

An improved Campus Student Management System Architecture based on User Satisfaction for Ethiopian Private Higher Education Institutions

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Abstract

This study aims to bridge the gap between the services offered by the Student Management System (SMS), which have not been thoroughly evaluated by investigating the factors that influence user satisfaction, identifying existing issues, and exploring alternative mechanisms and tools, this research aims to enhance the system's performance and align it with the requirements of registrar offices in private Higher Education Institutions (HEIs) in Ethiopia. The methodology employed in this study involves survey and case study methods. A survey was conducted using a self-administered data collection system to gather data from 385 users of the SMS who had previous experience using the system. User satisfaction was evaluated by examining three key areas: system quality, information quality, and service quality. Additionally, a case study was conducted using a Scenario-based approach to the System Architecture Analysis Method (SAAM) in two selected private HEIs. The findings indicated that the overall user satisfaction with the campus SMS was moderate, highlighting the need to identify and address gaps and improve the architecture of the campus Student Management System. Overall, this study provides valuable insights into user satisfaction with the campus SMS in private HEIs in Ethiopia and contributes practical improvements to the system architecture.

Keywords: Student Management System, User Satisfaction, System Architecture

1. Introduction

Ethiopia's Higher Education (HE) and Technical and Vocational Education and Training (TVET) system has played a major role in the development of the nation and economy, and will have an even more critical role to play in the coming decades as Ethiopia seeks to rebuild an innovative, knowledge-based economy that provides sustainable employment opportunities and achieves middle-income status in the near future. Tertiary education

plays a fundamental role in enabling every citizen to realize their full potential and in generating new ideas through research and community service, forming the foundation for wider developments in the country. Ethiopian tertiary education has seen exceptional development in recent years, with the number of institutions growing from less than ten to hundreds. The scale of investment in the system has expanded considerably; however, the quality and relevance of its outcomes still fall short of expectations. [1]

ICTs play an enabling role in achieving the goals of the education sector. Teaching and learning in the digital age has become increasingly flexible, interactive, and student-centered. Neither Higher Education (HE) nor Technical and Vocational Education and Training (TVET) can afford to ignore the potential of online and blended learning design to transform the way their staff teaches and their students learn, now and in the future. Research collaboration is now unthinkable without the use of ICT. [1]

The use of technology is changing the way things are done, including work in higher education institutions where the teaching and learning processes require significant improvement. Recognizing that automation systems are essential tools for facilitating academic activities and saving time and manpower, owners of private higher education institutions in Ethiopia have invested heavily in establishing internet services in their schools. The internet services provided have had a major impact on the university context, organization, and teaching and learning methods. Today, the situation demands digital transformation for all industries, and education is the most important sector seeking digital transformation. Automation in education has various benefits for management, administrative staff, administration, and students. Automation is a method or technique of operating and controlling a single or different process, with its core focus being to minimize manual work in repetitive tasks. It helps teachers, faculties, and administrators to focus more on proper teaching and learning processes for students. Many higher education institutions face challenges in bringing together various concerned bodies of institutions to fulfill the teaching and learning process in controlled and manageable ways. To manage every task and activity of the institution, a technology-enabled transformed automation tool like a student management system is necessary. This system has the requirements and capabilities to easily control and manage student management services, course management services, attendance management services, administration management services, document management services, and employee management services [2], [3]. In all private and public higher education institutions, registrar offices are the backbone of the teaching and learning process. The college registrar's office provides services for students, faculty, and staff of the college or university. During student applications for admission, the registrar officer collects all necessary documents, registers them in a specific department, provides timely and accurate course listings or registration slips, students' academic records, academic performance, student statistics, and attrition data [3], [4].

Higher education institutions' registrar offices use a Student Management System to accurately perform and manage their tasks. This computer system is one of the most fundamental requirements and provides complete information about students' courses, grades, faculty, and the educational institution. As a registrar and data analyst with several years of experience in both public and private higher institutes, I have observed that while the system design is fully automated, there are difficulties in using it, particularly in private higher education institutions. Therefore, my motivation is to conduct research that identifies, evaluates, and explores gaps in the system's architecture and contributes to its improvement, specifically in a private higher education institution.

