

# Design and Implementation of an Online Library Management System (OLMS) for Improved Efficiency of Library Operations in Northern Nigeria

Medina MOHAMMED (Ph.D)<sup>1</sup>; Aminu Ahmed BUBA (Ph.D)<sup>2</sup> & Abubakar IDRIS<sup>3</sup>

<sup>1</sup>Entrepreneurship Librarian, JD Amin Library, Federal University, Dutse – Nigeria

<sup>2</sup>Department of Library and Information Science, Faculty of Arts and Social Science, Federal University, Dutse – Nigeria

<sup>3</sup>Directorate Information Communication Technology, Federal University Dutse –Nigeria

\*Corresponding Author: Medina MOHAMMED (Ph.D)

DOI: <https://doi.org/10.5281/zenodo.21236698>

Article History	Abstract
<b>Original Research Article</b>	<p><i>This study was undertaken to design and develop an Online Library Management System (OLMS) to improve the efficiency of library operations. The system was developed to reduce operational errors, enhance record management, improve access to library resources and facilitate effective monitoring of library transactions. Specifically, the study examined the existing library management system, identified its limitations, designed a suitable library management solution, and developed a system for managing library activities. The study adopted the Waterfall Software Development Life Cycle (SDLC) model and Object-Oriented Methodology (OOM) for system analysis, design, and implementation. Data were collected through observation, consultation with library staff and users, and a review of relevant literature. System modelling tools, including use case diagrams, class diagrams, flowcharts, and entity relationship diagrams, were employed to capture requirements and guide system development. The system was implemented using PHP, HTML, CSS, JavaScript, and MySQL. The findings revealed that the existing manual library system was characterized by excessive paperwork, inefficient record management, delays in book lending and retrieval processes, difficulties in tracking borrowed materials, and a high likelihood of human error. The developed Online Library Management System automated key functions such as user registration, book cataloguing, borrowing and return transactions, and administrative monitoring. The system improved operational efficiency, enhanced record accuracy, and provided secure role-based access for users and administrators. The study concluded that the system provides a reliable, cost-effective, and user-friendly solution for library automation. It recommended the adoption of the system by academic libraries, regular data backup, enhanced security measures, user training, and future integration of mobile access, notification services, digital library features, and artificial intelligence-based recommendation capabilities.</i></p> <p><b>Keywords:</b> Online Library Management System, Library Automation, Object-Oriented Methodology, Waterfall Model, Academic Libraries, Database Management, Web-Based System.</p>
<b>Received: 11-05-2026</b>	
<b>Accepted: 14-06-2026</b>	
<b>Published: 07-07-2026</b>	
<b>Copyright © 2026 The Author(s):</b> This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY-NC) which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.	
<b>Citation:</b> Mohammed, M., Buba, A. A., & Idris, A. (2026). <i>Design and implementation of an online library management system (OLMS) for improved efficiency of library operations in Northern Nigeria</i> . UKR Journal of Arts, Humanities and Social Sciences, 2(7), 38-52.	

## Introduction

Libraries have long been recognized as essential institutions for supporting education, research, and the dissemination of knowledge. They serve as repositories of information resources and provide access to materials that facilitate learning, teaching, and scholarly activities. Through their services, libraries contribute significantly to intellectual

development and the advancement of society by ensuring that information is readily available to users whenever it is needed.

Traditionally, library operations were carried out manually using paper-based systems and physical records. Activities such as cataloguing, circulation, acquisitions, and user

registration relied heavily on manual procedures. Card catalogues were commonly used to organize and retrieve bibliographic information, while lending transactions were recorded in registers and borrower cards. Although these methods were effective for many years, they became increasingly difficult to manage as library collections and user populations expanded.

The rapid growth of information resources and the increasing demand for timely access to information exposed the limitations of manual library systems. Managing large collections through traditional methods often resulted in delays, inefficiencies, and difficulties in retrieving information. Manual systems also required considerable human effort and were prone to errors arising from inaccurate record keeping and misplaced documents.

The emergence of Information and Communication Technology (ICT) has transformed the way libraries operate and deliver services. ICT has introduced new tools and technologies that enable libraries to automate routine functions and improve service efficiency. Automation has become a key strategy for modern libraries seeking to enhance information management, streamline workflows, and provide better access to resources.

One of the major innovations resulting from the integration of ICT into library operations is the Online Library Management System (OLMS). An OLMS is a computerized platform designed to manage various library activities electronically. It provides an integrated environment for handling acquisitions, cataloguing, circulation, user registration, and inventory management, thereby reducing dependence on manual processes.

The Online Library Management System enables library staff to perform their duties more efficiently by automating repetitive tasks and reducing administrative workload. Through the use of databases and digital records, library personnel can easily track books, monitor borrowing transactions, generate reports, and manage user accounts. This improves operational efficiency and allows staff to focus on providing value-added services to library users (Adebayo & Abdulrahman, 2020).

For library users, an OLMS offers convenient and user-friendly access to library resources. Users can search the catalogue, check the availability of materials, reserve books, and monitor their borrowing status through an online interface. These features enhance user experience by eliminating the need to physically visit the library for every information-related activity.

Despite the benefits of automation, many academic institutions, particularly in developing countries, continue to rely on manual or partially automated library systems. Such systems are often associated with challenges

including misplaced records, duplication of efforts, delayed processing of transactions, and limited accessibility to information resources. These problems can negatively affect the quality of library services and user satisfaction.

An Online Library Management System provides an effective solution to many of these challenges by integrating various library functions into a single digital platform. Through database management systems, user authentication mechanisms, and automated reporting tools, OLMS improves accuracy, security, and efficiency in library operations. This integration enhances decision-making and supports the effective management of library resources (Ogunleye & Falaye, 2018).

The increasing demand for remote access to educational resources has further emphasized the importance of online library systems. Advances in internet technologies and the growth of distance learning have created a need for libraries to provide services beyond their physical locations. Online systems enable users to access information resources from any location at any time, thereby supporting flexible learning and research activities.

Furthermore, a well-designed Online Library Management System offers several advantages, including twenty-four-hour access to library services, real-time updates on resource availability, improved communication between libraries and users, and enhanced user satisfaction. As educational institutions continue to embrace digital transformation, the adoption of online library management systems has become essential for ensuring efficient information service delivery and meeting the evolving needs of library users in the digital age (Kumar & Singh, 2017).

### **Statement of the Problem**

Libraries provide efficient access to information resources through well-organized and automated management systems. Library operations such as acquisition, cataloguing, circulation, inventory control, and user services are managed through integrated digital platforms that ensure accuracy, speed and reliability. Such systems enable users to search library collections, determine the availability of resources, borrow and reserve materials remotely and access information services at any time. They also support library staff in maintaining accurate records, tracking transactions, generating reports, and delivering quality services that meet the information needs of users.

However, the reality in many academic and public libraries in Nigeria differs from this ideal situation. Library management in many institutions is still carried out manually or through outdated systems that are unable to meet contemporary information service demands. As a result, libraries often experience challenges such as

misplaced books, inaccurate records, delays in book issuance and return, difficulties in tracking borrowed materials, and time-consuming retrieval processes. In addition, users face limitations in accessing library resources outside normal working hours, while the absence of real-time updates makes it difficult to determine the availability status of resources and monitor overdue items effectively. These challenges reduce operational efficiency, affect service quality, and limit users' satisfaction with library services.

To address these challenges, there is a need for a modern, automated, and web-based library management solution that can enhance the efficiency of library operations and improve access to information resources. Therefore, this study seeks to design and develop an Online Library Management System that will automate key library functions, provide remote access to library resources, facilitate accurate record keeping, and support effective management of library transactions. By implementing such a system, the study aims to bridge the gap between the current state of library operations and the ideal of efficient, user-centred, and technology-driven library services.

### **Research Objectives**

1. To design a web-based platform that allows users to search, view, and reserve library materials online.
2. To reduce manual workload for library staff by automating book cataloging, lending, and reporting.
3. To implement the system that will handle the borrowing and returning of books via online in the library.

### **Review of Related Literature**

The concept of online library management systems has generated substantial scholarly discourse, with numerous researchers contributing to the body of knowledge surrounding this transformative technology. This chapter undertakes a comprehensive review of existing literature, examining various perspectives on library management, the evolution from manual to automated systems, and the empirical evidence supporting the implementation of digital solutions. The review encompasses theoretical foundations, practical applications, and the challenges and opportunities presented by library automation in contemporary information environments (Bamgbade et al., 2015; Rodin, 2016).

A library fundamentally represents a collection of information sources and similar resources made accessible to a defined community for reference or borrowing purposes. These institutions provide either physical or digital access to materials, existing as physical buildings, virtual spaces, or hybrid configurations incorporating both elements. Library collections encompass an extensive array

of formats including books, periodicals, newspapers, manuscripts, films, maps, prints, documents, microforms, CDs, cassettes, videotapes, DVDs, Blu-ray Discs, e-books, audio books, databases, and numerous other formats, ranging from modest collections of a few shelves to vast repositories containing millions of items (Centres, 2017).

Libraries serve as multifunctional spaces where diverse activities related to book management and information dissemination occur. As repositories of knowledge, they house collections of reference and general books, technical reports, periodicals, journals, conference proceedings, and other scholarly materials. Consequently, individuals can discover and acquire facts and knowledge through these varied sources within the library environment. The information contained in any of these sources can be recorded on microfilms, audiotapes, microchips, and other materials traditionally maintained in the library, which bears the responsibility of acquiring, organizing, maintaining, and judiciously circulating books and other library materials through its various sections for efficient user service (Devi et al., 2021).

Libraries are organized for use and maintained by public bodies, institutions, corporations, or private individuals, with public and institutional collections and services intended for people who either cannot afford to purchase extensive personal collections, require materials unavailable through individual means, or need professional research assistance. Beyond providing materials, libraries offer the services of librarians who are experts at finding, organizing, and interpreting information, thereby addressing complex information needs. Libraries typically provide quiet study areas while also offering common spaces to facilitate group study and collaboration. Importantly, libraries extend their services beyond physical boundaries by providing electronically accessible materials and offering librarian assistance in navigating and analyzing vast amounts of information using diverse digital tools (Reynolds, 2017).

Historically, libraries have operated as information institutions for many years before modern institutions emerged, positioning them as potential early beneficiaries of computer technology application to their operations and services. This historical foundation underscores the natural progression toward automated systems that enhance traditional library functions. The fundamental role of libraries in society as information gatekeepers and knowledge disseminators has remained constant, even as the methods of fulfilling this role have evolved dramatically with technological advancement (Reynolds, 2017; Abdullahi, 2017).

Libraries can be categorized into four distinct types: academic, public, special, and national libraries. Each

category serves specific purposes and communities, with unique operational characteristics and objectives. These classifications help understand the diverse information needs different user groups have and how library services are tailored accordingly. The categorization framework provides a useful lens for examining how automation and management systems must be adapted to suit the specific requirements of each library type (Dass, 2017). Public libraries function as social institutions playing significant roles in societal welfare through multiple functions. Several factors contribute to the evolution of public libraries, including people's urge for knowledge, improvement of literacy through self-education, serving as information dissemination centres, providing lifelong learning opportunities, functioning as community intellectual centres, offering recreational spaces, and responding to advancements in science and technology. With developments in computer and communication technologies, public libraries now provide quick information through mass media and internet access (Reynolds, 2017).

A public library is defined as a non-profit library established for public use and maintained chiefly through public funds, serving every citizen regardless of birth, caste, colour, sex, social, economic, or educational standing without cost. Libraries of all categories generally serve five purposes: education, information, recreation, aesthetic appreciation, and research. While academic libraries primarily serve education and research, and special libraries focus on information and research, public libraries accommodate all five purposes simultaneously, making them the most versatile library type (Reynolds, 2017).

The role of academic libraries is realized within the context of their institution's educational philosophy. Education represents a learning process aimed at developing capabilities among people, and academic libraries—comprising school, college, and university libraries—serve four primary user types based on educational levels: students, teachers, research scholars, and administrative, professional, and other institutional staff (Jelagat, 2016). The primary objectives of academic libraries include serving the academic community's needs, collecting and storing all kinds of reading and reference materials, providing adequate reading areas, rendering lending services appropriate for students, teachers, and researchers, and offering active reference and information services (Jelagat, 2016).

Academic libraries are categorized into three types: school libraries, college libraries, and university libraries. School libraries primarily collect and arrange syllabus-based books along with general reading materials like classics, biographies, adventure and travel books, and fiction. Their

main objectives include cultivating lifelong reading habits and opening knowledge windows for students, requiring collections of print and non-print information sources while functioning as media centres through services like reference, storytelling, debates, film shows, and book reading clubs (Reynolds, 2017).

College libraries support broadening young students' minds to meet new challenges, with college education differing significantly from school education due to larger class sizes preventing individual teacher attention. Consequently, students must depend on college libraries for studies and develop self-learning habits. University libraries are established, administered, and maintained to assist universities in five major functions: teaching and learning, research and new knowledge generation, research result dissemination and publication, knowledge and ideas conservation, and extension programmes. University libraries face challenging roles satisfying larger groups of students, research and post-doctoral scholars, various academic and executive body members, and administrative and professional staff ((Nwachukwu & Danjuma, 2021).

Special libraries emerged in the twentieth century, dealing with special user groups, special subject collections, and rendering special services. These libraries are established to meet the information requirements of their parent organizations, generally devoted to Research and Development (R&D) activities. They procure various document types including handbooks, technical reports, state-of-the-art reports, bibliographies, current awareness bulletins, periodicals, indexes, abstracts, directories, documentation lists, and accession lists (Kayode & Science, 2014). A special library is defined as a collection of books and other printed, graphic, or recorded material dealing with a limited knowledge field, provided by learned societies, research organizations, industrial or commercial undertakings, government departments, or educational institutions (Reynolds, 2017).

Special libraries function as integral parts of their parent institutions, fully supporting their programmes and activities. Their main objectives involve developing current and retrospective collections in core subjects based on parent organization projects and programmes, promptly providing latest information about significant field developments upon user request, and offering all types of academic, technical, and documentary support to specialists (Kayode & Science, 2014).

National libraries are maintained by national resources, typically entrusted with publishing national bibliographies. They collect and preserve national literature, usually receiving free copies of each book and periodical printed in the country through legal right, copyright, or deposit requirements. A National Library is specifically established

and funded by government to serve as the pre-eminent national information repository, lending limited books under certain terms and rarely allowing citizens to borrow rare, valuable, or significant works. The main objective involves identifying, acquiring, organizing, storing, and retrieving all print and non-print documents published within or about a particular country and by or about its nationals in other countries (Reynolds, 2017).

Traditionally, libraries consisted of collections of books, manuscripts, journals, and other recorded information sources, predominantly print media and manuscripts that were often poorly organized. Documents deteriorated rapidly, information was difficult to locate and procure, and publications did not reach users on time. Obtaining publications proved difficult without personal influence and contacts, restricted publications containing highly informative materials were not easily available, and information often became obsolete by publication time. Since materials were not properly indexed or listed, researchers faced long, tedious processes determining whether relevant materials existed (Nwachukwu & Danjuma, 2021).

Traditional libraries confined themselves within physical boundaries, with users unable to easily locate information, spending excessive time searching. However, in this Information Communication Technology (ICT) age, computers are being used for daily library housekeeping activities, reading and downloading text articles, reports, and other materials, saving time for both library professionals and end users while making library services smooth and effective (Perdana & Prasajo, 2020). Manual libraries have maintained similar information-sharing models for decades, emphasizing collections of physical materials like books, magazines, periodicals, manuscripts, and research papers arranged on shelves rather than detailed organization, with information searches based on authors and subjects indexed and physical proximity of related materials (Posigha Bassil et al., 2019).

Borrowing processes in manual libraries involve major human interaction to capture and maintain data regarding material movement between borrowers and libraries, with security being a major issue. Manual library management systems are vulnerable to human error, as librarians who misfile borrower records or incorrectly index books slow processes and waste student time. Manual systems operate slowly compared to computers for issuing and returning books, with locating and updating card indexes being laborious. They cannot store large amounts of data efficiently, causing librarians to spend considerable time on mechanical, clerical tasks rather than liaising with library visitors. These systems pose challenges including data duplication, lack of storage, common errors, poor data storage, slow data retrieval, inefficient searches, vulnerability to human error, being left behind on the information highway, putting limits on the future, and lack of security (Nwachukwu & Danjuma, 2021).

All manual libraries share common features: they preserve and distribute physical resources like books, magazines, journals, and periodicals; maintain these resources through cataloguing and classification; use physical searching methods for resource retrieval; store information in physical format; allow users to borrow resources; and include details of available stock in books and periodical subscriptions (Udo-Okon & Esiere, 2022). Manual library management systems face multiple challenges: slow retrieval of data with information stored in different parts requiring extensive time; putting limits on the future as e-books, podcasts, blogs, and video tutorials become inaccessible; being left behind on the information highway as libraries and information become increasingly digitalized; vulnerability to human error through misfiled records or incorrect indexing; excessive paper wastage consuming valuable space; poor data storage in filing cabinets vulnerable to misplacement and theft; data duplication; lack of storage causing common errors; searches taking longer and being less efficient; and lack of security (Raji et al., 2017).

The information is stored in different parts and takes a long time to retrieve the data. In a manual library system if you are not able to find a book of your choice have to spend a lot of time and effort in trying to find a particular book. Manual system is also slow to operate. Instead of using computer to issue and take back books, locating and updating a card index is slow and laborious. With manual system staff spends a lot of their time on mechanical, clerical tasks rather than liaising with library visitors. Librarians find it difficult to offer a wider range of new services with a manual library system. For examples, a library can put its catalog on the web allowing readers to access it remotely; with a manual system have to visit or telephone the library to find this information (Posigha Bassil et al., 2019).

E-books, podcast, blogs and video tutorials are all part of how the modern world communicates the sum of human knowledge. Libraries with manual system have limited access to this growing body of work. Any quality automated system, by contrast, will by default grant remote and on site access to most of these resources. Libraries and information are becoming digitalized at a rapid pace. Any library still using a manual operating system can't connect to digital resources. This make sharing information and publication much more difficult and time consuming than with an automated system. As the 21st century progresses and more resources become fully digital, patrons of manual libraries will be unable to access a growing percentage of information (Ogunleye and Falaye, 2018).

All system humans work with is vulnerable to errors made by a distracted, fatigued or incompetent team member. Automated system still requires human interaction, but reduce the number of decisions or operations a human must perform. Whether filing a patron's reserve request or tracking the arrival of new books, each step handled by a computer makes the entire system more efficient because it is less prone to mistakes. Paper takes up a massive amount of room in the site. If a

computer system was bought the paper could all go and there would lots more free space which could be used for other purposes. Poor Data Storage - All the data is stored in filing cabinets. Data could be misplaced due to human error. Data could be stolen very easily. Unavailability of Information (Posigha Bassil et al., 2019).

Empirical reviews examine previously conducted research directly related to designing and implementing online library management systems, providing insights into existing solutions, methodologies, outcomes, and gaps requiring attention (Adebayo & Abdulrahman, 2020; Kumar & Singh, 2017). Adebayo and Abdulrahman (2020) developed a web-based library management system for a Nigerian tertiary institution, including modules for book registration, user management, borrowing and return functionalities, and overdue fine calculation. Using PHP and MySQL, the project demonstrated that digitizing library services improved record accuracy and reduced service delivery delays. However, the system lacked advanced features such as email notifications and digital resource integration (Adebayo & Abdulrahman, 2020).

Buba, Jada and Faruk, A.A. (2024) designed an online library system for college students using open-source technologies, allowing students to search for books, view borrowing history, and make online reservations. The researchers noted improved access to library resources but limited administrative reporting tools and lacking security features like role-based access control. Ogunleye and Falaye (2018) conducted a case study on transitioning from manual to digital library systems in public universities, finding that library automation significantly reduced book loss and improved resource sharing across campuses. However, challenges included poor infrastructure, lack of staff training, and irregular system maintenance (Ogunleye & Falaye, 2018). Nwachukwu and Danjuma (2021) developed a mobile library app allowing users to access book summaries and request hard copies, focusing on improving user experience through mobile-first design. The limitation was the absence of a comprehensive backend for full library operations like book returns and overdue tracking (Nwachukwu & Danjuma, 2021).

Reviewed studies demonstrate that online and automated library systems offer significant benefits in accessibility, efficiency, and management (Adebayo & Abdulrahman, 2020; Kumar & Singh, 2017; Ogunleye & Falaye, 2018; Nwachukwu & Danjuma, 2021). However, common challenges persist including limited features, lack of security mechanisms, and poor internet infrastructure. These studies provide a foundation for projects seeking to address limitations by integrating secure, user-friendly web-based systems with essential administrative and user functionalities (Abdullahi, 2017; Tosin, 2015).

A library represents a system requiring management to provide efficient service delivery. A Library Management System is easy to use and fulfills all librarian requirements, bringing

efficiency to library operations while eliminating problems associated with manual systems (Morshed, 2008). Features include keeping records of different categories like books, journals, newspapers, and magazines; classifying books by subject; easily entering new books; maintaining complete book information including name, author, publisher, publication date, cost, purchasing date, and bill number; easy check-out and check-in procedures; automatic fine calculation for late returns; multiple book search criteria; and various reports including total books, issued books, and journals (Morshed, 2008).

Library management is a sub-discipline of institutional management that focuses on specific issues faced by libraries and library management professionals. Library management encompasses normal management tasks as well as intellectual freedom, anti-censorship, and fundraising tasks. Issues faced in library management frequently overlap those faced in management of non-profit organizations (Mahwasane & Mudzielwana, 2016). Library management system brings efficiency in the library operations and eliminates some of the problems associated with (manual) system used in the library. An important aspect of library management system is planning and maintaining library facilities. Planning the construction of new libraries or remodeling those that exist is integral as user needs are often changing (Sharma et al., 2016).

Important facts about library management systems include keeping records of suppliers and binders, customized report designing, being customizable and user configurable, requiring only basic computer knowledge for operation, and reducing errors while eliminating long, repetitive manual processing (Singh, 2014). A library is a place that contain books, magazines, videos, and other materials for reading, viewing, listening, and studying. Some of the important facts about the library management system are it keeps records of supplier, and binders, it has customized report designing, and is customizable and user configurable. Two more important facts about the library management system are that only basic knowledge of computers is required for operation of the system, and it reduces errors and eliminating the long and repetitive manual processing (Morshed, 2008).

Integrated Library Management Systems include collection acquisition, physical loading classification, cataloguing, circulation, reference service series, information access, and retrieval. When library services are computerized, this is termed library automation, defined as automation and technology concerning design and development processes reducing necessary human intervention in operations (Ozeer & Nagowah, 2019). Library automation is justified through factors including: rapid information growth rate making traditional handling difficult; difficulty updating information due to huge increases and specification degree rises; easier resource sharing between libraries and users; automation features offering high speed, accuracy, and extensive storage capacity; improved work efficiency, consistency, and control;

reduced repetitive work; and bibliographic controls, checks, and updates (Evora, 2010).

Computers increasingly serve as exercise books and textbooks for college students, meaning those not promoting new technologies will be left behind as current information becomes easily available through computer use. Library information preservation for future generations requires digitization and storage in small, portable, secure electronic media. With computer advent in education, physical library visits for books are unnecessary as people use e-books and soft copies requiring only flash disks, CDs, or laptops instead of books. Soft copies are manageable, easier to use and navigate than textbooks, cost-effective as one copy serves many people, can include animation impossible with hard copies, and are rarely destroyed, though users need computers or reading devices (Liaquat & Rahoo, 2016).

Computerized libraries surpass manually operated libraries in processing, organizing, and disseminating information efficiently and effectively. Automated libraries connected to networks like DELNET and INFLIBNET provide users—research scholars, students, and teachers—access to the academic world. Information Technology application in library organization and services has brought significant changes in library functioning over the last two decades globally (Rodin, 2016). Advanced libraries use computers for daily operations and housekeeping activities, with large modern libraries using computer networks with communication satellites for resource sharing enabling participating libraries to acquire not only bibliographic details but also full abstracts and indexes of required articles using Local Area Networks (LAN), fax, email, and internet attachments. Library automation involving database creation, information retrieval, telecommunication use for information handling, and computerized library networks requires careful, systematic planning (Singh, 2014).

Library automation refers to using computers to automate cataloguing and classification procedures, converting manual procedures to electronic operations. It assists libraries in carrying services easily and effectively, with academic libraries ideally being automated to facilitate service delivery, though most Nigerian libraries remain unautomated for various reasons (Mcpe & Vidyalyaya, 2019). Automated library systems and services require ICT facilities development, especially computers and associated devices for collection development, cataloguing, dissemination, and retrieval systems. Automated library systems are characterized by scientific and technological approaches converting daily library routines to electronic form in library administration, resource acquisition, circulation, serial control, and cataloguing and classification (Chaudhary, 2016).

In such situations, catalogue operation tools become machine-readable, making document access and location faster and easier. Circulation front desk operations and other functions like issuing, charging, discharging, returning, and reservations

are performed through computers, eliminating traditional manual shelf searching to determine document availability or reservation list status. All activities involving serial acquisition, control, and monitoring can be performed through search parameter queries from automated systems, with binding management also accomplished through computer systems. Other administrative jobs and technical library professional practices including call mark allocation are possible through computers in standalone, multi-user, or LAN-based configurations (Wan Abas & Mustapha, 2025).

Library automation may be defined as applying automatic and semiautomatic data processing machines to perform traditional library housekeeping activities such as acquisition, circulation, cataloguing, reference, and serials control (Mcpe & Vidyalyaya, 2019). In the current information explosion era, library service automation is imperative for effective working and efficiency. Automation advantages arise not only from abundant reading material and information flow but also from viability and economic considerations, making economy and efficaciousness of library systems most important outcomes of automation (Mcpe & Vidyalyaya, 2019).

Employee cut-backs occur with new automation systems as less funding remains for employees and fewer are needed, with automation systems performing work by scanning books and more. Users can be taught to handle terminals and systems, but it becomes harder to find staff for inquiries. Library closings and hour shortages result from economic pressures, with automation systems requiring funding that cannot support all branches. Government grants cannot cover all branches with rising technology costs, and smaller libraries cannot always afford automation costs independently (Mcpe & Vidyalyaya, 2019). Book budgets suffer as higher percentages spent on automated systems mean less money for books, with shelves shrinking making it less likely to find needed materials. Rising building and maintenance costs occur when automated systems are added, with added power consumption and heating and air conditioning changes seldom planned for, costing more than previous building maintenance (Wan Abas & Mustapha, 2025).

Not many years ago, libraries used card catalogues, typewriters, and manually assigned due dates. Library automation, an up-to-date method helping libraries and patrons effectively use resources, is now streamlined through computers and software. Automation uses machinery for easier working while saving human power and time, aiming to free librarians and staff to contribute more meaningfully to spreading knowledge and information. Automating a library restructures its functions and reinvents its services, using databases as a basis to converge new information storage and retrieval technologies with traditional housekeeping operations (Subhajit Panda, 2016).

Computers and advanced technologies have enhanced services across diverse industries including libraries, making in-house collections and resources computerizable, spreadsheets and

databases automatable, CD-ROMs available in-house, and internet accessible to patrons. Library automation reduces staff workload in cataloguing, circulation, and acquisitions, freeing time to provide higher quality patron service, with staff becoming available to answer reference questions, help with research, and find information on request. Finding library materials becomes easier and less time-consuming, with patrons no longer waiting ages for staff attention (Subhajit Panda, 2016).

With library automation, automated cataloguing standards like machine-readable cataloguing (MARC) help librarians catalogue items quickly using vendor-supplied catalogues. Professional cataloguing with scanning technology allows bar codes on books to be scanned directly into catalogue databases, making task tracking easier and quickly identifying inventory stock when budgeting for new materials (MCPE & Vidyalaya, 2019). However, despite numerous benefits, employee cutbacks remain a major disadvantage as substantial budget portions spent on automation leave less for salaries and benefits, and full staff complements are no longer needed since automation performs many previously human functions (MCPE & Vidyalaya, 2019; Subhajit Panda, 2016).

### **Methodology**

The study adopted the Waterfall System Development Life Cycle (SDLC) model as the guiding methodology for the development of the Online Library Management System. The Waterfall model was selected because of its structured, sequential, and easy-to-manage approach to software development. Under this model, each phase was completed before the commencement of the next phase, ensuring proper documentation, monitoring, and control throughout the project. The methodology also incorporated object-oriented analysis and design techniques, which represented the system in terms of classes, objects, and their relationships. This approach provided a clear framework for designing and developing a reliable and efficient software solution for library operations.

The research commenced with a comprehensive system analysis and evaluation of the existing library management practices. The manual system was carefully examined to identify its strengths, weaknesses and operational challenges. Through observation, consultation and data analysis, the research gathered the necessary information required to understand the existing system and establish the requirements for the proposed computerized solution. A feasibility study was conducted to determine the viability of the proposed system. The study assessed economic, technical, operational, and behavioural feasibility.

Data for the study were collected through both primary and secondary sources. Primary data were obtained through oral consultations and interactions with library staff and users, while secondary data were gathered from books, journals, conference papers, and relevant online academic databases.

Requirement analysis was subsequently carried out to identify and document all functional and non-functional requirements of the proposed system. The Waterfall model was considered suitable for this project because the system requirements were clearly defined, relatively stable, cost-effective to implement, and appropriate for an academic software development project.

Following requirement analysis, the study proceeded to the system design, implementation, and testing stages. During the design phase, the overall architecture of the system was developed, including hardware specifications, software requirements, database structures, and user interfaces. The implementation phase involved coding the system using appropriate programming tools and technologies, while individual modules were developed and subjected to unit testing. Thereafter, the modules were integrated and tested collectively to ensure that the system functioned according to specifications. Functional and non-functional testing were conducted to identify and correct errors before deployment. Upon successful testing, the system was implemented and made operational for intended users.

The developed system comprised two major categories of users: the System Administrator and the Library Users, consisting of students and staff. To facilitate system modelling and documentation, use case diagrams, class diagrams, flowcharts, database designs and algorithms were developed. The use case diagrams illustrated the interactions between users and the system, while class diagrams represented the system structure, including classes, attributes, and relationships. A relational database model was designed to manage records relating to users, books, borrowing transactions, and administrators, with all tables normalized up to the Third Normal Form (3NF) to ensure data integrity and reduce redundancy. The system was developed using PHP, HTML, CSS, JavaScript, and MySQL, while the hardware platform consisted of a personal computer equipped with a Core i5 processor, 8GB RAM, and adequate storage capacity to support the efficient operation of the application.

### **Use Case Diagram**

The use case diagram was utilized in this study to represent and visualize the interactions between users and the Online Library Management System. As a behavioral model in Unified Modeling Language (UML), the use case diagram illustrated the dynamic relationship between system actors and the various services provided by the system. It provided a graphical representation of how users interacted with the system and helped to identify the functional requirements needed for effective system development. Through the use case diagram, the researcher was able to gain a clear understanding of the system's behavior from the users' perspective and define the boundaries of the proposed system (Abdullahi S.H., 2017).

### **Use Case**

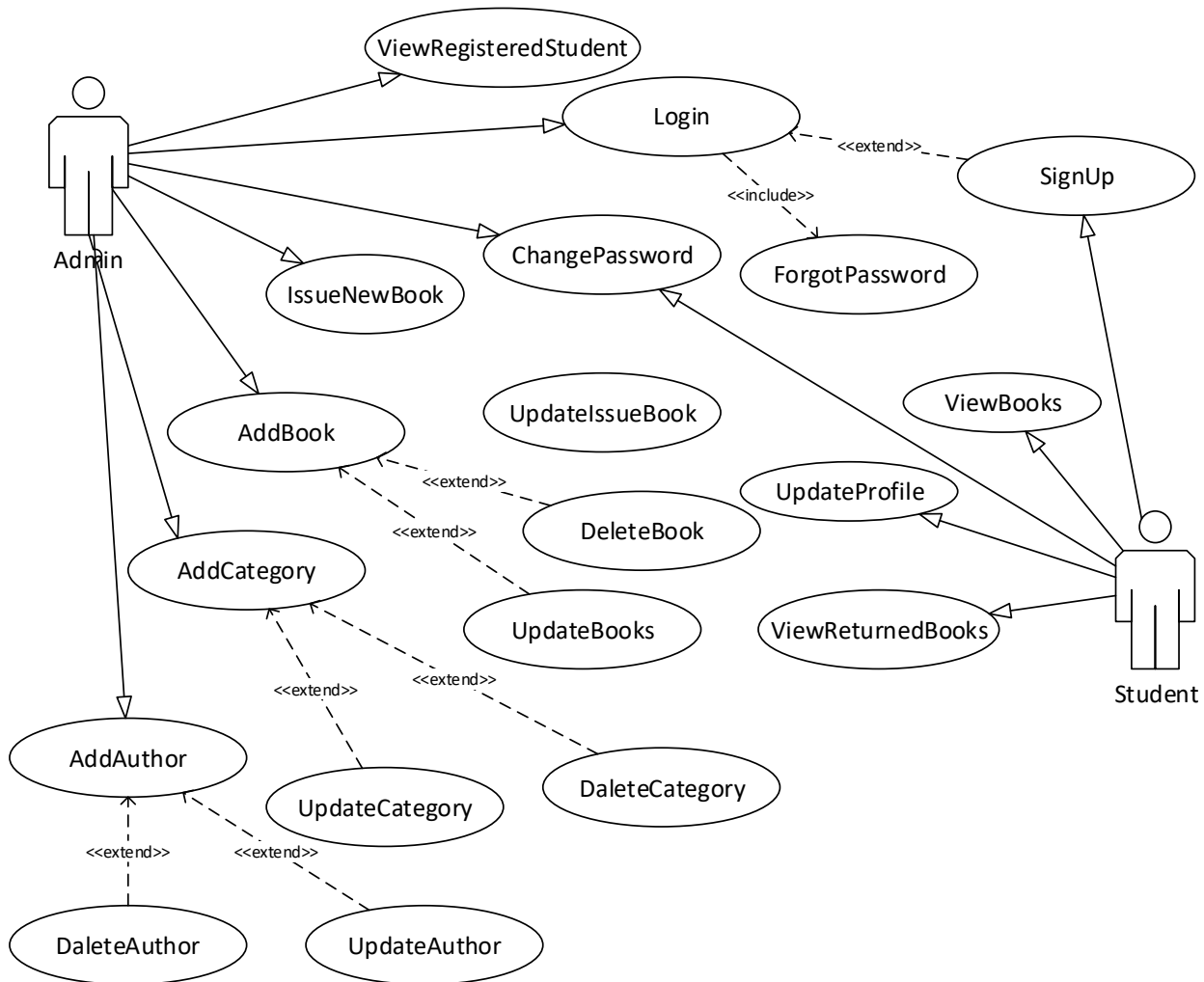


Figure: 1.0: Use Case Diagram

The use case diagram was particularly important during the system analysis and design stages because it facilitated the identification of actors and their respective roles within the system. For the Online Library Management System, the primary actors included students, librarians, and system administrators. The diagram illustrated how these actors interacted with system functionalities such as user registration, book searching, borrowing and returning books, catalog management, and record maintenance. By providing a simplified view of user-system interactions, the use case diagram enhanced the understanding of system requirements and ensured that all necessary functionalities were captured during development.

Furthermore, the use case diagram served as an effective tool for capturing and documenting the functional requirements of the system. It helped to model user goals and system responses, ensuring that the developed application addressed the actual needs of its users. The diagram also clarified access privileges and responsibilities by visually depicting how each actor interacted with specific system functions. In addition, it improved communication between technical developers and non-technical stakeholders by presenting system requirements

in a simple and understandable format, thereby reducing ambiguity during the development process (Kendall & Kendall, 2022; Larman, 2021; Dennis, Wixom, & Roth, 2021).

The use case diagram also contributed significantly to system design, implementation, and testing. Each identified use case provided a basis for developing detailed system scenarios and test cases used to validate system functionality. Moreover, the diagram documented the overall functional scope of the Online Library Management System by defining the system boundary and ensuring that all required services were incorporated into the design. Consequently, the use case diagram served as a valuable tool for requirement gathering, system modeling, stakeholder communication, and quality assurance throughout the software development process (Satzinger, Jackson, & Burd, 2020).

### Class Diagram

A class diagram was used in this study to represent the static structure of the Online Library Management System. It illustrated the system's classes, their attributes, methods, and the relationships among various objects within the application. As a key component of object-oriented

modeling, the class diagram provided a blueprint of the system and enabled the researcher to visualize how different components interacted with one another before implementation. The diagram also assisted examiners, developers, and supervisors in understanding the overall architecture of the system without examining the program code directly (Hafeez et al., 2019).

In the development of the Online Library Management System, the class diagram modeled major entities such as Users, Books, Librarians, and Transactions, together with their associated attributes and operations. It helped to define the logical relationships among these entities and provided a clear representation of how data and functionalities were organized within the system. Furthermore, the diagram supported database design by serving as a foundation for creating database tables and relationships. It also facilitated the application of object-oriented programming principles

such as encapsulation, inheritance, and polymorphism, thereby promoting a structured and maintainable system design (Larman, 2021; Arlow & Neustadt, 2020).

Additionally, the class diagram served as an effective communication and documentation tool throughout the project. It provided a visual means of conveying system design concepts to both technical and non-technical stakeholders, thereby improving understanding and collaboration among project participants. The diagram also documented the system's structure for future maintenance, upgrades, and modifications. Consequently, the class diagram played a significant role in system analysis, software design, database development, and overall project documentation, contributing to the successful development of the Online Library Management System (Fowler, 2022; Kendall & Kendall, 2022; Dennis, Wixom, & Roth, 2021).

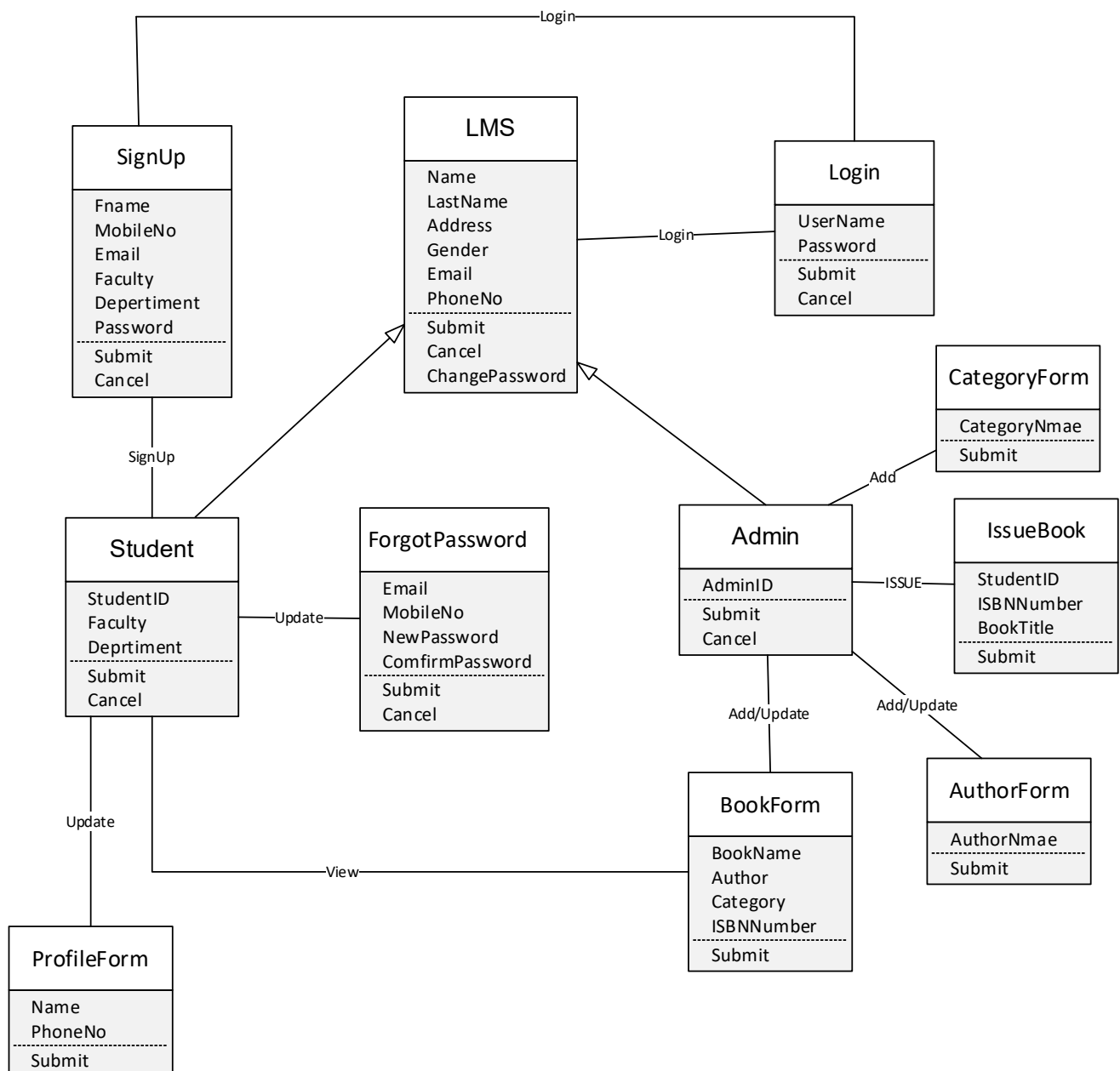


Figure: 2.0: Class Diagram

## System Flowchart

The system flowchart was used to provide a visual representation of the sequence of operations and processes within the Online Library Management System. It illustrated how users interacted with the system, beginning from registration and login to activities such as searching for books, borrowing and returning materials, and viewing

borrowing history. Similarly, administrators were able to perform functions such as managing users, updating book records, monitoring overdue returns, and reviewing transaction logs. The flowchart also incorporated decision points that directed the flow of activities based on user inputs and system responses, thereby ensuring a logical progression of operations within the system.

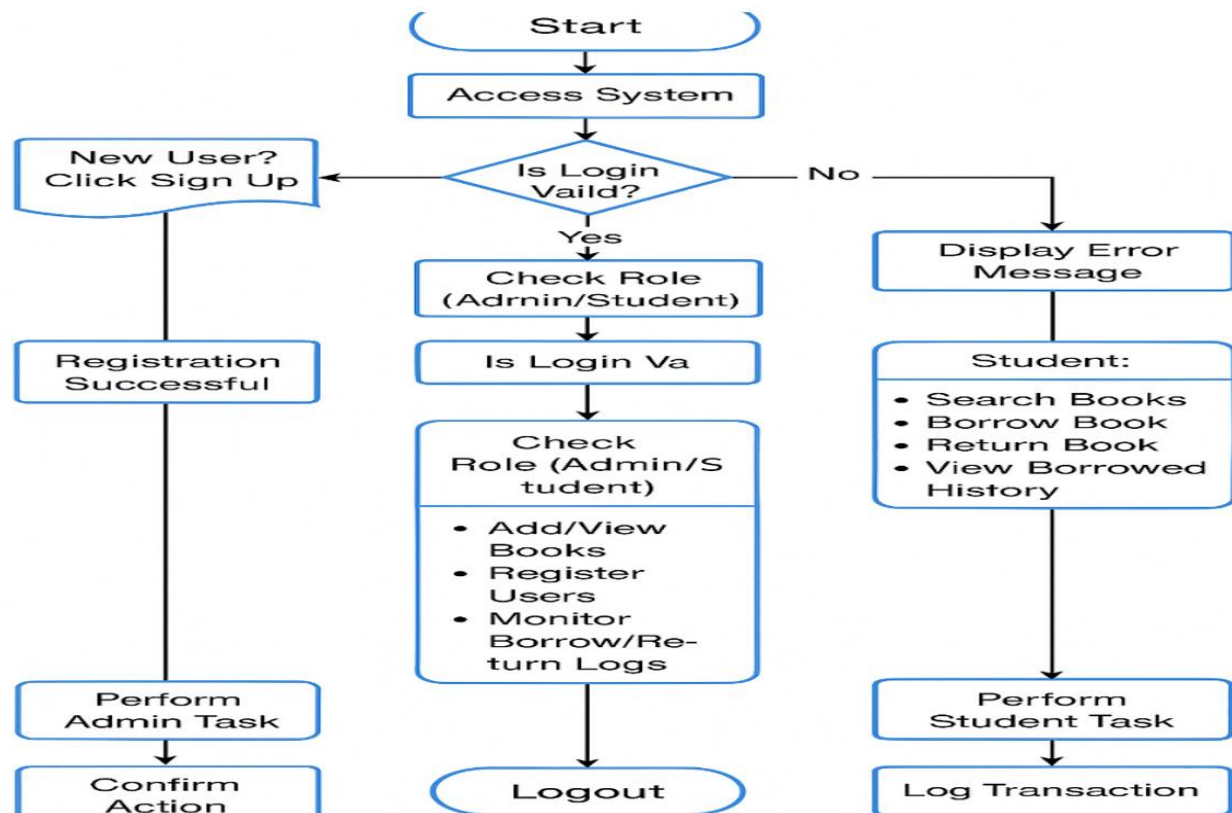


Figure 3.0: System Flowchart

Furthermore, the system flowchart served as a blueprint for the development of the application by clearly defining the relationships and interactions among various system components. It enabled the researcher and developers to visualize the overall workflow of the system, identify potential bottlenecks, and ensure that all processes were properly coordinated. By presenting system operations in a structured and sequential manner, the flowchart facilitated a better understanding of both the logical and physical aspects of the system, making it an essential tool during the analysis and design phases (Kendall & Kendall, 2019).

In addition, the flowchart played a significant role in system documentation, debugging, testing, and maintenance. It provided a common communication platform between system analysts, developers, and other stakeholders by translating system requirements into an easy-to-understand visual framework. This enhanced collaboration throughout the development process and ensured that the implemented system aligned with the specified requirements. Consequently, the flowchart contributed to the successful design, implementation, and long-term maintenance of the

Online Library Management System (Pressman & Maxim, 2020; Kendall & Kendall, 2019).

## Database Design

The database was designed to support the efficient storage, retrieval, and management of data within the Online Library Management System. A relational database model was adopted, consisting of interconnected tables linked through primary and foreign keys to ensure data integrity and consistency. The database was developed to securely store user information, manage book inventories, track borrowing and return transactions, and minimize data redundancy.

## Database Objectives

The database was designed to:

1. Securely store information relating to students, librarians, and administrators.
2. Manage book records and related metadata.
3. Track borrowing and return transactions.
4. Ensure data integrity and reduce redundancy.

## Entity Relationship Diagram (ERD)

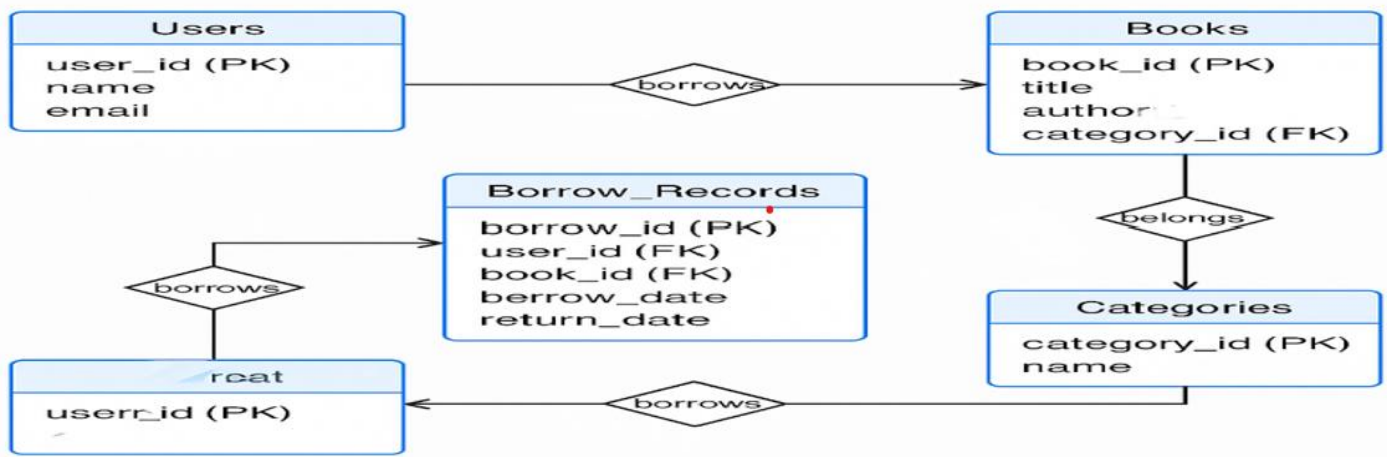


Figure 4.0: Entity Relation Diagram

The Entity Relationship Diagram (ERD) illustrated the relationships among the major entities in the system, namely Users, Books, Borrow Records, and Admins. It provided a visual representation of how data flowed and interacted within the database.

### Database Tables

The database comprised four major tables:

- Users Table: Stored user details such as user ID, name, email, password, role, and registration date.
- Books Table: Stored book information including book ID, title, author, ISBN, category, publisher, publication year, and quantity available.
- Borrow Records Table: Maintained records of borrowed books, including borrower details, borrowing date, due date, return date, and transaction status.
- Admins Table: Stored administrator information and access privileges where necessary.

### Relationships and Normalization

The database adopted one-to-many relationships between Users and Borrow\_Records, as well as between Books and Borrow Records. Foreign keys were used to enforce referential integrity and maintain consistency across tables. Furthermore, all tables were normalized up to the Third Normal Form (3NF) to eliminate redundancy, improve data consistency, enhance scalability, and optimize query performance.

### System Algorithm

The Online Library Management System began by displaying a main menu that allowed users to register, log in, or exit the application. During registration, user details were collected and stored in the database. Upon login, user credentials were verified and users were redirected to role-specific dashboards based on their access level.

Students were provided with functionalities such as searching for books, borrowing available books, returning borrowed books, and viewing their borrowing history. Librarians were granted additional privileges, including adding new books, updating or deleting book records, and monitoring transaction activities. The system automatically validated book availability before processing borrowing requests and updated records accordingly.

When a book was returned, the system updated its status, recorded the return transaction, and calculated any applicable overdue penalties. Upon completion of activities, users could log out, after which the system cleared active sessions and returned to the main menu, thereby completing the transaction cycle.

### Hardware and Software Requirements

The hardware requirements for the Online Library Management System included a personal computer with at least an Intel Core i5 processor, 8GB RAM, a visual display unit, and a minimum of 500GB hard disk storage. These specifications provided sufficient processing power, memory, and storage capacity to support the development and operation of the system efficiently.

The software requirements were divided into front-end and back-end technologies. The front end was developed using PHP, HTML, CSS, and JavaScript. PHP was used as the server-side scripting language, HTML provided the structure of web pages, CSS handled the presentation and layout of the user interface, while JavaScript enhanced interactivity and dynamic functionality. The back end was developed using MySQL, a relational database management system used for storing, managing, and retrieving data related to users, books, borrowing records, and other library transactions. Together, these technologies provided a robust, scalable, and user-friendly platform for

the Online Library Management System (Tarachandrao et al., 2021; Rajee & Roy, 2022).

### **System Design**

System design refers to the process of defining the architecture, components, modules, interfaces, and data structures of a system to satisfy specified requirements. It serves as a blueprint that guides the development, implementation, and testing of a software application. In this study, system design was employed to develop an Online Library Management System (OLMS) that would enable library administrators to manage users, books, and transactions efficiently, accurately, and securely. The design process translated the requirements identified during system analysis into a structured framework for software development, ensuring that all functional and non-functional requirements were adequately addressed (Abdullahi S.H., 2017).

The study adopted the Object-Oriented Methodology (OOM) for system design and development. Object-oriented methodology is a software development approach that models a system as a collection of interacting objects, each possessing specific attributes and methods. This methodology was selected because it promotes modularity, reusability, maintainability, and effective stakeholder communication throughout the development life cycle. Through object-oriented design techniques such as use case diagrams and class diagrams, the system components and their relationships were clearly defined, thereby facilitating a structured and systematic development process.

The Online Library Management System was developed using a three-tier architecture consisting of the presentation layer, application layer, and data layer. The presentation layer provided the user interface and was developed using HTML, CSS, JavaScript, and Bootstrap to ensure responsiveness and ease of use. The application layer, implemented using PHP, handled the business logic and processed user requests. The data layer comprised a MySQL database responsible for storing, retrieving, and managing library data. This architecture enhanced scalability, maintainability, and system performance by separating user interaction, application processing, and data management functions.

The development environment consisted of both hardware and software components required for designing, implementing, and testing the system. The hardware requirements included a computer with an Intel Core i5 processor, 8GB RAM, and 500GB storage capacity. The software environment comprised Windows and Linux operating systems, Apache web server through XAMPP, MySQL database server, Visual Studio Code as the development environment, and phpMyAdmin for database

administration. These tools provided a stable and efficient platform for system development and deployment.

The user interface was designed to provide a user-friendly environment that facilitated accurate and timely data entry while enhancing user experience. Various forms and interfaces were developed to support system operations, including the Admin Login Page, User Registration Page, User Login Page, Operations Hours Page, List of Books Page, List of Authors Page, List of Categories Page, View Registered Users Page, Change Password Page, Add and Manage Books Page, Add and Manage Authors Page, Add and Manage Categories Page, Issue Book Page, and About the System Designer Page. These interfaces incorporated validation mechanisms to ensure data accuracy and consistency throughout the system.

The Front Page served as the main entry point to the Online Library Management System and provided users with essential information about the library and available services. The Admin Login Page was designed to authenticate administrators and grant access to system management functions, while the User Registration and User Login Pages enabled users to create accounts and access system resources securely. Additional interfaces such as the View Registered Students Page, Add Book Page, Manage Book Page, Add Author Page, Manage Author Page, Add Category Page, Manage Categories Page, Issue Book Page, and Change Password Page facilitated the management of library resources, users, and transactions.

Furthermore, the Operations Hours Page provided information on library opening and closing times, as well as a brief history of the university library. Collectively, the various interface components were designed to support effective interaction between users and the system while ensuring efficient management of library operations. The integration of these interfaces with the application and database layers resulted in a comprehensive Online Library Management System capable of improving service delivery, enhancing record management, and supporting the automation of library processes.

### **Conclusion**

The study concluded that the Online Library Management System successfully achieved its objective of automating library operations and addressing the limitations of the manual system. The developed system improved the efficiency of book cataloguing, user registration, borrowing and return processes, reduced paperwork, enhanced record accuracy, and provided secure access to library resources. By utilizing open-source technologies such as PHP, MySQL, HTML, CSS, and JavaScript, the system offered a cost-effective, reliable, and user-friendly solution capable

of improving service delivery and supporting effective information management in academic libraries.

## Recommendations

1. Academic libraries should adopt and deploy the Online Library Management System to replace manual and outdated library management practices.
2. Regular data backup procedures should be implemented using both local and cloud-based storage solutions to prevent data loss.
3. Additional security features, including HTTPS encryption, user activity logging, and enhanced role-based access control, should be incorporated into future versions of the system.
4. Library staff and users should receive adequate training to ensure effective utilization and management of the system.
5. The system should be enhanced with mobile-responsive features or a dedicated mobile application to improve accessibility and convenience for users.
6. Future developments should integrate email or SMS notification services to provide reminders for overdue books and other library transactions.
7. Additional functionalities such as digital library services, artificial intelligence-based book recommendations, and multilingual support should be incorporated to further improve user experience and system functionality.

## References

1. Abdullahi S.H., 2017. "Design of client visual monitoring system of Abubakar Tafawa Balewa University E. library" Being a project wrote in Department of management and information Technology for the award of B.Tech. MIT (unpublished).
2. Adebayo, R. O., & Abdulrahman, M. A. (2020). Development of a Web-Based Library Management System for Tertiary Institutions. *Journal of Information Systems and Technology Management*, 15(2), 110–118.
3. Bamgbade, B. J., et al. (2015). Comparative analysis and benefits of digital library over traditional library. *World ScientificNews*, 24, 1-7.
4. Buba, A.A., Jada, H.M. and Faruk, A.A. (2024) Development of a Web-Based information system for student academic counselling in universities in Northern Nigeria. *Al-Nahda International Journal* 6(1), 127-147
5. Chaudhary (2016). Automated library booktruck for traditional libraries. 15(2), 1095–1101. <https://doi.org/10.11591/ijcecs.v15.i2.pp1095-1101>
6. Devi, K. C., Rupadevi, P. S., Kathija, S., Rasagna, V., & Chaduvula, K. (2021). EPRA International Journal of Research and Development (IJRD) Library Information Management System Using Kiosk. 7838(July), 412–423.
7. Jelagat, L. (2016). Information and Knowledge Management Challenges Faced by University Librarians in Creating Awareness of Library Services among Students: A Case of Moi University. 6(8), 34–38.
8. Kayode, B. Y. O., & Science, C. (2014). Design and Implementation of DHL Express Library Management System.
9. Kumar, R., & Singh, M. (2017). Online Library Management System: A Case Study on Modern Libraries. *International Journal of Computer Applications*, 169(9), 12–16. <https://doi.org/10.5120/ijca2017914484>
10. Liaquat, E., & Rahoo, A. (2016). Design and Development of an Automated Library Management System for Mehran University Library, Jamshoro. 6(1), 1–6.
11. Mahwasane, N. P., & Mudzielwana, N. P. (2016). Challenges of Students in Accessing Information in the Library: A Brief Review. *Journal of Communication*, 7(2), 216–221. <https://doi.org/10.1080/0976691x.2016.11884900>.
12. Mcpe, S., & Vidyalaya, R. M. (2019). Library automation and networking. December.
13. Nwachukwu, U. C., & Danjuma, A. M. (2021). Design and Implementation of a Mobile-Based Library System. *Nigerian Journal of Mobile and Embedded Computing*, 9(3), 55–62.
14. Ogunleye, A. O., & Falaye, A. (2018). Challenges of Manual Library Systems and the Need for Automation in Nigerian Institutions. *African Journal of Library, Archives and Information Science*, 28(1), 44–50.
15. Ozeer, A., & Nagowah, S. (2019). Turning a Traditional Library into a Smart Library. March 2020. <https://doi.org/10.1109/ICCIKE47802.2019.9004242>

16. Perdana, I. A., & Prasojo, L. D. (2020). Digital Library Practice in University: Advantages, Challenges, and Its Position. 401(Iceri 2019), 44–48. <https://doi.org/10.2991/assehr.k.200204.009>
17. Posigha Bassil, E., Rose, O., & Oberhiri-Oruma, G. (2019). The Challenges and Prospects of Cataloguing and Classification in Academic Libraries in Bayelsa State, Nigeria. *Asian Journal of Information Science and Technology*, 9(3), 14–18. <https://doi.org/10.51983/ajist-2019.9.3.294>
18. Raji, R. E., Oyedum, G. U., D, P. U. A. P., & Abu, A. A. (2017). Book Theft as a Factor Affecting Lending Services to Students in Two State University Libraries in North-Central Nigeria. *Journal of Applied Information Science and Technology*, 10(3), 41–47.
19. Reynolds (2017). Turning a Traditional Library into a Smart Library. <https://doi.org/10.1109/ICCIKE47802.2019.9004242>
20. Rodin, R. (2016). Analisis upaya dan kendala membangun perpustakaan digital pada perguruan tinggi negeri di propinsi bengkulu. *Al-Kuttab*, 3(1), 131-146. DOI: <http://dx.doi.org/10.24952/ktb.v3i1.584>
21. Sharma et al., 2016. Academic library leaders' challenges, difficulties and skills: An analysis of common experiences. *Libri*, 68(4), 301–313. <https://doi.org/10.1515/libri-2018-0063>
22. Singh, V. P. (2014). Library Management Submitted By: Division of Computer Science School of Engineering Cochin University of Science & Technology. March, 1–88.
23. Tosin A.T., 2015. "Library Management System of Federal University Oye Ekiti, Ekiti state" Being a project wrote in Department of computer Science for the award of B.Sc. Computer Science (unpublished).
24. Udo-Okon, T. N., & Esiere, E. U. (2022). Assessment of the steps in designing a web-based digital library management system for schools, opportunities and challenges. *International Journal of Eminent Scholars*, 8(1), 1–15.
25. Wan Abas, W. A. H., & Mustapha, M. F. (2025). ULib: Library management system with data analytics. *International Journal of Research and Innovation in Social Science (IJRISS)*, 9(10), 4249–4260. <https://doi.org/10.47772/IJRISS.2025.910000350>