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ORIGINAL

Class Information Display System to Enhance Real-Time Monitoring of Lecture Activities

Sistema de Visualización de Información de Clases para Mejorar el Monitoreo en Tiempo Real de las Actividades de Clase

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ABSTRACT

Introduction: Bali State Polytechnic faces challenges in monitoring offline and online lectures. This research aims to develop a lecture monitoring system in the form of a web application-based class information display system supported by a web API, in order to improve the effectiveness of lecture monitoring. This system integrates offline and online lecture data and provides a dynamic dashboard that displays lecture status, schedules, lecturer attendance and lecture recapitulation per department in real-time.
Method: this study uses a System Development Life Cycle approach. The system developed is connected to the Online Information System via the Web API to support seamless data retrieval and visualization. Features such as lecture status dashboard, detailed lecture information, attendance monitoring improve operational efficiency.
Results: the results of testing 30 respondents showed a high level of user satisfaction, ease of use, and system efficiency. By addressing the specific needs of lecture monitoring in a polytechnic environment, this study offers a comprehensive and real-time solution, which contributes to improving academic management and decision making.
Conclusion: the novelty of this study lies in the integration of offline and online lecture monitoring in one integrated web application platform that is easily accessible, providing a unique contribution to the digitalization of higher education management.

Keywords: Class Information System; Lecture Monitoring; Web Application; Higher Education; Digital Transformation.

RESUMEN

Introducción: el Politécnico Estatal de Bali enfrenta desafíos en el monitoreo de las clases presenciales y virtuales. Esta investigación tiene como objetivo desarrollar un sistema de monitoreo de clases en forma de una aplicación web que funcione como un sistema de visualización de información de clases, respaldado por una API web, con el fin de mejorar la efectividad del monitoreo de las actividades lectivas. Este sistema integra datos de clases presenciales y virtuales, y ofrece un panel dinámico que muestra el estado de las clases, los horarios, la asistencia del profesorado y una recapitulación de las clases por departamento en tiempo real.
Método: este estudio utiliza un enfoque basado en el Ciclo de Vida del Desarrollo de Sistemas (SDLC). El

sistema desarrollado está conectado al Sistema de Información en Línea mediante una API web para facilitar la recuperación y visualización fluida de datos. Funcionalidades como el panel de estado de clases, información detallada de las mismas y el monitoreo de asistencia contribuyen a mejorar la eficiencia operativa.
Resultados: los resultados de las pruebas realizadas a 30 personas usuarias mostraron un alto nivel de satisfacción, facilidad de uso y eficiencia del sistema. Al abordar las necesidades específicas del monitoreo de clases en un entorno politécnico, este estudio ofrece una solución integral y en tiempo real, que contribuye a mejorar la gestión académica y la toma de decisiones.
Conclusión: la novedad de este estudio radica en la integración del monitoreo de clases presenciales y virtuales en una sola plataforma web integrada, de fácil acceso, que aporta un valor único a la digitalización de la gestión de la educación superior.

Palabras clave: Sistema de Información de Clases; Monitoreo de Clases; Aplicación Web; Educación Superior; Transformación Digital.

INTRODUCTION

In the ever-evolving digital era, universities worldwide face challenges in managing academic activities efficiently, especially monitoring and managing lectures. Politeknik Negeri Bali (PNB), as a vocational higher education institution with various departments and study programs in both business and technology, faces this challenge. Before the information system, the lecture monitoring process at PNB was still manual, with no real-time information regarding lectures that had taken place or were taking place. This caused management to have difficulty in monitoring the status of lectures both offline and online and in making decisions that require fast and accurate data. The use of technology and information systems is effective and efficient in all administrative and academic activities,[1,2,3,4,5,6,7] and can improve the quality of education,[8] and quality of information.[9]

Along with efforts towards the digitalization of business processes in the university environment, PNB has developed several information systems to support its operational efficiency. One of them is a lecture monitoring system that can facilitate monitoring of lecture status, both lectures conducted offline and online. This system is expected to replace the manual method previously used and provide convenience in monitoring the number of classes running lecture status, and various information related to study programs and lecturers. Digitalization in the education sector, especially in lecture management, is the key to increasing efficiency and data accuracy in academic management. With an integrated digital system, universities can optimize academic information management, increase data transparency, and accelerate the decision-making process, all of which contribute to better quality education,[10,11,12,13,14,15] and increase competitive advantage.[16]

