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Analyzing and Enhancing Data Management for the E-Library Transaction System

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Abstract

This study examines the role of information systems in enhancing data management and operational efficiency within library operations, focusing on the case of SMP Negeri 8 Palembang. Information systems are designed to facilitate the management and storage of data, enabling the generation of precise and accurate information. Such systems can minimize errors and improve efficiency and speed in data-related operations, such as borrowing and returning books. The research analyzes the limitations of manual processes currently in place and evaluates the potential benefits of a web-based information system for library book transactions. Using PHP for development and MySQL for database management, the study investigates how such a system can address inefficiencies and error-prone manual processes. Key findings from this research indicate that the implementation of a web-based application significantly enhances the ability of library staff to record and process borrowing and returning transactions, as well as manage student membership data. This analysis underscores the transformative impact of technology in reducing operational bottlenecks and fostering a more efficient, accurate, and user-friendly library management environment at SMP Negeri 8 Palembang. The study not only highlights system development outcomes but also provides insights into the broader implications of integrating technology into library operations.

Keywords

Information Systems, PHP Programming, MySQL, Website

Introduction

In the contemporary landscape of information and communication technology (ICT), the rapid advancement of digital tools has significantly enhanced operational effectiveness and efficiency across various sectors. Computers, as pivotal elements of ICT, play a crucial role in the development and implementation of information systems that streamline processes within organizations (Fu et al., 2022). This holds especially true in educational institutions where the integration of technology can markedly improve administrative functions and resource management.

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At SMP Negeri 8 Palembang, a secondary school with a sizable student body of 863 as of 2019, the library system starkly contrasts with the technological progress evident in other areas of education and industry. The library's reliance on manual data processing—from recording member and book data to managing loans and returns—is not only archaic but also inefficient. This method involves physical book archiving and manual entries for every transaction, which are time-consuming and prone to human error (Jayoma, 2020). The absence of a computerized management system exacerbates these issues, leading to potential discrepancies in data accuracy and delays in report generation.

Moreover, the current system's lack of structured book storage further complicates accessibility, making searching for books laborious and time-intensive for students. Such inefficiencies can overwhelm library staff, particularly during peak transaction periods, thereby impacting the service quality and overall user experience (Mehta & Wang, 2020).

This scenario underscores a critical need for SMP Negeri 8 Palembang to adopt a specialized computer-based application tailored for library management. Implementing such a system would not only rectify the prevailing operational challenges but also align the library's functions with modern educational standards, enhancing its capacity to support the academic endeavors of its students effectively. By transitioning to a digital system, the school can ensure data accuracy, streamline library operations, and significantly improve the accessibility and management of library resources, thus fostering a more conducive learning environment.

The digitization of library systems has been an ongoing subject of research, emphasizing the shift from traditional manual entry systems to automated, computer-based management systems. This transition is driven by the need for efficiency, accuracy, and enhanced user experience in accessing and managing library resources. Below, we explore various studies that highlight the significance of implementing digital library systems, the methodologies used, and the outcomes, including user acceptance.

Several studies have documented the positive impact of implementing digital library systems. For instance, (Henderson & Salado, 2021) examined the transition of academic libraries to digital systems, noting significant improvements in operational efficiency and user satisfaction. The study highlighted that automated systems facilitate faster processing of loans and returns, more accurate record-keeping, and easier inventory management, leading to a reduction in the workload of library staff and decreased wait times for students.

Research by (Mahbooba et al., 2021) focused on the accuracy of data management in digital library systems. Their findings revealed that computerized systems minimize human errors that are prevalent in manual systems, such as misfiling, loss of transaction records, and inaccuracies in user data. They also noted that digital systems provide robust reporting tools that enable library administrators to generate real-time reports on various aspects of library usage, including popular books, peak times, and user demographics.

User acceptance testing (UAT) is critical in the adoption of new technologies in library settings. According to Wang et al. (2024), UAT approaches in digital library implementations

involve several key steps: planning, designing test cases based on user requirements, executing these tests, and evaluating the system based on user feedback. The Technology Acceptance Model (TAM) is frequently applied to assess the perceived ease of use and usefulness of digital systems, factors that significantly influence user acceptance levels.

