SOFTWARE REQUIREMENT SPECIFICATION

The Smart Public Library System of the City Knowledge Resource Centre(CKRC) of Metrovale City

Prepared by:
GROUP 02

Software Requirements Specification(SRS)
For
The Smart Public Library System of
the City Knowledge Resource Centre(CKRC)
of
Metrovale City

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1 Preface

1.1 Document Purpose

This document provides a detailed description of the requirements for the Smart Public Library System (SPLS) proposed for the **City Knowledge Resource Centre(CKRC) of Metrovale** City. It aims to c learly define the functionalities and constraints of the system and to obtain approval from stakeholders before proceeding to the design phase.

The system will facilitate seamless interactions between library members , librarians , and administrators regarding user registration, membership management, book borrowing , digital content access event management, and communication. These requirements will guide the development team in system design and implementation , ensuring that the final product meets user needs and expectations while modernizing the traditional library services of **CKRC**.

1.2 Revision History

This document is intended for the project stakeholders, including library system administrators, IT personnel, software developers, quality assurance teams, and partner vendors. It details the version history, including the rationale for each revision and a summary of changes made.

Revision	Author	Date	Description
1.0	Melani Disharan	2025 - 08– 20	Initial Draft including the Preface and Introduction that outlines the problem statement, project scope, goals stakeholders etc.
1.1	Hasini Chamuditha Disharan	2025 - 08 -20	Added ER diagrams to represent the database structure visually and aid in database design.
1.2	Shehan Didula Janudi Zayyan	2025 - 08 -21	Included Sequence diagrams to model interactions and system behavior for detailed system design and testing.
1.3	Shashika Dasun Dasuni Shehan Chamuditha	2025 - 08 -24	Revised System Requirements Definition with detailed use case description and added use case diagrams to refine system requirements and illustrate the cases for better understanding.
1.4	Pasindu Saad Mihiru Hashim	2025 - 08 -25	Added sections on non-fictional requirements, data requirements, user characteristics, testing and documentation requirements to address all aspects of systems requirements.
1.5	All team members	2025 - 08 -27	Concluded revision and error checkings, prepared the full report and finalized the document.

2 Introduction

2.1 Problem Statement

The **City Knowledge Resource Centre (CKRC) of Metrovale City** manages a network of public libraries across the city. The current process of managing member registrations, book loans, returns, and event coordination is largely manual and paper-based. This leads to significant errors, operational delays, and dissatisfaction among both library members and staff. Therefore, this project aims to develop a **Smart Public Library System (SPLS)** that will provide a centralized online portal for members and librarians to access and manage all library services efficiently and accurately.

2.1.1 The Problem:

The City Knowledge Resources Centre (CKRC) operates a large network of public libraries. The current system is traditional and fragmented, making it hard for members to access services seamlessly.

The identified problems and their impacts are follows.

1. **Manual Processes**
    - Problem: Most library operations such as registration, membership approval, and fines are handled manually.
    - Impact: Members face longer waiting times and reduced convenience and librarians are struggling with repetitive tasks.

2. **Limited Digital Services**
    - Problem: The current system provides only few digital resources. Audio books and online services are either unavailable or not well functioned.
    - Impact: Lack easy access for users to digital learning materials.

3. **Delays in Reservation and Borrowing**
    - Problem: Reserving or borrowing books often requires multiple states and physical presence.
    - Impact: Users may waste time visiting branches to reserve a book.

4. **Poor Integration of Events and Workshops**
    - Problem: CKRC organizes many educational events and workshops, but the current system does not allow for smooth online registration, ticketing, or reminders.

- Impact: Many users miss events because of poor communication. Librarians find it hard to manage attendance, and overall participation is lower than expected.

5. **Difficulty in Managing Fines and Payments**
   - Problem: Collecting fines and payment of membership fees is mostly manual or partly automated. Members need to visit branches in person or upload vouchers.
   - Impact: This creates inconvenience for users and delays revenue collection. It also raises the risk of mismanagement or disputes over unpaid fines.

