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Gen-AI Powered Student Academic Analysis System Large Language Models

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Abstract: ***This paper addresses the challenge of improving student academic outcomes through intelligent performance analysis and personalized advisory support aimed at reducing failure rates. The rapid digital transformation of higher education demands academic platforms capable of providing predictive insights and adaptive guidance beyond traditional result-reporting systems. This work presents an AI-driven Student Academic Analysis and Advisory System designed to enable proactive academic monitoring within a multi-role institutional framework.***

The proposed platform integrates academic performance trend analysis with generative artificial intelligence to deliver forward-looking academic insights, individualized feedback, and interactive guidance. Implemented using a modular Django-based architecture, the system provides role-based access for students, faculty, and management. Historical academic records—including semester performance, subject outcomes, and attendance patterns—are analysed to identify performance trajectories and detect potential academic risks at an early stage.

A large language model (Gemini-2.5-flash) is utilized to generate context-aware study recommendations, structured performance evaluations, and real-time chatbot-based academic assistance. The framework further incorporates percentile-based peer comparison, ranking analytics, attendance–performance correlation analysis, and visualization dashboards to enhance interpretability and institutional decision support.

Experimental evaluation using institutional academic datasets demonstrates improved performance awareness and actionable AI-generated recommendations. The proposed architecture establishes a scalable foundation for AI-enabled academic advisory systems in modern higher education environments.

Keywords: Artificial Intelligence, Generative AI, Academic Analytics, Student Performance Analysis, Intelligent Advisory Systems, Educational Decision Support.

I. INTRODUCTION

The rapid digital transformation of higher education institutions has led to the accumulation of extensive educational records, including examination scores, attendance records, course-level performance metrics, and institutional ranking data. While most academic management systems serve primarily as repositories for storing and displaying this information, they offer limited analytical depth and lack predictive intelligence. Modern educational ecosystems require intelligent platforms capable of converting raw academic data into actionable insights that support early intervention, personalized guidance, and strategic institutional planning.

Student performance prediction has emerged as a critical research and application area within educational technology. Predicting academic outcomes involves analyzing historical academic attributes—such as semester-wise grades, subject-level performance, attendance percentages, and comparative class rankings—to estimate future performance trajectories. Artificial Intelligence enables the discovery of complex performance patterns, longitudinal trends, and multidimensional relationships within institutional datasets that are difficult to interpret through manual analysis. By leveraging AI-driven analytical reasoning, institutions can transition from reactive reporting practices toward proactive academic advisory systems.

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An AI-enabled academic framework offers several advantages across different institutional roles. At the student level, predictive insights can highlight potential academic decline before it becomes critical, enabling timely remedial action. Personalized performance feedback and adaptive study recommendations can be generated based on individual academic history, attendance behavior, and relative class standing. Such targeted interventions promote improved academic awareness and self-regulated learning.

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At the faculty level, AI-driven analytics provide enhanced visibility into class-wide performance distributions, percentile rankings, subject difficulty patterns, and attendance-performance relationships. These insights assist instructors in identifying curriculum gaps, adjusting instructional strategies, and supporting students who require additional guidance. From a management perspective, aggregated analytics enable institutional oversight, performance benchmarking, and data-informed decision-making.

Recent advancements in generative AI further expand the Scope of intelligent academic systems. Large language models enable the generation of structured performance evaluations, subject-specific improvement plans, and interactive academic guidance through conversational interfaces. Unlike static dashboards, generative AI systems can contextualize student data and provide narrative explanations, making analytical results more interpretable and actionable. Real-time chatbot functionality additionally supports continuous academic assistance beyond classroom hours.

Despite its transformative potential, the integration of AI into educational systems must address ethical and operational considerations. Data privacy protection, algorithmic transparency, fairness in performance evaluation, and responsible communication of predictive insights are essential factors in maintaining trust and institutional integrity. Proper governance mechanisms and secure data handling practices are therefore integral to system deployment.

