

**DESIGN AND DEVELOPMENT OF AN ONLINE LIBRARY MANAGEMENT
SYSTEM FOR DEGREE COLLEGE**

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Abstract—

This research focuses on developing a computerized Library Management System (LMS) for the Degree College of Education (DCE). The system aims to streamline library operations and provide convenient digital access to resources such as books, magazines, newspapers, and other documents for both librarians and users. It addresses the limitations of the existing manual system, including restricted accessibility, document deterioration, and file mismanagement.

To overcome these challenges, a web-based LMS is proposed to replace traditional paperwork, reduce book procurement costs, and eliminate issues related to lost or damaged files. This system will support users with unrestricted, 24/7 access to digital materials, thereby encouraging reading habits and supporting educational advancement across diverse user groups—ranging from students and educators to researchers and the general public.

The platform is designed using Java, PHP, HTML, and MySQL for database management. It enables efficient handling of library tasks such as data entry, validation, updates, and user interaction. By digitizing library services, the system intends to broaden the reach of DCE's resources, making them available to users in remote areas and promoting equitable access to knowledge.

This initiative is not only a step toward modernizing DCE's library but also a foundation for a nationwide digital library framework that serves the broader community. Based on the current challenges in the manual system, strategic recommendations have been made to ensure effective implementation and continuous improvement.

Keywords— Library Management System, DCE, Digital Library, Database, Web-based System

I. INTRODUCTION

Degree College of Education is one of the prominent educational institutions in Eritrea. Currently, the DCE library operates through a manual system, relying on paper-based records to manage daily activities. In many developing countries like Eritrea, the absence of an automated Library Management System (LMS) significantly hinders efficient record-keeping and service delivery.

Manual processes at DCE lead to a range of issues, such as time-consuming transactions (e.g., book borrowing, returning, and searching), frequent human errors, and misplacement or damage of physical files. The growing volume of records further exacerbates space constraints and increases the difficulty of maintaining an organized system. These challenges highlight the urgent need for a digital solution.

This project proposes the development of a computerized LMS using the DCE Library as a case study. The system aims to streamline administrative tasks and improve interactions among administrators, users, and library members. By transitioning to a digital platform, the DCE library can significantly enhance efficiency, minimize errors, and reduce costs associated with book acquisition and record management. The proposed system will ultimately address the shortcomings of the current manual process and modernize library services.

II. BACKGROUND

A library is a structured repository of information resources made available for public use, often serving as a cornerstone for education, research, and personal development. Traditionally, libraries have managed and stored materials in physical formats. However, with the evolution of technology, the mode of access and information storage has shifted toward digital systems. Despite this shift, many libraries—especially in developing regions—still rely on outdated manual methods, which are inefficient and inflexible. Libraries are continuously growing entities; thus, their management systems must evolve to keep pace. The application of modern technologies in libraries is essential for the efficient retrieval, storage, and dissemination of information. A digital LMS not only ensures better organization and accessibility but also enhances user experience by providing timely and reliable services.

The development and implementation of a web-based digital LMS at DCE will serve as a foundation for transforming traditional library operations into a modern, user-centered information hub.

A Library Management System (LMS) is a software application designed to digitally manage the operations of a small to medium-sized library. It is primarily operated by library staff to handle various library functions efficiently through a computerized platform. The system enables librarians to manage key tasks such as issuing and returning books, adding new eBooks, registering new members, and tracking user activity.

The LMS incorporates modules for both user and book management, allowing for detailed records of all users and the resources available within the library. Unlike manual systems—

where data loss is common due to misplaced or damaged physical records—a computerized system significantly reduces the risk of losing important information.

Although the system provides open access to users for reading and searching digital content, administrative functions such as system maintenance, generating reports (e.g., lists of registered users, eBook additions, and book return records), and data updates are restricted to administrators. These functionalities enhance the librarian's ability to manage the library in a more organized, reliable, and effective manner.

Overall, this system is developed to assist librarians in maintaining accurate records of all book transactions, while also eliminating common problems associated with manual library operations, such as lost books and disorganized files.