6. **Lack of Real-Time Inventory Visibility**
   - Problem: The current system does not provide up-to-date tracking of books across branches. Users and librarians cannot quickly check how many copies are available or the condition of books.
   - Impact: Books may get misplaced, not be used enough, or be reported as unavailable when they exist in another branch. This lowers efficiency and frustrates members.

7. **Weak Analytics for Improvement**
   - Problem: The system does not gather or analyze enough data on reading patterns, borrowing trends, or user feedback.
   - Impact: Administrators do not have insights to make informed decisions about book purchases, event planning, or improving services. This limits the library's ability to grow and meet user needs.

2.1.2 Goals and Objectives:

Objectives:

The main goal of the Smart Public Library System (SPLS) is to update the City Knowledge Resource Centre (CKRC) by creating a centralized, simple, and technology-based platform. The system aims to give easy access to both physical and digital library resources. It wants to simplify membership and borrowing processes and help librarians manage inventory, events, and user interactions effectively. It also plans to improve user experience through convenient online services, secure payments, personalized recommendations, and timely notifications. Additionally, it will provide administrators with data to help them make decisions and improve services.

Goals:

1. Improve User Accessibility

- Provide members with 24/7 access to both physical and digital resources.
- Enable easy online registration, membership management, and use of digital services.

2. Streamline Library Operations

- Automate book reservations, borrowing, returns, and fine calculations.
- Reduce the manual workload for librarians by integrating inventory and staff management tools.

3. Enhance Digital Resource Availability

- Offer e-books, audiobooks, and online streaming options.
- Ensure secure access with DRM and membership-based restrictions.

4. Strengthen Communication and Engagement

- Introduce messaging and notification systems for reminders, events, and updates.
- Allow users to give feedback, suggestions, and communicate directly with librarians.

5. Facilitate Efficient Payment and Renewal Processes

- Support various payment options (online and offline) for memberships and fines.
- Provide automated invoices, receipts, and timely renewal reminders.

6. Provide Analytics for Continuous Improvement

- Track user reading patterns, preferences, and borrowing history.
- Help administrators make informed decisions about inventory, events, and services

2.1.3 The Scope:

The City Knowledge Resource Centre (CKRC) of Metrovale City runs a network of public libraries that offers access to thousands of physical and digital resources. To modernize its operations, CKRC is planning to implement a Smart Public Library System (SPLS) that combines all essential services for members, librarians, and administrators. This project will create a central platform for library members to access books, e-resources, events, and services. It will also enable librarians to manage inventory and operations effectively. The project focuses on providing convenient tools and features that improve user experience, simplify library processes, and strengthen communication between members and the library.

Problem Boundaries

- **Included Problems**

1. Registration and Membership Management

• Allow residents to register online using NIC and email verification.

• Offer different membership types (Basic, Premium, Family) with digital membership cards.

2. Book Search, Reservation, and Borrowing

• Let users search with filters, check availability, and reserve books online.

• Offer options for borrowing and returning, including automated fine calculation for late returns.

3. Digital Resource Access

• Give premium and family members access to e-books, audiobooks, and streaming options.

• Include features like bookmarking, annotations, and personal digital library history.

4. Event and Workshop Management

• Allow users to browse, register, and get e-tickets for events.

• Enable librarians to manage event capacity and track attendees.

5. Payment and Fines Management

• Let users pay membership fees and fines online or by uploading vouchers.

• Provide automated invoices and downloadable receipts.

6. Feedback and Communication

• Enable members to send feedback, suggestions, or reports for lost/damaged books.

• Offer messaging and notifications for due dates, events, and announcements.

7. Security Features

• Implement two-factor authentication and role-based access control.

• Ensure encrypted transactions for sensitive operations.

- **Excluded Problems**

1. Offline/Manual Registrations

• The system does not handle manual, in-person registration and membership approvals.

