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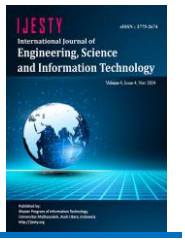

Design and Testing of a Web-Based Student Information Management System

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Abstract

Politeknik Piksi Ganesha is an institution of higher learning located in Bandung, Indonesia, specializing in engineering and technological curricula. The research's general objective is to describe the design and implementation of the web-based Student Information Management System (SIMS) to manage student data at Politeknik Piksi Ganesha Bandung. The functional and non-functional specifications are represented using Unified Modeling Language (UML) based on broad data collection through observation, interviews, and a literature review. It also entails black-box testing, which measures the system's performance against set criteria, focusing on the output without the details of its internal workings. The significant findings indicate that SIMS enhances highly administrative processes, accuracy in data, and good communication among stakeholders by applying clear UML diagrams of the system. This successful system development meets the institution's requirements and adds to the bar for other developments within the educational technology sector. The result has also emphasized the need for practical design methodologies and testing frameworks to develop reliable information systems to improve decision-making in academic institutions. The research has contributed significantly to the discipline because it has shown how different technological innovations can alleviate the problems surrounding managing student information at higher education levels.

Keywords: *Student Information Management System, Web-Based Application, Unified Modelling Language, Use Case Diagram, Class diagram.*

1. Introduction

Kasozi [1] describes universities as institutions of higher learning where knowledge is created, preserved, and disseminated. He highlights that the rise of private universities, driven by private entrepreneurs and philanthropists, has marked a shift in the dominance of traditional education providers. Although many of these institutions are not primarily profit-driven, they largely rely on tuition fees for survival. As educational institutions like schools, colleges, and universities continue to grow worldwide, the volume of student information has multiplied significantly. Managing this data manually has become increasingly difficult [2].

However, higher education faces challenges associated with technology and the delivery of education services. Neil Howe et al. [3] note that one of the significant trends is the shift in student needs, positioning students as customers and requiring service-oriented responses from institutions. Student expectations for faster, more economical, and personalized services have pressured universities to enhance the quality of services or risk losing enrollments to institutions offering better service. In response, universities have invested heavily in IT to improve operational efficiency and information flow. Relying on paper-based systems to handle such large amounts of information leads to various issues such as redundancy, inaccuracy, inefficiency, inconsistency, difficulty accessing data, and security risks.

To overcome these challenges and ensure more efficient, error-free management, student information management systems (SIMS) were developed. Adopting database models has improved student records' structured and organized storage, reducing data redundancy and updating errors while enhancing data consistency and integrity. This system also facilitates easy access to information and boosts data security, benefiting students, lecturers, and university administrators. The primary aim of implementing a student information management system (SIMS) is to streamline the management of college activities. SIMS can manage many details, such as student information, lecturer data, class schedules, course details, and fee payments. It also provides functionality for enrolling students, registering them in courses, recording grades and transcripts, calculating test results, tracking attendance, and handling other student-related information needs in educational institutions [4].

2. Literature Review

2.1. Review of Related Research Work

Previous studies have examined systems similar to the one proposed in this research, with different findings and analyses provided by the researchers. For example, in the "Design and Implementation of Student Academic Record Management System" research, A.A. Eludire [5] developed a student registration and course management database using Microsoft Access 2003. This system helped address data redundancy issues and outdated information in student files. Eludire discussed the challenges of selecting a suitable database model, interface design, system deployment, and maintenance. He also projected record growth in student population and system requirements.

Ngawang T. et al. [6] redeveloped a "Student Information System" first built by Dechen Wangmo [7], utilizing the PHP Laravel framework and MySQL database. Their system managed various student-related tasks such as registration, course enrollment, fee tracking, and student performance remarks. The second version, developed in 2016, was deployed by the college. It allowed students to upload information, enroll in courses, and view feedback from tutors, and it included a backup feature. However, after testing, it was found that the system worked best on Firefox and Chrome, limiting its efficiency on other browsers.

Shaimaa Q.S. et al. [8] (2017) implemented a "Student and Alumni Web Portal" using MySQL, HTML, CSS, JavaScript, jQuery, PHP, and AJAX. This robust system featured two subsystems for students and alums. The system's usability was tested using the System Usability Scale (SUS) method. Key features included messaging, grade objections, and access to exam announcements. However, a major shortcoming was that students could not update their personal information, which is addressed in my proposed system, allowing students to update their details seamlessly.

2.2. Universities and Student Records Management

Kasozi [1] defines universities as "centers of higher learning where knowledge is created, preserved, and disseminated." Cyganski [9] defines information as "knowledge communicated or received about a fact or circumstance." In the context of student information, it refers to education records containing personally identifiable details related to a student. These records may include names, student IDs, addresses, family member information, and other personal characteristics.

Student or educational records can be stored in various formats, such as handwriting, printed documents, microfilm, digital memory, or magnetic tapes. These records can be submitted by the student or generated by the university and are used by university offices to support their institutional objectives, tracking student progress and achievements. Common categories of student records include (1) admission records, which become part of a student's academic file once they enroll, (2) cumulative academic records; (3) academic advising records, (4) financial records, (5) disciplinary records, (6) medical records, and (7) personal and career counseling records. These records must be processed into meaningful information to aid decision-making.

2.3. Data Management and Expectations of the Millennial Generations

The three dimensions of information—time, location, and form—align well with the expectations of the millennial generation, who value convenience and efficiency [10]. This generation expects high-quality services that are fast and available when needed [11]. Howe et al. [12] also note that millennial students anticipate using technology to enhance their educational experiences. Information is crucial for planning, decision-making, and implementation, both in general and for university administrators [13]. Quick and easy access to information is essential for making timely decisions. Watson [14] explains that information helps set goals, identify gaps, and determine the necessary actions to achieve objectives. Students need fast and easy access to information to decide their goals, the actions required to reach them, and the resources needed.

2.4. Web-Based Applications

As web applications become more integral to organizational strategies, the demand for reliable, usable, and adaptable systems has increased. These applications include entire websites, specialized functionalities within websites, and information processing systems accessible via the internet or an extranet. Star and Ruhleder [15], Checkland and Holwell [16], and Srikanthan and Dalrymple [17] suggest that web-based systems act as support infrastructure for users, offering access to a variety of data to help with university-related tasks. Such systems also enable informal information sharing and contact with others within the university (Amin and Cohendet, 2004).