Digitalization in higher education can reduce administrative burdens, increase data accessibility, and facilitate more timely, informed decision-making. In addition, the implementation of appropriate information technology in the education sector can produce more accurate data and help more effective management of academic resources. Digitalization allows educational institutions to improve services and ensure that all data related to lectures can be easily accessed by all stakeholders. Integration of digital technology into the scope of education, namely integrated digital learning such as e-learning, mobile learning, digital learning, and ubiquitous learning.[17] Universities are undertaking digital transformation to meet the demands of today's generation.[18]

Several previous studies have examined academic management information systems in various universities.[10,20,21,22] Although many universities have implemented information systems to support education management, there is still little research that specifically discusses lecture monitoring systems that can integrate offline and online lecture data in one dynamic platform that can be accessed in real time. Several studies related to technology-based education management generally focus on broader academic information systems, which have not specialized in efficient and detailed lecture monitoring. Therefore, this study proposes the development of a more focused lecture monitoring system to facilitate monitoring of lecture status as a whole in universities, especially the Politeknik Negeri Bali.

The purpose of this research is to develop a lecture monitoring system that can help the leadership and management of departments at Politeknik Negeri Bali in monitoring lecture status more efficiently and accurately. This system is designed to display data dynamically in the form of a dashboard that includes lecture status, number of classes running, and other lecture information. With this system, it is expected to increase the effectiveness of lecture management in all departments. In addition, this system can also provide useful data for leaders in making decisions and making strategies related to lectures. The novelty of this study lies in the development of a lecture monitoring system that can integrate offline and online lecture status, and display structured and easily accessible data in one comprehensive platform. Unlike other studies that focus

more on academic information systems in general, this study offers a more specific and relevant solution for the needs of lecture monitoring in higher education institutions with certain characteristics, such as PNB which has various departments and classes with varying lecture modes.

METHOD

To develop and test a web-based lecture monitoring system in the form of a class information system dashboard that integrates offline and online lecture status, the study employed the System Development Life Cycle (SDLC) approach, which consists of several stages, as follows: planning, analysis, design, implementation, and testing. SDLC is a structured framework used by various software development organizations with a waterfall model approach.[23,24,25,26] This research was conducted at the PNB, focusing on 7 departments.

This research begins by identifying problems in the lecture monitoring process at PNB, namely the manual process that hinders efficient and accurate lecture data management. After that, the objectives of the lecture monitoring system are formulated to replace the manual process with a web-based solution that can integrate offline and online lecture status and display data in real-time.

The next stage is the analysis of system requirements to understand the features and functions needed by system users, consisting of leaders, department management, and lecturers at PNB. These needs are analyzed through interviews with related parties, observations, and literature studies on academic management information systems in other universities. This needs analysis produces a list of functionalities that must be present in the system, such as a lecture status dashboard, detailed lecture schedules, monitoring the number of lecturer meetings, and lecture recapitulations per department.

Next, the System Design for the system architecture and user interface is designed. The system design focuses on creating a class information display system that is easy to use by end users and is able to integrate offline and online lecture status data. The design also includes the use of web-based technology that allows access from various devices and can display data in the form of a dynamic and easy-to-understand dashboard. Furthermore, the System Implementation is integrated with the existing Online Information System (SION) and becomes a database for retrieving lecture data using the web Application Programming Interface (API).

This system will show study program data, course names, lecturers, lecture schedules, and lecture status (offline/online). Implementation also includes integrating features such as monitoring the number of lecturer meetings, recapitulation of ongoing classes, and lecture status in real-time. After that, system testing is carried out, including functionality testing to ensure that each feature is functioning properly and usability testing to measure user comfort in using the system. Testing is carried out on system users, namely leaders, department management, lecturers and PNB staff who have used the system. The final stage is Evaluation and Improvement of the test results and feedback from users. Based on this evaluation, the system was then improved and refined to improve the performance and reliability of the system. The improved system was then fully implemented for use by the PNB community in monitoring lectures.

