

A Unified Autonomous Role-Based ERP Framework for Academic Administration and Institutional Management

Aditi Hundre, Arihant Desai, Yuvaraj Talawar,
Sourabh Patil, Ruthika Mangaonkar

Department of Computer Science and Engineering
Jain College of Engineering and Research, Belagavi, VTU, Karnataka, India

Abstract - Higher education institutions handle various academic tasks such as managing student records, faculty information, subject assignments, attendance, and marks. When these activities are handled through separate systems and spreadsheets, they can lead to fragmented data and repeated manual work. The JCER Smart ERP System is developed as a centralized platform to address these issues by providing a role-based architecture for Admin, Principal, Dean, HOD, Faculty, and Student roles. The system manages student information, academic structure, faculty assignments, attendance, marks, and controlled access to academic records. It also supports Google Sheets integration, allowing spreadsheet-based academic data to be connected with the ERP, validated, and stored in the centralized database. Student identifiers such as Application ID and USN help maintain consistent student records across academic activities. The implemented system provides a connected workflow for academic administration and reduces dependence on separate data sources. Its main contribution is the integration of academic governance, role-based access control, student information management, spreadsheet integration, attendance management, and academic analytics within a single platform.

Keywords: *Smart ERP, Higher Education, Academic Management, Role-Based Access Control, Academic Governance, Google Sheets Integration, Student Information System.*

I. INTRODUCTION

Higher education institutions manage a large amount of academic information, including student records, faculty details, departments, subjects, attendance, marks, and academic assignments. These activities are often handled through different systems, spreadsheets, and manual processes. As a result, information can become scattered across different sources, leading to repeated data entry, difficulty in maintaining consistent records, and additional effort in coordinating academic activities. Managing these processes through a common platform can help institutions maintain academic information in a more organized and accessible manner.

The *JCER Smart ERP System* is developed as a centralized platform to bring major academic activities together within a single system. It provides a structured environment for managing student information, academic structure, faculty assignments, attendance, marks, mentorship, and academic analytics. The system follows a role-based approach with different levels of access for *Admin, Principal, Dean, HOD, Faculty, and Student* users. This allows academic activities to be managed according to the responsibilities of each user.

Another important part of the system is the integration of existing spreadsheet-based academic data. Attendance and marks maintained through Excel or Google Sheets can be connected with the ERP and validated before being stored in the centralized database. Student identifiers such as Application ID and USN are used to connect records and maintain consistency across academic activities. The system also includes implemented document and academic-data processing features where applicable, while additional AI-based capabilities can be extended in future versions.

The main objective of the proposed system is to reduce fragmented data handling, simplify academic workflows, and provide controlled access to academic information. By connecting academic administration, assignment-based access, student records, spreadsheet integration, attendance, marks, and analytics, the JCER Smart ERP System provides a unified platform for managing academic activities in a higher education environment.

II. LITERATURE SURVEY

The development of Enterprise Resource Planning (ERP) systems for higher education has received increasing attention because academic institutions manage large volumes of student, faculty, administrative, and academic data. Previous studies have explored higher education ERP architecture, academic functionalities, access control, data integration, student record matching, learning analytics, attendance prediction, and document processing. These studies provide the foundation for developing an integrated academic ERP system such as the proposed JCER Smart ERP System.

Bansal et al. [1] (2026), in Volume 56, Issue 5 of *Software: Practice and Experience*, presented “*Design and Implementation of a Multiuser Enterprise Resource Planning Solution for Higher Education Institutions: Enhancing Accreditation and Administration.*” The study focuses on the design and implementation of a multiuser ERP solution specifically for higher education institutions. The research addresses the need for a centralized platform through which different users and departments can manage academic and administrative information. The proposed ERP approach supports multiple users and integrates institutional processes into a common system. The study also emphasizes the importance of centralized information management, security, scalability, and efficient administration. Since higher education institutions involve different categories of users with different responsibilities, controlled access to information is an important requirement. This work is relevant to the JCER Smart ERP System because JCER also provides a centralized academic platform with different roles such as Admin, Principal, Dean, HOD, Faculty, and Student. However, JCER further focuses on academic assignment-based access, student identity management, spreadsheet integration, attendance, marks, mentorship, and academic analytics.

Sholeh et al. [2] (2025), in Volume 15, Issue 1 of *Jurnal Sistem Informasi Bisnis*, presented “*Benefits and Challenges of ERP Implementation in Higher Education Institutions: A Systematic Literature Review*.” The study reviews existing research related to ERP implementation in higher education and discusses both the benefits and challenges associated with adopting ERP systems. The research shows that ERP systems can improve institutional efficiency by integrating information and supporting better academic and administrative decision-making. A centralized ERP can reduce repeated data handling and provide a common source of information for different institutional activities. At the same time, the study identifies challenges such as system complexity, organizational changes, infrastructure requirements, implementation difficulties, and user adoption. These factors show that an ERP system must be designed according to the actual requirements and workflows of an institution. This study is relevant to JCER because the proposed system aims to reduce fragmented academic processes while providing a centralized platform. JCER also attempts to integrate existing spreadsheet-based academic practices with the centralized ERP instead of requiring all existing processes to be completely replaced.