3. Methods

This study uses a development method of student information systems with an object-oriented approach using Unified Modeling Language (UML) and black box testing. UML is a standardized language utilized for visualizing, designing, and documenting systems, often seen as a blueprint in software development [18]. Its primary objective is to streamline the software development process, ensuring the system effectively and accurately fulfills user requirements. One of the critical tools in UML for behavioral modeling is the use case. Use cases describe system needs and usage and are typically used to capture system requirements, outlining what the system should accomplish. The stages of the research are as follows:

3.1. System requirements analysis

In this stage, data collection and analysis of student information system needs at Politeknik Piksi Ganesha Bandung were carried out. The methods used are:

1. **Observation**: Directly observe the ongoing process of managing student data.
2. **Interviews**: Do question and answer with related parties such as academic administration staff to identify problems and needs of the system.
3. **Literature review**: Gathering information from various sources, including journals, books, and other relevant documents, with this research topic.

3.2. System design using UML

The stage includes system modeling using UML diagrams to depict student information systems' functional and non-functional needs. UML diagrams used include:

1. **Use Case Diagram**: Illustrates the interaction between an actor (user) and the system.

2. **Class Diagram**: Describes the system's structure in terms of defining classes that will be created to build the system.
3. **Activity Diagram**: Illustrates the flow of activities in a student information system.

3.3. System testing

System testing uses the black box testing method to ensure that the system functions as needed. The test is done on each module and feature of the student information system.

4. Results and Discussion

The purpose of this research is to analyze student information system design using UML diagrams and conduct the testing with the black box testing method. The results showed that using UML diagrams in designing academic information systems has a lot of benefits in understanding user requirements and system structure.

4.1. System design using UML

UML diagrams include use case diagrams, class diagrams, and activity diagrams. The employment of these diagrams assists the team in giving the following:

1. To identify actors and their interactions with the system
2. To define data structures and relations among entities in the system.
3. To describe the process flow within an academic information system.

4.1.1. Use case diagram

The author uses a use case diagram to effectively illustrate the interactions between users (actors) and the system being developed. The functions of this diagram can be summarized as follows:

1. **Visual Representation**: It provides an image of what the system does and how various actors operate its functionalities for easy understanding among stakeholders at high-level domain specifications.
2. **Communication Tool**: It enables communication among team members like developers, designers, or non-technical stakeholders by presenting a model language to discuss systems' requirements.
3. **Requirement Analysis**: The diagram reveals user requirements by describing how different users will use the system. This is essential during the early phase of software production to keep all customers' needs in mind before anything else.
4. **Scope Definition**: It helps define the system's boundaries in that what is internal and external are illustrated in the diagram, which is vital for managing project scope.
5.

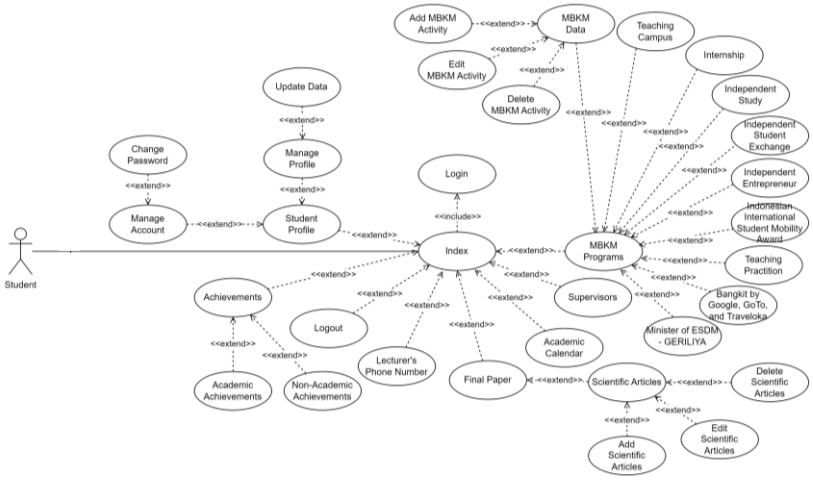

Fig 1. Use Case Diagram Of Student Information Management System

4.1.2. Activity diagram

Generally, an activity diagram for the author represents the processes and decisions followed in any given system. Hence, this makes their representation and understanding of complicated workflows easy. These summary diagrams depict sequences, conditions, and parallel activities in a particular use case or scenario, helping to tease out the latent logic behind any business process or operation. Activity diagrams help communicate methodology and results in a much more articulate manner by restricting the action, decision points, and interactions among varied participants, thereby helping to document and analyze research efforts in academic literature.