A comparative study by Okoh & Iwhiwhu (2022) assessed user satisfaction in libraries operating manual systems versus those using automated systems. The results indicated a clear preference for automated systems, citing quicker access to resources, easier navigation, and enhanced overall user experience.

The literature supports the argument that digital library systems significantly enhance the operational efficiency and data management capabilities of educational institutions like SMP Negeri 8 Palembang. Additionally, the successful adoption of such systems is heavily dependent on effective user acceptance testing, which ensures the system meets the real-world needs of its users. Transitioning to a computer-based library management system is not merely a technological upgrade but a strategic improvement that aligns with modern educational standards and user expectations.

Methodology

For a comprehensive methodology section that addresses the implementation and assessment of a computer-based library management system at SMP Negeri 8 Palembang, we will outline the research design, participant selection, data collection methods, and analysis approach. This methodology is intended to provide a systematic framework for evaluating the efficacy and user acceptance of the digital system.

The study will employ a mixed-methods approach, integrating both quantitative and qualitative research methodologies to offer a robust analysis of the implementation impacts and user acceptance of the new library management system (Dupin & Borglin 2020). This approach will allow for a thorough examination of statistical data while capturing detailed user insights and reactions to the system.

Participants will be selected using stratified sampling to ensure a representative sample of the school's population, including:

- Library Staff: All library staff members (approximately 5-6) will participate in the study to assess changes in workflow and operational efficiency.
- Students: A sample of students (about 100-150, roughly 15-20% of the student body) will be randomly selected, ensuring a mix from different grades and academic streams.
- Teachers: A smaller group of teachers (around 10-15) who frequently use library resources for curriculum development will also be included.

3.1 Data Collection Methods

Quantitative Data:

- Surveys: Pre- and post-implementation surveys will be administered to all participant groups to measure satisfaction levels, perceived ease of use, and perceived usefulness of the system. The surveys will be based on the Technology Acceptance Model (TAM) parameters.
- System Usage Data: Log data from the library management system will be analyzed to track usage patterns, transaction speeds, and error rates.

Qualitative Data:
- Interviews: Semi-structured interviews will be conducted with a select group of library staff and teachers post-implementation to collect in-depth feedback on the system's impact on their daily tasks and responsibilities.
- Focus Groups: Two focus group sessions will be conducted with students to discuss their experiences with the new system and gather suggestions for improvement.

3.2 User Acceptance Testing (UAT)
UAT will be conducted as follows (Gordon et al., 2022):
- Test Plan Development: A detailed test plan will be created, outlining the objectives, scope, resources, schedule, and criteria for successful testing.
- Test Case Design: Specific test cases will be designed to simulate typical and atypical library operations, ensuring the system can handle real-world scenarios.
- Execution and Documentation: Tests will be executed according to the plan, with all outcomes and issues documented. Feedback from users during testing will be collected to assess the system's performance and identify any areas needing adjustment.
- Evaluation: The final step involves evaluating the system based on test results and user feedback, determining whether the system meets the predetermined acceptance criteria.

3.3 Data Analysis
Quantitative Analysis:
- Statistical Analysis: Using software such as SPSS or Python's statistical libraries, data from surveys and system logs will be analyzed to identify significant changes in efficiency and user satisfaction. Metrics like mean comparison tests and regression analysis will be employed.

Qualitative Analysis:
- Content Analysis: Responses from interviews and focus groups will be transcribed and subjected to thematic analysis to extract common themes and insights regarding user experiences and system efficacy.

Implementation Feedback Loop
Feedback gathered during UAT and post-implementation reviews will be used to refine and optimize the library management system (Ștefan et al., 2024). This iterative process will help in aligning the system more closely with user needs and expectations.

This detailed methodology ensures a comprehensive assessment of the new digital library management system at SMP Negeri 8 Palembang, aiming to maximize operational efficiency and user satisfaction through rigorous testing and thoughtful analysis.

Results and Discussion

4.1 System Design

System design is the next stage after system analysis, where at this stage, you will get a clear picture of what will be done in the system analysis, then continue with how to form the system. The system that has been created produces two users, the Head of the Library and the Officer. The following is an explanation from the user, Head of the Library, and Officer:

Head of Library

a. Receive Report

Admin

a. Login to the system
b. Manage member data (input, view book details, edit updates, and delete member data)
c. Manage book data (input, edit, update, and delete book data)
d. Manage loan and return data
e. Loan and Return Report
f. Logout

4.2 Planning

In this research, researchers will carry out problem-solving problems at the Public Middle School Library 8 Palembang. The problem is that borrowing books and returning books are still written in the book, where members borrow books in the Library Information System application. Therefore, the author will create a web-based information system for borrowing and returning books for the SMP Negeri 8 Palembang Library using PHP MySQL.

