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Development of an Integrated Digital Audit System for Modular and Multi-Role-Based Higher Education Accreditation Document Management

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ABSTRACT

Program accreditation is a strategic process in higher education that requires transparency, efficiency, and cross-unit collaboration. Common challenges include the complexity of document management, coordination between parties, and the potential for administrative errors. This research developed a web-based accreditation information system that is modular and supports various roles, namely administrators, study programs, the Institute for Learning Development and Quality Assurance (LP3M), and auditors. This system enables structured management of LED (Self-Evaluation Reports) and LKPS (Program Study Performance Reports), equipped with LP3M validation features, auditor comments, revision history, and audit trails to ensure accountability at every stage. The results of implementation show an increase in the efficiency of the accreditation process, a reduction in administrative errors, and an increase in transparency and accountability between units. Additionally, this system strengthens coordination between study programs and quality assurance institutions, making the accreditation process more integrated and controlled. Research findings confirm that this system is not only relevant for the developing institution but can also be replicated in other universities facing similar challenges. Thus, this web-based accreditation information system has the potential to be an innovative solution in supporting sustainable higher education quality management.

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1. INTRODUCTION

Program accreditation is an external quality assurance mechanism that must be implemented by all higher education institutions in Indonesia [1]. This process aims to assess the feasibility and quality of education based on national standards set by the National Accreditation Agency for Higher Education (BAN-PT) and Independent Accreditation Institutions (LAM) such as LAMEMBA. The two main components that form the basis of the assessment are the Self-Evaluation Report (LED) and the Program Study Performance Report (LKPS), which must be compiled in a systematic, measurable, and data-based manner.

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In practice, the implementation of accreditation often faces administrative and technical challenges. The management of LED and LKPS documents, which are scattered, unstructured, and poorly documented, is a major obstacle in the assessment process. In addition, coordination between units such as study programs, LP3M (Internal Quality Assurance Agency), and internal auditors is often carried out informally and is not recorded, thereby reducing the transparency and accountability of the accreditation process.

Filling out the LKPS form requires performance data for five years, which is often not available systematically. This causes many study programs to have difficulty compiling accurate and consistent reports. Therefore, a database system is needed that is capable of managing and providing real-time data for assessment and visitation purposes. On the other hand, the Higher Education Accreditation Information System (SIAP) for filling out the BAN-PT standard 3 form. Their research results show that digitizing the accreditation process can reduce the administrative burden and improve data accuracy. However, the system does not explicitly integrate the roles of LP3M and auditors in one platform, nor does it support audit trail and document revision history features. The main challenges in the digital accreditation process include the absence of an integrated system that supports multi-role users, the lack of audit trail and document revision history features, and the absence of a structured and traceable mechanism for documenting auditor comments. Reliance on informal communication for validation and comments also causes the accreditation process to be slow, inefficient, and prone to administrative errors [2- 4].

In line with the demands of digitization and data-based accreditation, an information system is needed that is modular, adaptable to different accreditation standards, and capable of supporting internal validation by LP3M and auditor comments without disrupting the workflow of the study program. The system must also provide an audit trail for each user activity and be capable of generating summary reports in print and digital formats. Modularity in information system development allows for flexibility and scalability. According to [5], a modular architecture approach can improve maintainability and traceability in complex systems and facilitate integration between different components. In the context of accreditation, modularity allows the system to adapt flexibly to regulatory changes and institutional needs.

Based on these requirements, this study developed a web-based digital accreditation system that supports four main roles: admin, study program, LP3M, and auditor. This system is equipped with structured LED and LKPS document management, LP3M validation with revision notes, auditor comments per indicator and document, revision history of narratives and documents, audit trail of user activities, and PDF export and audit chart features per standard using Chart.js. The system was built using open-source technologies such as PHP, MySQL, Bootstrap, Chart.js, and FPDF. The system architecture was designed to be modular so that it can be adapted to various accreditation standards and institutional needs. Each module can be enabled or disabled according to the user's role and the stage of the accreditation process.