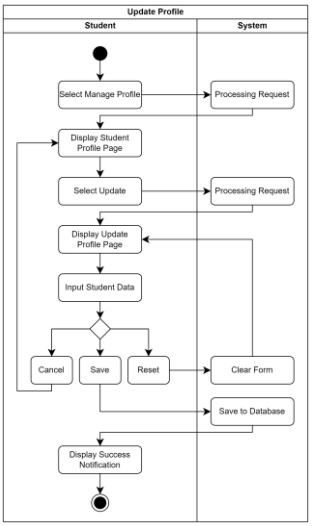

Fig 2. Activity diagram update data

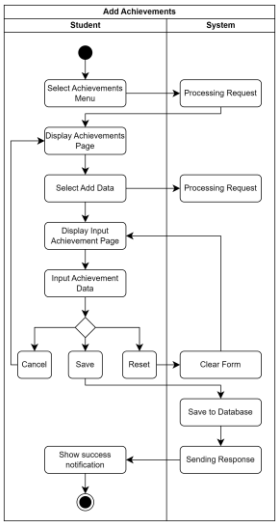

Fig 3. Activity diagram adds achievement

4.1.3. Class Diagram

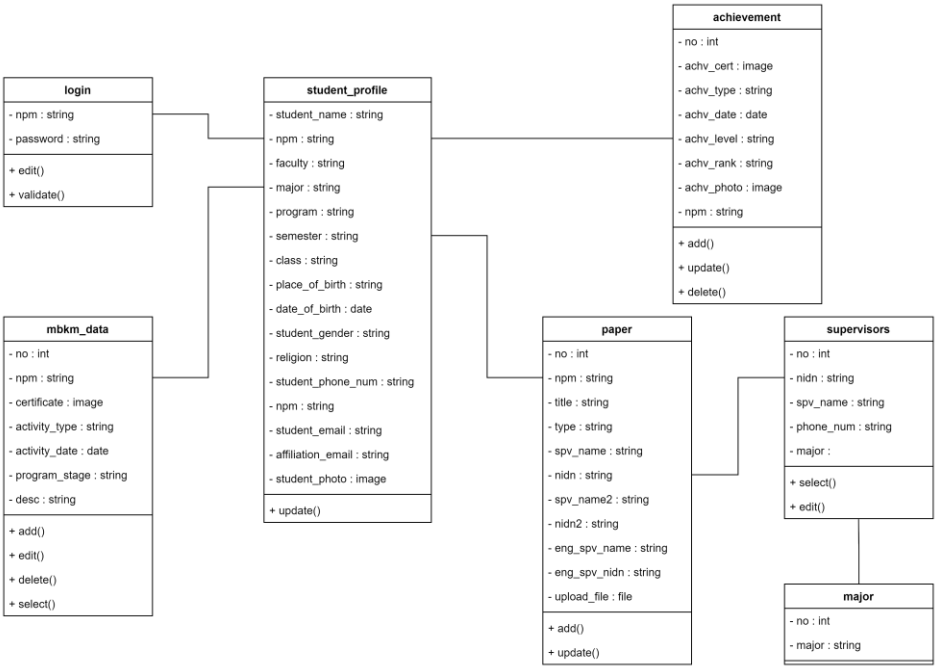

Fig 4. Class Diagram Student Information Management System

4.2. Implementation

a. Dashboard page

The function of this page is to serve as the main screen after login has succeeded.

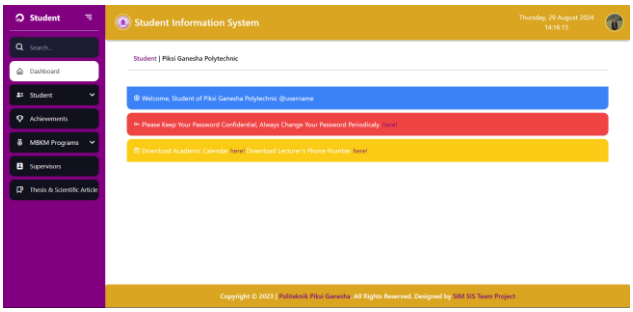

Fig 5. Dashboard page

b. Manage profile page

This page shows and edits student profiles.

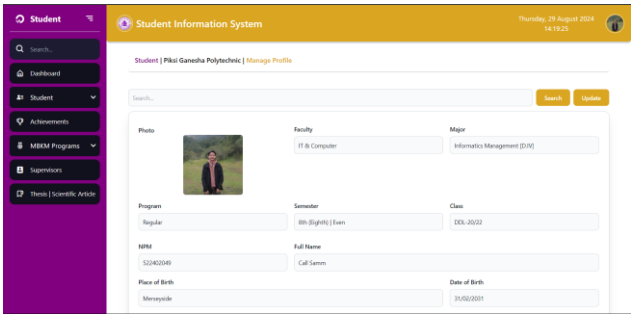

Fig 6. Manage student profile page

c. Achievements page

The function of this page is to show students' achievements.

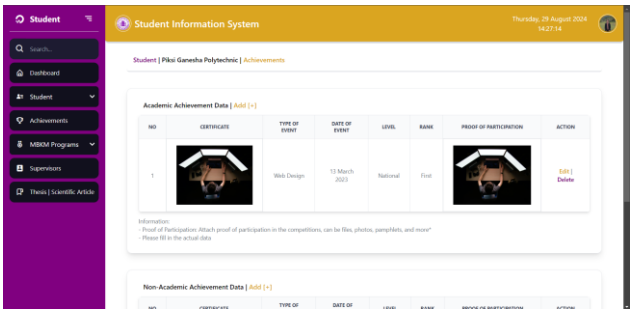

Fig 7. Student achievements page

d. MBKM data page

This page displays the MBKM activities that the student has done.

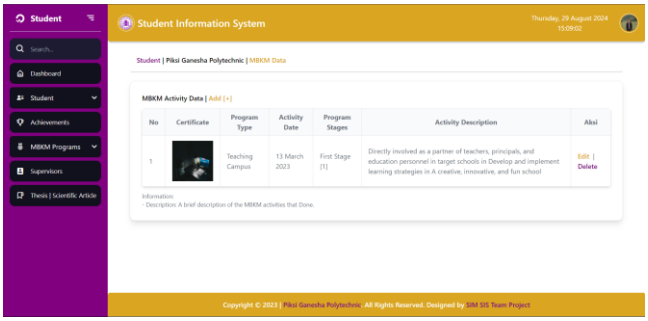

Fig 8. MBKM activity data page

e. Thesis page

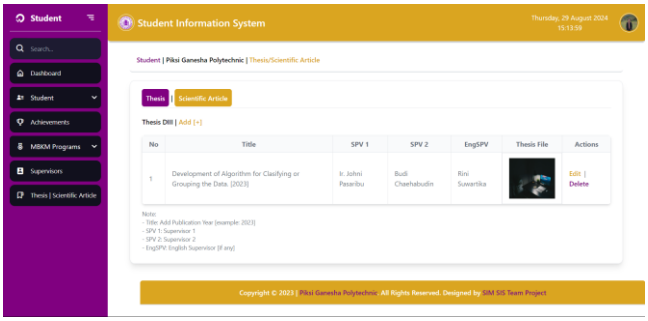

Fig 9. Thesis and scientific articles page

4.3. Testing

4.3.1. Student Data Test

Table 1. Upload Student Data Page Test Case

ID	Test Description	Expected Result	Test Result	Conclusion
A01	Input student data and click submit.	Data will be updated and saved in the system	Data stored successfully	Valid
A02	Update data by leaving the required section blank.	The system will refuse to save and give a notification to fill in the blank field.	The system gives a notification to fill the field	Valid
A03	Fill in the phone number field without following the pattern	The system will refuse to save and give a notification to follow the pattern	The system gives a notification to match the requested format	Valid