2. Third-Party Educational Integrations

• The system does not connect with external academic or non-library institutions.

3. Payment Handling

• Physical cash payment processing is excluded; only online and scanned voucher uploads are supported.

4. Detailed Librarian HR Management

• Internal HR processes beyond staff login and role assignment are not part of the system.

5. Multilingual Support

• The system offers services and an interface limited to English.

6. System Boundaries

- **Included System Boundaries**

1. **User Interface**

• Dashboards for members, librarians, and admins accessible via computers and mobile devices.

• Simple, user-friendly design that supports multiple device types.

2. **Database Management System**

• Central storage for user profiles, membership details, book catalog, reservations, and transactions.

3. **Authentication and Authorization Module**

• Role-based logins for members, librarians, and administrators.

• Two-factor authentication for sensitive actions.

4. **Catalog and Inventory Management**

• Real-time tracking of book availability, condition, and branch location.

• Automated reports for low stock or damaged items.

5. **Messaging and Notification System**

• Notifications via email and portal for reminders, fines, and announcements.

• Alerts for overdue books and event reminders.

6. **Payment Gateway**

• Integration with the municipal payment system and online banking/UPI.

• Automated verification and invoice generation.

7. **Digital Resource Management**

• Secure DRM-based system for e-book and audiobook access.

• In-browser reader and audio player with bookmarking and notes.

8. **Analytics and Reporting Module**

• Reading statistics and borrowing trends for users.

• Reports for administrators to aid decision-making.

- **Excluded System Boundaries**

1. **Physical Book Delivery Management**

• While borrowing is supported, detailed logistics of home delivery are outside the scope.

2. **Third-Party Payment Integrations (e.g., PayPal, Stripe)**

• Only municipal payment gateways and voucher uploads are included.

3. **External Library Networks**

• The system will not connect with non-CKRC library networks.

4. **Advanced Recommendation Systems**

• Personalized book recommendations driven by AI are not included in the current scope.

5. **Technical Troubleshooting Support**

• Real-time chat or helpdesk support for users is not part of the system.

2.1.4 The Impact:

The Smart Public Library System (SPLS) will have a major positive effect on the City Knowledge Resource Centre (CKRC), along with its members, staff, and the larger community.

- Impact on Members:

The system will significantly enhance the user experience by providing round-the-clock access to physical and digital resources. Members can easily register online, reserve or borrow books,

access e-books and audiobooks, and make payments without having to visit the library. This convenience encourages a stronger reading culture and attracts more members, including tech-savvy youth and families.

- Impact on Librarians and Staff:

SPLS lightens the load for librarians by taking care of repetitive tasks like managing reservations, calculating fines, and tracking inventory. Staff can spend more time helping readers, organizing events, and improving community programs. It also provides librarians with better tools for communication and event management, which makes operations smoother.

- Impact on Administrators:

Administrators gain valuable insights through data and reporting. They can track borrowing patterns, assess membership statistics, and pinpoint popular genres to inform future resource decisions. This helps improve decision-making and ensures CKRC meets the changing needs of the community.

- Impact on CKRC as an Organization:

The SPLS updates CKRC's image as a forward-thinking city library system. By providing both traditional and digital services on one platform, it keeps the library relevant in the digital world. This leads to increased membership, better financial stability through premium services, and greater trust in CKRC's effectiveness.

- Impact on the Community:

The SPLS promotes lifelong learning by making resources and events easier to access. It offers chances for education, literacy growth, and social interaction. By incorporating workshops, reading clubs, and digital resources, it strengthens community ties and supports Metrovale City's goal of becoming a smart city.

2.1.5 The Stakeholders:

The stakeholders affected by this problem and involved in the solution include:

- Library Members (Current and Prospective): Residents of Metrovale who use or wish to use library services.
- Librarians and Library Staff: Personnel responsible for day-to-day operations, member assistance, and resource management.
- System Administrators: IT staff managing the technical infrastructure and security of the SPLS.

