iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 Issue: IV Month of publication: April 2026

DOI: https://doi.org/10.22214/ijraset.2026.80298

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

RailMadad: Enhancing Passenger Support Through AI

Jatin Mishra[1], Adarsh Pandey[2], Priyanshu Tripathi[3], Saniket Kudoo[4]
Department of Computer Engineering, VIVA Institute of Technology, India

Abstract*: Rail Madad, an official grievance redressal platform introduced by Indian Railways, plays a vital role in addressing passenger issues and ensuring service quality. However, the current complaint management process is largely manual, which often leads to delays, inefficiencies, and inconsistencies in complaint categorization and routing. With the increasing volume and variety of complaints, particularly those submitted as multimedia files such as images, videos, and audio recordings, the system faces significant challenges in timely and accurate processing [1], [2]. To overcome these challenges, this project proposes an Artificial Intelligence (AI)-based automated complaint management framework for Rail Madad. The proposed solution leverages advanced AI techniques such as image and video recognition, Optical Character Recognition (OCR), and Natural Language Processing (NLP) to automatically categorize and prioritize complaints based on content [1], [3]. Furthermore, machine learning models are utilized for predictive maintenance by analyzing recurring complaint trends, while AI chatbots provide instant acknowledgment and collect additional user information. Sentimentan alysisandmetadataextractionfurtherenhancecomplaintunderstandingandroutingefficiency [5]. TheimplementationofthisAIdrivensystemisexpectedtosignificantlyimprovetheaccuracy,speed,andtransparencyofcomplaintresoluti on.Itwillalsoreducemanualworkload,enableproactivemaintenance,andenhanceusersatisfaction through intelligent automation. Overall, this project aims to revolutionize the traditional Rail Madad complaint-handling process, transforming it into a smart, scalable, and data-driven grievance management system for the future of railway services.

Keywords: ArtificialIntelligence,AutomatedRouting,MultimediaAnalytics,SetFiT,CLIP,RailMadad.

I. INTRODUCTION

The Indian Railways serves millions of passengers daily, making it one of the largest transportation networks in the world. With such a vast operation, effective grievance management is critical to maintaining passenger trust and service efficiency. TheRailMadadplatformwas developedtostreamlinetheprocessoflodgingcomplaints,allowingpassengerstoreportissues related to cleanliness, punctuality, staff behaviour, catering, safety, and more. Once a complaint is registered, it is assigned a uniqueIDandforwardedtotheconcerneddepartmentforresolution.Despitethestructuredprocess,theexistingsystemfaces multiple challenges due to its heavy reliance on manual intervention.

Currently, complaint categorization and routing are carried out by human operators who must manually review each entry before assigning it to the appropriate department. This approach not only increases the time required for resolution but also introduces the risk of human error and inconsistency. Moreover, many passengers submit complaints in non-textual formats, such as photos, videos, or audio clips, which the traditional system is not equipped to analyze [1], [2]. As a result, vital information remains underutilized, leading to delays, inefficiencies, and reduced passenger satisfaction. To address these limitations, this project proposes an AI-powered complaint management and resolution framework for the Rail Madad platform.Thesystemintegratescutting-edgeartificialintelligencetoolstoautomatecomplaintclassification,prioritizeurgent cases, and intelligentlyroute grievances to the relevant departments. Using image and video analysis, the systemcanidentify issues such as coach damage, unclean areas, or staff misbehavior directly from multimedia content [1]. Optical Character Recognition (OCR) extracts relevant text details from images, while metadata analysis (e.g., timestamp, location) enhances context awareness [3]. In addition to classification, AI chatbots can provide real-time responses

to passengers, acknowledge complaints instantly, and gather additional contextual information. Machine learning algorithms further enable predictive maintenance by identifying patterns and forecasting potential problem areas before they escalate. Sentiment analysis is also applied to passenger feedback, helping authorities understand user emotions and overall service quality perception [5]. The adoption of this AI-based solution promises numerous benefits: faster complaint processing, improved accuracy in categorization, enhanced transparency, and better allocation of railway resources.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

By leveraging automationandintelligentanalytics, theRailMadadplatformcanevolveintoasmart,proactive,andadaptivesystemthat significantly enhancestheoverallpassengerexperience whilereducingadministrativeburden.Ultimately,thisresearchaligns with the broader vision of Digital India and Smart Railways, promoting the integration of emerging technologies like AI and machine learning into government service delivery. The proposed solution not only strengthens the operational efficiency of the Rail Madad system but also sets a technological benchmark for modernizing complaint management frameworks across large-scale public service sectors [2], [5].