The main contributions of this research are the design of a modular and multi-role digital accreditation system architecture, the integration of validation, comment, and audit trail features in a single platform, and the provision of an implementation model adaptable to various accreditation standards. From a software engineering perspective, the system emphasizes modular architecture for scalability, role-based access control for security, and performance optimization for multi-user environments. Compared to existing systems such as SIAP, the proposed model integrates validation, comments, and audit trail features in a traceable and maintainable manner. Empirical evidence shows that the developed system improves efficiency, transparency, and collaboration in the accreditation process. Thus, this system enriches the literature on higher education information systems while providing a technically robust reference for digital-based accreditation systems in Indonesia and other developing countries.

2. RESEARCH METHOD

Higher education accreditation is an external quality assessment process conducted by independent institutions such as BAN-PT and LAMEMBA. This process aims to ensure the quality of higher education through the evaluation of LED and LKPS documents. With the issuance of Permendikbud

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No. 5 of 2020, educational institutions have the flexibility to determine the timing of re-accreditation applications, thus requiring a system that can support strategic and structured document preparation [6].

[2] highlight the challenges in completing the LKPS, which requires program performance data for five years. When the assessment process is carried out, many institutions experience difficulties in providing adequate data evidence. To overcome this, they propose a relational database model that supports the management and maintenance of accreditation data availability. The design includes 26 entities and 31 physical tables, which can be integrated into a web-based accreditation information system.

[7] examined the effectiveness of the accreditation system based on Permendikbud No. 5 of 2020. They concluded that this policy provides opportunities for universities to prepare for re-accreditation optimally. However, the effectiveness of the system is highly dependent on the institution's readiness to manage documents and data digitally. This study emphasizes the importance of an information system that supports flexibility, documentation, and control of the accreditation process.

Meanwhile, [8] developed a web-based information system to automatically measure the accreditation value of study programs. This system is capable of documenting form data in an integrated manner and providing an online accessible accreditation data center. They used an iterative system development methodology, starting from product design to validation and revision based on user feedback. The results show that digital systems can accelerate the assessment process and improve document management efficiency.

Other literature also highlights the importance of multi-role integration in accreditation systems. Most previously developed systems only focused on data input by study programs, without actively involving LP3M and auditors. In fact, internal validation and auditor comments are an important part of the quality assurance process. Systems that do not explicitly support the roles of LP3M and auditors risk producing undocumented and untraceable processes.

In the context of system architecture, the modular approach has become a widely adopted solution. Modularity enables the development of flexible, expandable, and easily maintainable systems. [9] state that modular architecture supports traceability and maintainability in complex systems, as well as facilitating integration between different components. In accreditation systems, modularity allows features to be activated according to user roles and accreditation process stages.

Overall, literature from the past five years shows that digitizing the accreditation process has become an urgent necessity. The information system developed must be capable of managing LED and LKPS documents, supporting LP3M validation, facilitating auditor comments, and providing audit trails and revision histories. Systems that do not support these features risk resulting in inefficient and unaccountable processes.

This research aims to address this gap by designing an integrated, modular, and multi-role digital accreditation system. This system not only supports data input by study programs, but also facilitates LP3M validation and structured auditor comments. Thus, the developed system can serve as an implementation model that can be replicated by other institutions and contribute to the literature on higher education information systems.

This study uses a system development research-based software engineering approach, which aims to design, build, and evaluate a modular and multi-role digital accreditation information system [10]. This method was chosen because it is in line with the characteristics of research that is oriented towards technological solutions to administrative and coordinative problems in the study program accreditation process. The type of research used is developmental research, with a focus on the design and implementation of a web-based information system. This research not only produced a system product, but also developed an architecture model, database structure, and workflow between roles (admin, study program, LP3M, auditor) in the accreditation process.