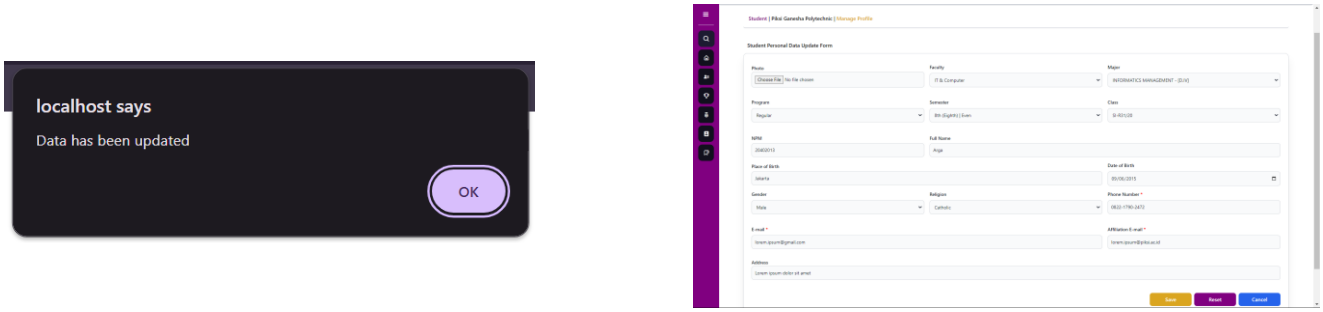

Fig 10. The student data has been successfully updated

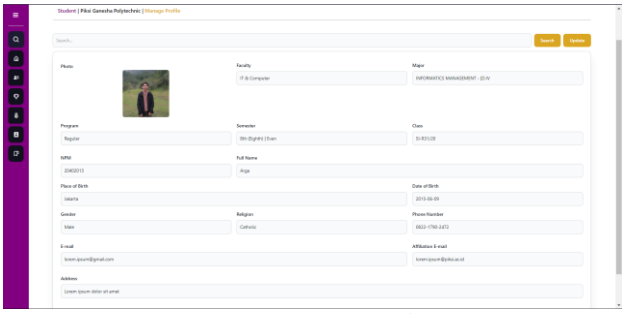

Fig 11. Display the stored student data from the database

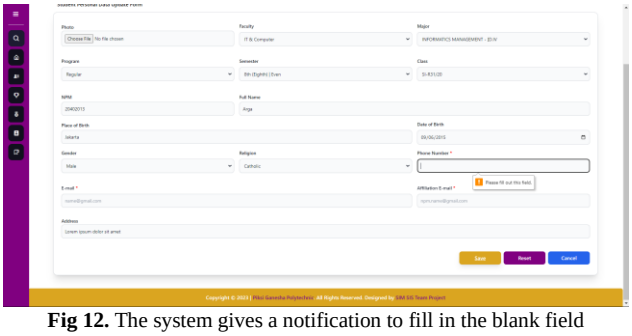

Fig 12. The system gives a notification to fill in the blank field

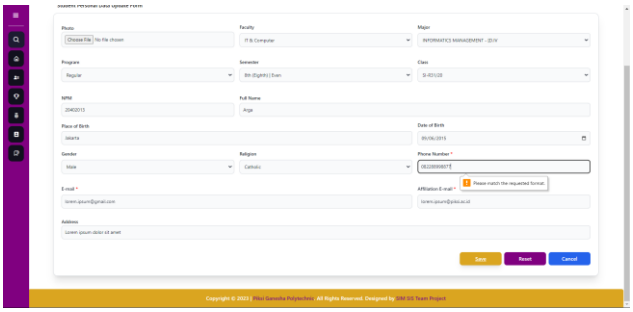

Fig 13. The system shows a notification to match the requested format

4.3.2. Thesis and Scientific Article Test

Table 2. Thesis and Scientific Article Test Case

ID	Test Description	Expected Result	Test Result	Conclusion
B01	Input data and click save	Data will be updated and saved in the system	Data stored successfully	Valid
B02	Click edit and change EngSPV and SPV2 field, then click save	The system will accept, and data will be stored in a database	Successfully update the data	Valid
B03	Click delete data on the action column	The system will show a success notification and delete data from the database.	The system deletes data from the database	Valid
B04	Insert blank form and click save	The system will refuse to save and show an error notification	The system shows a notification to fill the field	Valid