2 Literature Review

In accordance with [5], both private and public higher education institutions are increasingly adopting automated systems to streamline administrative tasks and enhance the teaching and learning process. This modernization involves the use of cloud, mobile, and digital technologies to improve operational efficiency and overall institution management, aligning with the institution's mission and objectives.

Incorporating technology in academic institutions, as suggested in [6], improves registration and course management through online forms, notifications, adaptable curricula, and Course Management Systems. It enhances teaching and learning, aids instructor evaluation, and helps students track progress efficiently.

To prevent communication gaps in academic institutions, [7] suggests implementing a web-based management system for seamless communication among students, administrators, staff, and teachers through various channels. This system also automates student record management, including attendance and discipline, easing the workload on instructors and enhancing operational efficiency. Additionally, it assists in tracking financial activities, such as fee collections, for improved financial management. As per [9] and [10], User Information Satisfaction (UIS) relates to user beliefs about system expectations. [8] revised the User Information Satisfaction Model, emphasizing user and organizational characteristics as fundamental factors influencing expectations. The model incorporates user, organizational, and system characteristics, which, when aligned or disconfirmed, determine user satisfaction or dissatisfaction. The EUCS model, as described in [11], gauges end-user computing satisfaction by considering factors like content accuracy, format, ease of use, timeliness, precision, reliability, currency, completeness, and format across various computer applications.

Three key software architecture evaluation methods are discussed: SAAM, ATAM, and CBAM [12], [13]. SAAM focuses on quality attributes like Modifiability and has six evaluation steps. It involves External Stakeholders, Internal Stakeholders, and the evaluation team. ATAM comprehensively assesses quality attributes like Performance and

has nine steps, involving similar stakeholder roles. CBAM emphasizes economic aspects, considering costs and benefits in its six-step process and involving the same stakeholder roles. Additionally, ALMA assesses modifiability with a five-step process and similar stakeholder roles [12], [13]. The chosen method for this study is SAAM, which evaluates scenario-based software architecture.

3 Related Work

According to research [3], the computerized registration system proves to be highly significant in higher education institutions by facilitating efficient data retrieval and management. This system effectively controls the student registration process, reducing redundancy and minimizing time wastage. Notably, it simplifies registration for students compared to manual methods, though it incurs a high initial setup cost. Importantly, both staff and students found the computerized system user-friendly, expressing a positive preference for it. However, the study pointed out a potential issue with the receipt system. Overall, this research underscores the benefits of tailored computer systems for student registration in higher education, shedding light on their potential to streamline and improve the overall registration experience.

Research [4] conducted at the University of Ibadan, Nigeria, focuses on the user satisfaction of a web-portal system for postgraduate students. The study employs statistical analysis to assess how system quality, information quality, service quality, technological and infrastructural aspects, and IT self-efficacy influence user satisfaction. The proposed system addresses existing limitations and offers numerous advantages, including accurate tracking of student attendance and assessment marks, elimination of redundancy, centralized information access, real-time data retrieval, and SMS notifications to parents regarding student absences. Moreover, it facilitates various administrative tasks, streamlines course management, and provides distinct user roles for administrators, faculty, and students. This research serves as a valuable foundation for understanding student management systems, their efficiency, and their implications within an educational context, shaping subsequent investigations in this field.

In a study focused on assessing users' perspectives regarding a student information management system [14], various aspects such as accessibility, user interface, reliability, timeliness, convenience, and privacy/security measures were examined. The research utilized a descriptive survey method with a sample size of 370 participants selected through random sampling techniques. The collected data underwent analysis using statistical measures like average weighted mean, frequency, and ranking. The study's results overwhelmingly indicated high user satisfaction with the student information management system, with positive evaluations across all assessed dimensions. This suggests that the system effectively met user needs and expectations. The study

recommended a follow-up assessment to delve deeper into user perspectives and identify areas for potential system enhancements. Overall, the findings underscore the system's success in satisfying users and advocate for further research to continuously improve the system and gather ongoing user feedback.