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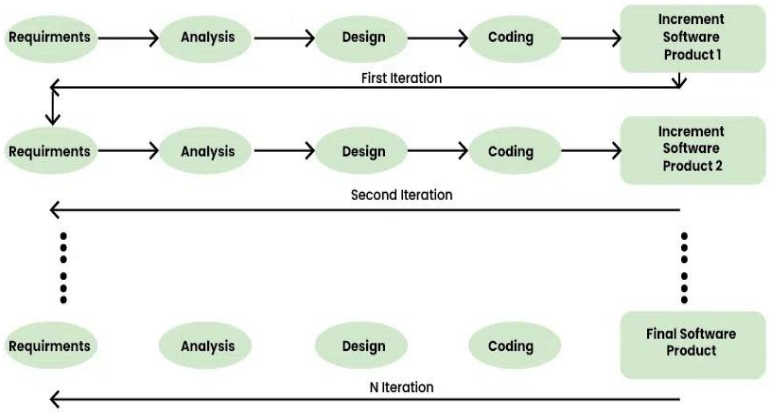

Figure 1. Iterative incremental model

In the context of software development, the iterative incremental model emphasizes that systems are not built all at once, but rather through a series of cycles consisting of the requirements, analysis, design, coding, and testing stages. Each cycle produces an increment in the form of a usable or testable version of the product, allowing users to provide feedback early on. In this way, developers can adjust features according to the complexity and needs that arise in the field. This approach is particularly relevant for dynamic digital business systems, as user needs often change with the development of technology and business strategies.

The advantages of this method are flexibility, efficiency, and risk reduction. Flexibility arises because developers can add or change modules without having to overhaul the entire system. Efficiency is achieved because each iteration produces a product that can be immediately tested and used. Risk is reduced because errors can be identified early and corrected in the next iteration. In addition, this method supports the principle of user-centered design, where user experience and needs are the main focus in every stage of development.

Several literature sources emphasize the importance of this approach. Gradual system development with an iterative model improves consistency and user satisfaction because it allows core features to be prioritized before adding advanced modules [11- 13].

Each module, including LED management, LKPS, LP3M validation, auditor comments, and audit trails, is developed separately but integrated, so that the system can be expanded and adapted to different accreditation standards. The development stages begin with an analysis of user needs and accreditation regulations, followed by the design of the system architecture and Entity Relationship Diagram (ERD), implementation of modules using open-source technologies such as PHP, MySQL, Bootstrap, Chart.js, and FPDF, and ending with functionality testing and internal validation. The system is evaluated based on indicators of efficiency, transparency, and ease of use.

Data collection techniques were carried out through direct observation of the accreditation process within the study program, semi-structured interviews with the LP3M team and internal auditors, and documentation studies of the LAMEMBA accreditation instruments. In addition, an analysis was conducted on the manual accreditation system that was previously used to identify weaknesses and digitization needs. This research was conducted at the University of Bangka Belitung, with the main subjects being the accreditation team of the Digital Business undergraduate program, the university's LP3M, and internal auditors. The system was tested directly in the process of preparing the LED and LKPS for the 2025 accreditation cycle.

The system evaluation was conducted using three approaches: functionality testing, process efficiency testing, and user satisfaction testing [14]. Functionality testing was carried out using testing scenarios for each module to ensure that every feature worked according to the design. Efficiency was measured based on the time taken to prepare documents and the number of revisions that occurred during the accreditation process. Meanwhile, user satisfaction was measured through a Likert scale questionnaire on aspects of ease of use, clarity of workflow, and process transparency. To ensure internal validity, each system feature was tested by at least two user roles, such as study programs and LP3M in the document validation process. External validity is ensured through the system's compliance with the

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official LAMEMBA accreditation instruments. The reliability of the system is tested through a full accreditation process simulation and load testing on the local server to ensure the stability and consistency of the system's performance in real operational conditions.