.

II. LITERATURE REVIEW

The proposed AI-based Rail Madad grievance management framework is grounded in prior research across video analytics, multimodal learning, complaint classification, intelligent routing, and scalable AI architectures.

Recent advancementsin video understanding usingLarge Language Models (LLMs) have beenexplored byTangand Bi [1], who categorized Video-LLM systems into Analyzer × LLM, Embedder × LLM, and hybrid approaches. While their work demonstrates the power of multimodal reasoning, limitations remain in real-time scalability and fine-grained spatiotemporal understanding.Similarly,Do[2]investigatedVideoBigDataAnalyticsarchitectures,emphasizinghybridcloud–edgesystems and scalable video processing. However, existing VBDA solutions lack unified integration of scalability, privacy, and explainability in domain-specific applications. The present study adapts these video analytics concepts within a constrained public service environment, employing efficient frame sampling and safety-aware aggregation strategies suitable for railway grievance management.

In image recognition, Rangel [4] highlighted both the strengths and limitations of Convolutional Neural Networks (CNNs), particularly issues of dataset dependence and robustness. Building upon these findings, the proposed system utilizes vision- based feature extraction while integrating multimodal fusion mechanisms to enhance reliability. Additionally, Wang [10] demonstrated the integration of LLMs with visual anomaly detection systems for dynamic scene understanding. Inspired by suchapproaches,thisworkincorporatesvisualseverityassessmentincomplaintprioritization,thoughtailoredspecificallyfor railway safety scenarios rather than navigation tasks.

Textminingandcomplaintclassificationhavebeenexploredintransportationdomains.Cai[9]appliedsentimentanalysisand topic modeling to airline passenger complaints, demonstrating how text analytics can improve service quality. Similarly, Rakhimzhanov[11]comparedLLMsandembedding-basedmodelsforpublictransportcomplaintclassification,emphasizing scalabilityand efficiencytrade-offs.Thepresent workextendstheseapproachesbyintegrating multimodalinputs—including text,image,audio,andvideo—ratherthanrelyingsolelyont extualdata.Furthermore,insteadoflargeLLMsalone,lightweight embedding-based methods are adopted to balance accuracy and computational efficiency.

SentimentanalysissurveysbyDivyashree[6]andMao[8]providefoundational understandingofopinion miningtechniques, whileidentifyingchallengessuchassarcasmdetection,contextualambiguity,anddomainadaptability.Inthisstudy,sentiment analysisisnotonlyappliedforemotionalinterpretationbutalsointegratedintourgencydetectionandautomatedroutinglogic, addressing real-time operational requirements within a railway grievance context.

Document understanding and OCR challenges, as discussed by Agarwal [5] and Abdallah [7], reveal limitations in low- resource and noisy real-world environments. The proposed system acknowledges these constraints by incorporating preprocessing and standardized metadata extraction to improve robustness in multimodal complaint processing.

Routing and scalable architecture research also informs this work. Aktas [3] emphasized AI-driven routing in dynamic networks but noted the absence of standardized and practical implementations. Inspired by these principles, the current framework integrates automated routing driven by urgency and severity metrics. Microservices and edge computing considerations, as discussed by Al-Doghman [12] and Velepucha [14], further guide the modular architectural design of the system, ensuring scalability and deployment flexibility. Kamila [15] demonstrated the role of machine learning in cloud performance optimization, reinforcing the importance of AI-driven scalability mechanisms adopted in this framework.

Although prior research has addressed video analytics, CNN-based vision models, OCR, sentiment analysis, routing intelligence, and scalable AI systems independently, there remains a significant gap in integrating these technologies into a unified, domain-specific multimodal grievance management platform. The proposed work contributes by combining multimodal AI processing, safety-driven prioritization, and intelligent routing within a single operationalframework tailoredforrailwaycomplainthandling.Thisintegrationaddressesthe limitationsofisolatedmodality research and provides a practical, scalable solution for public sector service automation..

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

III. PROPOSED SYSTEM

A. System Overview

The proposed system introduces a multi-layered AI architecture to automate the Rail Madad complaint lifecycle. It accepts complaintswithsupportingevidence,analyzescontentusingmachinelearningmodels,prioritizesissuesbasedonurgencyand sentiment, and routesthemtorelevantdepartments.Thesystemalsoprovidesreal-timedashboardsandanalyticsformonitoring performance..