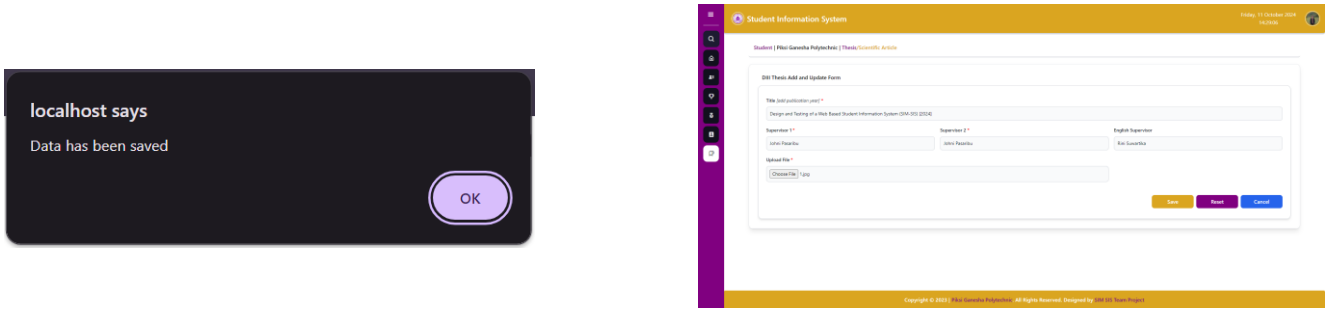

Fig 14. The data has been saved successfully

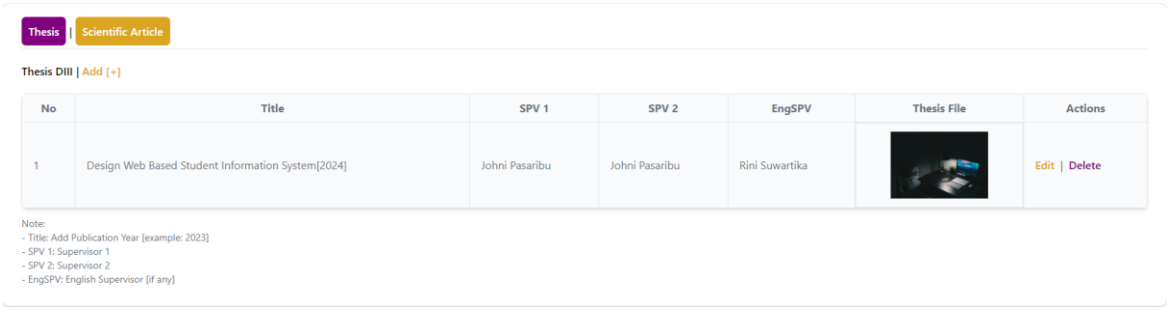

Fig 15. System displays the stored data from the database

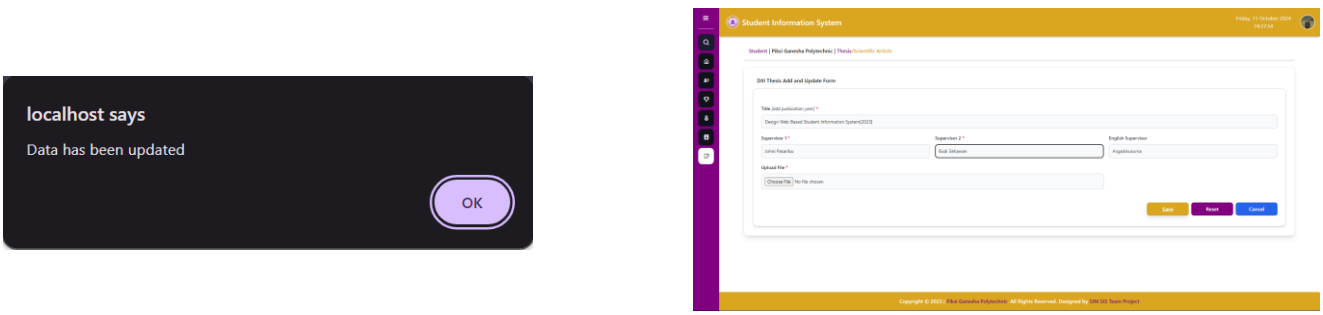

Fig 16. Data has been successfully updated

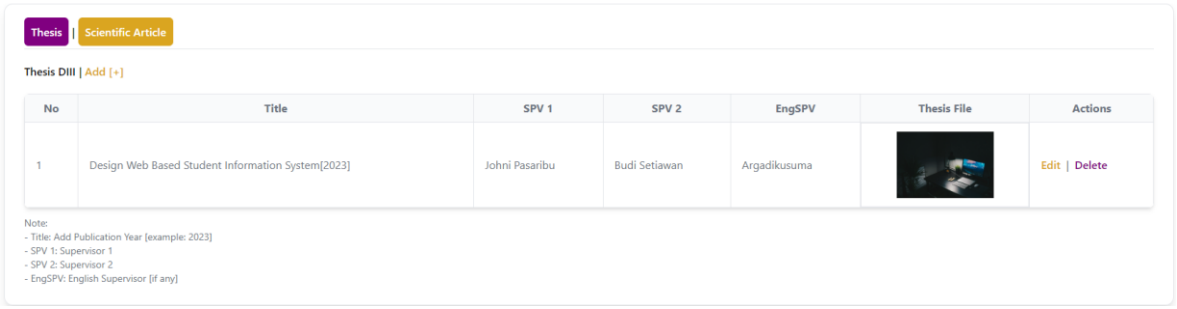

Fig 17. System displays the updated data from the database

Fig 18. System displays a deletion success notification

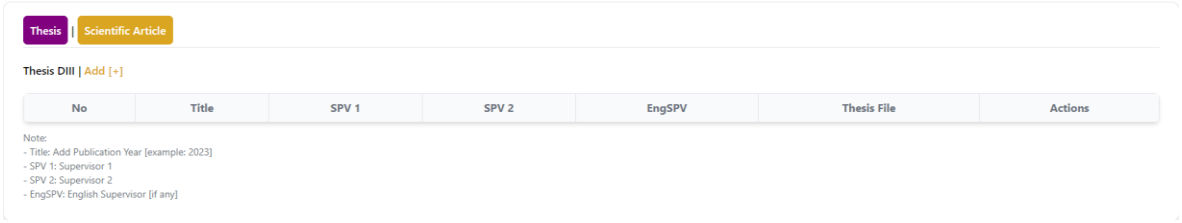

Fig 19. Data has been deleted from the database

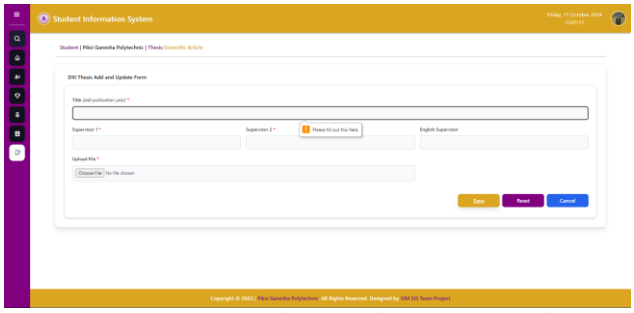

Fig 20. System shows notification to fill in the requested field

4.3.3. MBKM Data Test

Table 3. MBKM Data Test Case

ID	Test Description	Expected Result	Test Result	Conclusion
C01	Input MBKM data and click save	The system will save into the database and show a successful notification	The system shows a successful notification	Valid
C02	Click edit and change the Type of MBKM Program, then click save	The system will show success notification and update the data	The system shows a successful notification	Valid
C03	Click delete on existing data	The system will delete data from the database	The system shows a successful notification	Valid
C04	Click Add[+] and input blank field	The system will refuse to save and show a notification	The system shows a notification to fill the field	Valid