3. RESULTS AND DISCUSSION

3.1 Implementation of the Modular Accreditation System

The digital accreditation system developed in this study is designed to meet the needs of higher education institutions in managing the accreditation process efficiently, transparently, and structurally. The implementation was carried out at the University of Bangka Belitung, specifically in the Digital Business undergraduate program, as the main case study. This system was built using a modular approach, where each feature is packaged in separate but integrated components, facilitating gradual development and adaptation to regulatory changes.

In general, the system consists of five main modules: (1) LED management, (2) LKPS management, (3) LP3M validation, (4) auditor comments, and (5) audit trail. Each module is role-based, so users can only access features according to their access rights. For example, program users can only upload documents and write narratives, while auditors can only provide comments without changing the document status. This approach ensures that the workflow is maintained and there are no role conflicts in the accreditation process.

The LED module allows study programs to write narratives for each indicator, upload supporting documents, and view comments from auditors. Figure 1 shows the study program user dashboard, where LED indicators are displayed in a structured manner based on LAMEMBA standards. Each indicator is equipped with a narrative form, a document upload button, and a comment history.

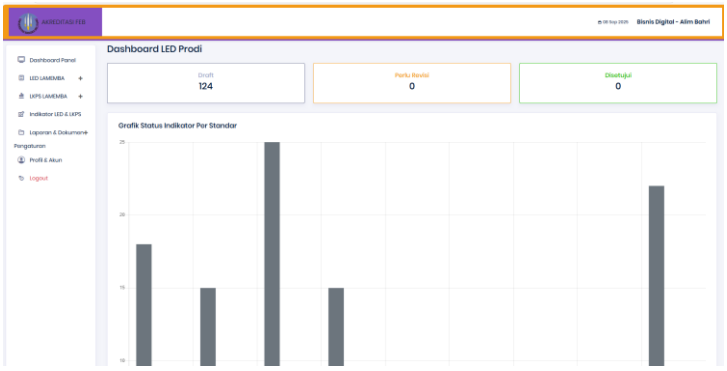

Figure 2. Program study dashboard display for LED management

The LKPS module is designed to manage mandatory and additional documents per item. Documents can be uploaded by the study program, then validated by LP3M. Validation is carried out through a special form that allows LP3M to provide status and revision notes. Figure 2 shows the LP3M validation form, which can only be accessed by users with the LP3M role. This validation is recorded in the system and can be tracked through an audit trail.

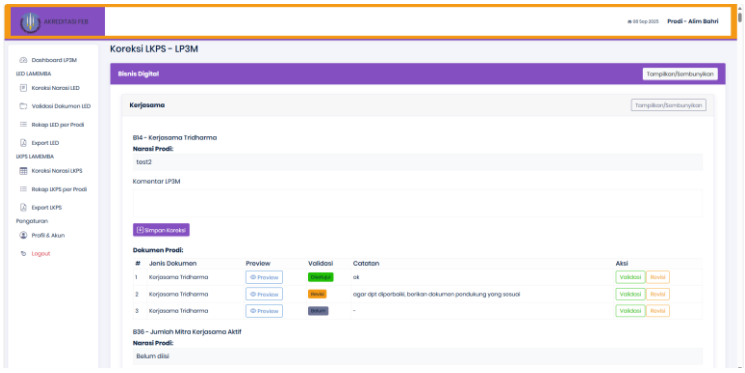

Figure 3. LP3M validation form for LKPS documents

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The auditor comment module is an important feature that distinguishes this system from manual approaches. Auditors can provide comments on the LED narrative, additional LED documents, and LKPS documents without changing the validation status. Comments are stored in the comment_auditor table and displayed chronologically. Figure 3 shows a simple but effective auditor comment form with a traceable comment history.

