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ERP Management System Implementation in Educational Institutions: A Comprehensive Institutional Digital Transformation Framework

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Abstract
Educational institutions such as schools and colleges have to deal with a lot of academic and administrative data, Many institutions still depends on traditional manual systems to manage their operations. it often leads to problems and also consumes more time to complete a tasks. Enterprise Resource Planning (ERP) systems offer a unified platform that helps institutions in optimizing operations including admissions, attendance monitoring, examination oversight, and faculty administration. This study suggests a cloud-based ERP management system for schools and universities to make their operations more efficient and centralize their data management. The proposed system combines Firebase services for authentication and real-time database management, AWS cloud storage for scalable and safe data handling, and a mobile app interface for faculty and administrative users to interact easily. The architecture allows for role-based access control (RBAC) and real-time syncing of academic data between departments. Experimental implementation in an academic setting shows that managing attendance and processing leave and academic monitoring is more efficient. this ERP framework improves institutional transparency ,reduces the faculty's workload and supports for quick decision-making through scalable cloud infrastructure.
keywords: ERP system, cloud computing, firebase, AWS cloud platform, Educational Management, Mobile App

Introduction

Educational institutions manage a huge amount of academic and administrative data such as student records, staff information, examination results, attendance, and fee management records. Maintaining these activities using traditional manual methods often leads to delays, inefficiencies, and data inconsistencies across various departments. As educational institutions grow in size and complexity, managing institutional workflows efficiently becomes more challenging.
Recent developments in cloud computing technologies have enabled modern Enterprise Resource Planning (ERP) systems to be deployed using scalable, reliable and secure cloud infrastructures. Platforms such as Firebase provide authentication services that allows only authorized users to log in. and access real-time databases for storing institutional data, while Amazon Web Services (AWS) offers reliable cloud storage solutions. These technologies contribute to the development of modern ERP systems that enable secure data management and real-time accessibility for educational institutions. Several studies have mentioned that ERP systems can significantly improve academic management efficiency in educational institutions and universities [1], [2], [5], [12]. ERP platforms integrate multiple institutional functions into a unified system, allowing administrators and faculty members to access centralized information and streamline institutional operations.
The main objective of this research is to design and implement a cloud-based ERP management system for educational institutions such as schools and universities. The proposed system integrates academic and administrative based operations into a unified digital platform using cloud platforms and mobile accessibility. The proposed ERP framework focuses on combining cloud technologies with mobile accessibility to improve academic management and administrative coordination within educational institutions .implementing this system can reduce manual administrative workload and make institutional processes quicker, improve data accessibility, and enable quicker decision-making processes for institutional management.
The remainder of this paper is organized as follows. Section 2 presents the literature review related to ERP implementation in educational institutions. Section 3 describes the research methodology and system architecture of the proposed ERP system. Section 4 explains the system modules and implementation details. Section 5 discusses the results and performance analysis of the proposed system. Finally, Section 6 concludes the paper and outlines future research directions.

Need for ERP implementation in educational institutions

The need of a ERP system came from several issues that will be solved with few changes from the existing module such as:

1. Manually uploading everything would always lead to errors, delay, and loss of university data knowledge.
2. There is a lack of real-time information, particularly concerning students' performance, attendance, and financial transactions.
3. Exams, admissions, fees, allocation, and other administration-based modules required so much work to be done.
4. Challenges in maritime regulation compliance, which entail record accuracy and data submission.

The ERP system was supposed to mitigate the drawbacks mentioned by using automation, centralization, and data-driven decision-making.