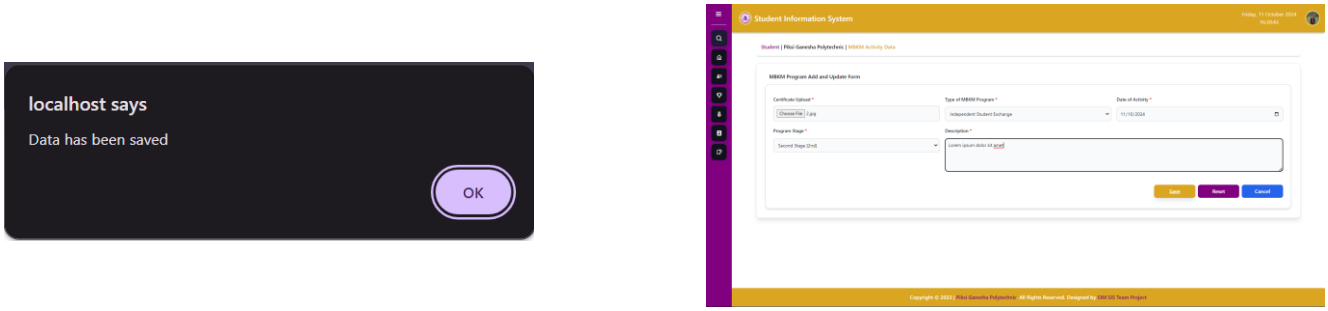

Fig 21. The system displays a success notification, and the data has been stored in a database

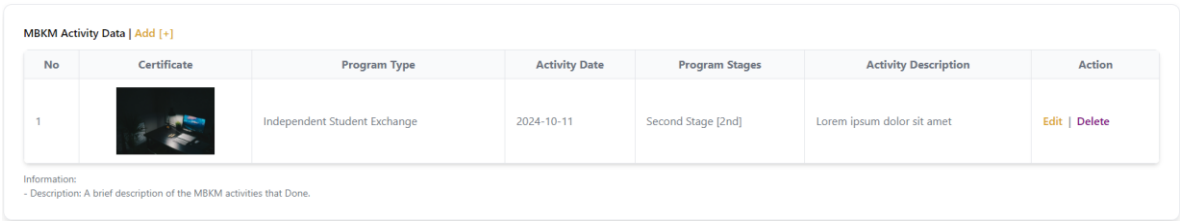

Fig 22. The system displays the stored data from the database

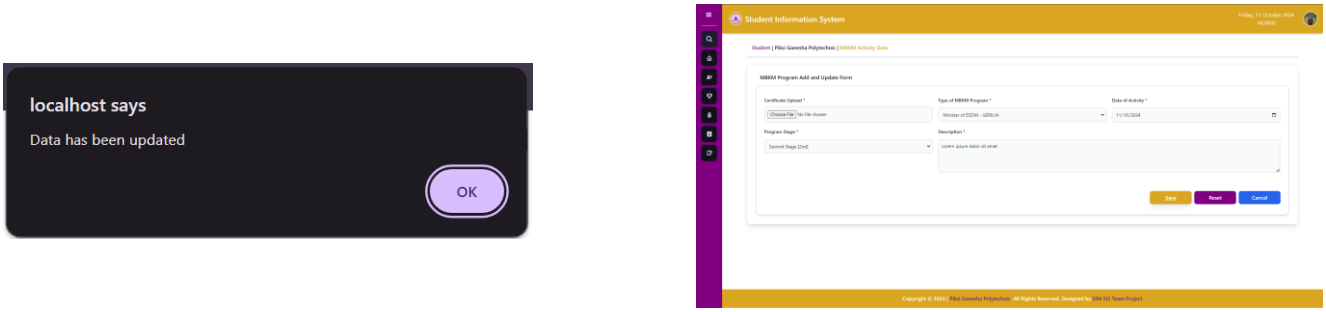

Fig 23. System displays a success notification

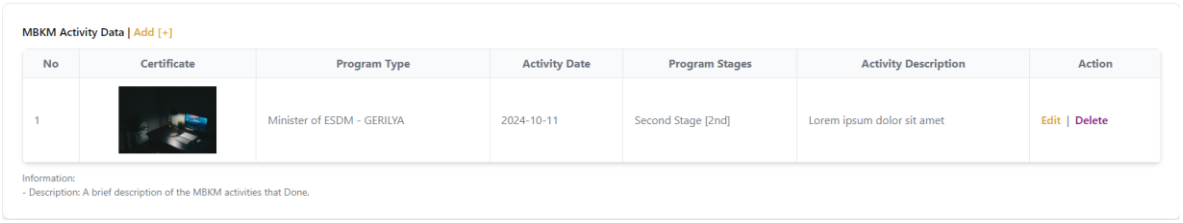

Fig 24. MBKM data has been successfully updated

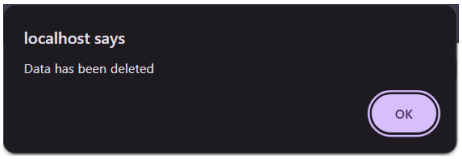

Fig 25. System displays a notification of successful MBKM data deletion

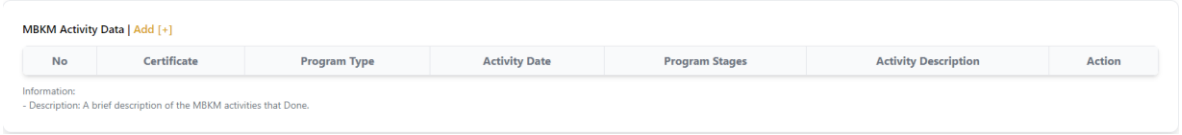

Fig 26. MBKM activity data has been deleted from the database

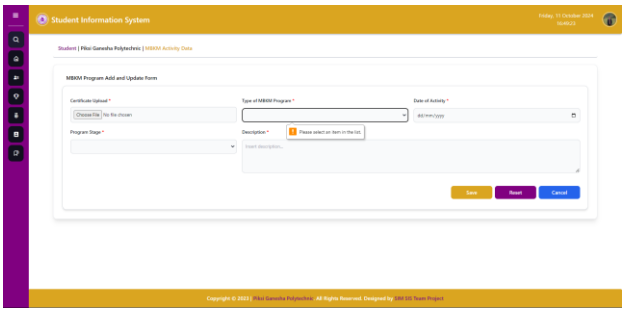

Fig 27. The system displays an error notification

4.3.4. Achievement Test

Table 4. Achievement Page Test Case

ID	Test Description	Expected Result	Test Result	Conclusion
D01	Input achievement data and click save	The system will show a success notification and save data into the database.	The system shows success notifications and data saved to the database	Valid
D02	Click edit on saved data and change rank from First[1st] to Second[2nd]	The system will show a success notification and save updated data into the database	Show success notification and successfully update the data	Valid
D03	Click delete on saved data	The system will show a success notification and delete data from the database.	The system shows a success notification, and data has been deleted	Valid
D04	Input achievement data with a black field	The system will show an error notification and refuse to save into the database.	The system shows a notification to fill in the blank field	Valid
D05	Input data on a non-academic form and click submit	Stored data will be shown on the non-academic table	Data shown on non-academic table	Valid