- Management of CKRC: Decision-makers overseeing library operations, budgeting, and strategic goals.
- Municipal Council of Metrovale City: Government body funding and regulating public library services.
- Third-Party Service Providers: Entities providing integrated services such as payment gateways or digital content delivery.

2.1.6 The Vision for a Solution

The vision is to implement a comprehensive and user-friendly Smart Public Library System (SPLS) for the City Knowledge Resource Centre (CKRC) of Metrovale City. The solution will provide a centralized digital platform that integrates all library services, enabling seamless access to both physical and digital resources. The system will streamline user registration, membership management, book search and reservation, borrowing, and fine payment processes. It will also support digital content delivery, event registration, and real-time notifications to enhance user engagement. By automating routine tasks and ensuring secure transactions, the solution aims to reduce manual workload for staff, minimize processing delays, and offer 24/7 availability of services. Ultimately, the SPLS will improve user satisfaction, foster a reading culture, and modernize CKRC's operations to meet the evolving needs of its members.

2.1.7 Summary (Problem Statement)

Libraries of CKRC presently operate as a network of public libraries relying heavily on manual processes and scattered systems. This leads to situations where reservations and borrowing are delayed, access to digital services is limited, payment of fines is tedious, and events and workshops integration is poor. This situation is inconvenient for the regular users as well as other limitations that deter librarians and administrators from efficiently conducting day-to-day operations and having the analytics capabilities for making data-driven decisions. Such limitations ultimately mitigate any capability the library network has to evolve and meet the expectations of its current techno-driven society.

To alleviate the above constraints, a comprehensive digital solution-the Smart Public Library System(SPLS)-is being proposed. SPLS will basically be a centralized, secure, and easy-to-use platform encompassing both physical and digital services for its members, librarians, and administrators. This would enable the system to modernize CKRC operations with facilities such as online registration, digital content access, automated inventory management, event management, and advanced analytics. To achieve the goals set by SPLS, user satisfaction improvements, streamlined processes, reduced manual workload, improved financial transparency, and the positioning of CKRC as a modern smart library, were all taken into consideration. SPLS also looks to CKRC as a learning hub, a center for literacy, and a community engagement enthusiast.