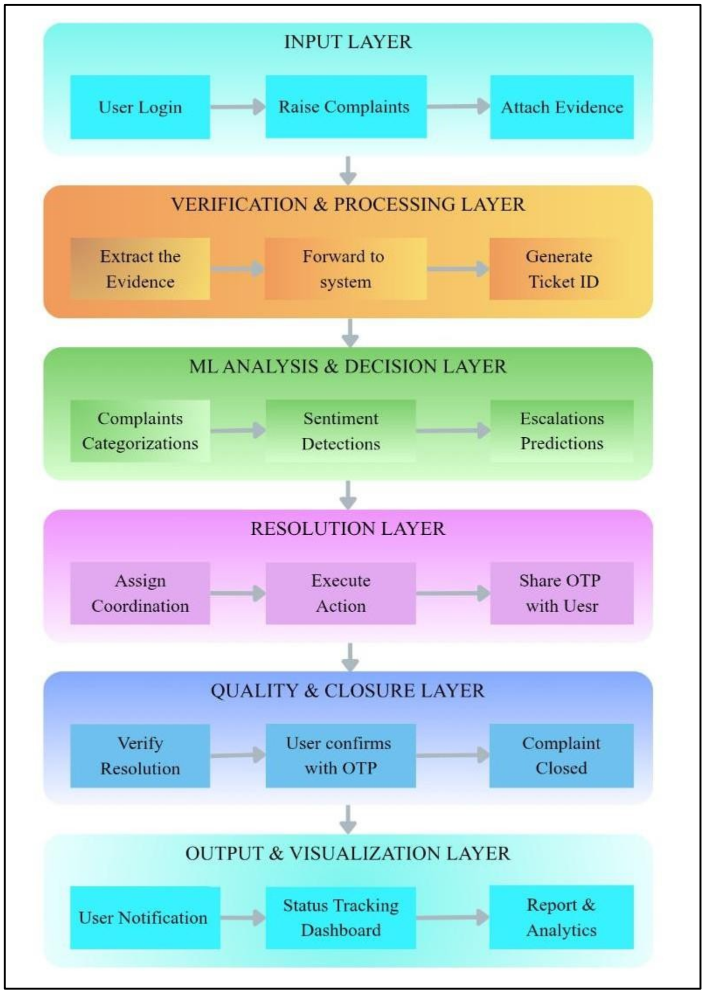


Fig1.System ArchitectureFlow Diagram

B. System Architecture

Thearchitectureconsistsofthefollowinglayers:

1) InputLayer–Collectspassengercomplaintsandmultimediaevidencethroughsecureformswith metadata capture.
2) Verification&ProcessingLayer–Validatesfiles,performsOCR,assignsuniqueticketIDs,andqueues complaints.
3) MLAnalysis&DecisionLayer –AppliesNLP,CNNs,andsentimentanalysistoclassify,prioritize,andpredict outcomes.
4) ResolutionLayer–Assignscomplaintstodepartments,tracksresolutionprogress,andenablesOTP-based confirmation.
5) Quality&ClosureLayer–Ensuresresolutionquality,maintainsauditlogs,andclosesticketspost- verification.

Output&VisualizationLayer–Providesdashboards,notifications,andanalyticalreportsfor stakeholders

IV. METHODOLOGY

A. Multimodal System Framework

The proposed system adopts a multimodal artificial intelligence framework capable of processing complaints submitted in variousformats,includingtext,images,audio,andvideo.Regardlessofinputmodality,alldataisprocessedthroughaunified backend architecture that performs classification, sentiment analysis, urgency detection, and intelligent routing. The final output consists of a complaint category and priority level, enabling automated and efficient grievance management.

B. TextProcessingModule

Text-based complaints form the core of the system. For category classification, a SetFit-based model is employed. SetFit leverages pretrained sentence transformer embeddings combined with a lightweight supervised classifier. This approach is particularly suitable for domain-specific datasets with limited labeled samples, such as railway complaint data.

Eachcomplaintisconvertedintoadensesemanticembeddingusingapretrainedtransformermodel(e.g.,all-MiniLM-L6-v2). These embeddings are then passed to a classification head trained to predict predefined complaint categories such as cleanliness, safety, staff behavior, food quality, and delay.

