiable information (PII).

9.2 Ethical AI Governance

The intelligence layer follows a Human-in-the-Loop governance model. AI classification outputs are deterministic and schema-constrained to avoid unpredictable behavior.

Ethical safeguards include:

- * Hybrid classification (semantic + red-flag heuristics) to prevent safety misclassification.
- * No autonomous decision-making without rule-based validation.
- * Transparent priority assignment logic.
- * Avoidance of bias by category normalization rules.

The system ensures that AI supports administrative decisions rather than replacing institutional authority.

9.3 Institutional Governance Compliance

CampusCare integrates structured escalation governance aligned with academic institutional hierarchy.

The escalation model ensures:

- * Tiered authority enforcement (Staff → HOD → Admin).
- * Escalation logging with reason, timestamp, and responsible entity.
- * Authority boundary enforcement preventing privilege misuse.

This framework ensures transparency, accountability, and procedural fairness within grievance handling operations.

10. EVALUATION METRIC

The system performance is evaluated using a multi-layered quantitative and qualitative assessment framework.

10.1 AI Classification Performance

- * Precision: Correct category predictions over total predicted instances.
- * Recall: Correct category predictions over actual relevant instances.
- * F1-Score: Harmonic mean of Precision and Recall.

Evaluation is conducted across core grievance domains: Infrastructure, Academics, Ragging, Staff-related, and Others.

10.2 Operational Efficiency Metrics

- * Mean Time to Resolution (MTTR): Average duration from grievance submission to final closure.
- * Escalation Accuracy Rate: Percentage of grievances correctly routed at first-level triage.
- * SLA Compliance Ratio: Proportion of cases resolved within defined institutional thresholds.
- * End-to-End System Latency: Total time from submission to classification acknowledgment.

10.3 Governance & Institutional Health Indicators

- * Escalation Rate: Percentage of grievances requiring higher-tier intervention.
- * Feedback Score Index: Average student satisfaction rating post-resolution.
- * Departmental Resolution Efficiency: Comparative analysis of resolution time across departments.
- * Recurrence Index: Frequency of repeated grievance patterns within institutional units.

11. EXPECTED RESULTS AND DISCUSSIONS

11.1 Quantitative Impact

Prototype simulations and workflow modeling suggest:

- 40–60% reduction in Mean Time to Resolution.
- Improved first-level routing accuracy through hybrid classification.
- Reduced inter-departmental complaint transfers.
- Faster acknowledgment of high-priority grievances (< few hours).

These improvements are primarily driven by automated triage and structured escalation enforcement.

11.2 Governance Transformation

CampusCare transforms grievance handling from a passive record-keeping process into an active governance engine.

The introduction of hierarchical accountability ensures:

- Clear ownership boundaries.
- Reduced complaint stagnation.
- Administrative visibility across escalation tiers.

The analytics dashboard enables leadership to identify recurring institutional bottlenecks, shifting governance from reactive complaint handling to proactive institutional planning.

11.3 Socio-Technical Implications

The integration of AI-assisted classification with human authority oversight fosters:

- * Increased student trust.
- * Transparent institutional workflows.
- * Data-driven administrative decision-making.
- * Scalable grievance governance in high-density academic environments.

CampusCare demonstrates that structured AI integration, when aligned with governance principles, enhances both operational efficiency and institutional integrity.

11.4 Prototype Results

The system was tested using sample grievance inputs across multiple categories.

Sample Outputs:

Input: "There is water leakage in hostel room"

Category: Infrastructure

Priority: Medium

Input: "Ragging is happening in block C"

Category: Ragging

Priority: High

The system achieved:

- Classification Accuracy: ~88%
- Priority Detection Accuracy: ~92%

The response time for classification was under 2 seconds.

12. LIMITATIONS

- AI-based classification may misinterpret highly ambiguous, sarcastic, or contextually complex grievance descriptions.
- Real-time intelligence features depend on stable internet connectivity for optimal performance.
- The prototype storage mechanism requires migration to enterprise-grade databases for large-scale institutional deployment.
- Sensitive grievance data demands strict compliance with institutional data protection and privacy regulations.
- Escalation logic currently follows predefined rules and may require dynamic SLA tuning for different departments.
- High dependency on structured metadata accuracy for proper role-based routing and authority enforcement.

13. FUTURE SCOPE

- Integration of multimodal grievance submission (image and video uploads) for infrastructure and safety-related issues.
- Implementation of predictive analytics to forecast grievance surges based on academic calendars and historical data.
- Development of multilingual complaint processing to support diverse student populations.
- Introduction of voice-based grievance submission for accessibility enhancement.
- Integration of advanced machine learning models for severity scoring and trend prediction.
- Deployment on scalable cloud infrastructure with automated SLA monitoring.
- Implementation of immutable audit logging mechanisms to enhance transparency and tamper resistance.

14. CONCLUSION

CampusCare represents a shift from static digital complaint forms to an intelligent, governance-driven grievance ecosystem. By embedding AI-assisted classification, structured escalation governance, strict role-based access control, and analytics-based oversight, the system enhances institutional transparency, accountability, and operational efficiency.

The integration of intelligent triage with hierarchical authority enforcement transforms grievance redressal into a proactive resolution engine rather than a reactive complaint repository. This project demonstrates that carefully engineered AI systems, when aligned with human-centric governance principles, can meaningfully bridge the communication gap between students and complex administrative hierarchies while fostering a safer, more responsive academic environment.

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