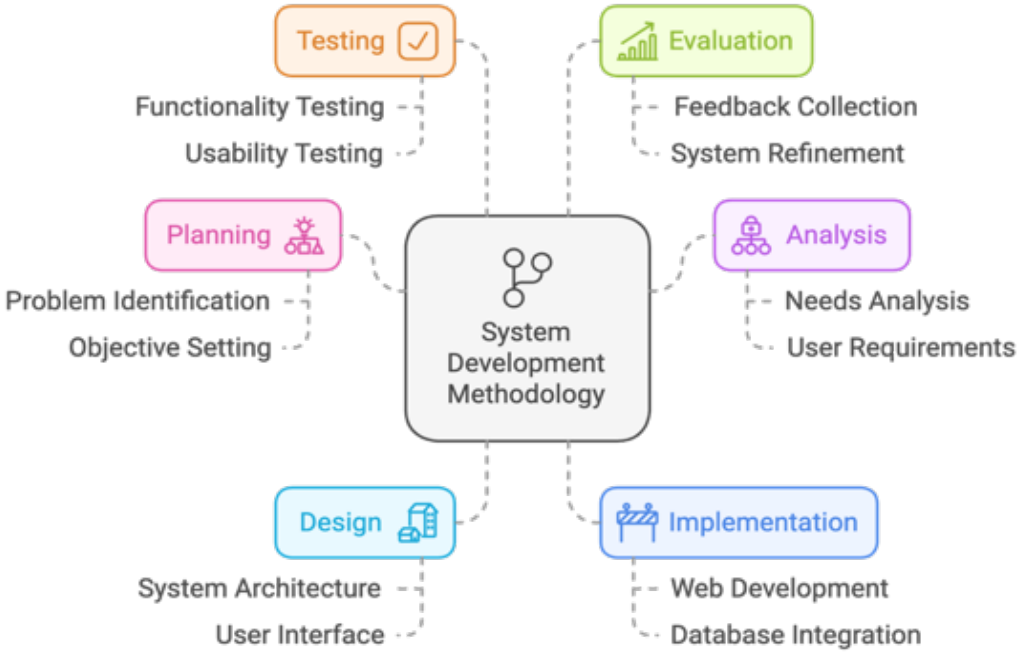

Figure 1. System Development Methodology

RESULT

At the needs analysis stage, data collection was carried out through interviews with related parties, such as department heads, lecturers, and administrative staff. The results of the analysis showed that the system must be able to provide several main features, including a lecture status dashboard that displays a recapitulation of the number of classes running each day and the status of lectures (offline or online) per department, lecture details that provide complete information about study programs, courses, lecturers, schedules, and lecture materials, monitoring the number of lecturer meetings to facilitate monitoring the number of meetings that have been conducted by lecturers and real-time updates that provide data that is updated in real time so that leaders can easily monitor the status of lectures. These needs are then converted into technical specifications that form the basis for the system design and implementation stages. At the system design stage, the system's architectural design and user interface (UI) are created based on the needs that have been analyzed. The interface is designed to ensure ease of use by various parties involved, with a focus on a user-friendly interface and clear navigation. Several user interface design features can be seen in table 1.

Table 1. System Features

Feature	Description
Dashboard	Displays a summary of lecture status in the form of an interactive chart. Users can easily see the number of classes running and the status of lectures (offline or online) per department every day
Lecture Details	Provides more detailed information about the schedule, course name, lecturer, room, and material taught
Lecture Recapitulation	Recapitulation of lectures in each department
Responsive and User-Friendly	The interface is designed with a simple and easy-to-navigate appearance. This ensures that users, both lecturers and leaders, can quickly understand and operate the system without requiring special training
Print and Save	To print and save lecture monitoring reports