Noaman and Ahmed [3] (2015), in Volume 65 of *Procedia Computer Science*, presented “*ERP Systems Functionalities in Higher Education*.” The study examines the functionalities required by ERP systems used in higher education institutions. The authors highlight that educational institutions have requirements that differ from conventional business organizations. Academic institutions need to manage information related to students, faculty, courses, academic structures, and other education-specific activities. The research provides an understanding of the functional areas that should be considered when designing ERP systems for higher education. It emphasizes the importance of adapting ERP functionality to the academic environment instead of directly applying a general enterprise model. This work is relevant to JCER because the proposed system is designed around academic requirements such as departments, semesters, sections, subjects, student enrollment, faculty assignments, attendance, marks, and academic progression. These academic entities are connected within the JCER ERP architecture to provide a structured academic management environment.

Jin et al. [4] (2020), in Volume 176 of *Procedia Computer Science*, presented “*Role and Object Domain-Based Access Control Model for Graduate Education Information System*.” The study proposes an access-control approach for educational information systems by considering both the role of the user and the academic objects or domains associated with that user. This approach is important because identifying a user only through a general role may not be sufficient in an academic environment. For example, two faculty members may have the same faculty role but may be responsible for different subjects, sections, or student groups. The role and object domain approach therefore provides more controlled access to academic information by considering the responsibilities and academic domain of the user. This concept is directly related to the JCER architecture. JCER combines role-based access with academic assignment information such as department, subject, semester, section, and academic year. As a result, a faculty member does not automatically receive access to all academic records simply because the user has a faculty role.

Budiman et al. [5] (2021), in Volume 1918, Issue 4 of the *Journal of Physics: Conference Series*, presented “*Implementation of ERP System Functionalities for Data Acquisition Based on API at the Study Program of Universities*.” The study focuses on the use of APIs for acquiring data within a university ERP environment. It demonstrates the importance of connecting separate data sources with an ERP system through structured interfaces. API-based data acquisition can reduce manual data transfer and allow information from external systems to be incorporated into a centralized ERP environment. This work is relevant to JCER's external academic data integration approach. JCER supports the integration of spreadsheet-based academic information,

particularly attendance and marks, into the ERP. Before the information is stored, the system validates the selected academic structure and matches the data with the appropriate student records. Therefore, the study provides support for the broader concept of connecting external academic data sources with a university ERP, while JCER applies the concept specifically to spreadsheet-based academic workflows.

Brizan and Tansel [6] (2006), in Volume 6, Issue 3 of *Communications of the IIMA*, presented “*A Survey of Entity Resolution and Record Linkage Methodologies*.” The study reviews different methodologies used for entity resolution and record linkage. Entity resolution is important when the same real-world entity appears in multiple datasets using different representations. Record linkage methods help determine whether records from separate sources refer to the same entity. This concept is particularly important in academic ERP systems because student information may originate from different sources such as admission records, academic records, attendance sheets, and marks sheets. Without proper record matching, duplicate student records may be created or academic information may be associated with the wrong student. JCER addresses this requirement through persistent student identity management. Application ID and USN are used to maintain consistency across academic activities and to connect records from different academic processes and spreadsheet sources with the correct student.

Zhang et al. [7] (2021), in Volume 12 of *Frontiers in Psychology*, presented “*Educational Data Mining Techniques for Student Performance Prediction: Method Review and Comparison Analysis*.” The study reviews educational data mining techniques used for predicting student academic performance. It focuses on how educational data can be analyzed to identify patterns associated with student performance and how different data mining methods can support prediction and decision-making. The research demonstrates that academic data can be used for purposes beyond simple record storage. When information such as marks, attendance, and other student records is maintained in a structured form, it can also support analytical functions. This research is relevant to JCER because the system provides centralized academic information that can be used for academic analytics and student performance monitoring. The centralized data structure also provides a foundation for extending the system with more advanced predictive analytics in future versions.

Akçapınar et al. [8] (2019), in Volume 16, Issue 1 of the *International Journal of Educational Technology in Higher Education*, presented “*Using Learning Analytics to Develop Early Warning System for At-Risk Students*.” The study investigates the use of learning analytics for identifying students who may be at academic risk. The research demonstrates how student-related academic information can be analyzed to identify patterns associated with poor academic outcomes. Early-warning systems can help educational institutions and faculty members identify students who may require additional academic support. The study shows that academic data should not only be maintained for record-keeping but can also be analyzed to support timely academic decisions. JCER provides a foundation for this type of functionality by centralizing attendance, marks, student academic records, mentorship information, and academic analytics. While the current implementation focuses on academic management and analytics, more advanced early-warning and predictive capabilities can be extended in future versions.

Li et al. [9] (2023), in Volume 37, Issue 11 of the *Proceedings of the AAAI Conference on Artificial Intelligence*, presented “*TrOCR: Transformer-Based Optical Character Recognition with Pre-Trained Models*.” The study introduces a Transformer-based approach for Optical Character Recognition (OCR). OCR technology is useful for converting information contained in document images into machine readable text. The research demonstrates how Transformer-based models can be used to recognize text from documents and visual sources. Document processing is relevant to higher education systems

because institutions handle various documents containing student and academic information. Automated extraction can reduce manual data entry when documents contain structured or semi-structured information. The work is relevant to JCER because document processing capabilities can support academic workflows such as admission and student information processing. The research provides a technical foundation for OCR-based document processing, while JCER places such processing within a larger academic ERP workflow that includes validation and centralized record management.