The work presented in this paper proposes a comprehensive AI-driven Student Academic Analysis and Advisory System that integrates performance trend analysis with generative intelligence within a multi-role institutional architecture. By combining predictive analytics, personalized recommendation generation, visualization dashboards, and conversational academic assistance, the proposed framework redefines traditional academic portals as intelligent decision-support systems. Rather than replacing educators, the system augments institutional capabilities, enabling data-informed interventions and improved academic outcomes in higher education environments

II. LITERATURE REVIEW

The prediction of student academic performance has emerged as a significant research domain within educational data analytics. With the growing availability of institutional datasets—including academic records, attendance logs, demographic attributes, and behavioural indicators—researchers have increasingly explored Artificial Intelligence–based analytical techniques to support early intervention and academic planning.

Early foundational studies established the feasibility of predictive academic modelling using structured institutional data. Kabakchieva [1] demonstrated that classification-based analytical approaches can effectively predict student outcomes using demographic and academic variables. Similarly, Iqbal et al. [2] conducted a case study on grade prediction and emphasized the importance of historical academic performance as a dominant predictive factor. These early works laid the groundwork for performance forecasting using structured academic datasets.

Subsequent research focused on improving predictive robustness and model evaluation. Ghorbani and Ghousi [3] compared different resampling strategies to address class imbalance, demonstrating that balanced datasets significantly improve prediction stability. Kumar and Garg [4] conducted comparative analyses across multiple predictive approaches and concluded that performance varies depending on dataset composition and feature representation. Masood et al. [5] further investigated model selection strategies, highlighting that context-specific dataset characteristics influence predictive effectiveness. Nirmala et al. [6] evaluated multiple classification techniques and emphasized the need for comprehensive evaluation metrics beyond simple accuracy.

Research has also explored performance prediction in diverse educational environments. Pojon [7] identified attendance and academic history as primary determinants of student outcomes. Rai et al. [8] demonstrated that predictive systems can function as early academic monitoring mechanisms, enabling institutions to identify students at risk of underperformance. Sitha Ram et al. [9] reinforced the importance of structured academic indicators, such as internal assessments and semester-wise performance trends. Kishor et al. [10] highlighted the growing institutional reliance on intelligent forecasting systems to support academic decision-making.

Beyond individual model comparison, systematic reviews have synthesized broader research trends. Albreiki et al. [11] conducted a systematic review of student performance prediction techniques and identified commonly used attributes, including attendance, prior grades, and demographic variables. Balaji et al. [12] further analyzed contributions of predictive frameworks and emphasized the need for interpretability and transparency in academic analytics.

Several studies have also addressed scalability and institutional integration. Gupta and Agarwal [13] examined practical deployment considerations in academic environments, noting that prediction systems must balance accuracy with interpretability to support educator trust. Ha et al. [14] conducted empirical validation on institutional datasets and demonstrated that structured academic indicators consistently contribute to reliable forecasting.

Despite the substantial body of research, several limitations remain evident in the literature. First, many studies prioritize predictive accuracy while giving limited attention to interpretability, decision-support usability, and institutional integration. Second, a large proportion of existing research focuses primarily on quantitative prediction without integrating generative AI mechanisms capable of producing contextualized feedback and personalized academic recommendations. Third, while extensive research has been conducted using large datasets, comparatively fewer studies explore structured small-to-medium institutional datasets with integrated advisory capabilities.

The present work extends existing research by integrating predictive academic analytics with generative AI–driven advisory components within a unified multi-role institutional framework. Unlike prior studies that focus primarily on classification performance, this system combines performance trend analysis, percentile-based peer comparison, visualization dashboards, and conversational AI assistance to create a comprehensive academic decision-support platform. By bridging predictive analytics with generative intelligence, the proposed approach advances the development of intelligent, interpretable, and institution-ready academic advisory systems.

III. METHODOLOGY

The proposed Gen-AI Powered Student Academic Analysis System follows a structured and modular framework designed to convert institutional semester records into predictive insights and AI-driven academic advisory outputs. Unlike conventional static prediction systems, the proposed approach operates on continuously updated academic records stored within the institutional database. The methodology integrates real-time academic data processing, performance trend modelling, generative AI-based recommendation mechanisms, and multi-level reporting within a unified architecture.