4 Existing Architecture

For this study the researcher is select two private higher institutions were selected which is one of them used student management system and other school use the Integrated Student Management information system. The existing system architecture, identifying strengths and weaknesses through scenario analysis, user feedback, and stakeholder interviews. Two private higher institutions are chosen: one using a Student Management System and the other an Integrated Student Management Information System.

The Student Management System comprises these modules:

- User Authentication
- Registration Management
- Course Management
- Attendance Management
- Grade Management
- Report Generation
- Data Backup and Recovery.



Figure 1: Modules for Integrated Student Management Information System (ISMIS)

5 Research Methodology

This study focuses on Campus Student Management System user satisfaction and system architecture improvement in private Higher Education institutions. The research methodology employs both survey and case study methods to gain a comprehensive understanding. Private Higher Education institutions are chosen due to their role in producing graduates, with the researcher's experience as a registrar in a medical college in Addis Ababa informing the focus. The study follows a mixed-methods approach, combining qualitative and quantitative research methods to gain deeper insights. The case study provides qualitative analysis, while the survey gathers quantitative data from a broader sample.

The data collection and analysis techniques include:

Questionnaire: A Likert scale-based questionnaire assesses user perceptions of current system practices, focusing on information quality, system quality, and system services provided by the student management system. It aims to gauge user satisfaction with the system. The Likert scale measures attitudes from (5) strongly satisfied to (1) strongly dissatisfied. The questionnaire gathers user opinions and attitudes about the system's effectiveness from their perspectives.

Interviews: Interviews are conducted to verify information gathered from the questionnaire. They help fill gaps and gather insights not covered in the survey. Separate interview guides are prepared for staff members of the registrar's office to explore their views on system management and decision-making.

Observation: The observation technique is used during visits to the registrar's office to assess the status of the student management system and observe user interactions. It involves two types: user interaction observations and workflow observations.

Case Study: Two private higher education institutions, chosen for their effective and long-term use of a student management system, are studied. The researcher's experience provides valuable data for the study.

Reliability and Validity:

Reliability: The study uses Cronbach's alpha to assess reliability. A value of 0.91 indicates strong internal consistency and reliability.

Convergent Validity: The Average Variance Extracted (AVE) is used to establish convergent validity, which ranges from 0.568 to 0.710, suggesting good validity.

Sample Design: Clustered sampling is employed. Private Higher Education Institutions in Addis Ababa are classified into three clusters (University, University College, and College), and two institutions are selected from each cluster. The sample size is 381.

Data Analysis: Data is analyzed using SPSS, and the architecture improvement process includes various steps such as requirements gathering, goal setting, analysis and validation, gap analysis, documentation, technology selection, design decisions, and iterative updates.

6 Data Analysis and Findings

6.1 Demographic Characteristics of the Sample

A total of 381 questionnaires were distributed from which 371 were returned which accounts to a 98% response rate. However, 10 questionnaires (2% of the total questionnaire distributed) were rejected due to high missing values.

The purpose of respondents was asked to state their gender to ensure that both gender groups were covered by the study. Out of 371 total number of respondents using Student managements system in private higher education, 181 (48.8%) of total respondents were male and 190 (51.2%) were female.

6.2 Level of User satisfaction of Student Management system

In this study, we conducted a comprehensive evaluation of a student management system in higher education institutions, seeking to gauge user satisfaction across three key dimensions: system quality, information quality, and service quality. Through surveys targeting both respondents and direct system users, we aimed to assess the system's effectiveness in facilitating teaching and learning, as well as streamlining administrative processes. Utilizing descriptive analysis, we examined each variable and overall user satisfaction to determine whether the system met the expectations and needs of stakeholders, including school registrars, administrators, students, and staff.