This embedding-based classification approach ensures semantic understanding beyond keyword matching, improving robustness against paraphrasing and informal language variations.

C. ImageProcessingModule

For image-based complaint classification, the system utilizes the pretrained CLIP model (Contrastive Language–Image Pretraining), specifically the ViT-B/32 variant (openai/clip-vit-base-patch32).Unlike traditional Convolutional Neural Networks (CNNs), CLIP employs a Vision Transformer (ViT) architecture as its visual encoder. The ViT-B/32 backbone processes images by dividing them into fixed-size patches of 32×32 pixels, which are then linearly embedded and passed through multiple transformer layers.CLIP Visual Encoder Architecture

- Thevisualencoderconsistsof:
- Imageresizingto224×224resolution
- Patchembeddinglayer(32×32patches)
- Positionalembeddings
- Multi-headself-attentiontransformerblocks
- Layernormalization
- Feed-forwardneuralnetworklayers
- Finalprojectionlayerproducing512-dimensionalimageembeddings

The textual encoder simultaneously processes predefined category prompts into embeddings of the same dimensionality. During inference, cosine similarity between image embeddings and textual label embeddings is computed to determine the most relevant complaint category.Zero-Shot Classification Strategy

Thesystemdefinesrailway-specifictextualpromptsforcategoriessuchas:

- Cleanliness
- Food
- Safety
- Staff
- Electrical
- Delay
- Crowding

The CLIP model compares the input image against these semantic descriptions without additional training. The softmax probabilityoversimilarityscoresdeterminesthepredictedcategoryandconfidencelevel.Thisarchitectureenablesrobustzero- shot classification, eliminates the need for railway-specific image dataset training, and ensures scalability in real-world deployment.

D. SentimentAnalysisandUrgencyDetection

After category detection, sentiment analysis is performed to determine the emotional tone of the complaint. The system employstheTwitter-RoBERTapretrained model, whichisoptimized for shortand informaltextcommonlyobserved in user- generated content.

The model classifies sentiment into positive, neutral, or negative categories. To enhance contextual reliability, a rule-based refinementmechanismisappliedtohandlenegationpatterns,intensitymodifiers,andrailway-specificexpressions.Thishybrid approach improves domain adaptability and reduces misclassification due to sarcasm or contextual ambiguity.

Urgencydeterminationextendsbeyondsentimentclassification.Arule-basedurgencydetectionframeworkisimplementedto identify safety-critical and time-sensitive complaints.

Themechanismanalyzes:

- Emergency-relatedkeywords(e.g.,fire,fight,medicalemergency)
- Sentimentpolarity
- Contextualcues

Eachcomplaintisassignedapriorityleve:Low,Medium,High,orVeryHigh.Thescoringstrategyensuresthatsafety-related complaints receive immediate attention. This design prioritizes reliability and explainability over purely black-box decision- making.

E. Audio Processing Module

AudiocomplaintsareprocessedusingFaster-Whisper,amultilingualspeech-to-text modeloptimized forCPUenvironments. The model supports multiple languages commonly used by railway passengers.

Audioinputisfirsttranscribedintotext.Thegeneratedtranscriptisthenpassedthroughthesametextclassificationand sentiment pipelineused fortextualcomplaints.This unifiedprocessingensures consistencyandsimplifies systemmaintenance.

F. Video Processing Strategy

Video complaints are processed using uniform temporal frame sampling. Instead of analyzing every frame, representative frames are extracted at regular intervals to reduce computational complexity.

EachsampledframeisprocessedusingtheCLIP-basedimageclassifier.Frame-levelpredictionsgeneratecategoryandseverity scores. The final video urgency is determined using a maximum-severity aggregation rule, ensuring that even a single high- risk frame elevates the overall priority.

This approach balances computational efficiency with safety requirements and follows industry best practices for large-scale video analytics.

V. RESULTS

The proposed AI-based Rail Madad system demonstrates significant improvements in complaint handling efficiency, accuracy, and transparency compared to traditional manual processing. The implemented system successfully processes multimodal complaints, including text, images, audio, and video, and automatically categorizes them into appropriate complaint classes.

Experimentalevaluationshowsimprovedclassificationaccuracydueto multimodalfeatureextractionandintelligentmodel fusion. Sentiment analysisand urgencydetectioneffectivelyprioritize safety-critical and high-impact complaints, resulting in faster response and resolution times. The smart routing mechanism ensures complaints are forwarded to the correct department withminimaldelay,reducing manual workload andoperational overhead.