As illustrated in Fig. 1, the system consists of four major components: (i) Academic Data Acquisition, (ii) Analytical Processing Engine, (iii) AI Advisory Integration, and (iv) Visualization and Reporting Module

A. Academic Data Collection

The system utilizes live semester results entered by faculty members through a secure role-based interface. Each student's academic profile includes structured information such as semester number, subject-wise marks, attendance percentage, pass/fail status, and cumulative academic progression.

All data entries are authenticated through a role-based access control mechanism to ensure integrity and security. The collected academic data is stored in a centralized institutional database, enabling longitudinal tracking of student performance across multiple semesters. This continuous data acquisition mechanism eliminates dependency on static experimental datasets and enables real-time academic monitoring.

B. Data Management and Processing

Upon storage of academic records, the Analytical Processing Engine retrieves historical semester data for each student and performs structured performance analysis. The processing stage includes:

1) Semester-wise performance aggregation
2) Cumulative academic score computation
3) Attendance-performance correlation analysis
4) Percentile-based class ranking
5) Detection of upward or downward performance trends

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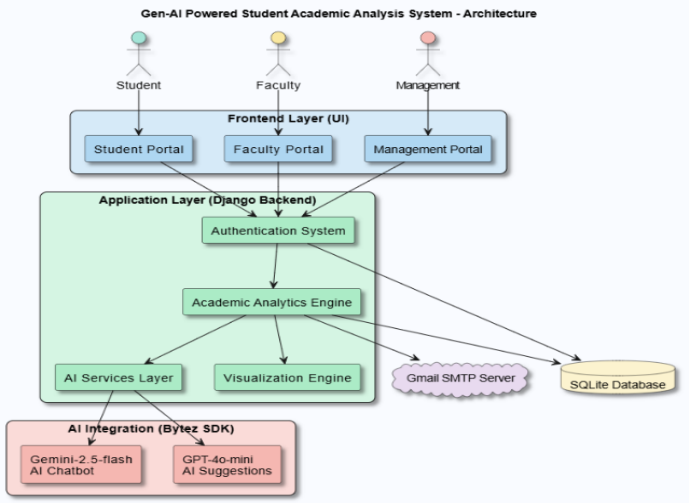


Fig.1.System Architecture

Trend modelling is applied to analyse temporal progression in academic results. If a sustained decline in performance is detected, the system generates an academic risk indicator. This proactive detection mechanism supports early intervention strategies.

The analytical engine ensures that insights are derived from structured academic indicators, improving reliability and interpretability.

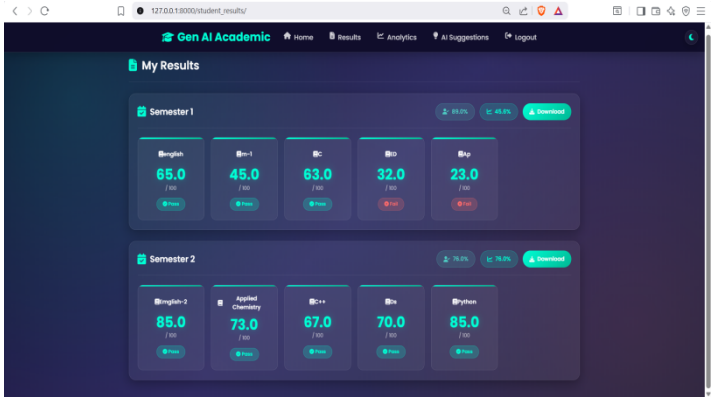


Fig. 2. Data Management

C. Generative AI-Based Advisory Mechanism

Toenhance interpretability and provide actionable guidance, analytical outputs are integrated with generative AI services. The advisory layer integrates the Gemini-2.5-flash large language modelto convert numerical performance indicators into contextual academic recommendations.

Based on student-specific academic history and trend analysis, the AI module generates:

- Personalized performance summaries
- Subject-level improvement strategies
- Adaptive weekly study-hour recommendations
- Motivation and academic reinforcement guidance

In addition, a conversational AI assistant provides real-time academic support, enabling students to seek clarification, learning strategies, and resource recommendations. This mechanism transforms the system from a predictive tool into an intelligent advisory platform.