3 User Requirement Definition

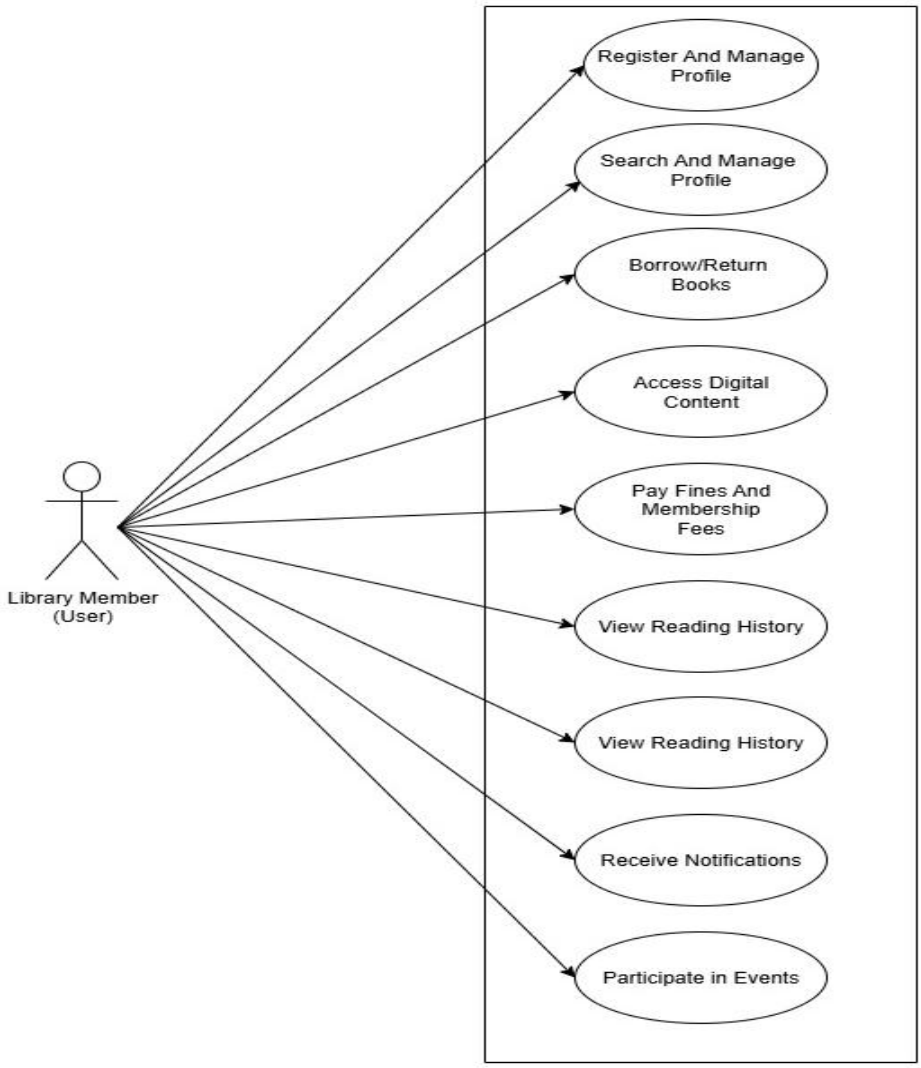
3.1 User Profiles

Membership Type	Cost	Borrowing Limit	Digital Access	Home Delivery	Duration
Basic	Free	Defined by CKRC policy	No	No	1 Year
Premium	Paid	Higher than Basic	Yes (E-books & Audiobooks)	Yes	1 Year
Family	Paid	Shared limit across linked accounts	Yes (Multiple accounts)	Yes	1 Year

3.1.1 Library Members (Users):

- Description: Residents of Metrovale City who register for library membership to access physical and digital resources.
- Characteristics: Diverse age groups, mixed technical skills, seeking easy access to books, e-books, and library services.