Based on the survey for Overall mean for system quality is 3.7746 which indicate that this variable is acceptable and the respondents are positive and agree with the quality of the system is satisfied. Overall mean for information quality is 3.7533 which indicate that this variable is acceptable and the respondents are positive with the information quality of the system is satisfied. Overall mean for service quality is 3.6443 which indicate that this variable is acceptable and the respondents are positive and agree with the service quality of the student management system is satisfied.

According to Figure 2, The research findings highlight low mean values in areas such as Student Management System accessibility, timeliness of information provision, and user satisfaction during interactions. These findings signify specific areas of user dissatisfaction and unmet expectations. To address these issues, the researcher will investigate the underlying causes through methods like reviewing existing studies, conducting user interviews or focus groups, and observing real-world interactions. This information will

guide efforts to enhance

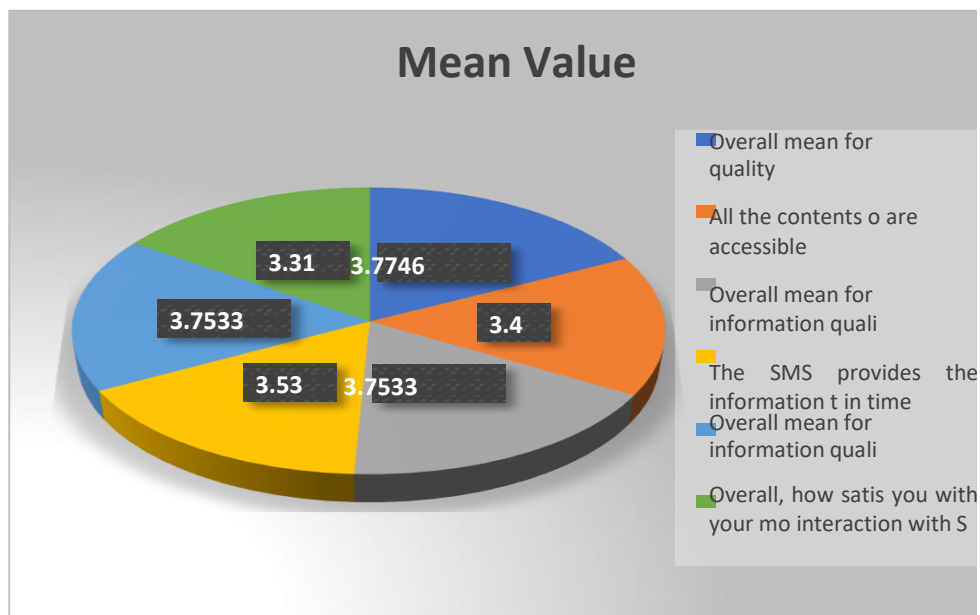


Figure 2: Overall mean values

6.3 Scenarios for Architecture of Campus Student Management System

Scenario 1: Adding a new student to the system

On the activities to add new students to the Campus Student Management System by the Registrar or Assistance registrar taking time and sometimes it makes Data entry errors: The process of adding new students to a student management system involves entering a lot of data, including personal information like Name, Date of birth, academic history, and other details. This data entry process can be prone to errors, which can cause problems. So, allow the system to fetch data from forms filled by students for this reason a modification on the architecture of a system will be done by adding new database tables or modifying existing tables to store student information, or adding new forms and user interfaces to allow students to input their information directly into the system.

Scenario 2: Integrations

To enhance the functionality and adaptability of the student management system within colleges, it is imperative that it seamlessly integrates with system accessibility, improve information timeliness, and address user satisfaction concerns, ultimately leading to a more effective Student Management System. Other vital software systems like the library management system (KOHA) and the financial management system. This integration necessitates a forward-thinking architectural approach, prioritizing design elements that facilitate such interoperability. Techniques such as web services and APIs should be employed to enable efficient data exchange and compatibility between systems.

Furthermore, adopting a modular architecture ensures flexibility, allowing for the effortless incorporation of new integrations as the evolving needs of the institution require, thereby creating a more cohesive and efficient digital ecosystem.