The flow of the Class Information Display System developed using web API can be seen in figure 2. Class Information Display System (CIDS) is displayed in the form of a Web Application (WebApp) and consists of two main processes, namely:

a. CIDS/{DeptID} to display the lecturer's schedule and attendance today: WebApp will make an API request with the get method to WebApi. Then WebApi receives a request from WebApp and will query the SION database using to get the lecturer's schedule and attendance level today. The datarow obtained from the SION database will be converted into a json array by the webapi to be returned as a response to the CIDS webapp. The CIDS WebApp will visualize the webapi response data in the form of a table and refresh every 15 seconds.

b. CIDS/Recap to display a recapitulation of the attendance of all departments that occurred today: WebApp will make an API request with the get method to WebApi. Then WebApi that receives a request from WebApp will query the SION database using to get a recapitulation of the lecturer's attendance level today. Datarow obtained from the SION database will be converted into a json array by the webapi to be returned as a response to the CIDS WebApp. The CIDS WebApp will visualize the webapi response data in the form of tables and graphs.

The implementation stage is carried out after the system design is approved. At this stage, the system is developed and tested to ensure that its functionality is in accordance with the identified needs. HTML user interface development uses Bootstrap and Canvas.js. The main features that have been successfully implemented include the Lecture Status Dashboard, Lecture Details, Lecture Recapitulation, Monitoring the Number of Lecturer Meetings Print and Save.

After implementation, system testing was conducted to ensure that all features function properly. Testing was conducted in two main stages, namely functionality testing to ensure that all system features function according to the expected objectives. The test results showed that the lecture status dashboard, detailed lecture information, and monitoring of the number of lecturer meetings can be accessed easily and accurately. The second test is the usability test to measure user comfort in using the system. The usability test aims to measure how easily and efficiently users can use the system to complete the specified tasks. This test was conducted by involving the leadership, department management, lecturers and staff of the Bali State Polytechnic. The test was conducted using a questionnaire that focused on three main aspects, namely ease of use, system efficiency and user satisfaction. The test was conducted by distributing questionnaires to 30 people, consisting of leaders, department management, lecturers and staff. The questionnaire used a Likert scale of 1-5 to measure respondents' perceptions of ease, efficiency, and satisfaction with Scale 1: Strongly Disagree, Scale 2: Disagree, Scale 3: Neutral, Scale 4: Agree, and Scale 5: Strongly Agree. After testing, the questionnaires were collected and the results were calculated to obtain an average score for each question.