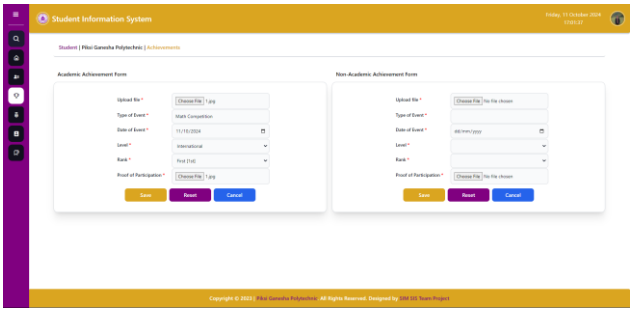

Fig 28. Achievement data has been successfully saved into the database

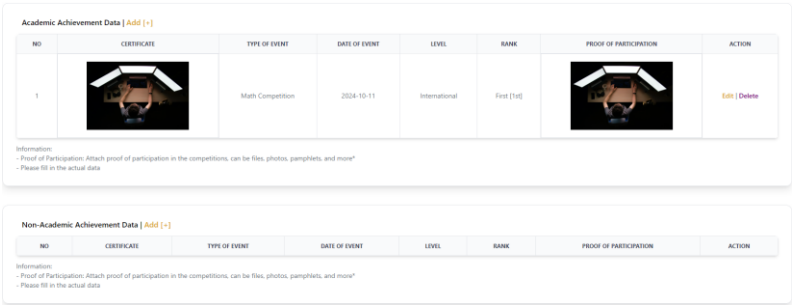

Fig 29. Display the saved achievement data from database

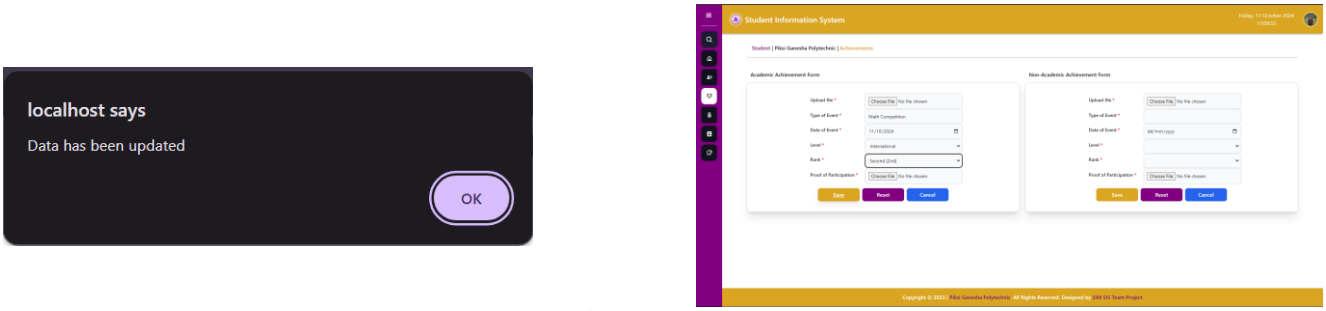

Fig 30. Successfully update the achievement data

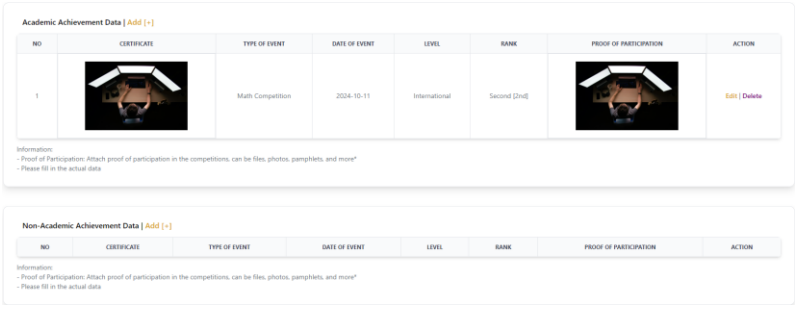

Fig 31. System displays the updated data from the database

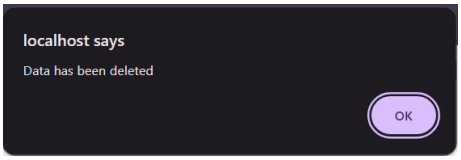

Fig 32. The system displays the notification of achievement data deletion

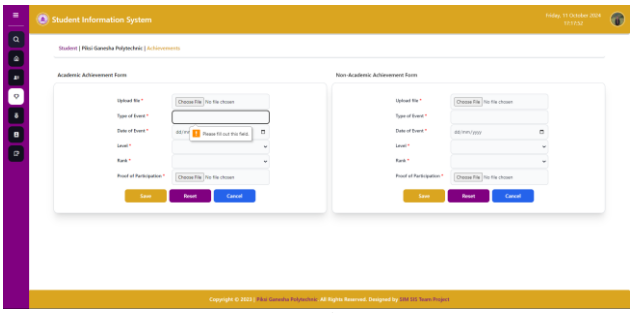

Fig 33. The system displays an error notification on the input achievement page

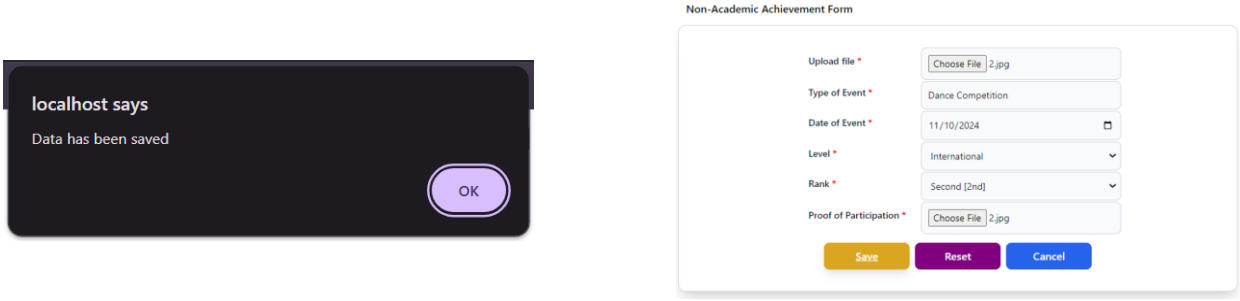

Fig 34. Input achievement data on non-academic form

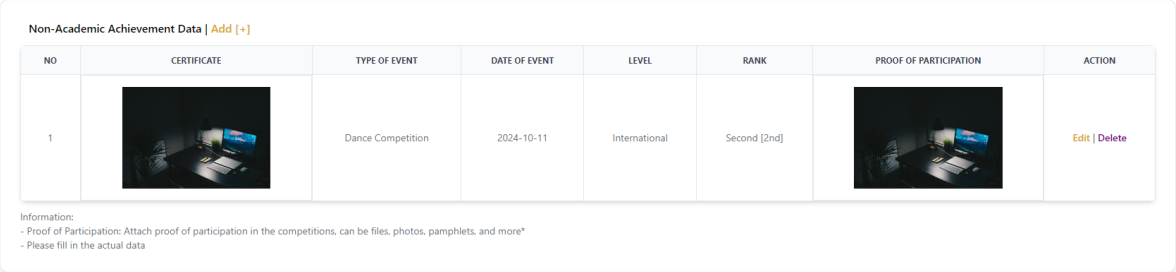

Fig 35. Data shown on non-academic table

5. Conclusion

The research reported in the journal describes the design and implementation of a web-based Student Information Management System (SIMS) of Politeknik Piksi Ganesha, Bandung, Indonesia. It has been indicated that there is a need for innovation concerning changes in student data through technology, as such information has lately increased while the efficiency of a paper-based system to handle them has become minimal.

The results show that the SIMS greatly enhances administrative efficiency by ensuring processes are appropriately optimized, and data accuracy improved. Using UML diagrams ensured communication among stakeholders effectively captured precise user requirements and fulfillment. Also, black box testing assured the system's dependability and allowed the detection and fixing of potential problems before the system could be launched.

Thus, the study identified that appropriate design and quality testing are crucial to developing educational technologies. The successful implementation of the SIMS had responded to immediate needs and created a bench against which future developments of educational data management systems would be measured. This guarantees efficient educational institutional operations toward better decision-making processes and improved services to students and administrators alike.

References

[1] A. Kasozi, University Education in Uganda: Challenges and Opportunities for Reform, Kampala, Uganda: Fountain Publishers, Kampala, 2003.

[2] e. a. Yu-Fang Tang, "Design and Implementation of College Student Information Management System Based on Web Services," in *2009 IEEE International Symposium on IT in Medicine & Education*, Ji'nan, China, 2009.