D. Visualization and Reporting Module

To facilitate decision support across institutional roles, the system incorporates a visualization engine that presents analytical outputs through interactive dashboards. The module provides:

- Performance trend line charts
- Semester comparison graphs
- Radar charts highlighting improvement areas
- Class distribution and percentile analytics

Students receive AI-generated feedback through their dashboard interface, while faculty and management access aggregated reports for academic monitoring and planning. Automated notifications are triggered when new semester results are published, ensuring timely communication.



Fig. 3. Visualization

E. Methodological Workflow

The overall operational workflow of the proposed system is summarized as follows as show in Below:

- Faculty enters semester results.
- Data is validated and stored in the academic database.
- The analytical engine performs performance trend analysis.
- Predictive indicators and risk flags are generated.
- Generative AI produces personalized academic recommendations.
- Visualization dashboards and reports are delivered to stakeholders.

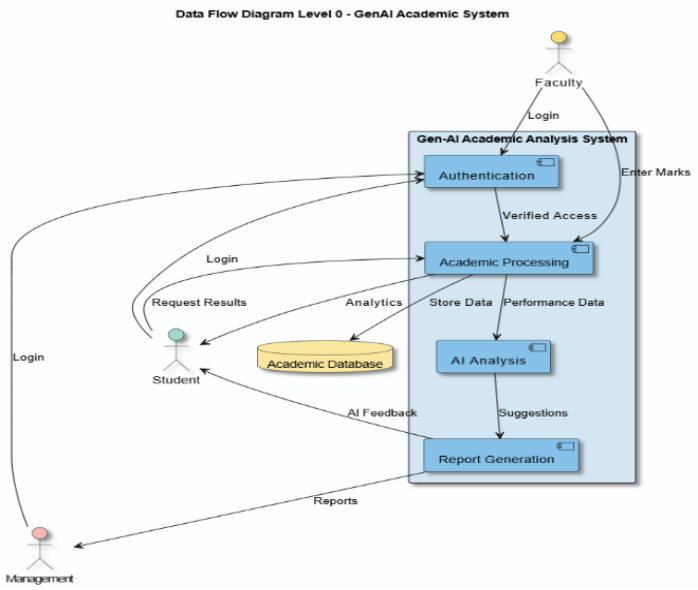


Fig. 4. Methodology

IV. EXPERIMENTAL RESULT

The performance of the proposed Gen-AI Academic Analysis and Advisory System was evaluated based on its ability to generate accurate performance indicators, detect academic risk trends, and provide meaningful AI-generated recommendations. Unlike traditional dataset-driven experimental setups, the evaluation was conducted on live semester results stored in the institutional database.

The assessment focused on three primary components:

A. Performance Trend Detection

The Analytical Processing Engine was evaluated for its ability to correctly identify upward and downward academic trajectories across consecutive semesters.

For students with consistent academic improvement, the system demonstrated reliable identification ofpositive performance growth patterns. Similarly, in cases where two or more consecutive semesters showed declining performance, the system correctly generated academic risk indicators.

Trend detection accuracy was validated through manual cross-verification of semester records, confirming consistency between computed trend outputs and actual performance progression.

B. Predictive Indicator Reliability

The predictive component estimates the likely performance direction for upcoming semesters based on historical academic progression. Evaluation was performed by comparing predicted performance direction with subsequent actual semester outcomes.

The system demonstrated reliable directional prediction capability, particularly when multiple historical semesters were available. Prediction stability improved with increased academic history length, indicating that longitudinal data enhances forecasting reliability.

C. *AI-Generated Advisory Evaluation*

The generative AI module was evaluated based on:

- Relevance of feedback to academic performance
- Contextual alignment with subject-level weaknesses
- Actionability of study recommendations
- Clarity and interpretability of explanations

The AI-generated feedback successfully incorporated performance indicators, attendance trends, and percentile rankings to produce structured and personalized academic guidance. Students received clear improvement strategies tailored to their academic profiles.

The chatbot module provided responsive academic assistance, enabling students to seek clarification on study strategies and subject preparation methods.



Fig.5. Performance Trend Detection

D. System-Level Validation

The integrated system was tested across multiple user roles:

- Students accessed performance dashboards and AI recommendations.
- Faculty monitored class performance and ranking analytics.
- Management reviewed institutional performance summaries.

