

An Automated Multi-Module Library Circulation Platform with Real-Time Transaction and Notification Services

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Abstract— Efficient management of library resources is essential for maintaining accurate records, improving book circulation, and providing timely services to users. This paper presents the design and implementation of a web-based Circulation Management System that automates the complete workflow of library circulation activities. The proposed system incorporates separate modules for administrator and librarian operations, enabling secure authentication, librarian management, patron registration, patron fund management, book catalog maintenance, book issuing, return processing, and revenue monitoring. An automated email notification mechanism is integrated to remind students about overdue books, thereby reducing delays in book returns and improving resource availability. The system is developed using Python with a MySQL database to ensure reliable storage and retrieval of circulation records. By replacing manual record-keeping with a centralized digital platform, the proposed solution minimizes administrative effort, enhances data accuracy, and improves operational efficiency. Experimental implementation demonstrates that the system effectively manages library transactions while providing secure access control, transparent financial tracking, and user-friendly interfaces suitable for educational institutions and small to medium-sized libraries.

Keywords— Circulation Management System, Library Automation, Book Circulation, Library Management, Python, MySQL, Administrator Module, Librarian Module, Book Issue and Return, Patron Management, Revenue Management, Email Notification System, Authentication, Database Management, Web-Based Library System, Digital Library Services, Automated Book Tracking, Library Information System.

1.INTRODUCTION

Libraries play a significant role in educational institutions by providing students, researchers, and faculty members with access to academic resources. As the number of books, users, and daily

transactions increases, maintaining circulation records manually becomes a time-consuming and error-prone process. Conventional library management methods often involve handwritten registers or isolated record-keeping systems that make it difficult to track issued books, monitor return dates, manage librarian activities, and generate financial reports efficiently [8]. These limitations can result in misplaced records, delayed book returns, and increased administrative workload. Consequently, there is a growing demand for automated library circulation systems that simplify daily operations while improving data accuracy and service quality [2].

Recent developments in web technologies and database management systems have enabled the development of digital library solutions capable of automating circulation activities through centralized information management. Such systems allow administrators to manage librarian accounts, maintain patron information, monitor financial contributions, and supervise overall library operations from a single platform [5]. Likewise, librarians can efficiently register new books, issue books to students, update return information, and maintain transaction records without manual intervention. Integrating automated notification services further enhances system functionality by reminding users about overdue books through email alerts, thereby encouraging timely returns and improving book availability. The combination of secure authentication, database-driven record management, and automated communication contributes to greater operational efficiency and reliability in modern library environments [7].

This paper presents the design and implementation of a Circulation Management System that digitizes the complete workflow of library circulation activities. The proposed system provides dedicated modules for administrator and librarian operations, including user authentication, librarian management, patron registration, investment tracking, book catalog management, book issuing, return processing, overdue email notifications, and revenue analysis [9]. The application is developed using Python with a MySQL database to ensure

secure data storage and efficient transaction management. By replacing conventional manual procedures with an integrated web-based platform, the proposed system improves record management, minimizes administrative effort, enhances transparency, and supports effective utilization of library resources. The developed solution is suitable for educational institutions and libraries seeking an efficient, secure, and user-friendly circulation management platform [10].

II. RELATED WORK

D. Daimari, N. Mazumdar, M. Narzary, and A. Nag (2021) presented “A Machine Learning Based Book Availability Prediction Model for Library Management System” [1]. The authors introduced a machine learning approach to estimate the future availability of books in a library by analyzing borrowing records and circulation history. Their model considered historical lending behavior and user demand to identify books that were likely to become unavailable during specific periods. The proposed prediction mechanism assisted librarians in planning acquisitions and improving resource allocation while minimizing the inconvenience caused by unavailable books. Experimental findings indicated that machine learning techniques can effectively support library decision-making by improving prediction accuracy over conventional record-based methods. The study demonstrated that predictive analytics can enhance library services by helping administrators maintain balanced book inventories and improve user satisfaction through better planning and resource management.

R. K. Deshmukh (2016) presented “A Study of Open Source Library Management Software” [2]. The study examined various open-source library management solutions and evaluated their ability to support routine library functions, including catalog management, circulation, user administration, and report generation. The author compared different software packages based on functionality, usability, customization capability, and implementation cost. The analysis revealed that open-source systems provide educational institutions with flexible and economical alternatives to proprietary software while maintaining essential library operations. The paper also discussed the importance of community support, regular software updates, and scalability for long-term system maintenance. The findings suggested that selecting an appropriate open-source platform enables libraries to automate their services efficiently, reduce operational expenses, and improve access to information without requiring significant financial investment.

K. Anwar *et al.* (2019) presented “Machine Learning Techniques for Book Recommendation” [4]. The authors proposed a recommendation framework that applies machine learning algorithms to analyze user preferences and borrowing history for suggesting relevant books. The system generated personalized recommendations by identifying similarities among readers and recognizing patterns in previous circulation records. By incorporating intelligent recommendation techniques, the proposed model aimed to increase user engagement and simplify book discovery within digital library environments. Performance evaluation demonstrated that machine learning-based recommendations improved the relevance of suggested books compared to traditional recommendation approaches. The research highlighted the importance of personalized services in modern libraries and showed that intelligent recommendation systems can enhance user experience while encouraging efficient utilization of available library resources through automated decision-making processes.