Kim et al. [10] (2022), in the European Conference on Computer Vision (ECCV) proceedings, presented “*OCR-Free Document Understanding Transformer*.” The study focuses on document understanding without depending on a conventional OCR pipeline. Instead of simply converting document images into text, the approach considers the information contained within the document for understanding purposes. This is useful for document-processing applications where the structure and content of a document are both important. The research demonstrates the use of Transformer-based techniques for document understanding and highlights the growing application of AI in processing complex documents. This work is relevant to academic ERP systems because documents submitted during admission and other academic activities may contain important student information. In JCER, such document-processing capabilities can support automated information handling, while extracted information can be validated before being stored as official academic records.

Huang et al. [11] (2022), in the Proceedings of the 30th ACM International Conference on Multimedia, presented “*LayoutLMv3: Pre-Training for Document AI with Unified Text and Image Masking*.” The study presents a Document AI approach that considers text, images, and document layout together. The research emphasizes that document understanding cannot always be achieved by analyzing text alone because the position and visual structure of information can also provide important context. Layout-aware document processing can therefore be useful for understanding forms and structured documents. This research is relevant to higher education systems because admission and academic documents may contain information arranged according to specific layouts. In JCER, document-processing capabilities can be connected with admission and student workflows, allowing information from documents to be processed and subsequently validated before being incorporated into the ERP database.

Gangeh et al. [12] (2021), in the Proceedings of the IEEE/CVF International Conference on Computer Vision (ICCV), presented “*End-to-End Unsupervised Document Image Blind Denoising*.” The study focuses on improving document image quality by removing noise from document images. Document quality is important because poor-quality images can affect subsequent OCR and document understanding processes. The research investigates techniques for document image denoising that can improve the quality of images before further processing. This type of preprocessing is relevant to systems that use automated document processing because improving image quality can support more reliable information extraction. In the context of JCER, document preprocessing can be used as part of the document-processing workflow before information is extracted and validated. The study therefore provides a technical basis for improving automated document handling within academic workflows.

“**Trajectory-Aware Attendance Risk Prediction in Higher Education**” [13] (2026), presented at the **4th International Conference on Inventive Computing and Informatics (ICICI)**, focuses on using attendance information to identify attendance-related risks among higher education students. The study demonstrates the importance of analyzing attendance patterns rather than treating attendance only as a static percentage. Attendance information can provide useful indicators of student participation and may support the

identification of students who require academic attention. This research is relevant to JCER because attendance management is one of the major academic functions of the system. JCER stores attendance in a centralized database and associates it with the appropriate student, subject, section, faculty, and attendance date. The centralized attendance data can therefore support academic monitoring and provide a foundation for future attendance-risk prediction capabilities.

A. Summary

The reviewed studies collectively show that higher education ERP systems are moving toward **centralized, integrated, and data driven academic management**. **Bansal et al. [1] (2026)** establish the importance of multiuser ERP systems for higher education, while **Sholeh et al. [2] (2025)** identify the benefits and challenges associated with ERP implementation. **Noaman and Ahmed [3] (2015)** further demonstrate that ERP systems for higher education require functionalities that are specifically designed around academic requirements. The literature also highlights the importance of **controlled access to academic information**. **Jin et al. [4] (2020)** demonstrate that access control can consider both the user's role and the academic domain or objects associated with that user. This concept is reflected in JCER through role-based and assignment based access, where faculty access is associated with department, subject, semester, section, and academic year. The studies by **Budiman et al. [5] (2021)** and **Brizan and Tansel [6] (2006)** provide a foundation for data integration and record matching. Data from different sources must be connected correctly before it can be used for academic activities. JCER applies these concepts by integrating spreadsheet-based academic data and using persistent student identifiers such as Application ID and USN to maintain consistent student records. The literature also demonstrates the increasing importance of **academic analytics and prediction**. **Zhang et al. [7] (2021)** discuss educational data mining for student performance prediction, while **Akçapınar et al. [8] (2019)** investigate early warning systems for at-risk students. The **Trajectory-Aware Attendance Risk Prediction study [13] (2026)** further demonstrates the potential of attendance information for identifying academic risks. These studies support the use of centralized academic information for monitoring, analytics, and future predictive functions. Finally, **Li et al. [9] (2023)**, **Kim et al. [10] (2022)**, **Huang et al. [11] (2022)**, and **Gangeh et al. [12] (2021)** demonstrate the development of AI-based methods for OCR, document understanding, layout-aware document processing, and document image preprocessing. These technologies provide opportunities for automating document-related activities in academic systems.

III EXISTING SYSTEM

In the existing academic workflow, higher education institutions generally manage different academic activities through separate systems, spreadsheets, and manual processes. Student information, faculty details, department information, subject assignments, attendance, marks, and other academic records may be maintained independently according to the requirements of each activity. Although these approaches can support individual academic tasks, the absence of a common centralized platform can make it difficult to maintain consistent information across the institution.

Student information is one of the major areas affected by this fragmented approach. The same student may be involved in multiple academic activities, including admission, enrollment, attendance, marks, mentorship, and academic progression. When information is maintained separately for each activity, the same student details may need to be entered or maintained multiple times. This can result in duplicate records, inconsistent information, and additional effort when academic records need to be connected using identifiers such as **Application ID and USN**.