Literature Background

3.1 ERP Systems in Educational Institutions. Enterprise Resource Planning (ERP) systems are increasingly used by educational institutions such as schools and universities to manage academic and administrative process more efficiently. These ERP systems help integrate various universities functions such as student records, course scheduling, examination processes, and fee management into a centralized platform.AboAbdo et al. [1] investigated that ERP implementation in higher education institutions and identified several critical success factors influencing the need of ERP adoption. Their study showed the importance of proper planning, stakeholder involvement, and institutional support in achieving successful ERP implementation.In the same way, Sadrzadehrafiei et al. [2] proposed a framework for the implementation of ERP systems in university environments, focusing on the integration processes within the organization. This research identified that the implementation of ERP systems in an organization leads to the elimination of duplicate records in organizational operations. Alharbi and Drew [5] researched the success factors in the implementation of ERP systems in public university environments. According to the research, the readiness of the organization, training of the users, and customization of the system affect the performance of the ERP system.Al-Mashari and Al-Sabaan [12] conducted an assessment study on the adoption and implementation of ERP systems in higher education institutions and found that ERP systems have a significant impact on improving the level of coordination within the institution. Obeidat et al. [15] conducted a study on the impact of ERP systems in organizational performance in the field of education and found that ERP systems have a significant impact on improving communication, information accessibility, and decision-making processes within the university.
3.2 Cloud-Based ERP Systems. With the advancement in technology in cloud computing, ERP systems have now shifted from traditional ERP to cloud ERP systems. The advantages of cloud ERP systems provide several advantages. An investigation was conducted by Asharani [3] regarding the implementation of cloud ERP systems in higher education institutions. He identified that the advantages of implementing cloud ERP systems are huge. The advantages are reduction in infrastructure costs, scalability of the system, and accessibility of academic information.For instance, Bond et al. [8] investigated the role of digital transformation in higher education and the significance of digital platforms in enhancing the efficiency of higher education institutions. According to the researchers, the study highlighted the role of digital technologies in the development of integrated management systems for the effective management of academic information. Alshamaila et al. have conducted a study on the adoption of cloud computing technology in higher education institutions with the help of the technology organization environment model. It has been identified that technology readiness, organizational support, and environmental factors are significant in the adoption of cloud computing technology in academic institutions.
3.3 Academic Management and Data Governance Systems. Apart from ERP systems, several research studies have focused on the development of integrated academic management systems. Kamal and Irani [9] have focused their research on the role of data governance and security in ERP systems implemented in higher education institutions. The research highlighted the importance of secure authentication mechanisms and effective data governance policies in the ERP system for the overall security of the institution.

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Rahman and Islam [11] proposed an integrated university management system, focusing on its effectiveness in improving academic management. The findings of their study revealed that centralized management systems play a significant role in facilitating information accessibility. The integrated management systems allow academic institutions to be better in managing academic workflows, enabling management to take appropriate decisions.

3.4 Research Gap

Though many studies have focused on ERP implementation in HEIs, as well as its advantages in terms of integrated management systems, there are certain limitations in ERP systems. For instance, most ERP systems available in the market mainly focus on web-based management systems, but there is a lack of integration of mobile management. There is also limited integration of cloud storage in many ERP systems, as well as academic real-time monitoring.

Thus, there is a need to develop a new ERP model that will incorporate the use of cloud computing, authentication, and mobile access in order to improve academic management in learning institutions. It is in this respect that there is a need to propose a new cloud-based ERP management model that will incorporate authentication services and cloud storage in order to improve academic management in educational institutions.

Methodology for ERP Development and Deployment. The proposed ERP system was developed using a structured methodology that focuses on requirement analysis, system architecture design, module development, and system testing. The development process aimed to create a cloud-based ERP solution capable of integrating academic and administrative functions within educational institutions. The system utilizes modern cloud technologies to ensure scalability, security, and real-time accessibility of institutional data.

4.1 Requirement Analysis and Process Mapping. The development of the ERP system began with a detailed requirement analysis conducted through discussions with faculty members, administrative staff, and department heads. The purpose of this stage was to understand the current academic management processes and identify limitations in the existing manual and semi-digital systems.During this phase, several institutional workflows were analyzed, including attendance tracking, academic assessment management, timetable scheduling, and faculty administration. Process mapping was performed to identify inefficiencies and redundant procedures in existing academic operations. Based on these findings, system requirements were defined to support integrated academic management through a centralized ERP platform.

4.2 System Architecture Design. The proposed ERP system is based on a cloud computing architecture, which is suitable for handling centralized data access. The architecture enables the integration of mobile applications and cloud computing services, facilitating real-time communication.The system architecture consists of three main layers. the user interface layer, the application processing layer, and the data management layer. The user interface layer will allow the faculty members and the students, as well as the administrators, to access the system using a mobile application. The application processing layer will be responsible for all the logic within the different modules. The data management layer will be comprised of cloud storage solutions.