Scenario 3: Adoption of Cloud-Based Solutions

The adoption of cloud-based solutions among Private Higher Education Institutions in Ethiopia is driven by several key factors. Firstly, cloud solutions prove cost-effective, eliminating the need for substantial hardware investments, making them accessible to institutions with budget constraints. Additionally, their accessibility from anywhere with an internet connection enhances convenience for students, teachers, and administrators. Cloud systems offer scalability, allowing easy adjustments to match organizational needs without extensive hardware upgrades. They also provide robust data security measures, safeguarding against cyber threats more effectively than local installations. Moreover, cloud service providers typically offer high reliability and uptime, reducing downtime. Nevertheless, challenges like limited internet connectivity in certain regions and concerns regarding data privacy and security persist. As Ethiopia's internet infrastructure improves, the adoption of cloud-based solutions, including Integrated Student Information Management Systems (ISIMS), is poised for continued growth.

Scenario 4: Remove unnecessary modules from the system

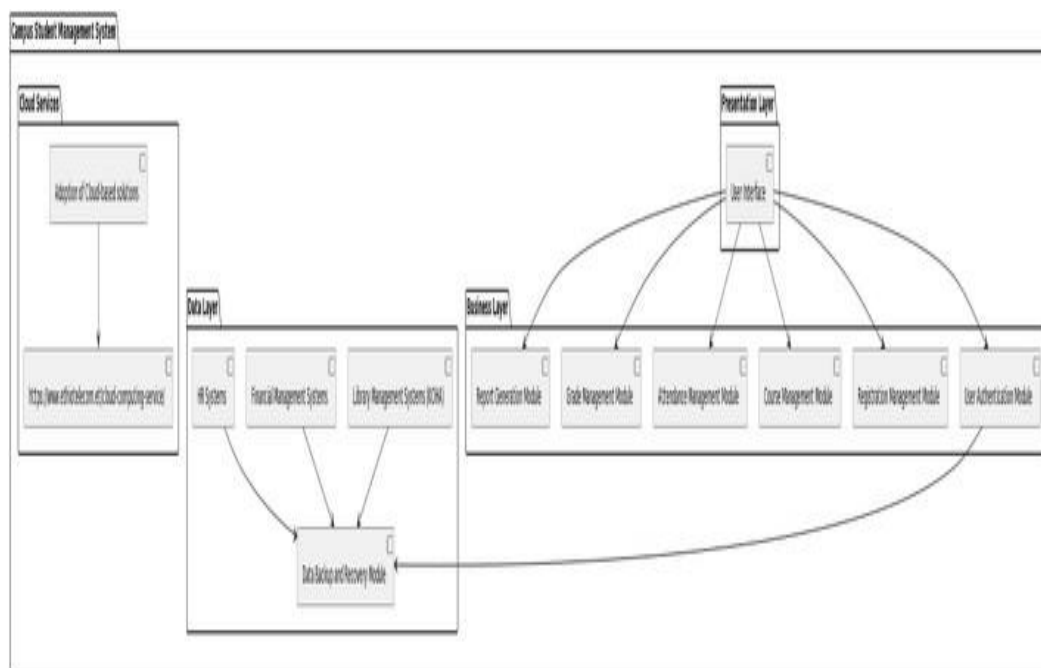
Organizations often grapple with the challenge of managing information systems that have accrued unnecessary modules over time, negatively affecting system performance and cost-effectiveness. To tackle this issue effectively, a comprehensive analysis was conducted, delving into system usage patterns, module interdependencies, and their potential impact on the overall system. This analysis aimed to identify and eliminate any redundant modules, a strategy supported by previous studies [15], [16], which have demonstrated that such removal can lead to substantial enhancements in performance, cost savings, and improved usability. Factors contributing to the accumulation of unnecessary modules often stem from inadequate planning, communication gaps between stakeholders, and a focus on short-term gains rather than long-term sustainability. To address these challenges, organizations can implement a systematic approach to system planning and development, foster collaboration among stakeholders, and prioritize sustainable development practices.