Academic structure and faculty responsibilities are also commonly managed through separate processes. Faculty members are associated

with particular departments, subjects, semesters, sections, and academic years. Therefore, simply identifying a user as a faculty member is not sufficient to determine which academic information the user should access. When such assignments are maintained separately, managing and verifying faculty responsibilities can require additional coordination between academic authorities.

Another limitation is the use of spreadsheets for academic activities such as attendance and marks. Faculty may maintain attendance or marks in Excel or Google Sheets because spreadsheets are convenient for day-to-day academic work. However, these records are separate from the central institutional database. Before the information can be used for centralized academic monitoring, the student, subject, section, faculty, and academic year information must be correctly matched. Incorrect or duplicate spreadsheet records can also create additional validation and data-cleaning requirements.

Attendance management becomes more difficult when attendance records are maintained independently for different subjects and sections. Attendance needs to be associated with the correct student and subject, and the attendance date must be correctly identified before attendance percentages and academic reports can be generated. When these records are not centrally connected, academic authorities may have to collect information from different sources to obtain an overall view of student attendance.

Marks and academic performance information can also remain distributed across different records. Faculty may maintain subject wise marks separately, while academic authorities require consolidated information to monitor student performance. Without a centralized academic database, combining these records can require additional manual processing and may make it difficult to obtain complete view of a student's academic progress.

Academic authorization is another area where separate workflows can create difficulties. Different academic roles have different responsibilities, and access to information should depend not only on the user's general role but also on the academic responsibilities assigned to the user. In a fragmented system, faculty authorization, HOD assignments, subject assignments, and other academic responsibilities may require manual coordination.

The existing approach also provides limited centralized visibility for academic authorities. The Principal, Dean, HOD, and other authorized users may need information from different sources to review departments, faculty assignments, student records, attendance, marks, and academic performance. Since the information is distributed across separate systems or spreadsheets, obtaining a complete academic view can require additional effort.

Therefore, the existing system has several limitations, including **fragmented academic data, repeated data entry, separate student records, manual faculty and academic assignment management, spreadsheet-dependent attendance and marks handling, difficulties in record matching, and limited centralized academic visibility**. These limitations create the need for a centralized ERP platform that can connect academic governance, student identity, academic structure, faculty assignments, attendance, marks, spreadsheet data, and academic analytics within a single system. The JCER Smart ERP System is proposed to address these limitations through an integrated and role-controlled academic management platform.

B. Working of Existing System

In the existing academic system, different activities are generally handled through separate processes and data sources. The workflow starts with collecting student information during admission and maintaining the required details for academic activities. Student information may then be used separately for enrollment, attendance, marks, mentorship, and other academic requirements. Since these activities can be maintained through different sources, the same student information may have to be entered or verified more than once. Faculty-related activities are also handled through separate academic processes. Faculty members are assigned to departments, subjects, semesters, sections, and academic years. These assignments are generally maintained according to the requirements of the respective academic activity. When a faculty member needs to manage attendance or marks, the faculty may use separate subject- or section-wise records.

For attendance management, faculty may maintain attendance using **Excel or Google Sheets**. A separate sheet or tab can be used for a particular subject and section, with student details and attendance recorded according to the attendance date. The attendance information remains in the spreadsheet until it is manually collected, processed, or transferred to another system. This makes it necessary to verify the student and academic information before the attendance can be used for centralized reporting.

Marks can also be maintained separately by faculty for their respective subjects. Subject-wise marks are recorded and later used for academic evaluation. If the institution needs a consolidated view of student performance, information from different subjects or sources has to be collected and combined.

Student records from different academic activities may need to be matched using available identifiers such as **Application ID, Roll Number, or USN**. When information comes from different sources, the records need to be checked to ensure that the data belongs to the correct student. Without a common identity structure, there is a possibility of duplicate records or incorrect mapping between academic information.

Academic authorization is also handled through separate levels of responsibility. HODs, faculty members, and other academic users have different responsibilities, but their access may require manual coordination. Faculty assignments need to be checked against the department, subject, semester, section, and academic year before academic information is accessed or modified.

Academic authorities may also need to collect information from multiple sources to monitor departments, faculty, students, attendance, and marks. For example, an HOD may need to refer to separate faculty assignment records and attendance or marks sheets, while higher academic authorities may need information from multiple departments. This makes centralized monitoring more difficult.

The overall working of the existing system can therefore be represented **Student/Faculty Data → Separate Academic Records → Spreadsheet-Based Attendance and Marks → Manual Data Verification → Individual Academic Processes → Separate Reports**

Although this approach can support individual academic activities, it does not provide a single connected workflow for all academic operations. Data matching, repeated entry, spreadsheet handling, faculty assignment verification, and collection of information from different sources increase the effort required for academic administration.

The limitations of this working model provide the basis for the proposed **JCER Smart ERP System**, which connects student identity, academic structure, faculty assignments, attendance, marks, academic

governance, spreadsheet integration, and analytics through a centralized platform.

C. Advantages of the Existing System

1. **Simple to use** – Tools such as Excel and Google Sheets are familiar to faculty and staff, so basic academic data can be maintained without extensive training.
2. **Flexible data entry** – Faculty can easily add or modify attendance, marks, and other academic information according to their requirements.
3. **Low initial cost** – Existing spreadsheet-based methods do not require a large investment in specialized academic management software.
4. **Easy sharing of information** – Spreadsheet-based records can be shared between faculty and academic staff when required.
5. **Suitable for individual activities** – Separate processes can effectively support specific tasks such as maintaining attendance, marks, or faculty records when the amount of data is limited.