This architecture enables seamless integration between various ERP modules while ensuring secure, reliable, and scalable system operation.

4.3 Technology Stack. The proposed ERP system uses a combination of modern cloud technologies to assist secure and scalable academic management.

Firebase Authentication is used for user authentication and access control in the system. It ensures that only authorized users can access certain modules in the system based on their roles, such as faculty members, students, department administrators, and so on.

Firebase Realtime Database is used to store academic records, attendance records, and institution records. The feature of synchronizing data in real time is useful in accessing the data in real time by the user.

Amazon Web Services is used to store academic resources such as course materials, documents, and assignment materials. The scalability of data is achieved by using Amazon Web Services, as it is required by the user.

The interface of the system is designed as a mobile application, in which the user can interact with the ERP system.

4.4 Workflow and Module Interaction. There are various modules in the ERP system that can be used in the management of an academic institution. All these modules can be integrated with each other using a single backend system. When a user logs into the system using the mobile application, the authentication service provided by Firebase can be used.

Once a user has been authenticated, various modules can be provided to the user based on their defined role. For example, faculty members can be provided with the option to register attendance, upload assessment results, etc. Students can be provided with the option to view various academic details such as attendance, etc. The Head of Department can be provided with the option to view faculty performance, etc.

Academic details generated by these modules can be stored in a centralized database. The documents uploaded by faculty members can be stored in the AWS cloud storage system. They can be provided with the option to view the documents using the ERP system.

4.5 System Testing and Evaluation. Before the implementation of the ERP system, several stages of tests were conducted. The main purpose of the tests conducted was to ensure that the ERP system is reliable. The first stage of the test was conducted in order to ensure that the ERP system is functioning properly. This stage of the test was referred to as the functional test. The second stage of the test was conducted in order to ensure that all the modules of the ERP system are functioning properly. This stage of the test was referred to as the integration test.

User acceptance tests were conducted. This stage of the test was conducted by allowing the faculty members of the educational institution to use the ERP system.

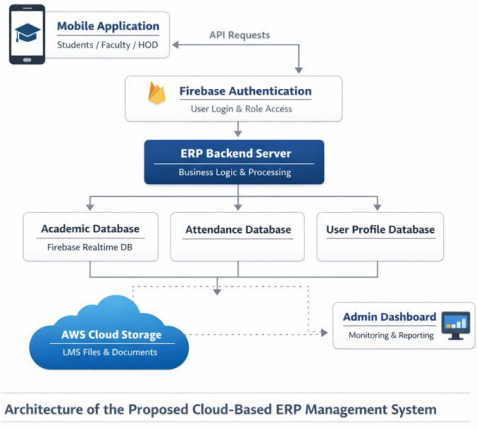

Figure 4.1: Architecture of the proposed cloud-Based ERP Management System

5. ERP Modules: Faculty and Head of department Implementation (Expanded Focus)

5.1 Faculty Module - Detailed Execution

This Faculty module provides a centralized interface for faculty members to manage daily academic activities. The Faculty Module helps get rid of paper work and makes things easier for teachers. This means teachers have time to teach and less time doing paperwork. The Faculty Module is good because it helps teachers do their jobs better and it is still fair, for the students. The Faculty Module is really important for teachers to use every day

Key Functional Components

Attendance Management System: Faculty members can see their classes on a dashboard. They mark if a student is present or not. When they do this the attendance information is available to the students the faculty members and the Heads of Department, at the time. The school does not have to keep attendance records so it is easy to see who is attending classes.

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Assessment and Marks Management: The module helps teachers put grades for tests and assignments in an organized way. It calculates scores on its own. Makes progressions that clearly show how students are performing. This means there are some errors when updating grades into the computer. staffs can see how students are performing in all semester long and find out which students are having difficulties.

Class Schedule and Timetable Management: The module shows us the class schedules and the subjects that are assigned to each class. It also shows the teaching timings. We get updates away if there are any changes made by the administration. This way the faculty and the department have the schedule. The faculty can plan their time better because they can see the schedule information, for the module. This function was truly helpful for the faculty to adopt their own class time with the class scheduling options and the teaching timings.