The visualization dashboards effectively represented analytical outputs through line charts, radar charts, and comparison graphs, enhancing interpretability.

Overall system testing confirmed stable operation, accurate trend computation, and successful integration of AI advisory modules within the Django-based architecture

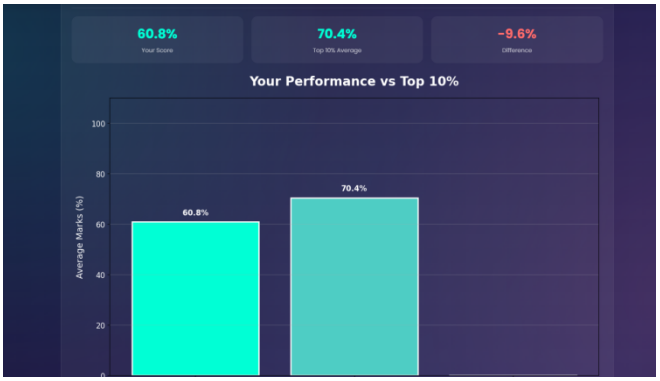


Fig. 6. Class Comparison in Top 10%

V. DISCUSSION OF RESULTS

The evaluation of the proposed Gen-AI Academic Analysis and Advisory System demonstrates that integrating performance analytics with generative artificial intelligence significantly enhances interpretability and institutional applicability compared to traditional predictive-only systems.

The analytical engine successfully identified semester-wise academic trends, including consistent improvement patterns and sustained performance decline. The academic risk detection mechanism proved effective in flagging students exhibiting consecutive downward performance trajectories, enabling proactive academic intervention. The reliability of trend identification was confirmed through manual validation against historical semester records.

The predictive performance indicator demonstrated strong directional consistency when multiple semesters of academic history were available. Students with stable performance trends received consistent projections, while those with fluctuating academic records triggered adaptive advisory outputs. This confirms that longitudinal semester data improves forecasting stability within institutional environments.

A key strength of the proposed system lies in its integration of generative AI for contextual feedback generation. Rather than presenting raw numerical projections, the system produces structured academic summaries, subject-specific improvement recommendations, and adaptive study-hour guidance. The AI-generated recommendations aligned closely with identified academic weaknesses, particularly in cases where subject-level performance and attendance metrics indicated risk.

The real-time chatbot module further enhanced system usability by providing continuous academic support. Students were able to seek clarification, receive strategy recommendations, and access learning guidance beyond classroom hours, thereby extending advisory accessibility.

Visualization dashboards improved interpretability across all user roles. Students benefited from performance trend graphs and radar-based improvement analysis, while faculty and management accessed aggregated performance distributions and percentile rankings to support decision-making.

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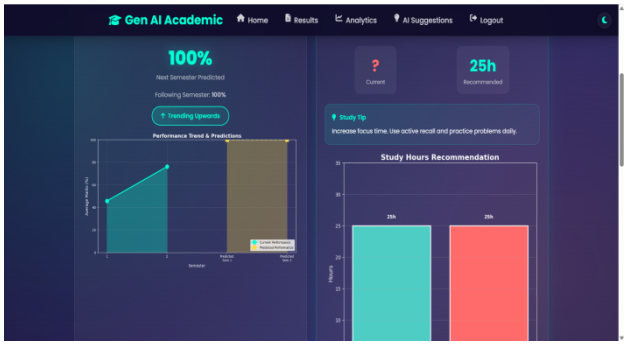