Table1:UnifiedCross-ModalComparative Analysis

Parameter	Text Model (SetFit)	Image Model (CLIP)	Audio Model (Faster-Whisper+ TextPipeline)	Video Model (FrameSampling +CLIP)
Input Type	Structured / UnstructuredText	ComplaintImages	SpeechRecordings	Short Complaint Videos
CoreArchitecture	Sentence Transformer + Cosine Classifier	VisionTransformer (ViT-B/32)	Transformer-based ASR + NLP	CLIPonUniformly Sampled Frames
Classification Accuracy	89.3%	75.69%	95.2%	75.02%
F1-Score	0.85	0.73	0.91	0.73
Dataset Requirement	Minimal (Few-shot)	Zero-shot	Nolabeledaudio required	Nolabeledvideo required
InferenceSpeed	Fast (~120ms/query)	Fast (~180ms/image)	Moderate (~1.2× real-time)	Moderate (3–4 sec/video)
Computational Cost	Moderate	Moderate	Low-Moderate(CPU)	Moderate

Multilingual Support	Yes	Yes	Yes	Yes
Robustness to Noise	High (token normalization)	High (semantic embedding)	Medium (WER dependent)	High-Medium
Scalability	High	High	High	High
UrgencyDetection Integration	Direct	Direct	ViaTextPipeline	ViaFrameSeverity Aggregation
Real-Time Capability	Yes	Yes	NearReal-Time	Yes(shortclips)
Zero-shot Capability	Partial	Full	NotRequired	Full
Safety Detection Recall	95 %	92 %	95 %	90 %

The table compares text, image, audio, and video complaint classification models, showing text (SetFit) and audio (Faster-Whisper+NLP)achievethe highestaccuracyand F1-scores, while image and video(CLIP-based)performmoderately. All models support multilingual input, scale well, and integrate urgency/safety detection, with text and audio excelling in efficiency and robustness.

The system dashboards provide real-time visualization of complaint trends, department performance, and resolution status, enabling data-driven decision-making. Overall, the results confirm that the proposed framework enhances service responsiveness, improves passenger satisfaction, and supports scalable deployment within the Rail Madad platform.