In this specific scenario, the system modules, and based on insights gained from the researcher's experience and interviews with system users, the Department Placement module and its sub-modules were identified, including Student Application and Record Management, Placement Decision Making, and Placement Notification and Acceptance. These functionalities enable administrators to establish placement criteria for students in specific departments or programs, communicate placement decisions to students, and

monitor student progress while generating related reports. However, it was observed that these functionalities hold greater significance for Ethiopian Public Universities rather than Private Higher Education Institutions in Ethiopia. By evaluating component dependencies, it became evident that the Department Placement module relied on the Admission Management module, but its utility within the campus was limited. Therefore, the recommendation is to remove the Department Placement module from the system to enhance performance and reduce complexity, especially in the context of Admission processes in Ethiopian Private Higher Education Institutions, which typically adhere to specific Admission Criteria set by the Ministry of Education (MoE) or the FDRE Education and Training Authority, allowing students to directly join specific departments based on fulfilling the criteria and institutional acceptance rates.

7. Improved Architecture and Discussions

According to those scenarios the architecture of the campus Student Management System has been improved in a way that is shown in the figure 3 below, which also presents the scenarios mentioned above with their explanations.



User Authentication Module - This module is responsible for authenticating users who want to access the system. It provides a secure login interface that allows users to enter their username and password to gain access to the system.

Registration Management Module - This module manages the registration process for

students. It allows students to register for classes, add and drop classes, and view their schedules.

Course Management Module - This module manages the courses offered by the institution. It allows administrators to add new courses, modify existing courses, and delete courses that are no longer offered.

Attendance Management Module - This module manages student attendance records for each class. It allows instructors to take attendance, view attendance records, and generate reports.

Grade Management Module - This module manages student grades for each class. It allows instructors to enter grades, view student records, and generate reports.

Report Generation Module - This module generates various reports related to student data, such as attendance reports, grade reports, and registration reports.

Data Backup and Recovery Module - This module is responsible for backing up student data to ensure that it is not lost in case of system failure. It also allows for the recovery of lost data if needed.

New Forms and User Interfaces - This includes new user interfaces and forms that allow students to input their information directly into the system, such as online registration forms.

Integrated Systems - This refers to the integration of external systems, such as Library Management Systems like KOHA and Financial Management systems and HR systems. This allows for seamless data exchange and better management of resources.

Cloud-based Solutions - This involves the adoption of cloud-based technologies to store and manage student data [17]. This allows for easy accessibility, scalability, and cost-effectiveness.

7.1 Validation of Improved Architecture

The validation of the improved system architecture involves confirming its alignment with user needs and defined requirements. This process incorporates requirements verification by assessing whether the architecture fulfills both functional and non-functional requirements. User feedback, obtained through interviews, plays a crucial role in validation, helping identify areas for improvement. One notable enhancement is the implementation of a user-friendly interface and data entry form, reducing errors and enhancing efficiency within the Campus Student Management System. Another improvement involves addressing slow performance during peak usage periods through hardware and software optimizations rather than costly load balancing. Lastly, the

integration of library management system KOHA and financial management systems offers benefits like improved efficiency, data accuracy, and streamlined processes, though considerations like data security, user training, and ongoing maintenance are essential to successful implementation.

The fourth improvement implemented is the adoption of cloud computing, recognized as a crucial step in meeting business requirements efficiently and a key component of digital transformation. With major public cloud providers like AWS, Azure, and Google Cloud experiencing substantial growth, cloud computing offers various models and deployment options to enhance the Campus Student Management System's architecture, aligning it with industry standards and user needs.

The fifth enhancement focuses on removing unnecessary system modules to create a more streamlined and efficient system, which, after gathering feedback from users, has proven to be a productive exercise. This effort emphasizes the significance of system performance, highlighting how eliminating redundant modules can lead to increased efficiency, benefiting both the registrar office and students.

Additionally, it addresses the adverse impact of unnecessary modules on system responsiveness and complexity while underlining the advantages of simplifying the system for improved user experience. Careful planning, including impact analysis, necessary modifications, and thorough testing, is crucial when removing modules. Furthermore, user feedback remains vital throughout these changes, ensuring that adjustments align with user expectations and enhance system performance.