III. LITERATURE REVIEW

Previous studies emphasize the importance of efficient information management systems and the long-term sustainability of library operations. These works highlight that the rapid growth of diverse data types has created challenges in retrieving accurate and relevant information. In response, our proposed system focuses on delivering more organized and accessible information for users of the DCE Library. It offers full administrative control, allowing the admin to manage and update records seamlessly.

Libraries play a vital role in supporting education, research, and the development of knowledge and skills. While our work shares common goals with previous research—particularly in ensuring the longevity and reliability of library systems—our system further enhances functionality by enabling complete digitization, including the integration of eBooks and remote access capabilities.

Management, as described by, is “the art of getting things done through people.” A manager achieves organizational goals by motivating and coordinating the efforts of others. While there has long been a debate on whether management is an art or a science, it is increasingly accepted that, in the context of modern technology, management has become more scientific in nature. In this project, management is viewed through the lens of a Management Information System (MIS), which involves planning, organizing, staffing, coordinating, and controlling activities to achieve institutional goals efficiently.

Asmait Futsumbrhan defines a library as a place that houses collections of books and other informational materials for reading, study, or reference. She also notes that library collections include a variety of resources such as manuscripts, newspapers, maps, and photographs. While this description reflects the traditional purpose of libraries, our system extends beyond this by

converting paper-based records into digital formats and introducing eBook functionality, enabling users to access content both within and outside the library premises.

The core mission of a library is to collect, organize, preserve, and disseminate knowledge and information. Libraries serve as custodians of cultural heritage, connecting past, present, and future generations. Whether this cultural record is stored in books or other media, libraries ensure its preservation and accessibility. Users from various professions rely on libraries for work, research, and recreational purposes. Scholars, in particular, use library resources to enhance their learning, develop research skills, and cultivate reading habits. As noted in , one of the most valuable roles of a library is to support the ongoing learning and intellectual development of individuals.

According to Ato Efrem Matiwos, director of the Asmara Public Library, the introduction of computerized systems significantly benefits users by saving time and effort. He described it as a major milestone in library development that motivates readers. However, as a public library, their system primarily serves the general community. In contrast, our project specifically addresses the academic needs of college students and instructors at DCE.

In alignment with our objectives, another study presents the library system as a rapidly growing database designed for efficient information retrieval. Their work focuses on digitizing daily library operations, introducing user login features, and organizing resources systematically. Our system builds upon this by incorporating a digital archive to store electronic files and offering an administrative interface to monitor and manage the system. The goals of our study are to develop a robust digital database, offer various search options for locating books, and generate comprehensive reports such as book listings and user activities.

IV. METHODOLOGY

A. Database Design

Database design plays a crucial role in minimizing data redundancy and ensuring efficient data organization. It involves creating a comprehensive data model that outlines the structure of the database, incorporating conceptual, logical, and physical storage components. This model is then implemented using a Data Definition Language (DDL), which is responsible for defining and creating the database schema.

A fully developed data model includes all necessary attributes for each entity and follows a structured design process carried out by database designers. The typical steps in the database design process include:

• Conceptual Design

The conceptual design phase focuses on developing a high-level representation of the system's data requirements. This stage bridges the gap between the initial system requirements and the final physical database implementation. The most widely used tool for this phase is the **Entity-Relationship (ER) model**, which provides a visual and logical representation of data and their relationships within a system.

An **Entity-Relationship Diagram (ERD)** is employed to illustrate entities, their attributes, and the relationships between them. In the context of the Library Management System (LMS), the ERD captures all data interactions, such as inputs, storage, transformations, and outputs. It emphasizes data objects, the attributes they contain, and the relationships that connect them.

The ERD (see Fig. 1) developed for the LMS clearly defines the main components of the system—such as users, administrators, books, and transactions—and outlines how these entities interact. This model forms the backbone of the database and ensures that all data flows within the system are accurately represented and logically structured.

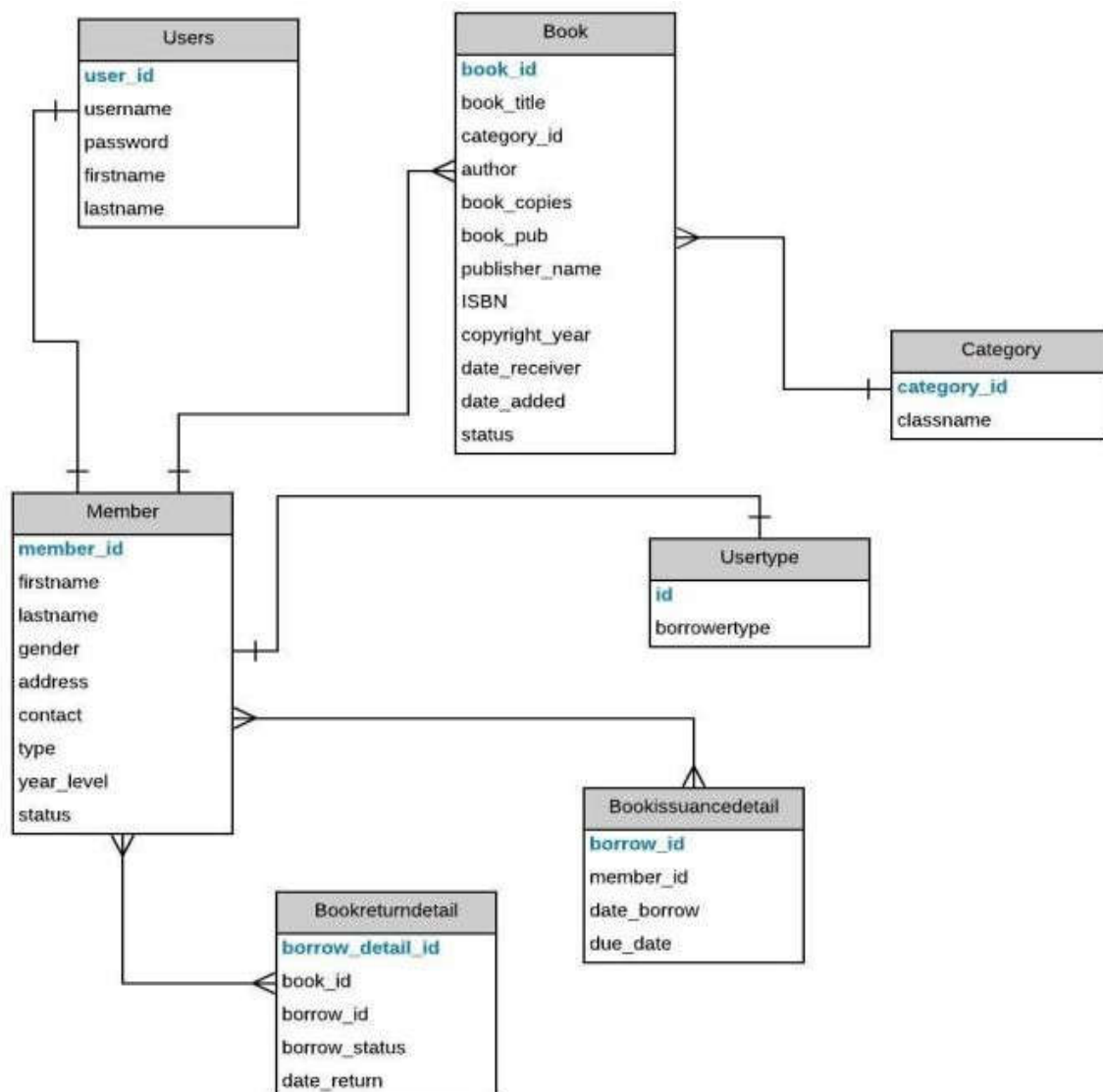


Fig. 1. Entity Relationship Diagram**• Logical Design**

The logical design phase focuses on organizing data into structured relationships known as **entities** and **attributes**. In a relational database context, an entity typically corresponds to a table, representing a specific category of data (e.g., users, books, transactions). Each entity consists of attributes, which represent the individual data elements or properties of that entity. In the database, attributes are implemented as columns within the table and help uniquely identify or describe an entity.

This stage of the design abstracts away from technical implementation details and instead concentrates on how the data relates logically, forming the foundation for a well-structured and normalized relational model.

• Physical Design

The physical design phase translates the logical data model into actual database structures. It involves defining how the data will be stored and accessed within the system. This includes specifying:

- **Table structures**
- **Data types for each attribute**
- **Field sizes**
- **Primary and foreign key constraints**

Although the complete physical design often includes indexing strategies and attribute domains for performance optimization, this project excludes those components for simplicity.

For this Library Management System, we are utilizing **MySQL** as the database management system (DBMS), and the design is built on a **relational model**. While conceptual and logical designs are independent of hardware or software constraints, the physical design is closely tied to implementation specifics, and thus receives primary focus during system development.

B. Architecture Design

Architecture design represents the high-level blueprint of the system, encompassing both hardware and software components. This phase defines the structure of the system's modules, their functionalities, interactions, and the technologies employed to implement the system.

The architectural model includes:

- A list of key modules and their responsibilities
- Interfaces and dependencies among the modules
- Associated database tables
- A system architecture diagram (see Fig. 2)
- Technology stack details (e.g., Java, PHP, HTML, MySQL)

After identifying the system's functional requirements, the architecture design helps determine the appropriate specifications for hardware, software, data resources, and the expected information output. Integration testing is planned during this phase to ensure smooth interaction between modules.

The architecture design serves as a foundational reference for the entire development process, enabling clear identification and management of system components and their interconnections.

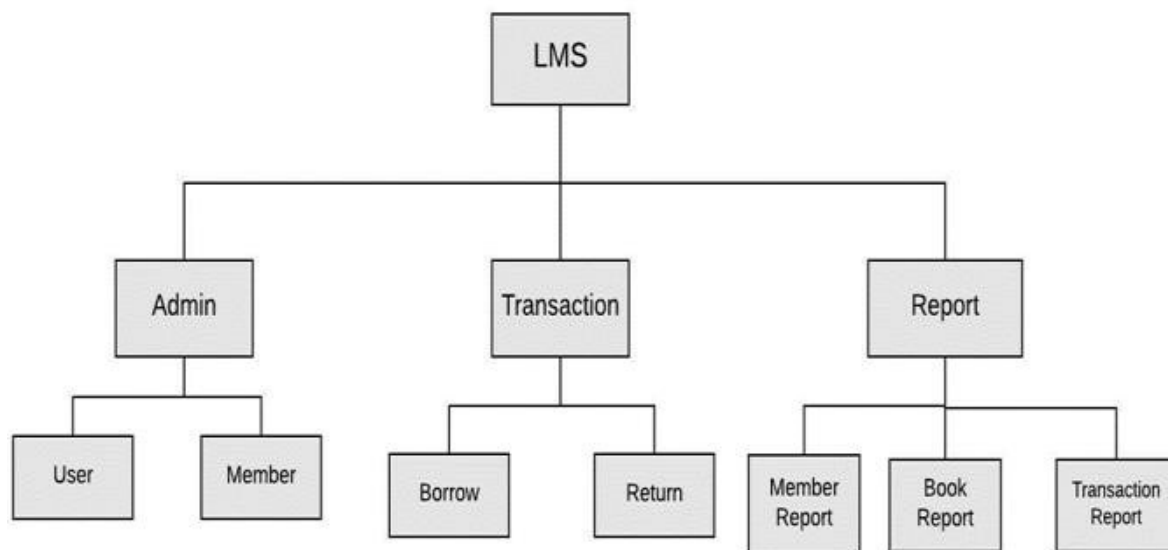


Fig. 2. Proposed system

C. Interface Design

User Interface (UI) Design focuses on anticipating user needs and ensuring the system provides intuitive, accessible, and user-friendly features to support those needs. A well-designed UI facilitates seamless interaction between users and the system by incorporating principles from **visual design**, **interaction design**, and **information architecture**. The goal is to create an interface that enhances user experience by making system functions straightforward to locate, understand, and operate.

D. Module Design

Module design, also referred to as **low-level design**, involves breaking down the overall system into smaller, manageable components or modules. Each module is independently defined and described in detail, enabling developers to begin the coding phase effectively.

This stage provides specific design elements, including control logic, data flow, and internal processing structures. The flow of the system, as illustrated in **Fig. 3**, represents the low-level design using a flowchart that outlines the logic of the program in pseudo-code. This ensures that each module functions as intended and contributes to the overall objectives of the system.

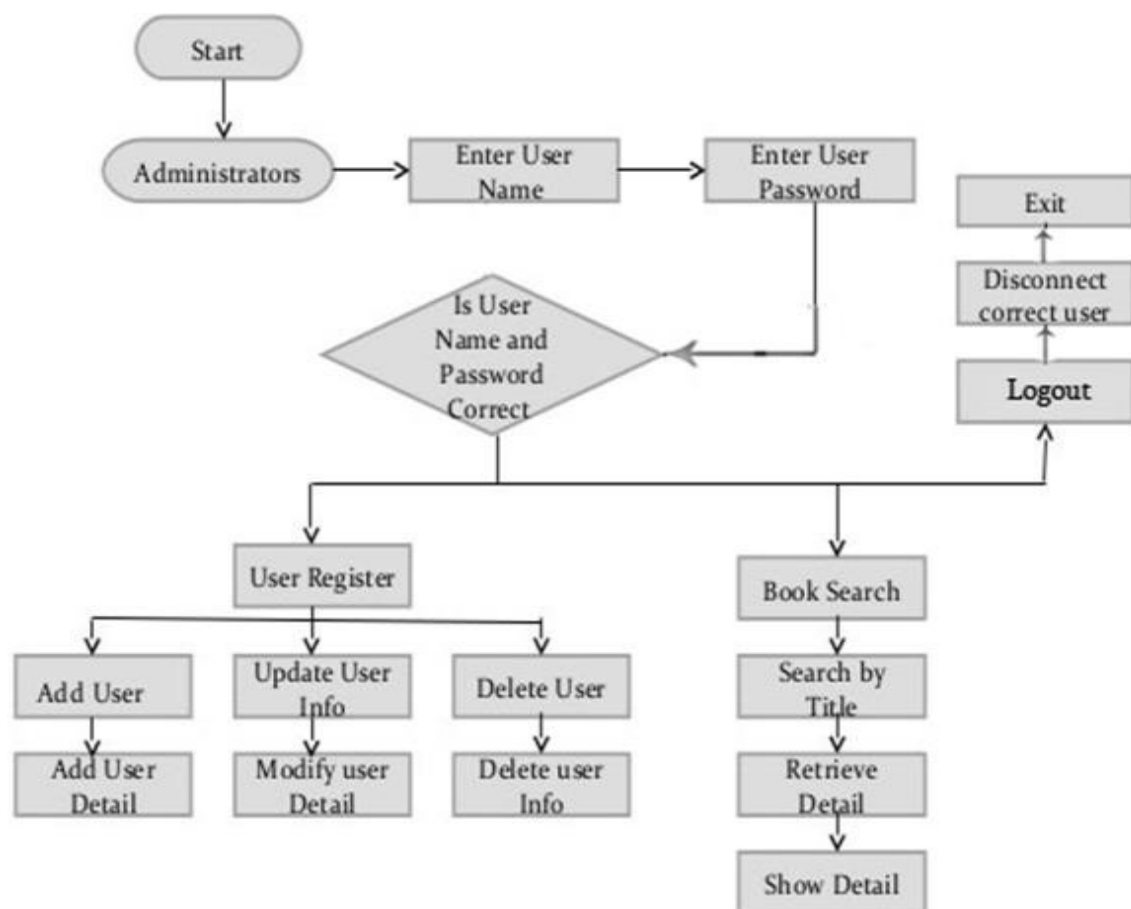


Fig. 3. Flowchart of the Proposed System

V. EVALUATION METHOD

The system testing process was conducted to identify and eliminate any defects in the developed Library Management System (LMS). The system was subjected to various test inputs, and observations were made to assess whether the application behaved as expected.

Based on these outcomes, the system's functionality and reliability were validated. The evaluation process was carried out through the following levels of testing:

A. Unit Testing

In accordance with the V-Model development approach, **Unit Test Plans (UTPs)** were created during the **Module Design** phase. Unit testing focuses on the smallest testable components of the system—typically individual functions or modules—to verify that each unit performs correctly in isolation. This testing phase is critical for detecting bugs at the code level and ensures that each module functions properly, even when separated from the rest of the application.

B. Integration Testing

Integration Testing was conducted during the **Architecture Design** phase. Once individual modules were tested and validated through unit testing, they were integrated to verify that they function correctly together. The goal was to ensure smooth communication and proper data exchange between modules. Integration test results were reviewed and shared with the client or user group to confirm that all integrated parts work cohesively.

C. System Testing

System Test Plans (STPs) were developed during the **System Design** phase. Unlike unit and integration testing, system testing evaluates the entire application as a whole. It verifies whether both **functional** and **non-functional** requirements—such as performance, usability, and security—are met. This phase includes comprehensive testing activities such as:

- **Load Testing**
- **Performance Testing**
- **Stress Testing**
- **Regression Testing**

System testing ensures that the complete application operates correctly under various conditions and meets the expectations of designers and stakeholders.

D. User Acceptance Testing (UAT)

User Acceptance Testing was designed during the **Analysis Phase** and is conducted by the end-users or business representatives. UAT is carried out in an environment that closely mimics the production environment using realistic test data. The objective is to confirm that the system meets user requirements and is ready for deployment in real-world scenarios. Successful completion of UAT indicates that the system is accepted by users and is ready for operational use.

VI. EXPERIMENTAL RESULTS

This section presents the outcomes generated from testing and evaluating the proposed Library Management System (LMS). The results serve to demonstrate the system's effectiveness and efficiency in providing seamless access and functionality for both users and administrators.

Table 1 summarizes the key findings based on the system's test plan, including the evaluation of system requirements, functional specifications, and design implementations. The results indicate that the system meets its intended objectives, functioning reliably under the defined conditions.

Furthermore, the comparison between the computerized system and the traditional manual system highlights significant advantages. Users benefit from faster access to resources, reduced errors, simplified management of data, and improved system reliability. These results validate the importance of transitioning from a manual to a digital system, underscoring the added value and performance improvements gained through automation.

Table 1. Proposed System Results

Test Case	Test Purpose	Test Condition	Expected Outcome	Actual Result
Login	Check username and password	If user details are not correct, display error message	Grant access to the applicable main system	User successfully logs into the system upon submission of correct login credentials.
Add member	To ensure that a new user is added to the system successfully.	If user already exists in the system, an error message should display.	New user should be successfully added to the system.	If email address entered already exists in the system, an error message is displayed. If the email address of the new member does not exist in the system, new member is successfully added.
Add book	To ensure that, is it a new book or copy is added to the system successfully.	If the book already exists in the system, it will increase the number of copies in the system.	Book should be successfully added to the system.	If the book title, author name, and ISBN exist with same record in the system, then it will increase the number of copies. However, if it does not exist in the system new book is successfully

				added.
Transaction module	To ensure that, is this book available in the system to borrow or to return the already borrowed books to the system successfully.	If the book exists in the system, it can be borrowed. If not, we must wait until returned.	Book should be successfully borrowed from the system and returned to the system.	If the book title, author name, and ISBN exist with same record in the borrowed system, then we must wait until the book return. However, if it does not exist in the system book can successfully be borrowed.
Archive	To ensure whether the e-books or electronic records were successfully added.	If the e-books exist in the system then the users can use it, if not we have to add the e-books to our archive.	E-books should be successfully added to the archive system.	If the e-book title, author name, and ISBN exist with same record in the system, then it will display already saved message. However, if it does not exist in the system new e-books are added successfully to the archive.

VII. CONCLUSION

The mission to make life easier and processing faster has led to the computerization of various processes. Computer technology converted so many sectors especially the Educational sector. To foster technology-driven education, a Web-based LMS has been developed to manage all library operations such as adding new books, updating user's record and the process of borrowing books, etc. In conclusion, from proper analysis and assessment of the designed system, it is safely determined that the system is an efficient, usable, and reliable LMS. It is working properly and adequately meets the minimum expectations which were proposed

initially. The innovative system is expected to be a benefit to the users and staff in terms of efficiency in the usage of the library system. Although this system answers all the drawbacks of the physical library, in terms of information storage of the members in the database, it will provide fast generation of the member's report, and using this database, any files can be added, adjusted, deleted at any time. This computerized system performs the most sophisticated way to give access for the users in different forms although it provides electronic records via Wi-Fi and the users can read an unlimited number of e-books at a time.

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