5.2 Head of Department (HOD) Module – Thorough Execution. The Head of department Module provides administrative oversight of faculty activities and departmental operations in the Educational institutions. The Head of departments are responsible for making sure the academic quality of their department is good that the faculty members are doing their jobs well that the students are learning what they need to and that everything is done according to the rules. The Head of departments also play an important role in communicating between the faculty members and the university administration. They are the ones who make sure everyone is working together and that the Head of department Module is running smoothly.

Critical Functional Components

Faculty Management and Oversight System: The heads of departments get to see everything that is going on with the teachers schedules how often they are attending classes. How well they are doing in the classroom.

The heads of departments can look at boards that show them what the teachers are doing at any given time

Leave Request Processing and Approval: The faculty leave requests all go to one place. It is easy to look at them and make a decision right away. When a request is approved it automatically updates the records that the Human Resources department and administrators use. This means that people do not have to update everything, which helps prevent problems with the schedule that can happen when someone is absent, without approval. The faculty leave requests system keeps a record of all the decisions that are made so it is easy to check that everything is being done correctly and follow all the rules.

Attendance and Academic Performance Monitoring: The Heads Of Departments can see how many students are attending classes and how well they are doing in their studies at any time. If the Heads of Departments notice that some students are not attending classes or are not doing well in their studies they can start programs to help these students. The Heads Of Departments can also look at how all the students, in the department're doing and see if there are any patterns. This helps the Heads of Departments to change what they teach and how they teach it to make sure all the students are doing their best.

Timetable Management and Workload Optimization: The module helps Heads of Departments create timetables for their departments. It also lets them approve schedules and make sure that the work for the faculty members is divided fairly. The module uses algorithms to balance the workload. These algorithms make sure that no one faculty member has to teach much. They also help use the classrooms in the way possible and make sure that all faculty members get the resources they need.

Assessment Verification and Quality Assurance: Faculty members submit the marks through the system. The Head of Departments reviews the Faculty member's marks. Approves the assessments before they are sent to the examination offices. This is an important step to make sure the marks are correct. It helps to find mistakes in the calculations. It also makes sure that the grading is consistent for the Faculty members assessments

6.Challenges Encountered

Moving to a digital system was not easy task at first, there are few issues we face by this process:

1. Resistance to Change: Many faculty members were used to doing things by hand and were hesitant to switch to a new way of working.
2. Different Workflows: Each department had its own way of doing things, so ERP system needs to be customized to fit everyone's specific needs.
3. Training Phase: We arranged a training period for staffs and administrators to make sure they feel confident and capable of working with new modern tools.
4. Data protection: Providing security to individual's data and keeping the system safe from unauthorized persons and from phishing.
5. Existing Software: We noticed that hoe to work efficiently with the older systems from the university to enhance into new updated versions.

By providing routine training to work with the project and updating our policies by listening to working faculties feedback, and try to improve the difficulties in the new system.

7. Results and Outcomes

7.1 Experimental Setup. The proposed ERP management system was evaluated with the help of the simulated academic environment, and the proposed system was tested with the help of various academic and administrative activities carried out in the academic environment.Most of the evaluation was centered on comparing the efficiency of these tasks when they are carried out using the traditional manual method and the proposed ERP system. The main tasks that have been considered for the evaluation of this ERP system include attendance management, assessment recording, leave management, and department monitoring. The ERP system was implemented using a cloud computing model, where Firebase authentication, Firebase Realtime database, and AWS cloud storage are used.The results to be discussed in this chapter include the benefits of using the ERP system in terms of task processing time.

7.2 Performance Evaluation Metrics. To measure the effectiveness of the proposed ERP system, different metrics have been identified. The metrics will be useful in measuring the efficiency of the academic management system in relation to the traditional manual management system.

Different metrics, which have been identified in relation to the effectiveness of the ERP system, are as follows:

Task Processing Time: It is the time taken in processing different academic activities, like the recording of attendance and leaves.