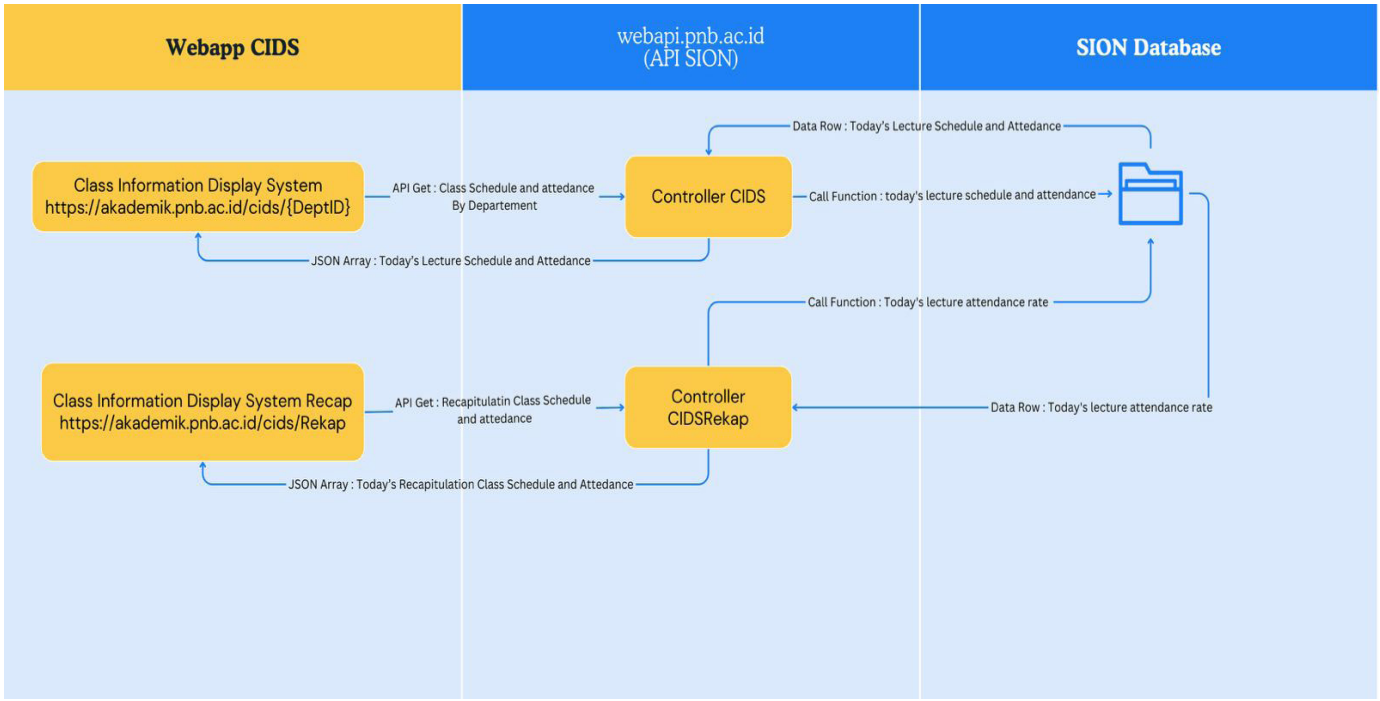

Figure 2. Information Display System Class Processing Flow with WebApi

Table 2. Recapitulation of Questionnaire Results

No	Questions	Average Score
1	The system interface is easy to understand	4,4
2	The system can be used quickly to search for lecture information	4,5
3	The print and save features are smooth	4,3
4	Searching for lecture recapitulations is easy to do	4,2
5	The lecture information displayed is precise and accurate	4,6
6	This system provides clear information about lecture status	4,4
7	This system makes it easy to monitor class status	4,3
8	The system interface is clean and easy to use without confusion	4,5
9	I am satisfied with the performance and speed of the system	4,5
10	Overall, I am satisfied with this system	4,7

Based on the calculation of the questionnaire recapitulation, the results obtained were that the highest average score was 4,7 on the question “Overall, I am satisfied with this system”. This shows that the majority of respondents are very satisfied with the system developed. The lowest average score was 4,2 on the question “Searching for lecture recapitulations is easy to do”, which still shows a fairly high value, but shows that there is little room for improvement in the aspect of ease of searching for lecture recapitulations.

It can be concluded that the results of the system testing are as follows that overall, this system is easy to use and provides a satisfying experience for users, with an average score for user satisfaction reaching 4,4, ease of use, namely this system is easy to understand and use by all respondents, with a clean interface and smooth functionality, efficiency, namely respondents can complete tasks quickly and without major obstacles and user satisfaction, namely the majority of users are satisfied with the system, especially with the accuracy of lecture information and the ease of monitoring class status. Based on the results of this usability test, the system developed is proven to be efficient and user-friendly, and meets the needs of its users well.

After testing and feedback from users, an evaluation of the system was conducted. Some feedback received suggested that the dashboard display be updated to add more detailed features related to monitoring the lecture schedule. Based on this feedback, improvements were made to the dashboard display and additional features were added to make it easier to search for lecture schedule information. This study offers several innovations in the management of lectures based on information technology, especially in the context of universities in Indonesia. Some of the innovations produced by this study are Integration of Offline and Online Lecture Status, Interactive Dashboard with Real-time Monitoring, Monitoring the Number of Lecturer Meetings, and Increasing

Accessibility Through Web Technology. With these innovations, this study makes a significant contribution to the development of a more efficient and transparent academic management information system in universities.

DISCUSSION

The development of the CIDS at the Bali State Polytechnic (PNB) marked a pivotal step in transforming how lectures are monitored and managed within the institution. Confronted with the inefficiencies of a manual monitoring process, the research team turned to the structured approach of the SDLC, adopting a waterfall model to guide the system's evolution from concept to implementation. This methodical framework allowed the team to build a digital solution that not only addressed existing problems but also introduced real-time, integrated monitoring capabilities to the academic environment.