D. Limitations of the Existing System

1. **Fragmented data** – Student, faculty, attendance, marks, and academic information may be stored in different sources, making it difficult to maintain a unified record.
2. **Repeated data entry** – The same student or academic information may need to be entered or verified in multiple places, increasing manual work.
3. **Difficult record matching** – Connecting student information across different spreadsheets and academic records can be difficult and may result in duplicate or incorrectly matched records.
4. **Limited centralized monitoring** – Academic authorities may need to collect information from multiple sources to obtain a complete view of departments, students, faculty, attendance, and marks.
5. **Manual access and assignment management** – Faculty responsibilities and access to subjects, sections, semesters, and academic records may require additional manual verification and coordination.

IV PROPOSED METHODOLOGY

The proposed methodology for the **JCER Smart ERP System** is designed to overcome the limitations of fragmented academic processes by providing a centralized and role-controlled platform for managing academic information. The methodology connects student records, academic structure, faculty assignments, attendance, marks, spreadsheet data, mentorship, and academic analytics within a common system. The system follows a structured workflow in which academic information is entered, validated, stored, and made available to authorized users according to their responsibilities.

A. System Architecture

System Architecture of JCER Smart ERP System illustrates the overall architecture of the proposed system and shows how different users, application modules, external data sources, analytics, database, and infrastructure are connected. The architecture is organized into different layers to separate user interaction, application processing, data management, and system infrastructure.

The **User Layer** represents the different users of the JCER Smart ERP System, including Admin, Principal, Dean, HOD, Faculty, and Student. Each user accesses the system according to their assigned role and academic responsibilities. This provides controlled access to the information and functions required by each user.

The **Application Layer** forms the main part of the system. The Presentation Layer provides the web interface through which users access dashboards, reports, and academic functions. The Business Logic Layer contains the major academic modules, including academic administration, student management, faculty management, attendance management, marks management, mentorship, academic analytics, and AI-assisted processing. The Security and Access Control component handles authentication, role-based access, assignment-based authorization, and data validation.

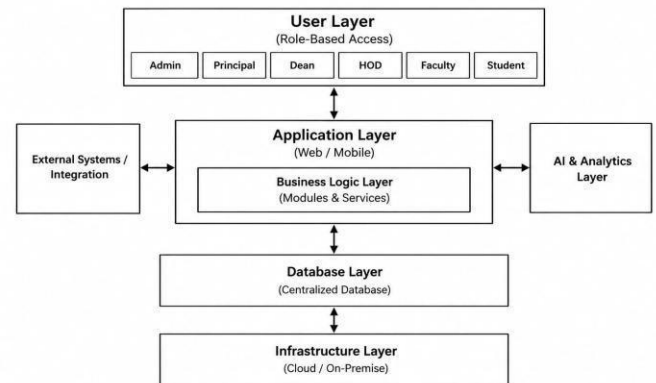


Fig 4.1 System Architecture

The architecture also supports **External Systems and Integration**. Excel and Google Sheets can be used for academic data such as attendance and marks. The imported information is processed and validated before being integrated with the ERP. API-based integration can also be extended to external systems where required. The **AI and Analytics Layer** supports document processing, data extraction, predictive analysis, and academic reporting. These functions can use information from documents and academic records to support data processing and academic monitoring. The **Database Layer** uses **PostgreSQL** as the centralized academic database. It stores the main academic information required by the system, including student, faculty, department, subject, attendance, marks, mentorship, and other academic records. The centralized database allows different modules to work with consistent academic information. Finally, the **Infrastructure Layer** represents the environment required to operate the system, including the application server, database server, hosting environment, security and backup mechanisms, and network connectivity. The layered architecture therefore provides a structured connection between users, academic operations, external data sources, centralized storage, and supporting infrastructure.

B. Workflow of the System

1. **User Login and Role Verification:** The workflow begins when a user logs into the JCER Smart ERP System. The system verifies the user's credentials and identifies the assigned role, such as Admin, Principal, Dean, HOD, Faculty, or Student. Based on the verified role, the user is provided access to the functions permitted for that role.
2. **Academic Assignment Verification:** After login, the system verifies the academic responsibilities associated with the user. This includes information such as department, subject, semester, section, and academic year. This step ensures that users can access only the academic information related to their assigned responsibilities.
3. **Academic Operations:** Once the user's access is verified, the user can perform the required academic operations. These may include managing student records, entering attendance, managing marks, viewing academic records, handling mentorship activities, and preparing academic reports according to the user's role.

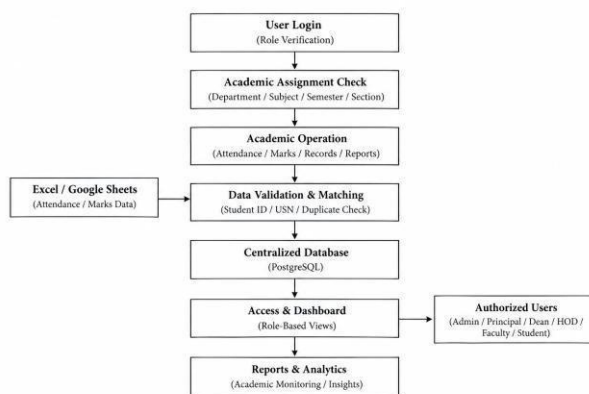


Fig 4.2 Workflow of the System

4. Data Validation and Matching: Academic information is validated before being stored in the centralized system. For spreadsheet-based data, such as attendance and marks, the system checks the available student identifiers, including Application ID and USN, and matches the records with the corresponding student and academic information. Duplicate or incorrectly matched records can also be identified during this stage.