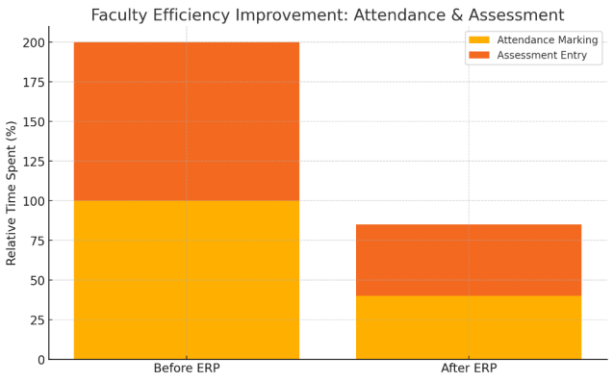
Data Accessibility: It is the rate at which academic data is being accessed by the faculty members of the academic institution.

Administrative Workload: It is the reduction in workload that is required in relation to the administration of academic records.

Monitoring Efficiency: It is the efficiency of department heads in monitoring the activities of faculty members as well as the performance of students in real time.

These metrics will be useful in measuring the effectiveness of the ERP system in relation to the management of workflow in academic institutions.

7. 3 Faculty Efficiency Improvement. The implementation of ERP has resulted in efficiency improvements in faculty management in terms of academic activities like attendance management and assessment management. Under the traditional manual system, faculty members need to manually record the attendance of the students and also calculate the assessment results, which is time-consuming.



However, with the implementation of ERP, these activities can be easily achieved by faculty members as it is automated by including a faculty module in ERP. The graphical results show that time is saved in terms of attendance management and assessment management after ERP implementation.

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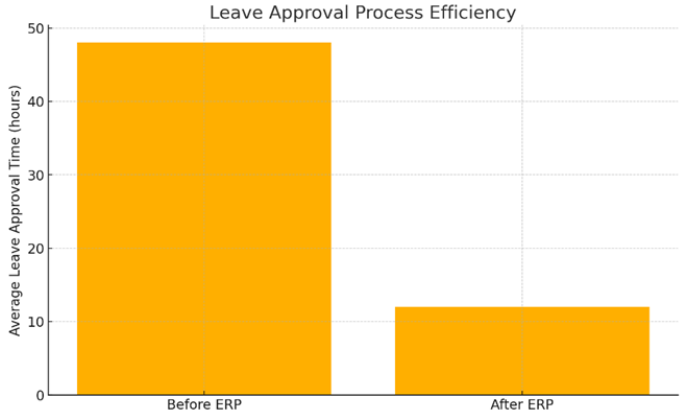
7.4 Employee Leave Processing Efficiency

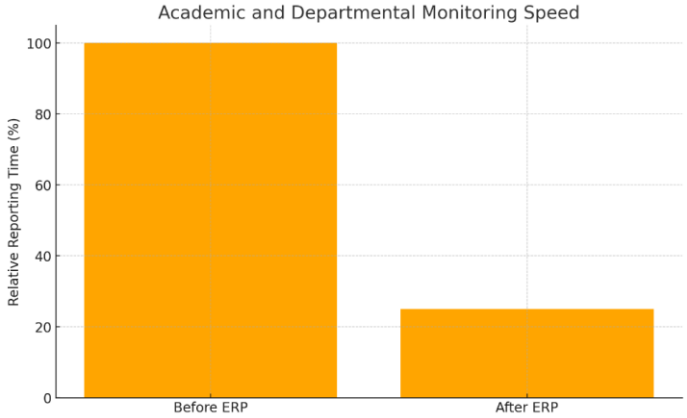
The ERP system improves the efficiency in the processing of the leave requests from the faculty members. The traditional system processed the leave requests for the faculty members through a manual form.

The proposed ERP system would increase the efficiency in the processing of the leave requests for the faculty members. The ERP system would provide a digital interface for processing the leave requests for the faculty members. The department heads would be able to process the leave requests for the faculty members through the interface of the ERP system.

From the results, it is clear that the ERP system would increase the efficiency in the processing of the leave requests for the faculty members.



7.5 Academic and Department Monitoring



This ERP system is useful for the department heads in monitoring the academic activities and the performances of the faculty members. During the course of handling the traditional system of academic management in the institution, it is necessary to collect the required information from various sources in order to monitor the activities of the faculty members and the performances of the students.