The journey began with a clear identification of the challenges in the existing system—chiefly the delays and inaccuracies stemming from manual data handling.[27] Through planning and problem identification, the team set clear objectives: to design a web-based system that could unify both offline and online lecture statuses, provide real-time updates, and present information in a user-friendly dashboard format. The subsequent analysis phase involved gathering detailed user requirements through interviews with department heads, lecturers, and staff, as well as observations and literature studies. These activities ensured that the system would be tailored to meet the practical needs of all stakeholders involved.

In the design phase, emphasis was placed on user-centered principles. The user interface was crafted to be intuitive and navigable, with a responsive layout that could be accessed across multiple devices.[28] The architectural design incorporated seamless integration with PNB's existing SION, allowing the new platform to pull real-time data on course schedules, lecturer attendance, and lecture formats through a web API. This allowed for the implementation of key features such as a lecture dashboard, detailed schedule views, meeting tracking, and reporting tools—all of which were rigorously tested during the implementation stage.

Testing involved both functional and usability assessments. Functionality testing confirmed that features operated as expected, while usability testing focused on how easily users could navigate and benefit from the system.[29] A total of 30 users—including leadership, lecturers, and administrative staff—participated in a questionnaire-based evaluation. The results were encouraging: the system received an average satisfaction rating of 4,4 out of 5, with the highest score of 4,7 indicating overall satisfaction. Even the lowest-rated item, the ease of searching lecture recapitulations, scored a strong 4,2, revealing only minor areas for future refinement.

The feedback gathered did not go unnoticed. In response to suggestions, particularly regarding the dashboard, the system was further improved. Additional features were added to streamline the lecture schedule search process and enhance the detail and clarity of information presented. This iterative refinement process reinforced the system's alignment with user needs and its adaptability in a dynamic academic context.

In terms of innovation, the CIDS offers several important contributions to the academic information system landscape, especially within the context of Indonesian higher education.[30] It is one of the first systems to effectively integrate monitoring of both online and offline lectures in real time. The use of dynamic dashboards and live data feeds empowers decision-makers with timely insights, while the scalable web-based design ensures broad accessibility without requiring significant new infrastructure.[31]

Ultimately, the success of this initiative lies in its comprehensive understanding of user needs, its methodical development process, and its capacity to adapt and improve based on real-world use. The Class Information Display System not only solves the immediate challenges faced by PNB but also sets a benchmark for how educational institutions can leverage technology to foster transparency, efficiency, and accountability in academic management.

CONCLUSION

This research has successfully developed the Class Information Display System (CIDS), a web-based lecture monitoring system designed to improve the efficiency and accuracy of lecture management. This system is able to integrate offline and online lecture status in one platform, thus facilitating monitoring of academic activities by leaders, department management, and lecturers. Several main features that have been successfully implemented include the Lecture Status Dashboard, Lecture Details, Lecture Recapitulation, Lecturer Meeting Monitoring, Print and Save Data: The test results show that this system can improve the efficiency of monitoring and decision making by presenting accurate and structured data. The usability test also shows a high level of user satisfaction with the ease and efficiency of this system.

For further research, several recommendations that can be used as a basis for further development are implementing artificial intelligence (AI) to analyze historical data and provide predictions or recommendations, such as predicting lecturer attendance levels or analyzing academic activity trends and adding automatic notification features via email or instant messages to remind lecturers or students about lecture schedules or warnings regarding meetings that have not been implemented.

REFERENCES

1. Zulkhairi Z. Implementasi Sistem Informasi Manajemen Akademik SEVIMA dalam Mengoptimalkan Mutu Layanan Akademik Perguruan Tinggi. Idarah (Jurnal Pendidikan dan Kependidikan) [Internet]. 2020;4:73–88. doi: 10.47766/idarah.v4i1.2084.

2. Dioputra S, Wahidin D, Iriantara Y, Warta W. Academic Information System Management To Improve Service Quality To Students During The Covid-19 Pandemicat Universities In Jambi Province. International Journal of Educational Research & Social Sciences [Internet]. 2022;3:1165–1169. doi: 10.51601/ijersc.v3i3.385.