5. Centralized Database: After validation, the academic information is stored in the centralized **PostgreSQL database**. The database maintains student, faculty, department, subject, attendance, marks, mentorship, and other academic records. Centralized storage allows different modules of the ERP to work with consistent academic information.

6. Role-Based Dashboard: The stored information is made available through dashboards according to the user's role and academic permissions. Admin, Principal, Dean, HOD, Faculty, and Student users receive different views and functions based on their responsibilities. This provides controlled access to academic information.

7. Reports and Analytics: The final stage provides academic reports and analytics using the centralized information. Academic authorities can use the available information for monitoring students, departments, faculty activities, attendance, marks, and overall academic performance.

8. Excel/Google Sheets Integration: Excel or Google Sheets can provide attendance and marks data to the system. The spreadsheet data is passed to the **Data Validation and Matching** stage, where student and academic records are checked before the information is stored in the PostgreSQL database. This allows existing spreadsheet based academic practices to be connected with the centralized ERP workflow.

C. Algorithmic Flow

The algorithmic flow describes the sequence of operations performed by the JCER Smart ERP System, from user authentication to academic data processing and reporting.

Step 1: Start

The system starts when a user accesses the JCER Smart ERP System.

Step 2: User Authentication

The user enters the required login credentials. The system verifies the credentials and identifies the user's role.

Step 3: Role Verification

The system checks whether the authenticated user is an **Admin, Principal, Dean, HOD, Faculty, or Student**. The corresponding permissions are loaded based on the identified role.

Step 4: Academic Assignment Verification

For academic operations, the system checks the user's assigned **department, subject, semester, section, and academic year**. If the required assignment is not available, the system restricts the operation.

Step 5: Select Academic Operation

The authorized user performs the required operation, such as:

- Student record management
- Attendance management
- Marks management
- Faculty/subject management
- Mentorship
- Academic reports

Step 6: Receive Academic Data

The system receives data either through the ERP interface or through supported **Excel/Google Sheets** data for activities such as attendance and marks.

Step 7: Validate and Match Data

The system validates the received information and matches student records using identifiers such as **Application ID and USN**. Duplicate, missing, or incorrectly matched records are checked before storage.

Step 8: Store Data

After successful validation, the data is stored in the centralized **PostgreSQL database**.

Step 9: Generate Role-Based View

The stored information is retrieved according to the user's role and academic assignments. The system displays the appropriate dashboard, records, and functions.

Step 10: Generate Reports and Analytics

The system uses the centralized academic data to provide reports, dashboards, and academic analytics for authorized users.

Step 11: End

The operation is completed after the required academic information or report is displayed to the authorized user.

D. Advantages

1. Centralized Academic Data

The system stores student, faculty, attendance, marks, mentorship, and other academic information in a centralized database, reducing dependency on separate data sources.

2. Reduced Data Duplication

Using consistent student identifiers such as Application ID and USN helps reduce duplicate student records and repeated data entry.

3. Role-Based Access

Users receive access according to their roles, such as Admin, Principal, Dean, HOD, Faculty, and Student. This helps protect academic information from unauthorized access.

4. Assignment-Based Access Control

Faculty access can be associated with department, subject, semester, section, and academic year. This ensures that academic operations are performed within the user's assigned responsibilities.

5. Spreadsheet Integration

Excel and Google Sheets data for attendance and marks can be connected with the ERP, validated, and stored in the centralized database without completely replacing existing spreadsheet-based practices.

6. Improved Academic Monitoring

Centralized attendance, marks, student records, and academic information allow authorized academic authorities to monitor student and departmental activities more easily.

7. Better Record Consistency

Validation and record matching using student identifiers help maintain consistent information across different academic activities.

8. Simplified Academic Workflows

The system connects admission, academic structure, faculty assignments, attendance, marks, mentorship, and reporting within a common platform, reducing the need to manage each activity separately.

9. Academic Reports and Analytics

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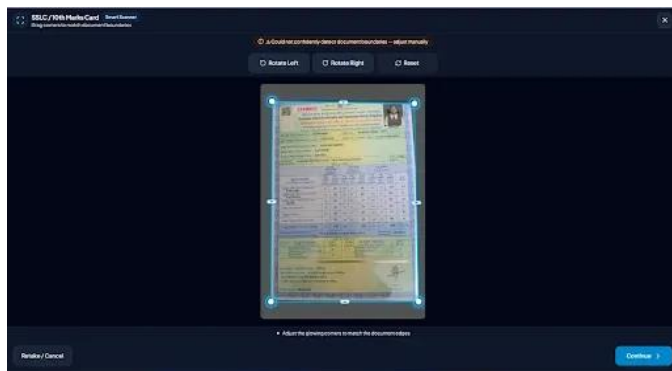


Fig 5.4 Cropping Image Model

VI. RESULTS ANALYSIS

A. Functional Testing Results

The implemented JCER Smart ERP System was tested across the major academic workflows, including user authentication, academic structure management, student management, faculty assignments, attendance, marks, mentorship, and academic reporting. The testing confirmed that the implemented modules performed their intended operations and maintained the required relationships between students, faculty, subjects, departments, semesters, and sections. Role-based and assignment-based access also ensured that users could access academic functions according to their assigned responsibilities.