With the help of ERP, it is possible to maintain the academic information in a centralized manner. It is possible for the department heads to make use of the reports in order to gain better knowledge regarding the academic activities in their respective departments.

As per the findings obtained from this study, it is clear that ERP is useful in increasing the efficiency in the academic monitoring of the institution. It is useful in saving time while preparing the reports.

7.6 Comparative Analysis

The comparison between the manual system and the proposed ERP system shows the efficiency of the proposed system in the management of academic affairs. The proposed ERP system helps in the reduction of time spent in the performance of routine work and easy access of the data.

Task	Manual system	ERP system
Attendance Recording	15 min	3 min
Leave Approval	10 min	2 min
Academic Monitoring	20 min	5 min

The results show that the proposed ERP system is efficient in the management of the institution's workflow and provides faster access to the academic information of the institution. The cloud-based system can be accessed by many people at the same time.

7.7 Key Findings

The results obtained from the experimental evaluation clearly indicate the effectiveness of the proposed ERP system in improving the academic management efficiency. The integration of cloud-based services such as Firebase and AWS allows the centralized storage and access of the institution's data. The proposed system reduces the time taken for the performance of routine academic management activities compared to the traditional manual system.

The proposed system automates the attendance, leave, and academic management activities, improving the productivity of the faculty members and the staff. The centralized system architecture also improves the data access and transparency within the institution. The results obtained from the proposed system clearly indicate that the proposed system is an effective solution for the academic management of the institution.

8. Discussion

The ERP implementation significantly improves educational institutions functions by reducing the Human manual working effort and improving the relations between the different departments. It enhanced the work transparency, Reduced errors, and enabled the faster decision-making using the centralized and real-time data access

9. Conclusion and future work

9.1 Summary of Findings

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This research proposes a cloud-based ERP management system that designed to help in the effective management of academic and administrative activities in academic institutions.
The proposed ERP management system integrates several institutional activities using various cloud computing technologies like Firebase authentication, Firebase Realtime Database, and AWS cloud storage.
The experimental results demonstrates that the proposed system can help in the effective management of various academic institution activities. For example, the time required for the effective management of attendance management is reduced from 15 minutes to 3 minutes using the proposed ERP management system. This is a reduction of almost 80% when compared with the traditional system.
Similarly, the time required for the effective management of leave management is reduced from 10 minutes to almost 2 minutes using the proposed ERP management system. In the same way, the time required for the effective management of academic monitoring is reduced from 20 minutes to almost 5 minutes using the proposed ERP management system.

9.2 Research Contribution

The contribution of the research is in developing an ERP management framework that can efficiently manage academic and administrative activities by implementing cloud technology. The proposed system has the potential to provide mobile access, as well as cloud technology, for the management of academic activities in real time.
Unlike other academic management systems, which require manual processing of academic data or use different digital technologies, the proposed system enables the management of academic data in a centralized manner using authentication techniques in association with cloud technology. The use of Firebase technology in association with AWS cloud infrastructure enables the management of academic activities in a real-time manner in an efficient way.
The proposed ERP management framework is capable of efficiently managing the workflow of academic institutions by using academic monitoring, attendance, etc.

9.3 Limitations of the Study

Even though the proposed ERP system shows promising results in terms of the efficiency of academic management, there are some limitations identified in the current system implementation. The evaluation of the proposed ERP system was conducted in a controlled environment using fewer users from the institution. Hence, the performance of the system for large-scale institutional users needs to be evaluated.
Moreover, the current system implementation mainly focuses on the academic management activities such as attendance management, assessment management, and department management. Other management activities such as financial management, library management, and student counseling are not implemented in the current system.

9.4 Future Work

Some of the areas that could be improved in the future include the extension of the ERP system to enable it to incorporate other institutional modules such as financial management, library management, and student support services. In addition, the integration of other advanced technologies such as AI could help in the improvement of the system used for academic monitoring.
Some of the other areas that could be improved in the system include the integration of predictive models that could help in the identification of the students who need academic support. Other ways that could improve the system include the integration of other advanced security features and cloud computing infrastructure to enable the deployment of the system in other institutions.

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