3. Hendriyati P, Agustin F, Rahardja U, Ramadhan T. Management Information Systems on Integrated Student and Lecturer Data. APTISI Transactions on Management (ATM) [Internet]. 2022;6:1–9. doi: 10.33050/atm.v6i1.1527.

4. Abubakari A-R, Inusah M, Abdulai A-A. The Effects of Information Communication Technology on Administrative Efficiency of Tamale Technical University. American Journal of Industrial and Business Management [Internet]. 2023;13:394–417. doi: 10.4236/ajibm.2023.135025.

5. Mohanad Ghazi Yaseen, Hayder Sabah Salih, Mohammed Aljanabi, Ahmed Hussien Ali, Saad Abbas Abd. Improving Process Efficiency in Iraqi universities: a proposed management information system. Iraqi Journal for Computer Science and Mathematics. 2023;211–219. doi: 10.52866/ijcsm.2023.01.01.0020.

6. Putriyani I, Sugiharto BB. Analisis Literatur Tentang Peran Sistem Informasi Akademik Dalam Meningkatkan Efisiensi Administrasi Di Institusi Perguruan Tinggi. J-CEKI : Jurnal Cendekia Ilmiah [Internet]. 2024;4:2283–2289. doi: 10.56799/jceki.v4i1.5881.

7. Nguyen Minh Tri, Duy Hoang. The Impact of Digital Transformation in Higher Education: The Case Study from Vietnam. Journal of Higher Education Theory and Practice. 2023;23. doi: 10.33423/jhetp.v23i5.5922.

8. Riani VA, Trisnantari HE, Junaris I. IMPLEMENTASI SISTEM INFORMASI MANAJEMEN (SIM) BIDANG AKADEMIK DALAM MENINGKATKAN KUALITAS LAYANAN PENDIDIKAN. Educational Leadership: Jurnal Manajemen Pendidikan. 2024;4:23–33.

9. Nasaruddin H, Shofian S, Akib H, Niswaty R. The Effectiveness of the Use of Academic Information Systems. Jurnal Office [Internet]. 2021;7:379. doi: 10.26858/jo.v7i2.42939.

10. Chugh R, Turnbull D, Cowling MA, Vanderburg R, Vanderburg MA. Implementing educational technology in Higher Education Institutions: A review of technologies, stakeholder perceptions, frameworks and metrics. Educ Inf Technol (Dordr). 2023;28:16403–16429. doi: 10.1007/s10639-023-11846-x.

11. Adejo O, Connolly T. An Integrated System Framework for Predicting Students' Academic Performance in Higher Educational Institutions. International Journal of Computer Science and Information Technology [Internet]. 2017;9:149–157. doi: 10.5121/ijcsit.2017.93013.

12. Al Kodri MN. Digital transformation in higher education: challenges, opportunities and threats. Proceeding Of Seminar On Language, Education, And Technology. 2022. p. 9–20.

13. Alenezi M, Wardat S, Akour M. The Need of Integrating Digital Education in Higher Education: Challenges and Opportunities. Sustainability [Internet]. 2023;15:4782. doi: 10.3390/su15064782.

14. Bygstad B, Øvrelid E, Ludvigsen S, Dæhlen M. From dual digitalization to digital learning space: Exploring the digital transformation of higher education. Computers & Education [Internet]. 2022;182:104463. doi: 10.1016/j.compedu.2022.104463.

15. Fernández A, Gómez B, Binjaku K, Meçe EK. Digital transformation initiatives in higher education institutions: A multivocal literature review. Educ Inf Technol (Dordr) [Internet]. 2023;28:12351–12382. doi: 10.1007/s10639-022-11544-0.

16. Mohamed Hashim MA, Tlemsani I, Matthews R. Higher education strategy in digital transformation. Educ Inf Technol (Dordr) [Internet]. 2021;27:3171–3195. doi: 10.1007/s10639-021-10739-1.