[3] N. &. S. W. Howe, Millennials Go to College: Strategies for a New Generation on Campus : Recruiting and Admissions, Campus Life, and the Classroom, Great Falls, VA: LifeCourse Associates, 2007.

[4] N. Gagliordi, "US universities at greater risk for security breaches than retail and healthcare: BitSight," 21 August 2014. [Online]. Available: https://www.zdnet.com/article/us-universities-at-greater-risk-for-security-breaches-than-retail-and-healthcare-bitsight/. [Accessed 18 October 2024].

[5] A. Eludire, "The Design and Implementation of Student Academic Record Management System," *Research Journal of Applied Sciences, Engineering and Technology*, vol. 3, no. 8, pp. 707-712, 2011.

[6] N. N. P. S. J. D. T. &. T. T. Tenzin, "Student Information System," *A Technical Journal of Science, Engineering and Technology*, vol. 3, no. 1, pp. 1-6, 2016.

[7] S. N. Dechen Wangmo, *Student Management System*, Phuntsholing, Bhutan: The College of Science and Technology, 2014.

[8] e. a. Shaimaa Q.S., "Design and Implementation of Student and Alumni Web Portal," *Science Journal of University of Zakho*, vol. 5, no. 3, p. 272 –277, 2017.

[9] D. e. a. Cyganski, Information Technology: Inside and Outside, New Jersey: Prentice Hall, 2001.

[10] J. W. Lowery, "Student Affairs for a New Generation," *New Directions for Student Services 2004(106):87 - 99*, vol. 2004, no. 106, pp. 87-99, 2004.

[11] R. a. H. M. Kvavik, "Transformation of Student Services: The Process and Challenge of Change," *Educause Quarterly*, vol. 2, pp. 30-37, 2000.

[12] N. &. S. W. Howe, Millennials Go to College: Strategies for a New Generation on Campus, American Association of Collegiate Registrars, 2003.

[13] S. Uwaifo, "Management use of records in Delta State University, Abraka, Nigeria.," *Records Management Journal*, vol. 14, no. 2, pp. 85-89, 2004.

[14] R. Watson, Data Management: Databases and Organizations, Michigan: Wiley, 2004.

[15] S. a. R. K. Star, "Steps toward an ecology of infrastructure: design and access for large information spaces," *Information Systems Research*, vol. 7, pp. 111-135, 1996.

[16] P. a. H. S. Checkland, Information, Systems and Information Systems, Chichester: John Wiley, 1998.

[17] G. a. D. J. Srikanthan, "Implementation of a holistic model for quality in higher education," *Quality in Higher Education*, vol. 11, no. 1, pp. 69-81, 2005.

[18] J. e. a. Pasaribu, Rekayasa Kebutuhan dan Pemodelan Sistem PL: Konsep, Teori dan Praktik dengan UML, Padang: Get Press, 2024.