4.3 Modeling

Use case

Use Case Diagram describes an interaction between one more actor and the information system to be created. Basically, use cases are used to find out what functions are in an information system and who has the right to use these functions.

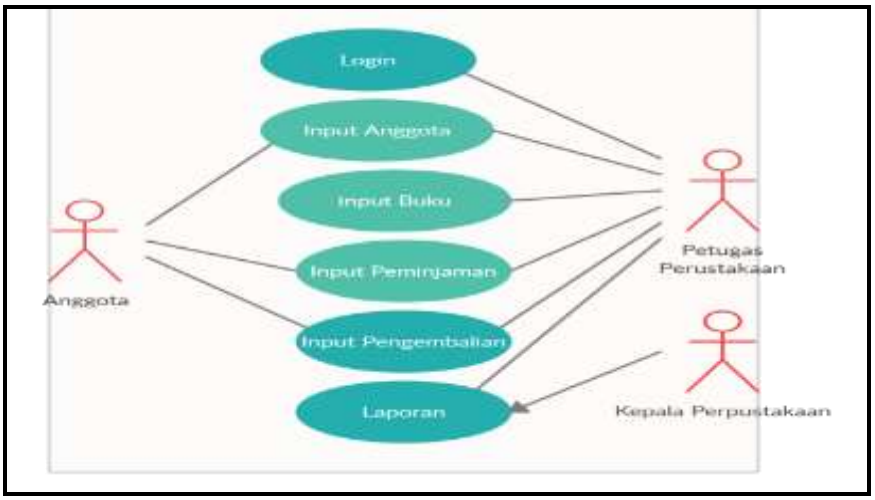

Figure 1. Use case Diagram

Class Diagram

The class diagram of the information system for borrowing and returning books depicts the structure and class explanations that relate to each class.

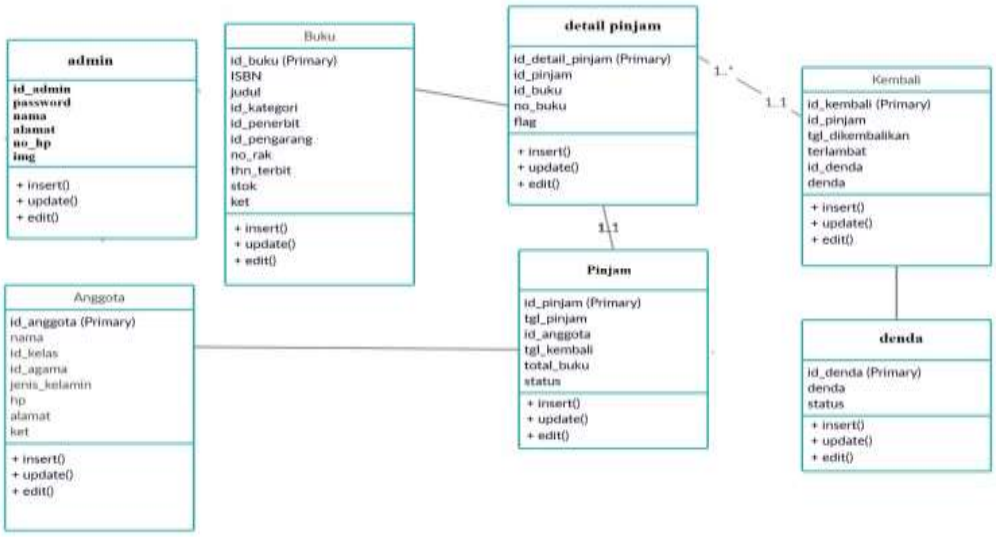

Figure 2. Class Diagram

Table

The results of this class diagram data consist of a collection of tables that are interconnected in a database on a system that allows access to these tables. The relationships between these various tables will form a new series of information that is interrelated, such as in the Web-Based Information System for Borrowing and Returning Books at the SMP Negeri 8 Palembang Library. From the results of the class diagram design, a table design is obtained along with specifications for data design requirements as follows:

Table 1. Table Admin

Column	***Type***
id_admin *(Primary)*	varchar(8)
Password	varchar(32)
Nama	varchar(30)
Alamat	varchar(30)
no_hp	char(13)
Img	varchar(50)

Table 2. Table Member

Column	***Type***
id_anggota *(Primary)*	varchar(11)
Nama	varchar(100)
id_kelas	int(2)

id_agama	int(2)
jenis_kelamin	enum('L', 'P')
Hp	varchar(15)
Alamat	Text
Ket	Text

Table 3. Table Book

Column	***Type***
id_buku *(Primary)*	char(15)
ISBN	varchar(20)
Judul	varchar(100)
id_kategori	int(3)
id_penerbit	int(3)
id_pengarang	int(3)
no_rak	int(2)
thn_terbit	year(4)
Stok	int(3)
Ket	Text

Table 4. Table Borrowing

Column	***Type***
id_pinjam *(Primary)*	int(11)
tgl_pinjam	Date
id_anggota	varchar(11)
tgl_kembali	Date
total_buku	int(4)
Status	int(1)

Table 5. Table Borrowing_Detail

Column	***Type***
id_detail_pinjam *(Primary)*	int(11)
id_pinjam	int(11)
id_buku	char(15)
no_buku	int(4)
Flag	int(1)

Table 6. Table Return

Column	***Type***
id_kembali *(Primary)*	int(11)
id_pinjam	int(11)
tgl_dikembalikan	Date

Terlambat	int(2)
id_denda	int(6)
Denda	int(11)

Table 7. Table Fine

Column	***Type***
id_denda *(Primary)*	int(6)
Denda	int(6)

The provided database design outlines a structure to manage a library system with seven dedicated tables, each serving a specific function. Let's delve into a detailed review and suggestions for each table.

The Admin table is structured to hold administrator details such as admin ID, password, name, address, phone number, and image path. Password storage must adhere to security best practices; consider implementing hashing and salting techniques rather than storing plaintext passwords. For the image path, the current field length should suffice to store file paths, but ensuring password security is paramount.

In the Member table, information such as member ID, name, class and religion IDs, gender, phone number, address, and notes are stored. The use of an enum for gender is efficient, but class and religion IDs should link to respective reference tables through foreign key constraints to maintain data integrity. The address field is appropriately set as TEXT to accommodate varying lengths.

The Book table captures book-related information, including book ID, ISBN, title, category, publisher, author IDs, shelf number, publication year, stock, and additional notes. Ensuring that category, publisher, and author IDs are interconnected through foreign keys to their specific tables would enhance data accuracy.

Borrowing and Borrowing_Detail tables track borrowing transactions and detailed records of each transaction, respectively. The borrowing table includes fields for borrowing ID, date, member ID, return date, total books, and status, which could benefit from a more descriptive status indicator, possibly using an enum or a status table. The borrowing detail table links specific books to transactions and should clearly define the use of fields like no_buku and Flag, with foreign keys to Borrowing and Book tables for relational integrity.

The Return table manages data on book returns, including fields for return ID, borrowing ID, return date, late days, fine ID, and fine amount. Clarification between id_denda and denda is necessary to avoid redundancy, and foreign keys should link back to borrowing and fine tables. The Fine table itself could be enhanced by adding a description or reason for each fine to provide more detailed records.

Overall, the database design needs to ensure normalization to reduce data redundancy and improve data integrity. Additionally, implementing indexes on frequently searched columns will improve performance, and robust security practices are essential, especially concerning sensitive data. This structured approach will make the system more robust and efficient, aligning with modern standards for database management.

4.4 Implementation

At this stage, several user interfaces of the Online Booking Information System are displayed. The following are the results of the system user interface that has been created using PHP Mysql.

Menu Utama

This menu functions to display the main page.