B. Student Data and Record Matching Findings

The student identity management functionality was evaluated using Application ID and USN to maintain consistency across different academic activities. The system uses these identifiers to connect student information with enrollment, attendance, marks, mentorship, and other academic records. During spreadsheet integration, the imported records are checked against existing student information before being stored. This helps identify unmatched and duplicate records and reduces the possibility of creating separate records for the same student.

C. Usability Assessment

The usability of the JCER Smart ERP System was assessed based on the ease of navigation, clarity of the interface, accessibility of academic functions, and overall interaction with the system. The role specific dashboards provide users with functions relevant to their responsibilities, reducing unnecessary navigation between different academic activities. The assessment indicates that the centralized interface provides a more organized way to perform academic operations compared with managing the same activities through separate sources.

D. Comparative Evaluation

The proposed JCER Smart ERP System was compared with the existing approach in which academic information may be maintained through separate spreadsheets, records, and manual processes. In the existing approach, student information, attendance, marks, and faculty assignments may require separate verification and coordination. The proposed system brings these activities together through a centralized PostgreSQL database, role-based access, assignment-based authorization, and spreadsheet integration. This provides a more connected approach to academic data management and reduces dependence on fragmented records.

E. System Performance Assessment

The performance of the implemented system was evaluated by observing commonly used academic operations such as user authentication, dashboard access, student record retrieval, attendance processing, marks management, and spreadsheet data integration. The layered architecture separates presentation, business logic, validation,

and database operations, allowing requests to be processed through defined services. Under normal usage conditions, the system provides a consistent workflow for storing and retrieving academic information while maintaining access control and data validation.

F. Summary of Findings

The overall evaluation shows that the JCER Smart ERP System provides an integrated platform for managing major academic activities within a higher education environment. The implementation connects student records, academic structure, faculty assignments, attendance, marks, mentorship, and spreadsheet-based academic data through a centralized system. The use of Application ID and USN improves student record consistency, while role-based and assignment-based access provides controlled academic operations. The results indicate that the proposed system can reduce fragmented data handling and provide a more organized approach to academic administration and monitoring.

G. Table I. Comparative Evaluation

Parameter	Existing Approach	JCER ER
Data Storage	Multiple	Centralized
Student Records	Manual matching	Application ID & USN
Attendance	Separate sheets	Integrated
Access Control	Manual	Role-based
Monitoring	Multiple sources	Centralized
Reporting	Manual	System-based

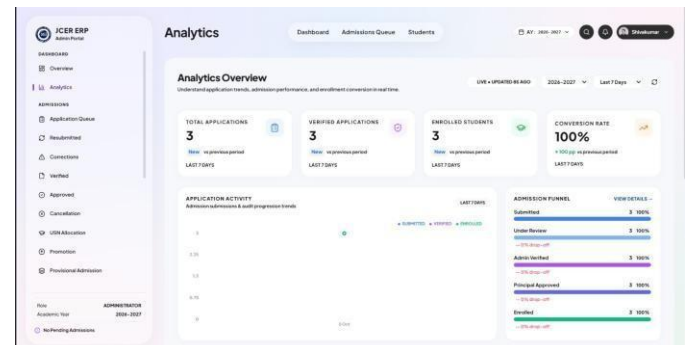


Fig 6.1 The JCER ERP Analytics Dashboard

The JCER ERP Analytics Dashboard provides a real-time overview of the admission process. It displays the total applications, verified applications, enrolled students, and conversion rate. The Application Activity section shows admission progress over time, while the Admission Funnel tracks students from submission to final enrollment. It also allows the admin to filter data by academic year and time period.

VII CONCLUSION

The JCER Smart ERP System was developed as a centralized academic management platform to address the limitations of fragmented academic processes, separate spreadsheets, repeated data entry, and manual coordination in higher education institutions. The system brings major academic activities, including student management, academic structure management, faculty and HOD management, faculty assignments, attendance, marks, mentorship, and academic reporting, into a common platform. The implemented architecture provides separate access for Admin, Principal, Dean, HOD, Faculty, and Student users, while role-based and assignment-based authorization

ensures that academic information and operations are available according to the responsibilities assigned to each user. The student identity mechanism using Application ID and USN provides a consistent method for connecting student information across admission, enrollment, attendance, marks, mentorship, and other academic activities, thereby reducing the possibility of duplicate or incorrectly linked records. The integration of Excel and Google Sheets further extends the system by allowing existing spreadsheet-based attendance and marks data to be brought into the ERP through a structured process of data reading, validation, student and academic record matching, duplicate checking, and centralized storage. The use of PostgreSQL provides a common data layer through which different academic modules can access consistent information, while REST-based backend services connect the frontend interfaces with the underlying business logic and database operations. The system also provides academic dashboards, reports, and monitoring facilities that allow authorized academic authorities to obtain information from a centralized source instead of depending on multiple independent records. Additional implemented capabilities such as document processing, OCR-related processing, and record validation provide scope for reducing manual handling of academic information where applicable. The functional evaluation and comparative assessment indicate that the proposed system provides a more organized approach to academic data management by connecting academic governance, student identity, faculty responsibilities, attendance, marks, spreadsheet integration, and reporting within a single workflow. The system therefore provides a practical foundation for improving the consistency, accessibility, and management of academic information while maintaining controlled access to institutional records. Although the present implementation focuses mainly on the academic workflows covered by the system, its modular architecture provides scope for further expansion through additional institutional services, improved document and data processing, advanced academic analytics, predictive student performance and attendance analysis, examination and timetable management, library services, learning resources, and other future academic requirements. Overall, the JCER Smart ERP System demonstrates how a centralized, role-controlled, and assignment aware ERP approach can be used to connect different academic processes and provide a more integrated environment for academic administration and decision-making.