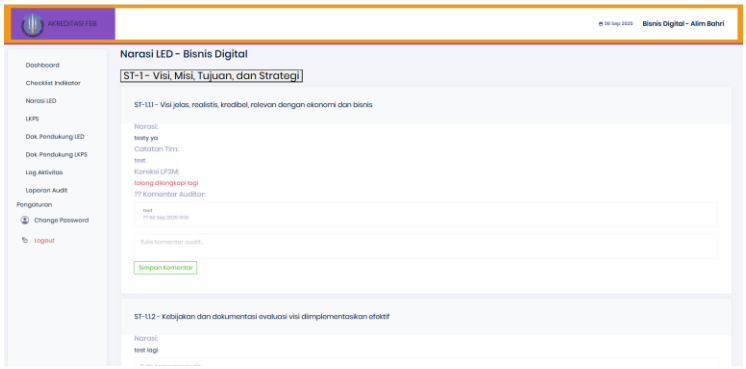

Figure 4. Auditor comment form for LED documents

To support transparency and accountability, the system is equipped with an audit trail module [15]. Every user activity, from document uploads, narrative storage, validation, to comments, is recorded in the audit_log table with a timestamp and entity reference. This feature allows LP3M and administrators to conduct internal audits of the accreditation process. In addition, the system provides visualization of accreditation progress using Chart.js. Figure 4 shows a graph of document validation progress per standard, which helps the accreditation team monitor status in real time.

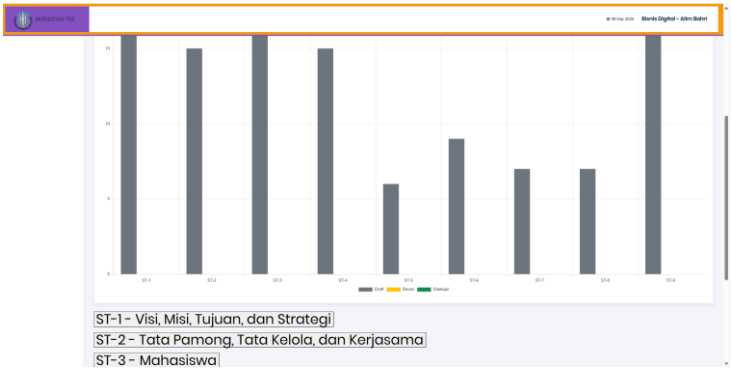

Figure 5. Document validation progress chart per standard

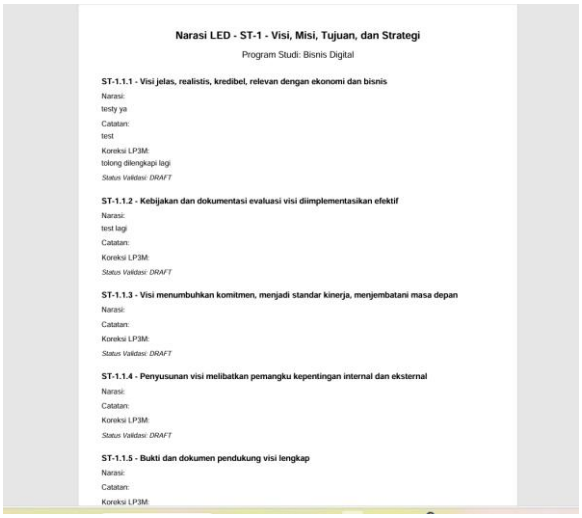

Figure 6. Example of LED narrative PDF output and supporting documents

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The system also supports the export of LED and LKPS documents to PDF format using the FPDF library. Compiled documents can be printed per standard, complete with narratives, document lists, and comment histories. This feature is very useful in the visitation or reporting process to LAMEMBA. Figure 5 shows an example of the PDF export results from the LED narrative and supporting documents.

The technologies used in developing the system include PHP for application logic, MySQL for relational databases, Bootstrap for responsive user interfaces, Chart.js for progress visualization, and FPDF for document export. All components were developed using an open-source approach so that the system can be replicated and further developed by other institutions.

With this implementation, the system successfully integrates the entire accreditation process into a single modular, audit-ready, role-based digital platform. The results are increased efficiency, reduced administrative errors, and improved transparency in the program accreditation process.