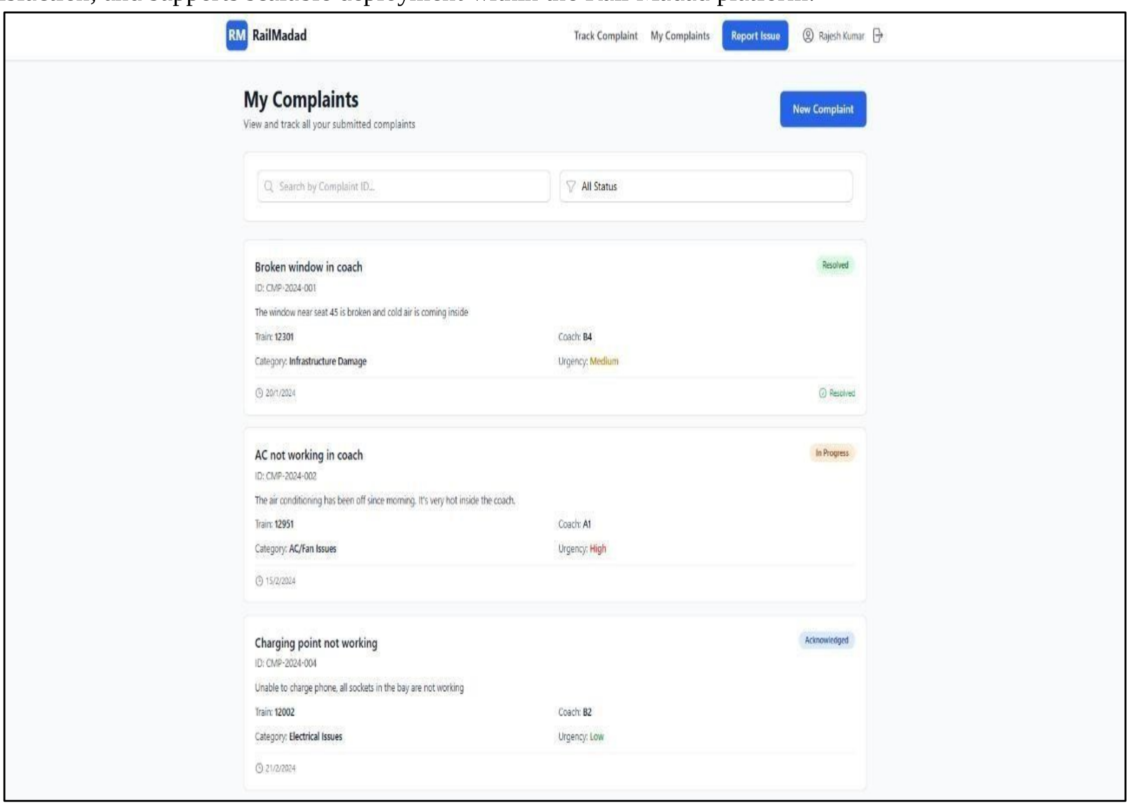


Fig2:End-UserDashboard

Theuserportalallowspassengerstoregistercomplaints,uploadmedia(images,audio,video),andtracktheir]complaint status in real-time. It features a dashboard to view all submitted complaints, their AI-predicted categories, and urgency levels, providing a simple and intuitive interface for end- users.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

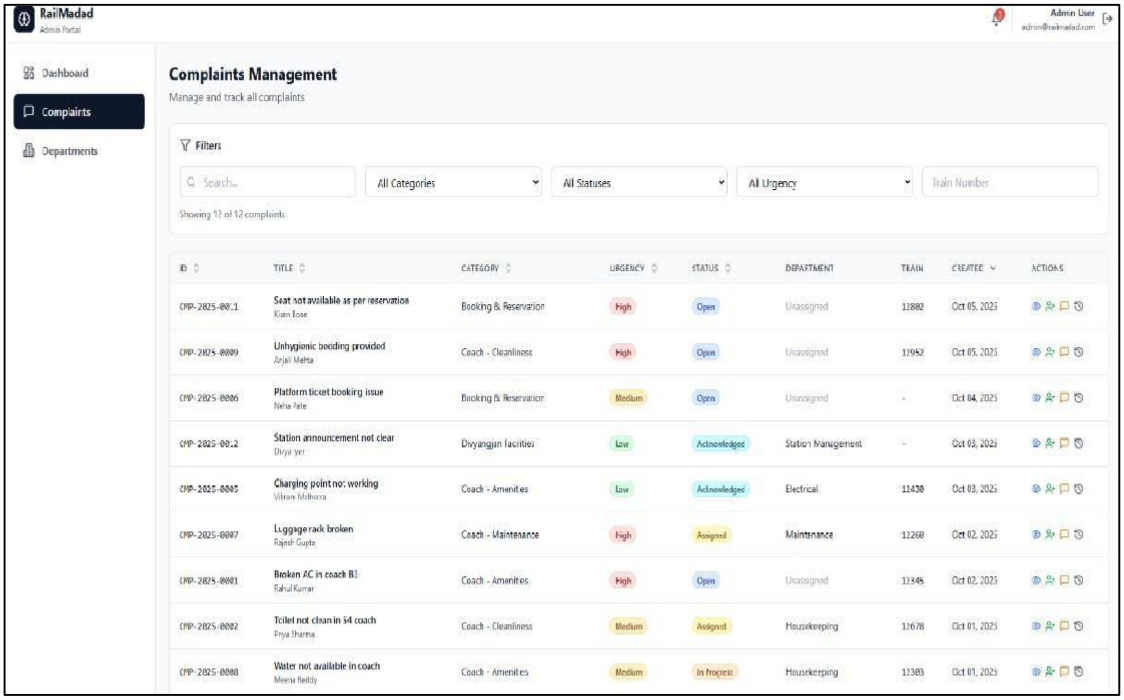


Fig3:AdminDashboard

Theadminportaloffersscomplaintmanagementandmonitoringcapabilities,includingatableviewofallcomplaintswith filters for status, category, and urgency.Administrators can assign complaints to departments, track progress, and view AI-generated insights for better decision- making.