Future Scope

Notes and Study Materials – Integrate a centralized platform for faculty to upload and students to access notes, assignments, question papers, and other learning resources.

Library Management – Add library facilities for managing books, availability, issue and return records, and fine tracking.

Examination Management – Extend the system with examination scheduling, registration, hall-ticket generation, result processing, and examination reports.

Advanced Academic Analytics – Introduce advanced analytics and predictive models for student performance, attendance trends, and early identification of academically at-risk students.

REFERENCES

- [1] D. Bansal, D. Sinha, D. Sinha, and S. K. Khandelwal, "Design and Implementation of a Multiuser Enterprise Resource Planning Solution for Higher Education Institutions: Enhancing Accreditation and Administration," *Software: Practice and Experience*, vol. 56, no. 5, pp. 551–587, 2026, DOI: 10.1002/spe.70060.
- [2] M. B. Sholeh, R. F. Samodra, and A. P. Widodo, "Benefits and Challenges of ERP Implementation in Higher Education Institutions: A Systematic Literature Review," *Jurnal Sistem Informasi Bisnis*, vol. 15, no. 1, pp. 21–33, 2025, DOI: 10.14710/vol15iss1pp21-33.
- [3] A. Y. Noaman and F. F. Ahmed, "ERP Systems Functionalities in Higher Education," *Procedia Computer Science*, vol. 65, pp. 385–395, 2015, DOI: 10.1016/j.procs.2015.09.100.
- [4] G. Jin, D. Wang, D. Yang, D. Hong, et al., "Role and Object Domain-Based Access Control Model for Graduate Education Information System," *Procedia Computer Science*, vol. 176, pp. 1241–1250, 2020, DOI: 10.1016/j.procs.2020.09.133.
- [5] K. Budiman, A. T. Putra, Alamsyah, E. Sugiharti, M. A. Muslim, and R. Arifudin, "Implementation of ERP System Functionalities for Data Acquisition Based on API at the Study Program of Universities," *Journal of Physics: Conference Series*, vol. 1918, no. 4, p. 042151, 2021, DOI: 10.1088/1742-6596/1918/4/042151.
- [6] D. G. Brizan and A. U. Tansel, "A Survey of Entity Resolution and Record Linkage Methodologies," *Communications of the IIMA*, vol. 6, no. 3, Article 5, 2006, DOI: 10.58729/1941-6687.1324.
- [7] Y. Zhang, Y. Yun, R. An, J. Cui, H. Dai, and X. Shang, "Educational Data Mining Techniques for Student Performance Prediction: Method Review and Comparison Analysis," *Frontiers in Psychology*, vol. 12, Article 698490, 2021, DOI: 10.3389/fpsyg.2021.698490.
- [8] G. Akçapınar, A. Altun, and P. Aşkar, "Using Learning Analytics to Develop Early-Warning System for At-Risk Students," *International Journal of Educational Technology in Higher Education*, vol. 16, Article 40, 2019, DOI: 10.1186/s41239-0190172-z.
- [9] M. Li, T. Lv, J. Chen, L. Cui, Y. Lu, D. A. F. Florêncio, C. Zhang, Z. Li, and F. Wei, "TrOCR: Transformer-Based Optical Character Recognition with Pre-Trained Models," *Proceedings of the AAAI Conference on Artificial Intelligence*, vol. 37, no. 11, pp. 13094–13102, 2023, DOI: 10.1609/aaai.v37i11.26538.
- [10] G. Kim, T. Hong, M. Yim, J. Nam, J. Park, J. Yim, W. Hwang, S. Yun, D. Han, and S. Park, "OCR-Free Document Understanding Transformer," *Proceedings of the European Conference on Computer Vision (ECCV)*, 2022, pp. 498–517, DOI: 10.1007/978-3-031-198151_29.
- [11] Y. Huang, T. Lv, L. Cui, Y. Lu, F. Wei, and Y. Zhou, "LayoutLMv3: Pre-Training for Document AI with Unified Text and Image Masking," *Proceedings of the 30th ACM International Conference on Multimedia*, 2022, pp. 4083–4091, DOI: 10.1145/3503161.3548112.
- [12] M. J. Gangeh, M. Plata, H. R. Motahari Nezhad, and N. P. Duffy, "End-to-End Unsupervised Document Image Blind Denoising," *Proceedings of the IEEE/CVF International Conference on Computer Vision (ICCV)*, 2021, pp. 7888–7897.
- [13] For attendance, I recommend adding the newly verified 2026 paper: "Trajectory-Aware Attendance Risk Prediction in Higher Education," *2026 4th International Conference on Inventive Computing and Informatics (ICICI)*, 2026, DOI: 10.1109/ICICI68773.2026.11580718.