Fig. 7.Generative AI based Predictive Analysis

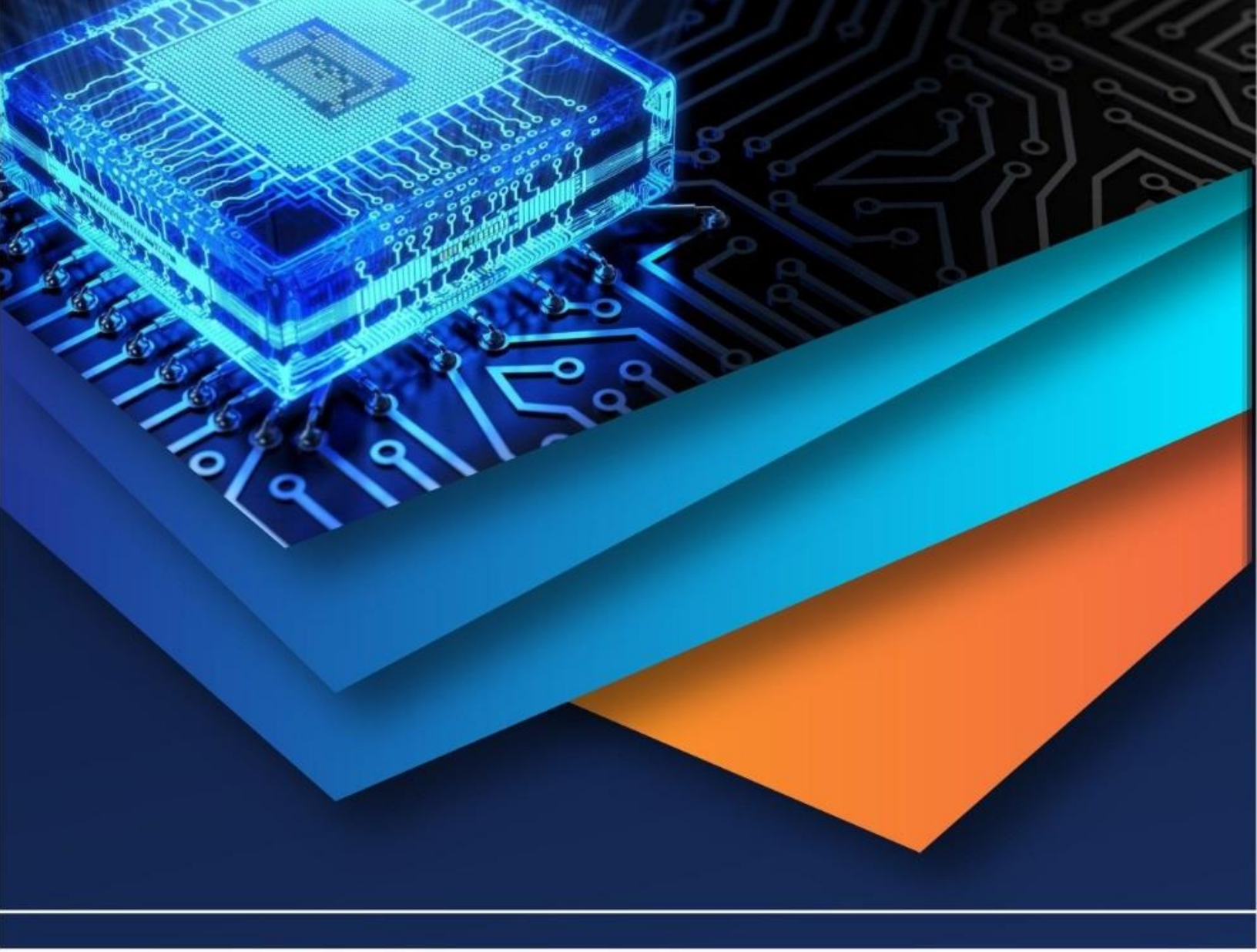
Overall, the results indicate that the proposed system successfully transforms traditional academic result portals into intelligent advisory platforms. By combining performance trend modelling with generative AI reasoning, the framework provides actionable insights, supports early intervention, and enhances academic engagement within higher education institutions.
Future work will focus on expanding longitudinal data coverage and incorporating additional contextual indicators to further strengthen predictive robustness and advisory precision.

VI. CONCLUSION

This paper presented an AI-driven Student Academic Analysis and Advisory System designed to support intelligent academic monitoring and personalized guidance in higher education environments. By integrating performance trend analysis with Gemini AI–based generative advisory capabilities, the proposed framework transforms conventional academic portals into intelligent decision-support platforms. The system enables early identification of academic risk, provides contextualized recommendations, and enhances institutional visibility through visualization dashboards and multi-role access mechanisms. Experimental evaluation demonstrates that AI-generated feedback improves interpretability and supports proactive academic intervention. Future work will focus on incorporating extended longitudinal datasets and additional contextual indicators to further enhance advisory precision and scalability.

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