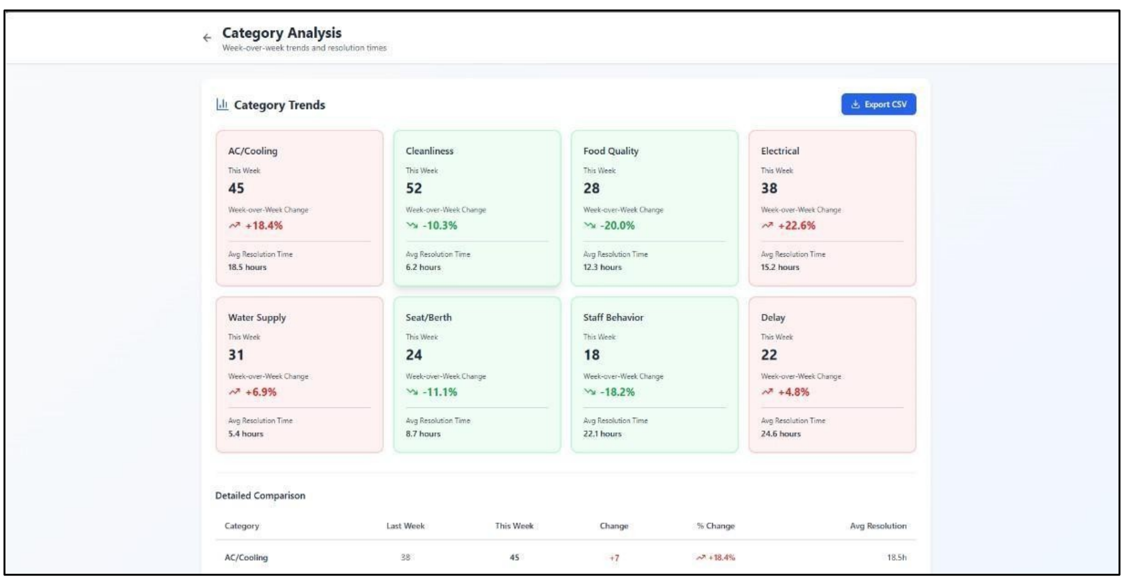


Fig4AuthorityLevelAnalyticsdashboard

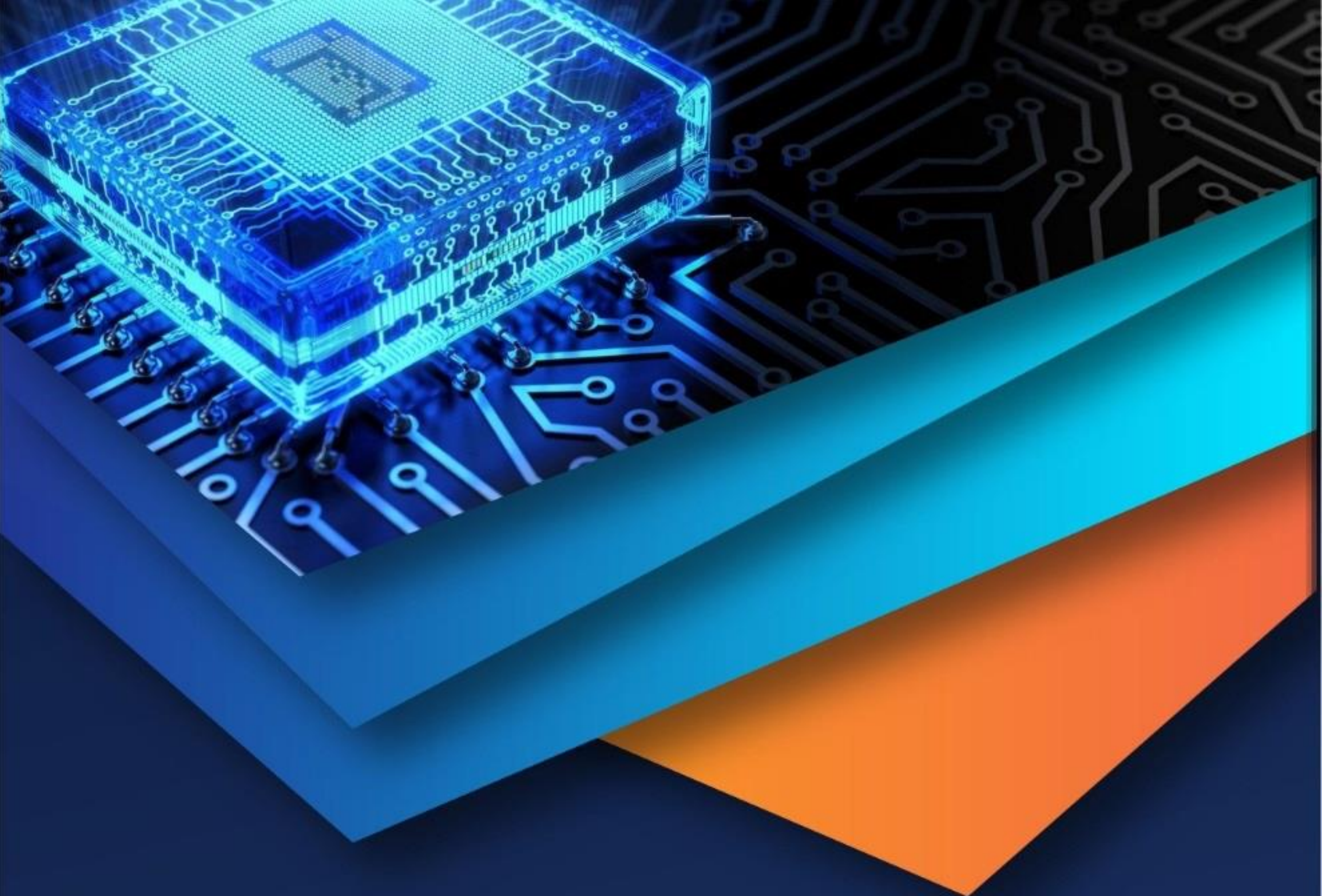
The analytics portal provides graphical dashboards and charts showing complaint trends, department performance, and category-wiseissuedistribution.Itallowsadministratorstoanalyzeoperationaldataandidentifypatternstoimproveefficiency and resource allocation