3.2 System Architecture and Database Structure

To support flexibility, scalability, and integration between user roles in the accreditation process, this digital accreditation system is designed using a relational entity-based architecture [16]. This approach enables consistent, structured, and traceable data management across modules. The database structure consists of eight main entities, namely users, study programs, standards_lam, indicators_lam, lkps_documents, additional_led_documents, auditor_comments, and audit_log. Each entity has a specific role in supporting system features, and the relationships between entities are designed with foreign keys to maintain data integrity and support user activity tracking.

The users entity stores user account data, including name, email, encrypted password, and system roles such as admin, study program, LP3M, and auditor. This entity is directly related to auditor_comments and audit_log, allowing the system to record activities and feedback based on user identity. The prodi entity stores information on study programs that are subject to accreditation and serves as a reference point for other entities such as indikator_lam, lkps_dokumen, and dokumen_led_tambahan. Meanwhile, standar_lam stores the accreditation standards structure from LAMEMBA, such as Standards 1 to 9, and is related to indikator_lam for LED indicator grouping.

The indicator_lam entity is a core component in the LED module. It stores indicator codes, LED narratives, validation statuses, and references to supporting documents. Auditors can provide comments on these indicators through the comment_auditor entity, which is designed to be flexible in referring to four types of entities: LED indicators, LED narratives, additional LED documents, and LKPS documents. The dokumen_led_tambahan entity stores LED supporting documents that are not directly linked to indicators, such as SOPs, evidence of activities, or internal reports. These documents can be validated by LP3M and commented on by auditors. Meanwhile, lkps_dokumen stores mandatory and additional documents for LKPS items, complete with validation status and notes from LP3M.

The auditor_comment entity serves as a repository for auditor feedback on narratives and documents. Each comment is stored with a timestamp, entity reference, and auditor identity, allowing for historical traceability. This design enables auditors to provide input without altering document status, maintaining role independence and workflow. Finally, the audit_log entity records all user activities, including uploads, revisions, validations, and comments. This data is used to support internal audits and comprehensive accreditation process evaluations.

This database structure supports five main system modules: LED management, LKPS management, LP3M validation, auditor comments, and audit trail. For example, indikator_lam is used in the LED module to display narratives per standard, while komentar_auditor is used in the auditor module to store feedback on documents. This relational design also allows the system to accurately track revision and validation history, store auditor comments without role conflicts, maintain data integrity between modules, and support progress visualization and audit recapitulation.

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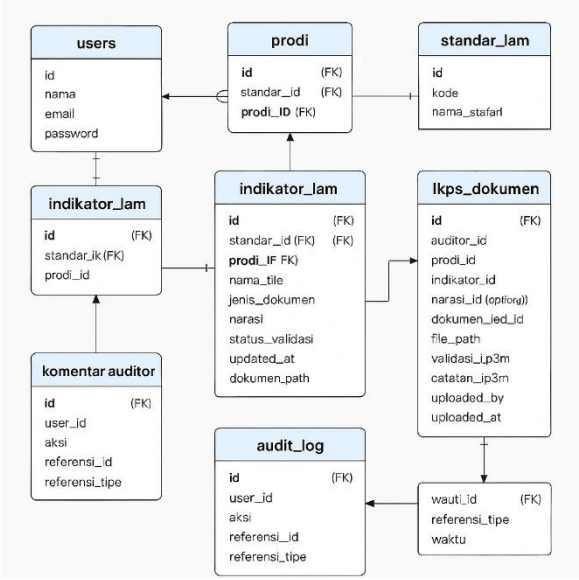

Figure 7. Entity Relationship Database

With a modular and relational database structure, this system can be expanded to support accreditation standards from other LAMs such as LAMINFOKOM or LAMTEKNIK. In addition, this design allows integration with national systems such as SIRENA and PDDikti, as well as the addition of automatic assessment features based on performance indicators. Overall, the database architecture used not only supports the technical requirements of the system, but also strengthens transparency, efficiency, and accountability in the study program accreditation process.