Q. Wang *et al.* (2020) presented “Research on Management of Digital Library Based on Information Platform” [7]. The authors focused on developing an integrated information platform to improve the management and accessibility of digital library resources. Their proposed framework centralized the storage, retrieval, and maintenance of digital content while supporting efficient communication between library administrators and users. The system emphasized information sharing, resource integration, and simplified management through modern information technologies. Experimental analysis demonstrated improvements in system efficiency, data organization, and service quality compared with conventional digital library management practices. The study concluded that adopting an integrated information platform can strengthen digital library operations by reducing management complexity, improving resource utilization, and providing users with faster and more reliable access to electronic information.

J. Zhou and T. Huang (2023) presented “Application of Machine Learning Algorithm in Electronic Book Database Management System” [12]. The authors investigated the use of machine learning algorithms to improve the management of electronic book databases through intelligent data processing and automated resource organization. Their approach utilized learning algorithms to optimize database operations, classify electronic resources, and support efficient retrieval of digital content. The proposed system improved search performance by recognizing user behavior and organizing

information according to usage patterns. Experimental observations showed that integrating machine learning techniques enhanced database efficiency, reduced retrieval time, and improved the overall management of electronic library resources. The research demonstrated that intelligent database management systems can provide faster access to digital materials while supporting scalable and effective electronic library services in modern educational environments.

III.DATASET DETAILS

The proposed Circulation Management System utilizes a relational database that stores information associated with library operations, including librarians, patrons, books, book issue records, return transactions, patron contributions, and revenue details. The dataset is maintained in a MySQL database, where each table represents a specific module of the system and is linked through unique identifiers to ensure consistency and efficient data retrieval. Librarian records contain authentication credentials and employee information, while book records include details such as book title, author, category, availability status, and unique token identifiers. Transaction tables maintain information related to book issuance, student details, issue dates, return dates, overdue status, and collected fines. Patron-related tables record contributor information and financial investments made to the organization. Before deployment, the database is initialized using predefined SQL scripts that create the required tables and establish relationships among different entities. During system operation, records are continuously updated whenever new books are added, books are issued or returned, patrons are registered, or financial transactions are performed. The application validates user inputs before storing them in the database to maintain data integrity and minimize inconsistencies. The stored information also supports automated email notifications for overdue books by identifying transactions that exceed the permitted borrowing period.

The dataset serves as the foundation for all administrative and circulation activities within the proposed system. It enables secure user authentication, efficient management of library resources, monitoring of book availability, financial tracking, and generation of operational reports. Experimental implementation demonstrates that the structured database effectively supports real-time library transactions while ensuring accurate record maintenance, fast information retrieval, and reliable management of day-to-day circulation activities.

IV.PROPOSED METHODOLOGY

The proposed Circulation Management System is designed to automate the complete workflow of library circulation activities through a secure web-based platform developed using Python and MySQL. The primary objective of the system is to replace conventional manual record management with a centralized digital solution that simplifies library administration, improves transaction accuracy, and enhances service efficiency. The application provides separate authentication mechanisms for administrators and librarians, ensuring that each user can access only the functions assigned to their role. The integrated architecture enables efficient management of books, librarians, patrons, circulation records, financial transactions, and overdue notifications within a single environment. The operational workflow begins with administrator authentication, after which the administrator registers librarian accounts and maintains patron information along with their financial contributions. Librarians authenticate using the credentials assigned by the administrator and perform routine library operations such as adding new books, updating book information, issuing books to students, and recording returned books. Every circulation transaction is stored in the MySQL database, where each issued book is associated with student information, issue date, return status, and other relevant details. The centralized database continuously updates records whenever new books are added or circulation activities are performed, ensuring data consistency and reliable retrieval of information. To improve library services, the proposed system incorporates an automated notification mechanism that periodically identifies overdue transactions and sends email reminders to students who fail to return books within the permitted borrowing period. In addition, the system maintains financial records related to patron investments and fines collected during book returns, allowing authorized users to monitor revenue and generate operational reports. Secure authentication, database validation, and role-based access control ensure reliable management of sensitive information while preventing unauthorized modifications. The proposed methodology integrates user authentication, circulation management, database administration, automated email notification, and financial monitoring into a unified platform. Experimental implementation demonstrates that the system efficiently manages library resources, reduces manual documentation, improves record accuracy, accelerates transaction processing, and enhances overall library administration. The developed framework provides a scalable and practical solution for educational institutions and libraries seeking a secure, reliable, and user-friendly circulation management system.



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allowing authorized access to the librarian module. The registered librarian can later log in to perform circulation activities such as adding books, issuing books, updating return records, and viewing revenue reports. This module simplifies librarian account management, improves data accuracy, eliminates manual record maintenance, and ensures secure role-based access for efficient library administration.

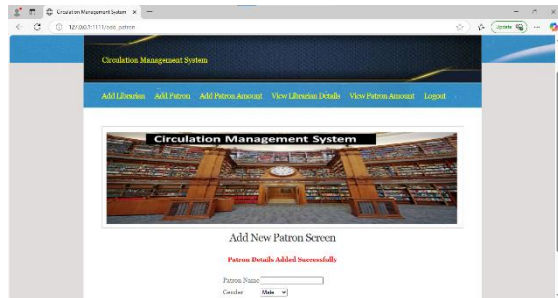


Figure 3: Add New Patron Module

Figure 3 illustrates the Add New Patron interface of the proposed Circulation Management System. This module enables the administrator to register individuals who contribute financial support to the library or institution. After successful administrator authentication, the user can access this module through the navigation menu and enter the required patron information, including the patron's name and gender. Once the details are submitted, the system validates the entered information and securely stores the record in the MySQL database. A confirmation message is displayed to indicate that the patron has been successfully added to the system. The registered patron information is subsequently utilized in the Patron Amount module to record investment or donation details. By maintaining centralized patron records, the system simplifies financial management, improves data consistency, reduces manual documentation, and enables administrators to efficiently monitor all patron-related activities. This module contributes to secure and organized management of patron information within the overall library circulation system.

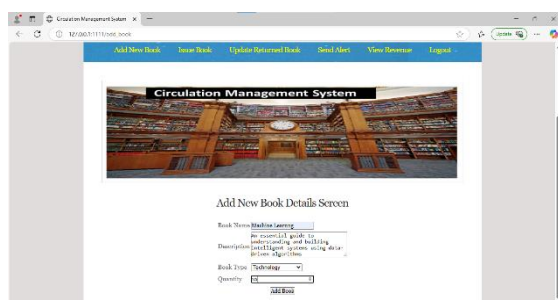


Figure 4: Add New Book Module

Figure 4 illustrates the Add New Book interface of the proposed Circulation Management System. This module is accessible only to authenticated librarians and is used to register new books in the library

database. The librarian enters essential book information, including the book name, description, book type, and quantity available in the library. After the required details are provided, the librarian submits the information by clicking the Add Book button. The system validates the entered data and securely stores the book details in the MySQL database while assigning a unique book identifier for future circulation activities. The newly added books become immediately available for issue to students through the book circulation module. This module enables efficient maintenance of the library catalog by ensuring accurate storage and retrieval of book information. It minimizes manual documentation, improves inventory management, maintains up-to-date records of available books, and supports smooth circulation operations, thereby enhancing the overall efficiency and reliability of library resource management.

DISCUSSION

The Circulation Management System integrates administrator, librarian, and database modules to automate the complete lifecycle of library circulation activities. The system follows a structured workflow that includes user authentication, librarian registration, patron management, book catalog maintenance, book issuing, return processing, automated email notifications, and revenue monitoring. All operational information is stored in a centralized MySQL database, enabling secure and efficient management of books, users, circulation records, and financial transactions. The web-based interface simplifies day-to-day library operations by providing authorized users with dedicated modules for performing administrative and circulation-related tasks while maintaining data consistency and minimizing manual intervention. The implementation demonstrates that the proposed system effectively manages book circulation by accurately recording issue and return transactions, updating book availability in real time, and maintaining complete transaction histories. The automated email notification feature assists librarians by sending reminders to students with overdue books, thereby improving return compliance and increasing book availability. The revenue management module further enables efficient monitoring of fines and patron contributions, while the reporting facility provides comprehensive information on librarians, patrons, book circulation, and financial records. Overall, the developed framework enhances operational efficiency, improves record accuracy, reduces administrative workload, and provides a secure and

scalable solution for modern library management in educational institutions.

VI.CONCLUSION

This paper presents a Circulation Management System that automates library operations through a secure web-based platform developed using Python and MySQL. The proposed system integrates administrator and librarian modules to manage librarian registration, patron information, book catalog maintenance, book issuing, return processing, automated email notifications, and revenue monitoring within a centralized database environment. By replacing conventional manual record-keeping with a digital management system, the application improves the accuracy of circulation records, simplifies administrative tasks, and ensures efficient management of library resources. The implementation demonstrates that the system effectively maintains book availability, securely stores transaction records, tracks overdue books, and generates timely notifications to users, thereby enhancing the overall quality of library services. In addition, the integrated reporting and revenue management modules provide administrators with reliable operational insights for better decision-making. The proposed framework offers a practical, scalable, and user-friendly solution suitable for educational institutions and libraries of various sizes. Future enhancements may include RFID-based book tracking, barcode integration, mobile application support, cloud-based deployment, online book reservation, digital payment facilities, advanced analytics, and machine learning techniques for intelligent book recommendations and circulation prediction, further improving the efficiency and accessibility of modern library management systems.

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