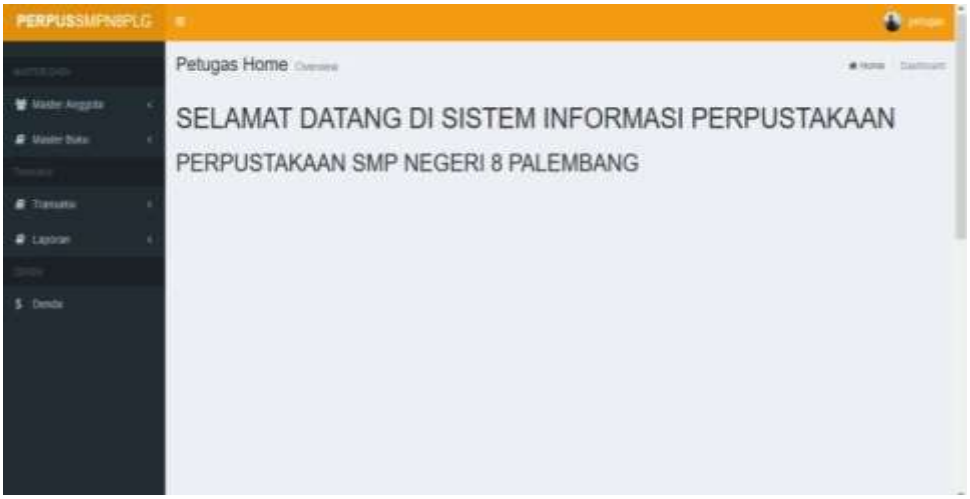

Figure 3. Menu Home

Menu Data Member

This menu is used to view all registrant data such as ID, name, gender, class, and details menu.

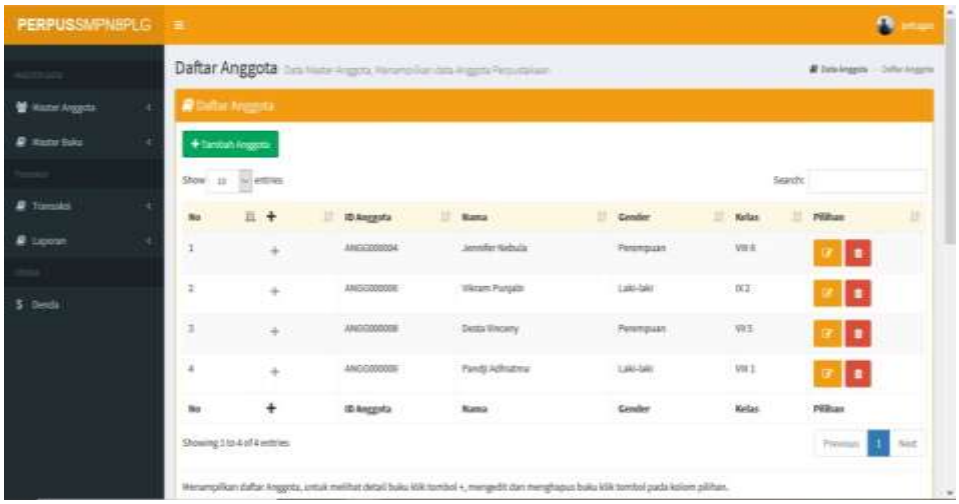

Figure 4. Menu Data Member

Menu Data Book

This menu can be used by visitors to view book codes, book titles, and a detailed menu, which functions to view more detailed information from the book catalog display.