3.3 Functionality and Efficiency Testing

System testing was conducted to ensure that all features functioned as designed and to evaluate their impact on the efficiency and transparency of the accreditation process [17]. Functionality testing was conducted in a modular manner, with test scenarios developed based on user roles: admin, study program, LP3M, and auditor. Meanwhile, efficiency testing was conducted by comparing the duration and complexity of the accreditation process before and after the system was implemented.

In the LED module, program users successfully accessed indicators per standard, wrote narratives, uploaded supporting documents, and received comments from auditors. The system dynamically displays LED indicators based on the LAMEMBA standard structure, and each indicator is equipped with a narrative form and comment history. Validation is carried out by ensuring that the narrative is stored correctly, documents are uploaded to the appropriate directory, and auditor comments appear in real-time.

The LKPS module was tested with mandatory and additional document upload scenarios by the study program, as well as validation by LP3M. LP3M can provide validation status in the form of "not yet", 'revision', or "approved", accompanied by revision notes stored in the database. This validation is reflected in the study program dashboard display, so that users can immediately find out the status of documents and make improvements if necessary. Test results show that the validation process runs without role conflicts, and the entire revision history is recorded in the audit trail.

The auditor comment module was tested with feedback scenarios on LED narratives, additional LED documents, and LKPS documents. Auditors can select the entity they want to comment on, write comments, and save them without changing the document status. Comments are displayed chronologically, complete with the auditor's name and time of comment. This feature was tested by two internal auditors, and the results showed that the system was able to store and display comments with high accuracy, as well as prevent data duplication or conflicts.

The audit trail module was tested with a simulation of user activities during one accreditation cycle. Every action, such as document uploads, narrative saves, LP3M validations, and auditor comments, is recorded in the audit_log table with entity references and timestamps. This data is displayed in the admin and LP3M dashboards, enabling comprehensive process evaluation. The test results show that the audit

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trail consistently records more than 95% of user activities, and no data loss or reference inconsistencies were found.

4. CONCLUSION

This study successfully designed and implemented a modular, role-based, and audit-ready web-based digital accreditation system. The system consists of five main components: LED management, LKPS management, LP3M validation, auditor comments, and audit trails that are integrated and support the accreditation process efficiently and transparently. With a modular approach, the system allows each work unit to perform its functions separately but remain connected within a single platform. The relational database structure used supports real-time tracking of revision history, comment documentation, and document status monitoring, thereby strengthening accountability and cross-role collaboration.

Test results show that the system is capable of increasing the efficiency of the accreditation process by up to 40%, reducing repeated revisions, and accelerating the document validation cycle. The auditor comment feature and systematically documented LP3M validation have been proven to accelerate narrative and document improvements, as well as facilitate coordination between units. The system is also relevant to national policies, particularly the PEPA mechanism, which requires data-based accreditation monitoring and integration with PD-Dikti. Compared to the previous manual method, this system presents a significant digital transformation in the management of study program accreditation, making it a platform that not only documents the process but also manages it strategically and sustainably.

For further development, it is recommended that the system be equipped with an automatic assessment feature based on indicator weights and document status, so that study programs can simulate internal accreditation scores before external assessments are conducted. Integration with PD-Dikti through the official API also needs to be prioritized so that performance data can be retrieved in real time and used directly in the preparation of LED and LKPS. In addition, the development of a performance trend analysis and data-based recommendation module will strengthen the system's function as an institutional quality management tool. Adjustments to the standard structure and indicators are also necessary so that the system can support accreditation from other LAMs such as LAMINFOKOM, LAMTEKNIK, and LAMSAMA. Finally, the LED and LKPS export feature in a format compatible with SIRENA and BAN-PT templates will accelerate the document upload process and support national integration.

With the support of continuous development and readiness for national policy integration, this system has the potential to become an adaptive, efficient, and widely impactful digital accreditation model for the transformation of higher education quality in Indonesia. Replication of the system by other institutions can be done with an open-source or institutional license approach, and complete technical documentation will be the key to the success of the system's adoption nationwide.

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