17. Sarker MNI, Wu M, Cao Q, Alam GMM, Li D. Leveraging Digital Technology for Better Learning and Education: A Systematic Literature Review. International Journal of Information and Education Technology [Internet]. 2019;9:453–461. doi: 10.18178/ijiet.2019.9.7.1246.

18. Akour M, Alenezi M. Higher Education Future in the Era of Digital Transformation. Educ Sci (Basel). 2022;12. doi: 10.3390/educsci12110784.

19. Thelma CC, Welbeck BA, Sain ZH, Mpolomoka DL, Sylvester C, Phiri EV. The effect of management information system on student academic performance: A case of selected higher learning institutions in Lusaka District, Zambia. World Journal of Advanced Research and Reviews [Internet]. 2024;24:118–129. doi: 10.30574/wjarr.2024.24.3.3669.

20. Musti KSS. Management Information Systems for Higher Education Institutions: Challenges and Opportunities. Quality Management Implementation in Higher Education [Internet]. IGI Global; 2020. p. 110–131. Available from: http://dx.doi.org/10.4018/978-1-5225-9829-9.ch006.

21. Sethi MsN, Malhotra DrA. Efficiency Engine: Designing and Implementing an Academic Management System. International Journal of Innovative Research in Engineering and Management [Internet]. 2023;10:115–120. doi: 10.55524/ijirem.2023.10.3.15.

22. Asio JMR, Leva EF, Lucero LC, Cabrera WC. Education Management Information System (EMIS) and Its Implications to Educational Policy: A Mini-Review. International Journal of Multidisciplinary: Applied Business and Education Research [Internet]. 2022;3:1389–1398. doi: 10.11594/ijmaber.03.08.01.

23. Chan MO, Yazid S. A Novel Framework for Information Security During the SDLC Implementation Stage: A Systematic Literature Review. Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi) [Internet]. 2024;8:88–99. doi: 10.29207/resti.v8i1.5403.

24. Dávila-Campos R, Mora M, Reyes-Delgado PY, Muñoz-Arteaga J, López-Torres GC. The Landscape of Rigorous and Agile Software Development Life Cycles (SDLCs) for BPMS: A Systematic Selective Literature Review. IEEE Access [Internet]. 2024;12:57519–57547. doi: 10.1109/access.2024.3386167.

25. Ramadhan D, Sitorus Z, Penjaitan MS. Design and Development of an SDLC-Based E-Learning Application as a Learning Medium Using the Blended Learning Model. Bulletin of Information Technology (BIT). 2024;5:173–179. doi: 10.47065/bit.v5i3.1480.

26. Christanto HJ, Singgalen YA. Analysis and Design of Student Guidance Information System through Software Development Life Cycle (SDLC) dan Waterfall Model. Journal of Information Systems and Informatics [Internet]. 2023;5:259–270. doi: 10.51519/journalisi.v5i1.443.

27. da Costa TP, da Costa DMB, Murphy F. A systematic review of real-time data monitoring and its potential application to support dynamic life cycle inventories. Environ Impact Assess Rev [Internet]. 2024;105:107416. doi: 10.1016/j.eiar.2024.107416.

28. Li W, Zhou Y, Luo S, Dong Y. Design Factors to Improve the Consistency and Sustainable User Experience of Responsive Interface Design. Sustainability. 2022;14:9131. doi: 10.3390/su14159131.

29. Lewis JR, Sauro J. USABILITY AND USER EXPERIENCE: DESIGN AND EVALUATION. HANDBOOK OF HUMAN FACTORS AND ERGONOMICS. Wiley; 2021. p. 972–1015.

30. Fauzi R, Ar Rosyid H, Herwanto HW. Digitalization of information systems and educational laboratory management in higher education institutions. Bulletin of Social Informatics Theory and Application. 2024;8:260–270. doi: 10.31763/businta.v8i2.740.

31. Bugwandeen K, Ungerer M. EXPLORING THE DESIGN OF PERFORMANCE DASHBOARDS IN RELATION TO ACHIEVING ORGANISATIONAL STRATEGIC GOALS. South African Journal of Industrial Engineering. 2019;30. doi: 10.7166/30-2-2021.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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