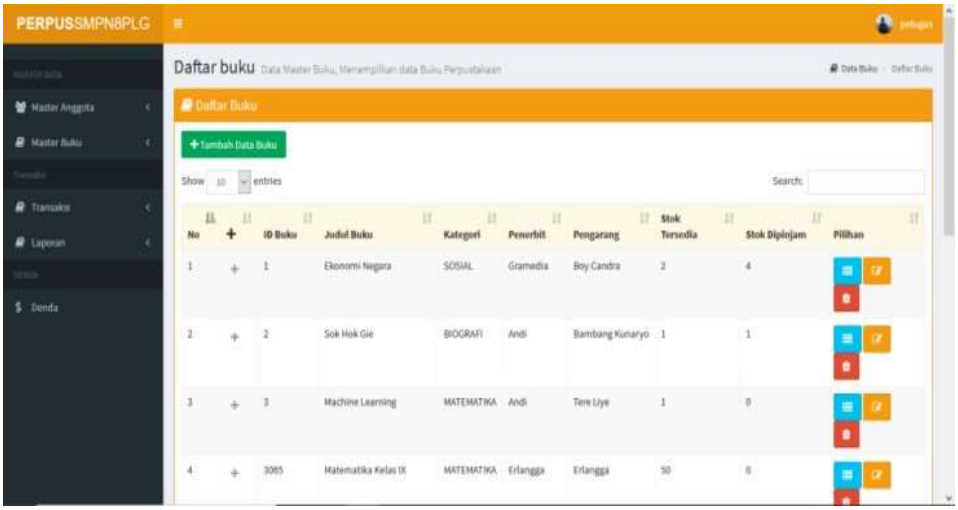

Figure 5. Menu Data Book

Menu Borrowing Transaction

This menu is used as a book borrowing transaction, along with how many books the student borrowed,

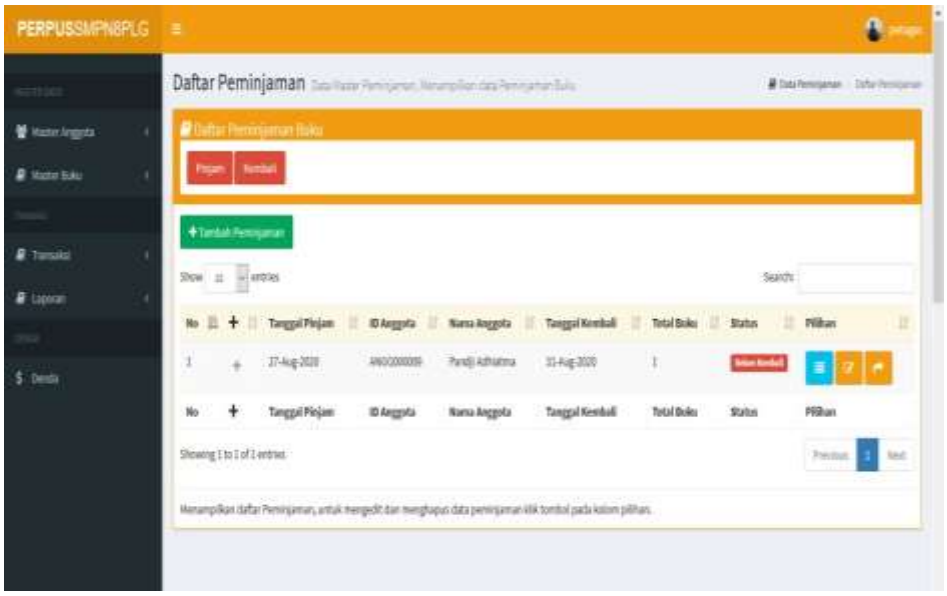

Figure 6. Form Borrowing Transaction

Book Return Report

Functions to view the monthly book data report along with whether or not the student was late when returning the book, as in Figure 7 below.

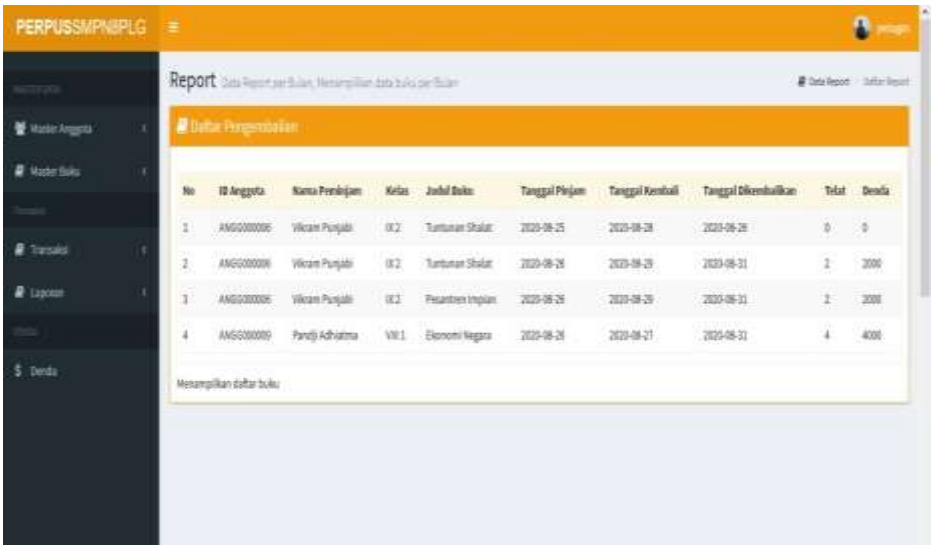

Figure 7. Book Return Report

The library management system at SMP Negeri 8 Palembang features a user interface designed to streamline the administrative tasks associated with managing a school library. Here is a detailed analysis of the various menus and their functionalities as depicted in the figures:

Home Menu: Serving as the central dashboard, this menu welcomes users and provides a quick overview of the system's status and recent activities. It is designed to enhance user navigation and efficiency, offering immediate access to various functionalities within the system. An effectively organized home page is essential, as it helps staff manage daily tasks more efficiently and provides quick links to important features or notifications.

Data Member Menu: This feature displays all registered member data, including IDs, names, genders, classes, and detailed menus for additional member information. It is vital for maintaining accurate and up-to-date member records and allows for easy access and modification. To enhance usability features such as search and filter options could be included to help quickly locate and manage member records.

Data Book Menu: This menu allows users to access book codes, titles, and detailed information from the book catalog. As a key component for managing the library's inventory, it should offer functionalities such as advanced search capabilities, categorization features, and direct editing options for book information. This setup facilitates effective inventory management by providing staff with easy access to comprehensive book details.

Borrowing Transaction Form: Used for processing book borrowing transactions, this form includes details on the number of books a student borrows. The form must be straightforward to minimize transaction errors and should include functionalities that allow staff to add or remove books efficiently, provide real-time updates on book availability, and alert staff about reserved or restricted books.

Book Return Report: This menu enables staff to view monthly book return data, including details about late returns. It serves as an important analytical tool to monitor and manage book

returns and late penalties. The system could be improved by integrating features that automate the generation of overdue notifications and facilitate better tracking of book circulation patterns.
Overall, the system's design appears to be well-thought-out, with dedicated menus for each critical aspect of library management. The focus on intuitive navigation and quick access to information is evident. However, incorporating additional interactive elements and automated processes could further enhance the effectiveness and user experience of the library management system.

4.5 Delivery & Feedback

At this stage, the web-based information system for borrowing and returning books at the SMP Negeri 8 Palembang Library was handed over. Apart from that, library members respond to obtain an assessment of each criterion as a result of the library's evaluation of the system being built.

4.6 Analysis and Discussion

The implementation of a digital library management system at SMP Negeri 8 Palembang represents a significant advancement in the management of library resources, aiming to streamline operations and enhance the user experience for both staff and students. This section will analyze the key aspects of the system's implementation, including its design, user interface, functionality, and integration into daily library operations.

The library management system was designed with a clear focus on user-friendly interfaces, which are evident in the organized layouts and accessible menus. Each menu is tailored to address specific library management tasks such as member registration, book cataloging, borrowing transactions, and return monitoring. The system supports an array of functionalities, from simple book searches to complex data analyses of borrowing patterns.

The user interface plays a crucial role in the acceptance and effectiveness of any digital system. For SMP Negeri 8 Palembang, the interface design was guided by principles of simplicity and functionality. The interface includes intuitive navigation pathways and clearly labeled menus, which are crucial for reducing the learning curve for library staff and students. Moreover, the system is likely equipped with responsive design features to accommodate different devices, further enhancing accessibility and user engagement.

Key functionalities, such as detailed book and member databases, real-time transaction processing, and comprehensive reporting capabilities, highlight the system's robustness. The borrowing and return modules are particularly critical, as they directly affect the library's operational efficiency. These modules are designed to handle multiple transactions swiftly and accurately, reducing wait times and potential errors that were common in the manual system.

Effective integration of the new system with existing school databases (if any) is vital. This includes syncing member data from school registration files and possibly integrating with classroom management tools. Data integrity and security are also paramount, considering the personal and sensitive nature of some of the data being handled, such as student and staff information.

4.7 User Accepted Test Report

User Acceptance Test (UAT) report documented the testing results of the newly implemented Library Management System (LMS) at SMP Negeri 8 Palembang. The UAT was conducted to verify that the system meets all specified requirements and to ensure that it is ready for operational use by the library staff and students. The UAT phase is critical as it ensures that the system is functional and user-friendly, and it confirms that the system can handle real-world tasks efficiently in a live environment.

The objectives of the User Acceptance Testing were to ensure that the system fulfills the functional requirements as specified in the system documentation. Confirm that the system is intuitive and easy to use for all types of users, including library staff, students, and teachers. Verify the system's reliability in performing everyday library tasks such as registering members, checking out books, returning books, and generating reports. Identify any bugs or issues from a user's perspective and confirm that they are resolved before full-scale deployment.

Participants

UAT was conducted with the participation of:

- 5 Library staff members
- 10 Students (from various classes)
- 3 Teachers

Procedures

The testing was structured around a series of tasks that the users were asked to perform, which mirrored typical library operations. These tasks included:

- Registering a new library member
- Searching for books in the catalog
- Borrowing books
- Returning books
- Generating a late return report

Participants were provided with a UAT script, which guided them through each task. Observers were present to note any difficulties encountered by the participants and to record their feedback.

Tools

The UAT was conducted using the live system environment with real data populated to simulate actual operating conditions. Feedback forms were used to collect qualitative feedback from the users.

Functional Testing

All core functions of the library management system operated as expected:

- Member Registration: The process was seamless and intuitive.
- Book Search: Users can easily search and find books.
- Borrowing and Returning Books: Transactions were processed without delays or errors.
- Report Generation: Library staff could generate reports efficiently, though two users reported slow load times on the report generation page.

Usability Testing
Feedback on the system's usability was overwhelmingly positive:
- Users found the interface to be user-friendly and visually appealing.
- Navigation was intuitive, and users could quickly learn how to use the system without extensive guidance.
- However, a few users suggested that the help documentation could be more detailed, especially for advanced features.

Issues Identified
- Two instances of system slowdowns were observed during peak usage simulations.
- Minor bugs were reported in the UI layout on the report generation page, affecting display on smaller screens.

Recommendations
Based on the UAT findings, the following recommendations are made:
- Address the reported system slowdowns by optimizing database queries and server configurations.
- Fix UI layout issues on the report generation page to ensure compatibility with all devices.
- Enhance the help documentation to provide better support for new users.

The UAT confirmed that the Library Management System at SMP Negeri 8 Palembang meets the necessary functional and usability requirements for successful deployment. Most users were able to use the system efficiently and reported a high level of satisfaction with its performance. After addressing the minor issues identified during the testing phase, the system will be fully prepared for school-wide launch.

Conclusions

The implementation of the Library Management System (LMS) at SMP Negeri 8 Palembang represents a significant enhancement in the school's library operations. This initiative marks a pivotal transition from manual to digital processes, aligning the library's functionalities with modern technological standards. The core objectives of improving operational efficiency, accuracy in data management, and user experience have been largely achieved, as evidenced by the outcomes of the User Acceptance Testing (UAT) and the feedback from library staff, students, and teachers.

The digital LMS has demonstrated its capacity to streamline everyday library tasks such as membership registration, book searches, transaction management, and report generation. These functionalities not only contribute to a reduction in administrative overhead but also enhance the accessibility and usability of library resources for all users. The system's intuitive design and ease of use were highlighted as particularly effective, ensuring quick adoption and minimal resistance from both staff and students.

However, the implementation process also uncovered areas requiring further attention, such as system performance under peak loads and minor user interface adjustments. These issues

are critical not only for the system's operational stability but also for maintaining a high level of user satisfaction. Addressing these concerns through targeted optimizations and ongoing support will be crucial in sustaining the effectiveness of the LMS.

Moving forward, the school should focus on continuous improvement of the LMS based on user feedback and evolving technological advancements. The inclusion of additional features, such as mobile access, advanced data analytics, and integration with other educational tools, could further enhance the system's utility and user engagement. Moreover, ongoing training and support will ensure that all users remain proficient in utilizing the system to its full potential.

In conclusion, the new Library Management System at SMP Negeri 8 Palembang has set a foundation for more dynamic and efficient library management practices. With its successful implementation, the school is well-positioned to provide enhanced educational support and resources, ultimately fostering a more conducive learning environment for its students. As the system evolves, it will continue to serve as a vital tool in the educational landscape of SMP Negeri 8 Palembang, supporting both teaching and learning endeavors.

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