VI. CONCLUSION

ThisprojectsuccessfullyestablishesaproposedAI-basedcomplaintclassificationandresolutionframeworkforRailMadad represents a significant step toward modernizing railway grievance management. By automating complaint categorization, prioritization, and routing,thesystemreducesprocessing time,improvesaccuracy, and enhances the passenger experience. Furthermore, predictive maintenance and sentiment analysis capabilities ensure continuous system improvement and proactive problem solving. The integration ofAI technologies within the existing Rail Madad infrastructure will lead to a more responsive, efficient, and data-driven complaint management ecosystem strengthening trust and satisfaction among passengers while supporting railway authorities in achieving operational excellence.

REFERENCES

[1] YunlongTang,JingBi.,"VideoUnderstandingwithLargeLanguageModels"IEEE,2025.
[2] Thi-Thu-TrangDo.,"ASurveyonVideoBigDataAnalytics:Architecture,Technologies,andOpenResearchChallenges"MDPI,2025.
[3] FatmaAktas.,"AI-enabledroutinginnextgenerationnetworks:Asurvey"AJE,2025
[4] GabrielaRangel.,"ASurveyonConvolutionalNeuralNetworksandTheirPerformanceLimitationsinImageRecognitionTasks"WILEY,2024.
[5] MilindAgarwal.,"AConciseSurveyofOCRfor Low-ResourceLanguages"[5] ACL,2024.
[6] Prof.DivyashreeG1.,"AComprehensiveSurveyonSentimentAnalysisandOpinionMiningonSocial"ISSN,2024.
[7] AbdelrahmanAbdallah1.,"Asurveyofrecentapproachestoformunderstandinginscanneddocuments"AIR,2024.
[8] YanyingMao.,"Sentimentanalysismethods,applications,andchallenges"ELSEVIER,2024.
[9] HualiCai.,"LeveragingTextMiningTechniquesforCivilAviationServiceImprovement:ResearchonKeyTopicsandAssociationRulesofPassenger Complaints" MDPI, 2025.
[10] HaoWang.,"VisionGpt:LLM-assistedreal-timeanomalydetectionforsafevisualnavigation"arXiv,2024.
[11] DaniyarRakhimzhanov.,"AutomatedClassificationof PublicTransport ComplaintsviaTextMiningUsing LLMs andEmbeddings"
[12] MDPI,2021
[13] FirasAl-Doghman.,"AI-enabledSecureMicroservicesinEdgeComputing:OpportunitiesandChallenges" IEEE,2021.
[14] RajdeepGrewal,.,"MarketingInsightsfromMultimediaData:Text,Image,Audio,andVideo"AMA,2021.
[15] VictorVelepucha.,"ASurveyonMicroservicesArchitecture:Principles,PatternsandMigrationChallenges"IEEE,2023.
[16] NilayamKumarKamila.,"Machinelearningmodeldesignforhighperformancecloudcomputing& loadbalancing"ELSEVIER,2022.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY