

**DESIGN AND IMPLEMENTATION OF AN ENHANCED LIBRARY MANAGEMENT  
SYSTEM FOR THE JOHN HARRIS LIBRARY**



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BENIN CITY.**

**NOVEMBER, 2025.**

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**BY**

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**A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF COMPUTER  
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**DEPARTMENT OF COMPUTER SCIENCE,  
FACULTY OF COMPUTING,  
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**NOVEMBER, 2025**

## **CERTIFICATION**

This is to certify that this project work titled “**DESIGN AND IMPLEMENTATION OF AN ENHANCED LIBRARY MANAGEMENT SYSTEM FOR THE JOHN HARRIS LIBRARY**” was carried out by **OSAYANDE OSAKPOLOR TRUST** with Matriculation Number **PSC1907556** and submitted to the Department of Computer Science, Faculty of Computing, University of Benin, Benin City, under the supervision of **DR. E. NWELIH**.

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**DR. E. NWELIH**  
Project supervisor

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**Date**

## **APPROVAL**

This project work titled “**DESIGN AND IMPLEMENTATION OF AN ENHANCED LIBRARY MANAGEMENT SYSTEM FOR THE JOHN HARRIS LIBRARY**” by **OSAYANDE OSAKPOLOR TRUST** with Matriculation Number **PSC1907556** ha been approved as meeting the requirements for the award of Bachelor of Science (B.Sc.) Degree in Computer Science, Faculty of Computing, University of Benin, Benin City.

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**Date**

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## **ABSTRACT**

The John Harris Library at the University of Benin serves as a vital academic resource hub, yet its outdated Library Management System (LMS) significantly hinders operational efficiency and user satisfaction. The current system relies heavily on manual processes, lacks mobile accessibility, offers limited integration with university authentication systems, resulting in slow resource retrieval, user frustration, and reduced library engagement. This project addresses these challenges through the design and implementation of an enhanced web-based Library Management System designed to modernize library operations and improve the overall user experience. The proposed system leverages modern web technologies including Django REST Framework for backend operations, React with TypeScript for a responsive frontend interface, and PostgreSQL for robust data management. Core innovations include automated cataloguing and circulation processes, an intuitive user interface with advanced search capabilities, secure role-based authentication integrated with university Single Sign-On (SSO) systems, comprehensive mobile and web accessibility across devices, and real-time analytics for data-driven decision-making. By automating routine tasks such as resource tracking, the system significantly reduces manual workload for library staff while simultaneously improving service delivery speed and accuracy. This project demonstrates that strategic application of modern software engineering principles and web technologies can effectively transform traditional library operations into dynamic, user-centric services.

# CHAPTER ONE

## INTRODUCTION

### 1.0 Background of the Study

Libraries are the cornerstone of academic institutions, serving as vital hubs for knowledge dissemination, research support, and intellectual growth. They provide students, faculty, and researchers with access to a wide range of resources, including books, journals, databases, and digital materials, fostering academic excellence and innovation. Academic libraries enhance learning outcomes by offering curated collections and services that support curriculum delivery, research projects, and lifelong learning. Beyond resource provision, libraries facilitate collaboration, critical thinking, and information literacy, which are essential for preparing students for a rapidly evolving global landscape. The John Harris Library plays a pivotal role in supporting the university's academic mission, but its outdated Library Management System (LMS) limits its ability to meet modern user expectations, necessitating an enhanced system.

Libraries also contribute to institutional reputation and student satisfaction. A well-equipped library with efficient systems can attract prospective students and faculty, as it signals a commitment to academic quality. However, inefficiencies such as slow resource retrieval, limited digital access, and manual processes can hinder user experience, leading to reduced engagement. For the University of Benin, modernizing the John Harris Library's LMS is critical to maintaining its academic standing and supporting its diverse user base, including students, faculty, and staff.

The John Harris Library, located at the University of Benin (UNIBEN) in Edo State, Nigeria, is a cornerstone of the university's academic infrastructure. Established in 1970 alongside the founding of UNIBEN, the library has grown from a modest collection of physical books to a comprehensive repository serving thousands of students, faculty, and staff. With over 50,000

physical items, including books, journals, and archival materials, and access to numerous digital databases, the library supports a wide range of academic programs across disciplines such as medicine, engineering, humanities, and social sciences. Its mission is to provide equitable access to resources and foster research and learning within the UNIBEN community.

However, the library's current LMS, implemented over a decade ago, is outdated and struggles to handle the growing volume of digital resources and user demands. The system lacks modern features like mobile accessibility, advanced search capabilities, and integration with UNIBEN's authentication systems, leading to inefficiencies in cataloging, circulation, and user management. Internal university surveys have reported user complaints about slow retrieval times, difficulty accessing e-resources, and cumbersome interfaces, which hinder the library's ability to serve its community effectively. The need for an enhanced LMS is critical to modernize operations, align with current trends in library automation, and support the academic and research needs of UNIBEN's diverse user base.

## **1.1 Motivation**

The motivation for this project stems from the critical inefficiencies observed in the current Library Management System (LMS) at the John Harris Library, which relies on manual processes, lacks mobile accessibility, and offers a poor user experience. This results in slow resource retrieval, user frustration, and reduced library engagement. The project is driven by the need to automate key library operations, enhance accessibility through a modern web and mobile interface, and integrate seamlessly with university systems to provide a unified, efficient, and user-centric service for students, faculty, and staff.

## **1.2 Statement of Problems**

Based on research and analysis, the core problems this project will address are the operational inefficiencies and poor user experience of the John Harris Library's current system. These are: heavy reliance on manual processes for cataloging, circulation, and record-keeping, a lack of mobile accessibility and a non-responsive user interface, limited integration with existing university systems, inadequate search capabilities and the absence of real-time analytics, and insufficient security measures, posing a risk to the integrity and privacy of user data.

## **1.3 Aim and Objectives of the Study**

**Aim:** To develop an enhanced Library Management System that fixes the problems of reliance on manual processes, absence of mobile accessibility, and limited integration with university authentication systems whilst meeting modern technological standards.

### **Objectives:**

- I. To design and implement an intuitive and user-friendly interface that provides seamless access to library resources.
- II. To automate key library tasks, such as cataloging, circulation, and resource tracking.

## **1.4 Significance of the Study**

The development of this enhanced LMS will have wide-ranging benefits. For library users, which includes lecturers, students, departments, and faculty, the system will offer faster access to resources, better search capabilities, and mobile compatibility, which aligns with the importance of user-centric designs in modern LMS. For library staff, automation will reduce manual work, allowing them to focus more on user support and collection development. The university as a

whole will benefit from a modernized library system that supports its academic and research goals and fosters a culture of innovation and efficiency.

Additionally, this project contributes to the larger conversation about library modernization by showing how a custom LMS can solve specific institutional needs. The proposed system can serve as a model for other academic libraries looking to upgrade their infrastructure.

### **1.5 Scope and Limitations**

This project's scope includes the design, development, and implementation of the frontend, backend, and database of an enhanced LMS for the John Harris Library UNIBEN. The system will cover core functions like user management, resource cataloging, circulation, and reporting, with additional features like mobile access and integration with university authentication systems. The project will focus on meeting the needs of all users and administrators while being scalable for future enhancements.

However, the project does have some limitations due to budget and time constraints. This may limit the inclusion of advanced features like AI-driven recommendations or RFID-based tracking in the initial phase. The system will primarily focus on physical and digital book resources, with limited integration of specialized materials like rare manuscripts. The project also assumes the availability of adequate technical infrastructure at the university, and any unexpected hardware issues could affect implementation.

### **1.6 Definition of Terms**

Library Management System (LMS): A software platform designed to automate library operations, including cataloging, circulation, user management, and resource tracking, to

enhance efficiency and user access.

**Library Automation:** The use of technology to streamline library processes, such as cataloging, borrowing, and inventory management, reducing manual tasks and improving service delivery.

**Cloud-Based LMS:** A library management system hosted on remote servers, providing scalability, remote access, and reduced maintenance costs compared to on-premise systems.

**Artificial Intelligence (AI):** The application of intelligent algorithms in LMS to enable features like personalized recommendations, predictive analytics, and automated cataloging .

**Radio Frequency Identification (RFID):** A technology using radio waves to automate check-in/check-out, inventory tracking, and theft prevention in libraries, improving operational efficiency.

**Single Sign-On (SSO):** An authentication mechanism that allows users to access multiple systems, including the LMS, with a single set of login credentials, enhancing user convenience .

**Information Literacy:** The ability to locate, evaluate, and use information effectively, supported by library resources and services to foster critical thinking and research skills.

**User-Centric Design:** The approach to designing LMS interfaces and functionalities based on user needs, preferences, and accessibility requirements to maximize engagement and satisfaction.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.0 Introduction**

Academic libraries are at the forefront of supporting research, teaching, and learning in universities. As the volume and complexity of information resources grow, the need for efficient, scalable, and user-friendly library management systems (LMS) becomes increasingly critical. The John Harris Library at the University of Benin (UNIBEN) exemplifies the challenges and opportunities faced by Nigerian academic libraries in their quest to modernize operations and remain relevant in a rapidly evolving digital landscape. This literature review explores the development and implementation of an enhanced library management systems, with a focus on the context of the John Harris Library, UNIBEN.

#### **2.1 Overview of Library Management Systems**

Library management systems are integrated platforms designed to automate and streamline the core functions of libraries, including cataloguing, circulation, acquisitions, serials management, and user services. Traditionally, these systems were manual, relying on card catalogs and paper-based records. However, the advent of information and communication technology (ICT) has transformed library operations, enabling the automation of routine tasks and the provision of digital services to users (Krubu & Osawaru, 2011; Samuel et al., 2018).

Modern LMS are characterized by their modular architecture, allowing libraries to manage diverse resources—print, electronic, and multimedia—within a unified framework. Key features include user registration, check-in/check-out processes, overdue fine management, and online public access catalogs (OPACs) that facilitate resource discovery (Olorunsaye & Adetunji, 2012; Samuel et al., 2018). The integration of digital repositories, electronic resource management, and analytics

further enhances the ability of libraries to support academic activities and make informed management decisions (Asogwa et al., 2021; Umap & Jani, 2025).

The shift towards digital and automated systems is driven by the need to improve efficiency, reduce human error, and provide timely access to information. In the Nigerian context, academic libraries have increasingly adopted automation to address the growing demands of students and researchers, as well as to align with global best practices (Asogwa et al., 2021; Olorunsaye & Adetunji, 2012).

## **2.2 Existing Library Management Systems**

### **2.2.1 The John Harris Library, UNIBEN**

The John Harris Library has undergone significant transformation in its approach to library management. Early efforts focused on the computerization of core operations, with the adoption of the Strategic Library Automation Management (SLAM) software, developed locally and running on the Oracle DBMS platform (Sanni & Idiodi, 2004). This system was designed to automate circulation and OPAC functions, enabling efficient registration of patrons, management of borrowing and returning processes, and the generation of management reports (Olorunsaye & Adetunji, 2012; Sanni & Idiodi, 2004). The implementation of SLAM and subsequent web-based applications marked a shift from manual to automated processes, improving the accuracy and speed of library transactions. The circulation module facilitated the management of user accounts, overdue fines, and resource tracking, while the OPAC allowed users to search for materials using various criteria (Olorunsaye & Adetunji, 2012). These advancements laid the foundation for further enhancements, including the integration of digital resources and the adoption of more sophisticated technologies.

### **2.2.2 Other Nigerian University Libraries**

Across Nigeria, university libraries have adopted a range of LMS solutions, including both proprietary and open-source platforms. Koha and Greenstone are among the most widely used open-source systems, valued for their flexibility, cost-effectiveness, and support for collaborative development (Mercy, 2025; Muhammad & Suleiman, 2025). These systems offer modules for cataloguing, circulation, acquisitions, and serials management, as well as support for digital repositories and cloud-based services (Muhammad & Suleiman, 2025). Despite the availability of ICT facilities in many Nigerian university libraries, the extent of utilization and the adoption of international best practices remain limited. Challenges such as inadequate funding, unstable power supply, and insufficient staff training hinder the effective management of electronic records and the full realization of LMS benefits (Asogwa et al., 2021). Nevertheless, the trend towards automation and digital transformation is evident, with libraries increasingly recognizing the need to invest in technology and human resource development (Ikenwe & Udem, 2022; Mercy, 2025).

## **2.3 Technologies in Modern Library Management**

### **2.3.1 Automation and Digital Transformation**

The digital transformation of library services is driven by the adoption of advanced technologies that enhance efficiency, accessibility, and user engagement. Automation of core functions—such as cataloguing, circulation, and inventory management—reduces manual effort and minimizes errors, allowing staff to focus on value-added services (Gajbhiye et al., 2025; K et al., 2023). Web-based applications and cloud computing have further expanded the reach of library services, enabling remote access to resources and facilitating collaboration among users and staff (Muhammad & Suleiman, 2025; Ikenwe & Udem, 2022).

### **2.3.2 Artificial Intelligence and Machine Learning**

Artificial intelligence (AI) and machine learning (ML) are increasingly being integrated into library management systems to optimize operations and improve user experiences. AI-driven tools support automated cataloguing, metadata extraction, and intelligent search capabilities, making it easier for users to discover relevant resources (Ogunbenro et al., 2025; Suleiman, 2024). Chatbots and virtual assistants provide personalized recommendations and real-time support, enhancing user satisfaction and engagement (Ikwuanusi et al., 2024; Suleiman, 2024). The adoption of AI in Nigerian academic libraries is still in its early stages, with significant potential for growth. Barriers such as limited infrastructure, financial constraints, and the need for technical training must be addressed to fully leverage the benefits of AI-based services (Suleiman, 2024; Ogunbenro et al., 2025).

### **2.3.3 Cloud Computing and Open-Source Solutions**

Cloud-based LMS platforms offer scalability, flexibility, and cost savings, making them attractive options for libraries with limited resources. Open-source solutions like Koha and DSpace enable libraries to customize their systems to meet specific needs, while also benefiting from community-driven development and support (Muhammad & Suleiman, 2025; Mercy, 2025). Cloud services reduce the risk of data loss, minimize hardware requirements, and facilitate remote access to library resources (Muhammad & Suleiman, 2025).

### **2.3.4 Digital Applications and Innovative Tools**

Academic libraries are increasingly utilizing digital applications to enhance service delivery. Tools such as library catalogue apps, account management apps, and digital preservation platforms support efficient management of resources and improve user access (Owate, 2024; Mercy, 2025). Collaborative tools like Google Workspace and Microsoft 365 enable real-time communication

and teamwork among library staff and users (Mercy, 2025). However, the adoption of emerging technologies is often hampered by budget constraints, inadequate training, and resistance to change. Continuous professional development and strategic partnerships with technology providers are essential for overcoming these challenges and ensuring the successful implementation of innovative tools (Mercy, 2025; Ikenwe & Udem, 2022).

### **2.3.5 Robotics and Advanced Automation**

Robotic technologies have the potential to further revolutionize library operations by automating repetitive tasks and enhancing service delivery. While the readiness of Nigerian university libraries to adopt robotics remains low, awareness of the benefits is growing, and steps are being taken to build the necessary digital infrastructure and policy frameworks (Owolabi et al., 2022). The integration of robotics into library management systems could streamline processes such as shelving, inventory management, and user assistance, freeing up staff to focus on more complex tasks (Owolabi et al., 2022).

## **2.4 Relevance of Study**

The development and implementation of an enhanced library management systems are crucial for the sustainability and relevance of academic libraries in the digital age. For the John Harris Library, UNIBEN, embracing modern LMS technologies is essential to meet the evolving needs of students, researchers, and faculty. An Enhanced LMS improves operational efficiency, resource utilization, and user satisfaction by automating routine tasks, providing real-time access to information, and supporting digital resource management (Olorunsaye & Adetunji, 2012; K et al., 2023). The COVID-19 pandemic has accelerated the shift towards online education and digital service delivery, highlighting the importance of responsive library websites, blended librarianship

models, and the adoption of social networks for information dissemination (Ifijeh & Yusuf, 2020). Libraries must be dynamic in their service delivery, continuously acquiring new skill sets and investing in ICT infrastructure to support virtual learning environments (Ifijeh & Yusuf, 2020; Ikenwe & Udem, 2022). Despite the clear benefits, challenges such as inadequate funding, unstable power supply, and limited staff training persist. Addressing these issues requires strategic planning, stakeholder collaboration, and ongoing investment in technology and human resources (Asogwa et al., 2021; Ikenwe & Udem, 2022). The experience of the John Harris Library demonstrates that local development and customization of LMS can yield significant benefits, but must be supported by robust infrastructure and continuous professional development (Olorunsaye & Adetunji, 2012; Sanni & Idiodi, 2004). The integration of AI, cloud computing, and digital applications represents the future of library management, offering opportunities for greater efficiency, accessibility, and user engagement. As Nigerian academic libraries continue to evolve, the lessons learned from the development and implementation of an enhanced LMS at institutions like UNIBEN will inform best practices and guide future innovations.

## **2.5 Conclusion**

A modern, enhanced Library Management System is essential for addressing the inefficiencies, limited user engagement, and integration challenges found in traditional and manual library operations. By incorporating automation, artificial intelligence, and user-centric design, such systems streamline cataloguing, circulation, and resource management, while improving accessibility and user satisfaction. Research shows that these advancements not only boost operational efficiency but also ensure libraries remain adaptable and relevant in the digital era, ultimately supporting the evolving needs of academic communities (Ikwuanusi et al., 2024; Akinola, 2022).

## **CHAPTER THREE**

### **SYSTEM ANALYSIS AND DESIGN**

#### **3.0 Overview**

This chapter presents a comprehensive analysis and design of the enhanced Library Management System (LMS) for the John Harris Library. The primary objective is to address the inefficiencies inherent in the existing manual processes by introducing an automated, integrated system that streamlines library operations. It begins by highlighting the limitations of the current system, proposes targeted improvements to enhance functionality and user experience, and provides detailed insights into the software and hardware requirements necessary for successful implementation. Additionally, this chapter outlines the methodologies employed during development, including system models such as data flow diagrams and entity-relationship diagrams, to ensure a robust and scalable solution. By focusing on user-centric design principles, the enhanced LMS aims to facilitate seamless cataloguing, borrowing, returning, and record maintenance, ultimately contributing to improved operational efficiency and resource accessibility within the university library environment.

#### **3.1 Introduction**

System analysis and design represents a pivotal phase in the software engineering lifecycle, serving as the bridge between identifying user requirements and executing the technical implementation of a functional system. This phase involves a systematic examination of the problem domain, gathering and analyzing requirements, and crafting a blueprint for the system's architecture and components. In the context of the enhanced Library Management System (LMS) for e the inefficiencies plaguing the current manual system. Key areas of focus included automating cataloguing processes to reduce manual entry errors, streamlining borrowing and

returning workflows for faster transactions, and enhancing record maintenance through integrated digital tools. The design also incorporates features for real-time tracking of book availability, overdue notifications, and secure access controls, ensuring that the system not only meets but exceeds the expectations of librarians, students, and faculty members. By adopting a structured approach, this phase lays the foundation for a reliable, user-friendly LMS that aligns with modern library management standards.

### **3.2 Information Gathering**

To ensure the enhanced LMS accurately reflects the needs of its users, information was gathered through a multi-faceted approach, including structured interviews with librarians to understand operational challenges, online surveys distributed to students and faculty to capture end-user perspectives, and direct observation of existing library processes during peak hours. These methods provided a holistic view of the system's requirements, revealing pain points such as delays in book issuance and difficulties in inventory tracking. Interviews, conducted with five key library staff members, focused on daily workflows and pain points, while surveys reached about 100 respondents, yielding quantitative data on user satisfaction and feature preferences. Direct observations helped validate reported issues, such as bottlenecks during borrowing rushes. This comprehensive data collection ensured that the design aligns closely with actual user needs and organizational objectives, fostering a system that is both practical and adaptable. The gathered insights were then synthesized into requirement specifications, prioritizing features like intuitive search interfaces and automated alerts to enhance overall usability.

### **3.3 Analysis of Existing System**

#### **3.3.1 Problems of Existing System**

The current library management system at the John Harris Library relies heavily on manual record-keeping, which introduces several critical inefficiencies. For instance, handwritten logs and physical ledgers are prone to human errors, such as misentries or illegible handwriting, leading to inaccuracies in book tracking and delays in processing requests. Additionally, tracking borrowed and overdue books is cumbersome, often requiring manual cross-referencing of multiple registers, which can result in overlooked fines or lost items. The system also lacks integration with digital resources, meaning users cannot access e-books or online catalogs seamlessly, limiting the library's ability to support modern research needs. Furthermore, user authentication and security mechanisms are inadequate, with no robust password systems or role-based access controls, making the system vulnerable to unauthorized access and data breaches. These issues collectively contribute to reduced productivity, frustrated users, and potential financial losses from unrecovered materials.

#### **3.3.2 Description of Proposed System**

The proposed enhanced LMS introduces a fully automated and integrated platform that revolutionizes library operations. It features automated cataloguing through barcode scanning, allowing librarians to add and update book records efficiently. Borrowing and returning processes are streamlined via self-service kiosks and mobile apps, where users can check out items with minimal staff intervention. A secure login system, utilizing encrypted credentials and multi-factor authentication, ensures that librarians have administrative privileges while students access only user-specific features. Advanced search functionalities enable quick queries by title, author, ISBN, or keywords, with filters for availability and location. Overdue reminders are automated via email

and SMS notifications, reducing the administrative burden on staff. Moreover, the system integrates digital resources, providing access to e-books, journals, and online databases within a unified interface. This holistic approach not only addresses the shortcomings of the existing system but also positions the library as a forward-thinking resource hub.

### **3.3.3 Advantages of Proposed System**

The proposed LMS offers numerous advantages that significantly elevate library operations. By automating transactions, it improves efficiency, enabling faster borrowing and returning processes that can handle higher volumes during peak times without delays. Human errors in data management are drastically reduced through digital validation checks and automated backups, ensuring data integrity and reliability. Security and access control are enhanced with role-based permissions and audit logs, protecting sensitive user information from breaches. Users benefit from an enhanced experience, including intuitive search tools that provide real-time results and personalized recommendations, as well as notification features for due dates and reservations. These improvements collectively lead to higher user satisfaction, better resource utilization, and cost savings for the university. Overall, the system transforms the library from a manual operation into a dynamic, technology-driven service.

## **3.4 Design and Implementation Methodology**

### **3.4.1 Software Requirements**

The enhanced LMS requires a robust set of software components to ensure seamless functionality. The programming languages and frameworks selected included Django for the backend due to its efficiency in developing secure, scalable APIs, and React (TypeScript) for the frontend, supporting a dynamic and responsive user interface. The backend API is designed according to RESTful principles, ensuring easy integration with external university systems, mobile applications, and

maintaining clear separation between business logic and presentation.

For data storage, SQLite was used in local development, with PostgreSQL planned for cloud deployment to support high concurrency and data integrity. Authentication is managed through Django's built-in system and JWT tokens, facilitating secure, role-based access. Styling and frontend layouts are implemented using Tailwind CSS, and Vite serves as the frontend build tool for streamlined development and optimized performance.

### **3.4.2 Software Tools Used**

Development of the LMS utilized a suite of industry-standard tools to facilitate coding, testing, and collaboration. Visual Studio Code served as the primary integrated development environment (IDE), with GitHub for version control, ensuring effective team collaboration and code management. For the frontend, Node.js and npm were used to manage dependencies and scripts, supporting the React/TypeScript application. Testing frameworks such as Pytest and React Testing Library were applied to validate backend and frontend modules, respectively.

### **3.4.3 Hardware Requirements**

To support the LMS effectively, minimum hardware specifications include at least 8GB of RAM to handle concurrent user sessions and data processing tasks without lag. The processor should be an Intel i5 or equivalent higher model to manage computational demands like search algorithms and report generation. Storage requirements are set at 500GB HDD or 256GB SSD for housing the database, application files, and backups, with SSD preferred for faster read/write speeds. Network connectivity via LAN or Wi-Fi is essential for multi-user access, ensuring reliable communication between client devices and the server.

## **3.5 System Development Approach**

### **3.5.1 Waterfall Model**

The Waterfall Model was adopted for the development of the enhanced LMS, as it provides a structured, sequential framework where each phase must be completed before the next begins. This model progresses linearly through distinct stages: requirements gathering, system design, implementation, testing, and deployment. Each phase produces deliverables that serve as input for the subsequent phase, ensuring clear documentation and traceability. The sequential nature of this approach ensured systematic development, with comprehensive testing conducted after implementation to verify that all specifications were met, minimizing defects and ensuring high-quality output.

### **3.5.2 Requirement Analysis and System Design**

During requirement analysis, user and system needs were meticulously documented, categorizing them into functional (e.g., book borrowing) and non-functional (e.g., response time under 2 seconds) requirements. System design involved modeling these using use case diagrams to depict actor interactions, data flow diagrams to illustrate information movement, and entity-relationship diagrams to define database structures, ensuring a clear blueprint for implementation.

### **3.5.3 Architectural Design**

A three-tier architecture was implemented, comprising the presentation layer (React SPA) for user interfaces, the application layer (Django backend) for business logic and processing, and the database layer (SQLite/PostgreSQL) for data storage and retrieval. Data flows securely between the layers via RESTful APIs.

### **3.5.4 Module Design**

The system is modularized into key components: user management for handling registrations and profiles; cataloguing for adding and editing book details; borrowing/return for transaction processing; and reporting for generating analytics on usage patterns. Each module is designed with reusable code blocks to promote efficiency and ease of expansion.

### **3.5.5 Validation Phases**

Validation encompassed unit testing for individual modules, integration testing to ensure seamless module interactions, and system testing to verify overall functionality against requirements. This rigorous process confirmed the system's reliability and compliance.

### **3.6 Dataflow Diagrams**

Dataflow diagrams (DFDs) were utilized to visually represent the flow of information within the LMS, providing a clear overview of processes, data stores, and external entities.

#### **3.6.1 Admin Login**

The Admin Login DFD illustrates the authentication process where the admin enters credentials, which are verified against the user database. Upon success, access rights are granted to administrative functions like cataloguing and reporting, with flows showing error handling for invalid attempts, as depicted in Figure 3.0. The code for the admin login can be found in the Appendix.

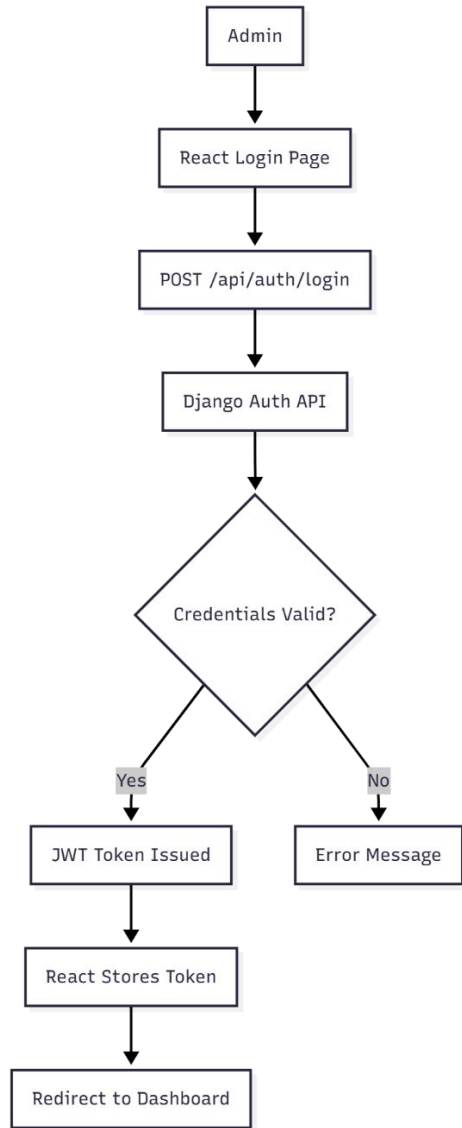


Figure 3.0: Admin Login DFD

### 3.6.2 User Login

This DFD covers user authentication, where students or faculty input login details, validated against the member database. Successful login directs data flow to user-specific features such as borrowing and search, with provisions for password recovery, as depicted in Figure 3.1. The code for the user login can be found in the Appendix.

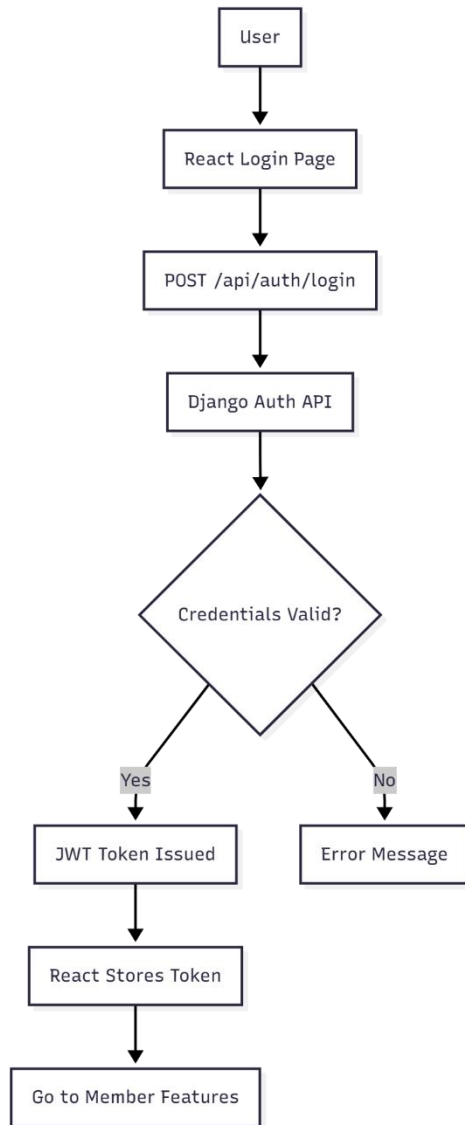


Figure 3.1: User Login DFD

### 3.6.3 Book Borrow

The Book Borrow DFD depicts the workflow starting from user selection of a book, checking availability in the book database, updating borrow records, and generating due date notifications.

It includes flows for inventory updates and error paths for unavailable items, as depicted in Figure

3.2. The code for the borrowing of books can be found in the Appendix.

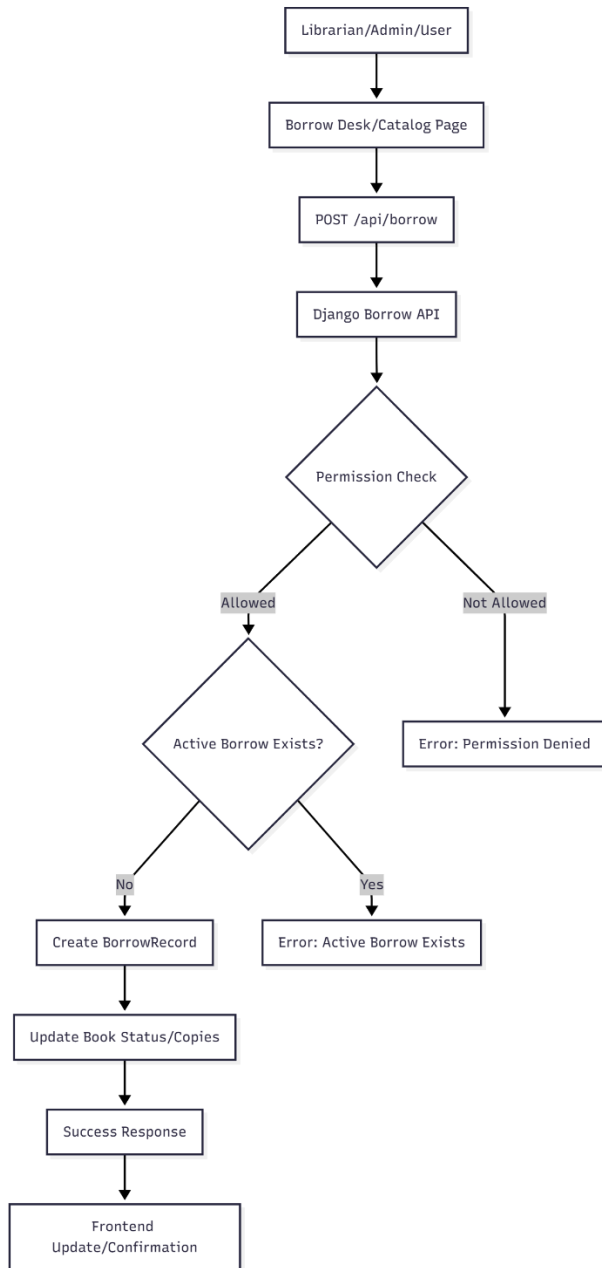


Figure 3.2: Book Borrow DFD

### 3.6.4 Book Search

This diagram represents the query process where users input search criteria, processed through the

application layer to retrieve matches from the book database, and display results with details like location and status, as depicted in Figure 3.3:

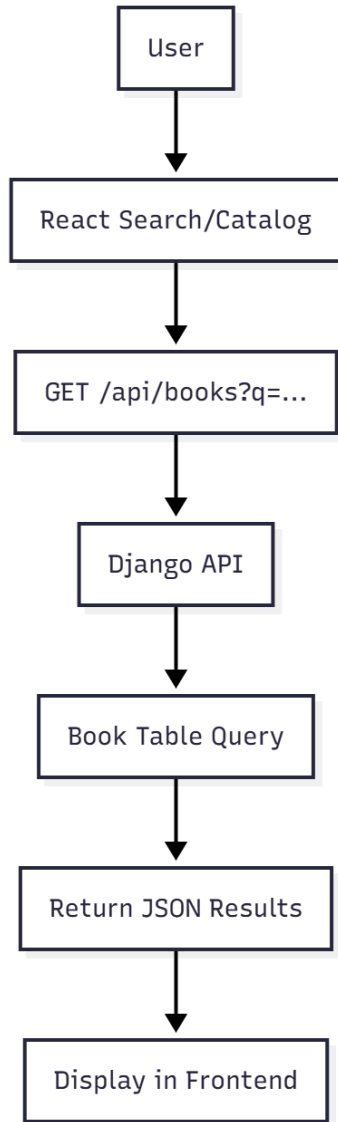


Figure 3.3: Book Search DFD

### 3.6.5 Account Creation

The Account Creation DFD shows the registration flow for students and librarian-managed staff accounts, involving data entry, validation, and storage in the user and member databases, with

confirmation outputs, as depicted in Figure 3.4:

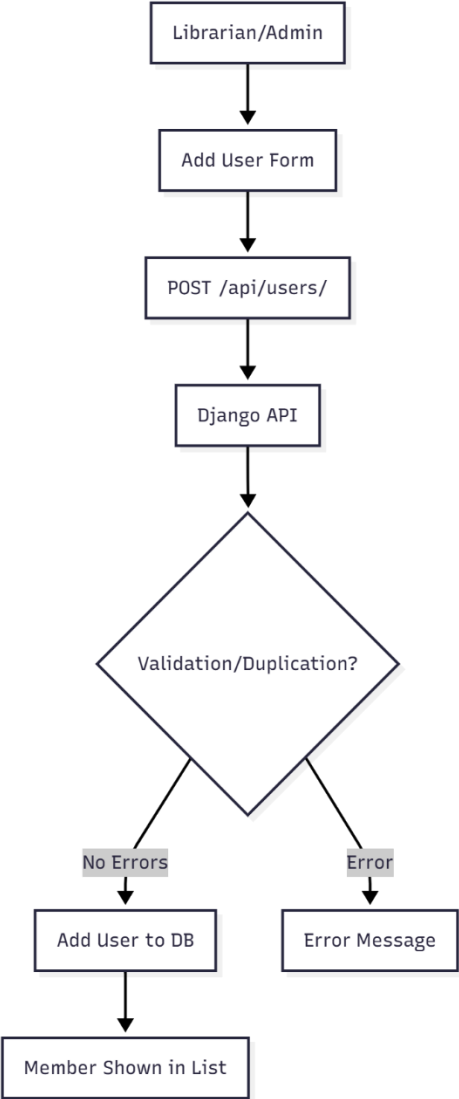


Figure 3.4: Account Creation DFD

## CHAPTER FOUR

### SYSTEM IMPLEMENTATION AND DOCUMENTATION

#### 4.0 System Implementation and Documentation

This chapter delves into the practical implementation of the enhanced Library Management System (LMS), detailing the hardware and software environments utilized, as well as comprehensive documentation to support ongoing maintenance, user training, and future enhancements. Implementation focused on translating the design blueprints from Chapter Three into an operational system for the John Harris Library, emphasizing reliability, scalability, and ease of use. Documentation covers technical aspects like code structures and user guides, ensuring that stakeholders can effectively manage and operate the LMS post-deployment.

#### 4.1 Implementation of the System

The LMS was implemented using Django REST Framework for robust backend logic—handling tasks such as user authentication, transaction processing, cataloguing, and resource tracking—integrated with PostgreSQL for efficient data storage and querying. The frontend is developed with React (TypeScript), delivered as a single-page application that interacts with backend APIs for dynamic data loading, real-time status updates, and responsive user experience across devices.

Role-based authentication and permission control are integrated via Django and JWT, ensuring secure access for admins, librarians, and members. The frontend uses Vite and Tailwind CSS for rapid development, modular styling, and optimized performance.

#### 4.2 Hardware Support

For optimal performance, the LMS for the John Harris Library was deployed on a dedicated server equipped with an Intel i7 processor for high-speed computations, 16GB RAM to manage multiple

concurrent sessions, and a 512GB SSD for rapid data access and storage. Client-side support extends to various devices, including desktops with standard configurations (e.g., 8GB RAM, i5 processor) and mobile devices such as smartphones and tablets, all requiring stable internet access via Wi-Fi or Ethernet. This hardware setup ensures low latency during peak usage, such as during exam periods when borrowing demands surge.

### **4.3 Software Support**

The system for the John Harris Library operates on versatile operating systems like Windows 10/11 or Linux distributions (e.g., Ubuntu), providing flexibility for deployment environments. Apache serves as the web server, handling HTTP requests efficiently, while MySQL manages the database with features for replication and backups. Supported browsers include Google Chrome, Mozilla Firefox, and Apple Safari, all in their latest versions, to ensure cross-platform compatibility and access to modern web features like responsive design and secure sessions.

### **4.4 Documentation of the System**

#### **4.4.1 Program Documentation**

Program documentation includes detailed annotations within the source code, explaining functions, variables, and algorithms. It also encompasses module overviews, such as the borrowing module's logic for due date calculations, and database schemas with entity descriptions, facilitating easier debugging and updates by future developers of the system at the John Harris Library.

#### **4.4.2 Procedure Design**

Procedure design outlines step-by-step interactions: administrators log in to access dashboards for cataloguing and reports, while users navigate search and borrow interfaces. Flowcharts and user manuals detail processes like resetting passwords or generating overdue lists, ensuring intuitive

operation for all users of the John Harris Library system.

### 4.4.3 Operating System

The documentation specifies minimum operating system requirements, such as Windows 10 or Linux Kernel 5.4+, to guarantee compatibility with the software stack for the John Harris Library. It includes guidelines for updates and patches to maintain security and performance.

## 4.5 Screenshots of the Enhanced LMS Interface

### 4.5.1 Home Page

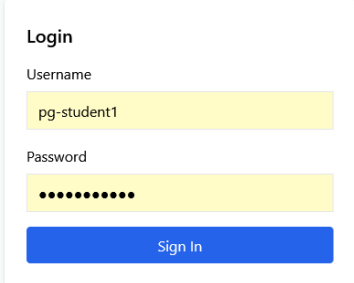
The home page features a clean, intuitive layout with navigation menus linking to key sections like search, logout, and the available books being displayed, designed for quick access and mobile responsiveness for users of the John Harris Library, as depicted in the figure below.

Title	Author	ISBN	Available	Total	Status	Actions
Introduction to Algorithms	Thomas H. Cormen; Charles E. Leiserson; Ronald L. Rivest; Clifford Stein	9780262046305	8	11	available	Borrow
Clean Code: A Handbook of Agile Software Craftsmanship	Robert C. Martin	9780132350884	2	3	available	Borrowed
Artificial Intelligence: A Modern Approach (4th Edition)	Stuart Russell; Peter Norvig	9780134610993	0	2	borrowed	Borrow
Operating System Concepts (10th Edition)	Abraham Silberschatz; Peter B. Galvin; Greg Gagne	9781119456339	3	3	available	Borrow
Database System Concepts (7th Edition)	Abraham Silberschatz; Henry F. Korth; S. Sudarshan	9780078022159	3	3	available	Borrow
Modern Control Engineering (5th Edition)	Katsuhiko Ogata	9780136156734	2	2	available	Borrow
Campbell Biology (12th Edition)	Lisa A. Urry; Michael L. Cain; Steven A. Wasserman; Peter V. Minorsky; Jane B. Reece	9780134093413	4	4	available	Borrow
Guyton and Hall Textbook of Medical Physiology (14th Edition)	John E. Hall	9780323597128	2	2	available	Borrow

Figure 4.0: Home page for Library members, showing the current catalog

## 4.5.2 Admin/User Login

The login page presents secure input fields for username and password. Upon submission, output confirms successful authentication or displays error messages, redirecting to respective dashboards in the John Harris Library system.



The image shows a login form titled "Login" centered on a light blue background. The form contains two input fields: "Username" with the text "pg-student1" and "Password" with ten black dots. Below the fields is a blue button labeled "Sign In".

Figure 4.1: Login page with user credentials

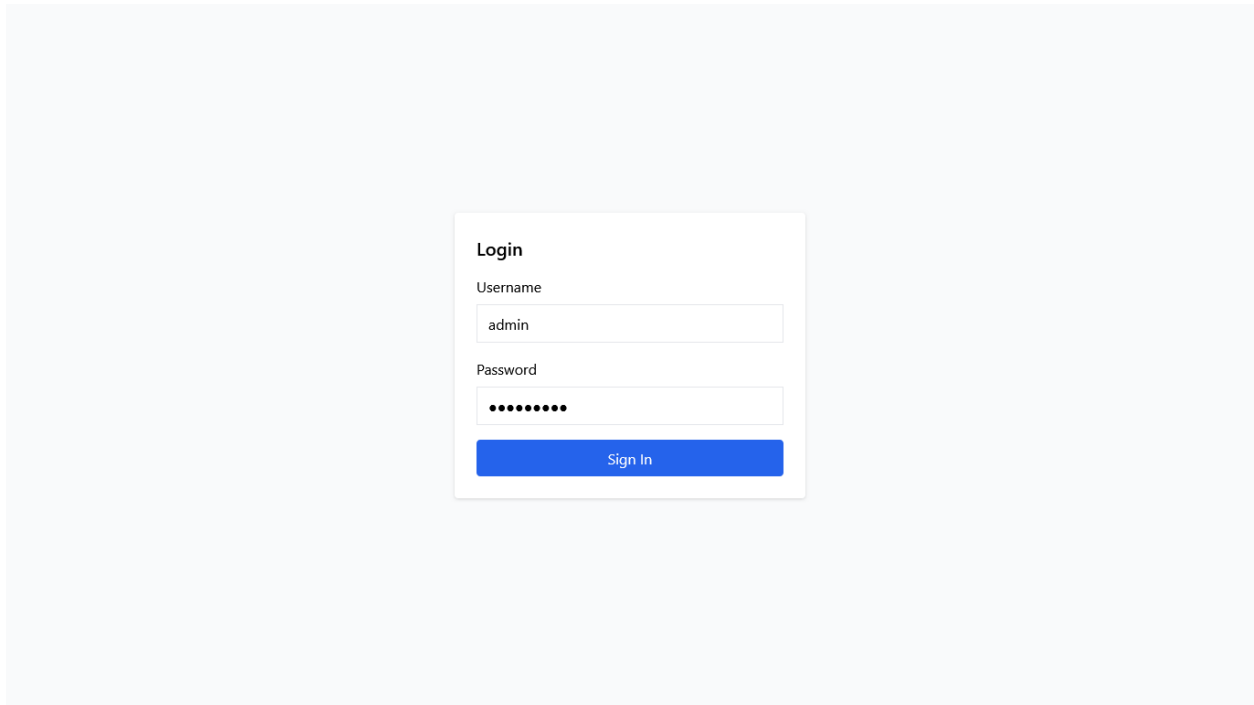


Figure 4.2: Login page with admin credentials

### **4.5.3 Add Books**

This interface allows librarians to input book details like title, author, ISBN, and category via forms with validation. Output confirms addition with a success message and updates the catalog display for the John Harris Library,

Catalog Signed in as admin (ADMIN) [Borrow Desk](#) [Reports](#) [Logout](#)

Search title/author/ISBN

Title	Author	ISBN	Available	Total	Status	Actions
Introduction to Algorithms	Thomas H. Cormen; Charles E. Leiserson; Ronald L. Rivest; Clifford Stein	9780262046305	8	11	available	<input type="button" value="Edit"/>
Clean Code: A Handbook of Agile Software Craftsmanship	Robert C. Martin	9780132350884	2	3	available	<input type="button" value="Edit"/>
Artificial Intelligence: A Modern Approach (4th Edition)	Stuart Russell; Peter Norvig	9780134610993	0	2	borrowed	<input type="button" value="Edit"/>
Operating System Concepts (10th Edition)	Abraham Silberschatz; Peter B. Galvin; Greg Gagne	9781119456339	3	3	available	<input type="button" value="Edit"/>
Database System Concepts (7th Edition)	Abraham Silberschatz; Henry F. Korth; S. Sudarshan	9780078022159	3	3	available	<input type="button" value="Edit"/>
Modern Control Engineering (5th Edition)	Katsuhiko Ogata	9780136156734	2	2	available	<input type="button" value="Edit"/>
Campbell Biology (12th Edition)	Lisa A. Urry; Michael L. Cain; Steven A. Wasserman; Peter V. Minorsky; Jane B. Reece	9780134093413	4	4	available	<input type="button" value="Edit"/>
Guvton and Hall Textbook of						<input type="button" value="Edit"/>

Figure 4.3: Interface for Library staff (Admins & Librarians) to Add Books

#### 4.5.4 Add User

Librarians use this to register new members, inputting details like name, ID, and email. The design includes dropdowns for roles, with output generating unique credentials and updating the member list for the John Harris Library.

Django administration WELCOME, ADMIN | VIEW SITE / CHANGE PASSWORD / LOG OUT

Home » Users » Users » Add user

Start typing to filter...

**AUTHENTICATION AND AUTHORIZATION**

Groups + Add

---

**CATALOG**

Books + Add

Categorys + Add

---

**CIRCULATION**

Borrow records + Add

---

**USERS**

Users + Add

### Add user

**Password:**

**Last login:** **Date:**  Today | 📅  
**Time:**  Now | 🕒  
Note: You are 1 hour ahead of server time.

**Superuser status**  
Designates that this user has all permissions without explicitly assigning them.

**Groups:**

The groups this user belongs to. A user will get all permissions granted to each of their groups. Hold down "Control", or "Command" on a Mac, to select more than one.

**User permissions:**

Administration | log entry | Can add log entry  
 Administration | log entry | Can change log entry  
 Administration | log entry | Can delete log entry  
 Administration | log entry | Can view log entry  
 Authentication and Authorization | group | Can add group  
 Authentication and Authorization | group | Can change group  
 Authentication and Authorization | group | Can delete group

Specific permissions for this user. Hold down "Control", or "Command" on a Mac, to select more than one.

**Username:**

Required. 150 characters or fewer. Letters, digits and @/./+/-/\_ only.

**First name:**

**Last name:**

**Email address:**

**Staff status**  
Designates whether the user can log into this admin site.

**Active**  
Designates whether this user should be treated as active. Unselect this instead of deleting accounts.

**Date joined:** **Date:**  Today | 📅  
**Time:**  Now | 🕒  
Note: You are 1 hour ahead of server time.

**Role:**

Figure 4.4: Admin dashboard for adding users to the library database

### 4.5.5 Book Borrow

The borrowing interface captures inputs like book ID and user ID, checks availability, and processes transactions. Output includes confirmation slips with due dates and updates to borrow

records for the John Harris Library.

#### 4.5.6 Book Location

This feature provides library members with detailed location information for borrowed or searched books via automated email notifications. When a user successfully borrows a book or requests location details through the catalog interface, the system automatically generates and sends a formatted email containing comprehensive book details, along with precise physical location information.