7.2 Discussions

Through interviews with staff members from private higher education institutions, the strengths and weaknesses of the current Campus Student Management System were evaluated. While the system offers essential tools like user authentication, student enrollment, course management, grade management, and reporting tools, it also exhibits weaknesses, including usability issues, limited customization options, technical infrastructure challenges, and integration difficulties. User feedback highlighted problems such as slow performance, interface comprehension difficulties, and inadequate user training and support. Achievements of the system include improved administrative efficiency, enhanced data accuracy, streamlined processes, and increased user satisfaction. Cost-effectiveness was considered, encompassing implementation, maintenance, and training costs, as well as long-term benefits such as reduced administrative overhead. Future improvements involve continuous user research, enhanced user experience, ongoing support, and addressing customization limitations, infrastructure issues, and integration challenges.

The observational study of the Campus Student Management System identified user roles and tasks, including administrators managing admissions and records, faculty members handling grades and course materials, and students enrolling and accessing grades. Interface design varied among user roles, affecting navigation. Data entry and retrieval processes were observed for tasks such as student information input and grade retrieval, while system responsiveness was monitored, with response times noted. Error handling and recovery processes were observed when users encountered system errors. Overall user satisfaction was assessed, with administrators expressing high satisfaction, faculty members being moderately satisfied, and students finding the system straightforward. User feedback included suggestions for improved search functionalities, mobile accessibility, and interface customization options, providing valuable input for future enhancements to the system.

8. Conclusion, Recommendation and Future Work

A student management system is essential for private higher education institutions to provide efficient learning environments and services, aligning with government policies emphasizing education quality. However, challenges persist in ensuring that these institutions utilize modern technology effectively while upholding educational standards. Improper digital technology use significantly impacts information management. This study focused on two private higher education institutions, identifying gaps and making modest improvements in their campus student management system architecture. The Registrar office and staff members cited challenges such as inconsistent guidelines and budget allocation for system upgrades, and a lack of technology transfer from government institutions. Consequently, system updates and improvements vary among institutions, hindering uniform progress and efficiency.

In today's educational landscape, the role of digital technology cannot be overstated, particularly in the efficient management and monitoring of educational systems. Timely and accurate information delivery is crucial for ensuring quality education and effective training, enabling educational institutions to attract students and remain competitive. To achieve these goals, institutions often rely on software and IT companies offering systems like Student Management Systems (SMS) and Student Information Management Systems (SIMS) for streamlined communication and administration. However, there exists a prevalent lack of awareness and proficiency in utilizing modern technology for information management, particularly among private higher education institutions. To bridge this gap, it is imperative for software development companies to raise awareness and offer affordable solutions to institution owners and top-level managers, allowing them to harness the full potential of digital technology in education. Addressing challenges and ensuring efficient system monitoring is essential to fully unlock the benefits of digital technology in

the educational sector, facilitating seamless communication with education authorities such as the ETA and MoE.

Future research directions can encompass several key areas. First, a comparative study should investigate the variance in digital technology adoption for student management systems between private and government higher education institutions. This research can delve into the underlying reasons for any disparities, assess their impact on service delivery and educational quality, and uncover best practices that could be shared across both sectors. Strategies for efficient technology transfer between these sectors should also be explored, with a focus on overcoming challenges and barriers, and the development of frameworks or guidelines to facilitate consistent and equitable technology adoption.

Secondly, cost-effectiveness analysis is paramount to understand the financial implications of implementing and sustaining student management systems in private institutions. This analysis should encompass initial investments, operational expenses, and strategies to enhance affordability and sustainability for institutions with limited budgets. Additionally, research should delve into the training and capacity-building needs of staff responsible for system management, identifying knowledge and skill gaps and proposing comprehensive training programs to bolster staff proficiency and optimize digital system utilization. Lastly, research should examine the long-term sustainability of student management systems in private institutions. This includes addressing challenges related to system upgrades and maintenance while proposing strategies and guidelines for consistent resource allocation and budget management to support ongoing technological advancements.

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