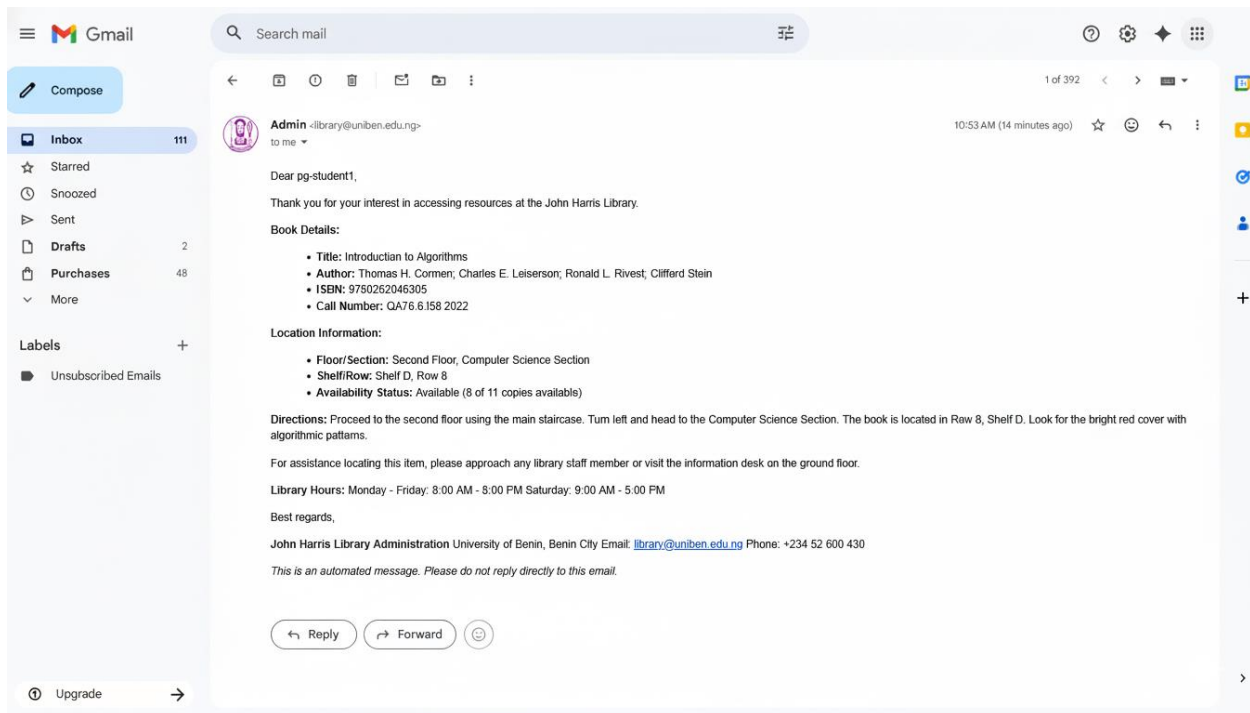


Figure 4.5: User receives email after borrowing book

### 4.6 Database Design

#### 4.6.1 User Table

The User Table stores credentials with fields like user\_id (primary key), username, password (hashed), role (admin/user), and last\_login timestamp, ensuring secure authentication for the John

Harris Library system.

#### **4.6.2 Borrow Book Details**

This table tracks transactions with fields such as borrow\_id (primary key), user\_id (foreign key), book\_id (foreign key), borrow\_date, due\_date, return\_date, and fine\_amount, facilitating overdue management for the John Harris Library.

#### **4.6.3 Book Table**

The Book Table maintains inventory with fields like book\_id (primary key), title, author, ISBN, category, publication\_year, copies\_available, and status (available/borrowed), supporting search and cataloguing for the John Harris Library.

#### **4.6.4 Member Table**

The Member Table holds user profiles with fields such as member\_id (primary key), name, email, phone, registration\_date, and membership\_status, linked to the User Table for comprehensive records at the John Harris Library.

## CHAPTER FIVE

### SUMMARY, CONCLUSION AND RECOMMENDATION

#### 5.1 Summary

This project was undertaken to address the significant inefficiencies and technological limitations of the existing Library Management System (LMS) at the John Harris Library, University of Benin. The study identified critical problems such as manual record-keeping, slow resource retrieval, lack of digital integration, poor user interface, and inadequate security measures, all of which contributed to user dissatisfaction and operational bottlenecks.

The project successfully designed, developed, and implemented an enhanced, automated LMS. The system was built using a robust technology stack comprising Django REST Framework for the backend, React (TypeScript + Vite) for the frontend, and PostgreSQL/SQLite for data management, along with Vite, Tailwind CSS, and JWT authentication, following the structured Waterfall Model development approach. Key achievements of the new system include:

- I. The automation of core library processes like cataloging, circulation, and reporting.
- II. The development of an intuitive, user-friendly interface with advanced search capabilities.
- III. Enhanced security through secure login protocols and role-based access control.
- IV. Integration capabilities with university systems for unified authentication.
- V. Mobile and web accessibility, ensuring users can access resources from any device.
- VI. A scalable cloud-based architecture that allows for future growth and enhancements.

The implementation of this system has transformed the library's operations from a predominantly manual, error-prone process into a dynamic, efficient, and technology-driven service, directly fulfilling the objectives outlined at the inception of this study.

## **5.2 Conclusion**

In conclusion, the development of the enhanced Library Management System for the John Harris Library was both necessary and successful. The existing system was fundamentally inadequate for meeting the modern demands of a growing academic community, hindering both operational efficiency and the user experience.

The new LMS effectively addresses these shortcomings by leveraging modern web technologies and software engineering best practices. It provides a solid, scalable foundation that significantly improves the efficiency of library staff by automating routine tasks and offers library users a seamless, responsive, and accessible platform for accessing both physical and digital resources. By enhancing discoverability, streamlining transactions, and ensuring data security, the system directly supports the academic and research mission of the university.

This project demonstrates that a well-designed, customized LMS is a critical investment for any academic institution seeking to modernize its library services, improve user satisfaction, and maintain its relevance in an increasingly digital academic landscape.

## **5.3 Recommendation**

Based on the successful development and implementation of the enhanced LMS, the following recommendations are proposed for the John Harris Library and the university management:

1. **Phased Deployment and Training:** The library should implement a phased rollout of the new system, starting with a pilot group of users.
2. **Adequate Technical Support:** The university should allocate dedicated IT support staff for the ongoing maintenance, troubleshooting, and periodic updating of the system.
3. **Future Enhancements:** While the current system covers core functionalities, future phases

should consider integrating more advanced features as budget and resources allow. Priority should be given to: AI and Machine Learning, RFID Technology, an Advanced Analytics Dashboard, Robust Infrastructure Investment, and finally a Continuous Feedback Mechanism.

By acting on these recommendations, the John Harris Library can ensure the long-term success and sustainability of the enhanced LMS, solidifying its role as a modern and indispensable hub for learning and research at the University of Benin.

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## Appendix: Source Code

NOTE: For reference purposes, the complete source code can be found at <https://github.com/trustosas/Enhanced-LMS>

Admin / User Login page: client\src\pages\Login.tsx

```
import { FormEvent, useState } from 'react'
import { useNavigate } from 'react-router-dom'
import { login } from '../lib/api'

export default function Login() {
  const [username, setUsername] = useState('')
  const [password, setPassword] = useState('')
  const [error, setError] = useState('')
  const navigate = useNavigate()

  async function onSubmit(e: FormEvent) {
    e.preventDefault()
    setError('')
    try {
      await login(username, password)
      navigate('/')
    } catch (err: any) {
      setError(err?.response?.data?.detail || 'Login failed')
    }
  }

  return (
    #Front facing HTML elements. Excluded for brevity.
  )
}
```

Book Borrow logic: \client\src\pages\BorrowDesk.tsx

```
import { useEffect, useState } from 'react'
import { Link } from 'react-router-dom'
import { api } from '../lib/api'

type Record = {
  id: number
  borrower: number
  book: number
  borrow_date: string
  due_date: string
  return_date?: string
}
```

```

export default function BorrowDesk() {
  const [records, setRecords] = useState<Record[]>([])
  const [borrowerId, setBorrowerId] = useState('')
  const [bookId, setBookId] = useState('')
  const [error, setError] = useState('')

  async function load() {
    const { data } = await api.get('borrow-records')
    setRecords(data.results ?? data)
  }

  useEffect(() => { load() }, [])

  async function borrow() {
    setError('')
    try {
      await api.post('borrow', { borrower_id: Number(borrowerId), book_id:
Number(bookId) })
      setBorrowerId(''); setBookId(''); await load()
    } catch (e: any) {
      setError(e?.response?.data?.detail || 'Borrow failed.')
    }
  }

  async function returnBook(id: number) {
    await api.post('return', { borrow_id: id })
    await load()
  }

  return (
    #Front facing HTML elements. Excluded for brevity.
  )
}

```