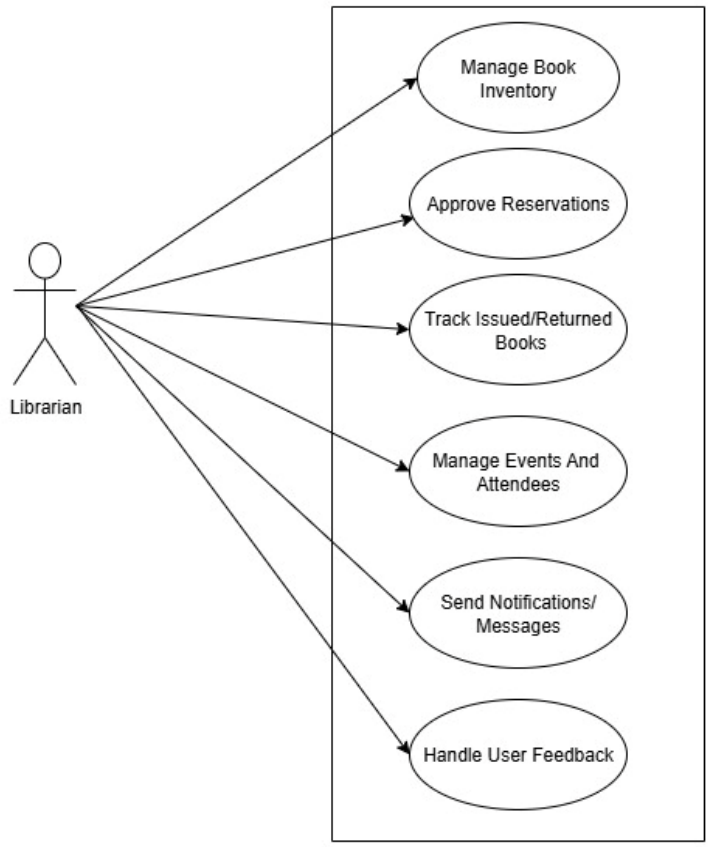
Use case for library member



3.1.2 Librarians:

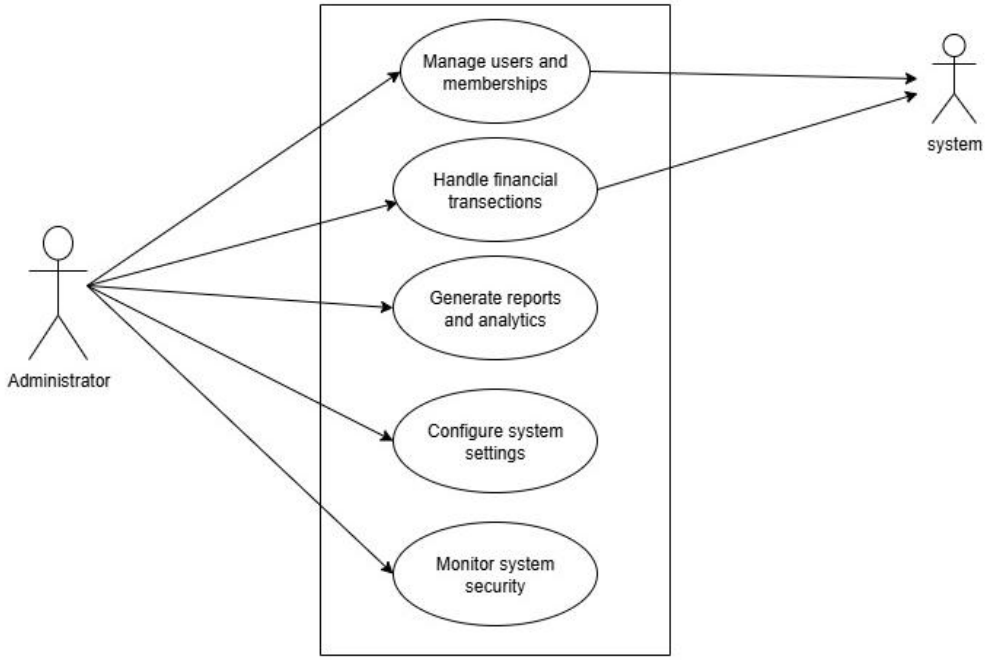
- Description: Staff responsible for managing book inventory, reservations, issuing/returning books, and assisting members.
- Characteristics: Proficient in library management tasks, require tools for reservation handling, inventory updates, and user communication.

Librarian Use case diagram



3.1.3 Administrators:

- Description: System admins and senior staff who oversee the overall functioning of the library system, including user management, financial processing, and system security.
- Characteristics: Skilled in administrative operations, need advanced access for reports, analytics, and configuration.



Administrator use case diagram

3.2 User Needs and Goals

User Profile	Description	Key System Interactions
Library Member (User)	A resident with a verified account.	Registration, search, reservation, borrowing, digital access, event registration, payment.
Librarian	Staff managing daily operations and user interactions.	Inventory management, process reservations, check-in/out books, manage events, send messages.
Administrator	Super-user with system-wide configuration rights.	Manage all memberships, configure settings, generate system reports, send announcements.

3.2.1 Library Members (Users):

- Primary Goals:

- Register and manage personal profiles.
- Search and reserve physical books across branches.
- Borrow and return books easily (with home delivery for premium).
- Access e-books, audiobooks, and digital content.
- Pay membership fees and fines online.
- Receive alerts for due dates, events, and announcements.

- Secondary Goals:
  - View reading history and personalized recommendations.
  - Participate in events, workshops, and reading clubs.

3.2.2 Librarians:

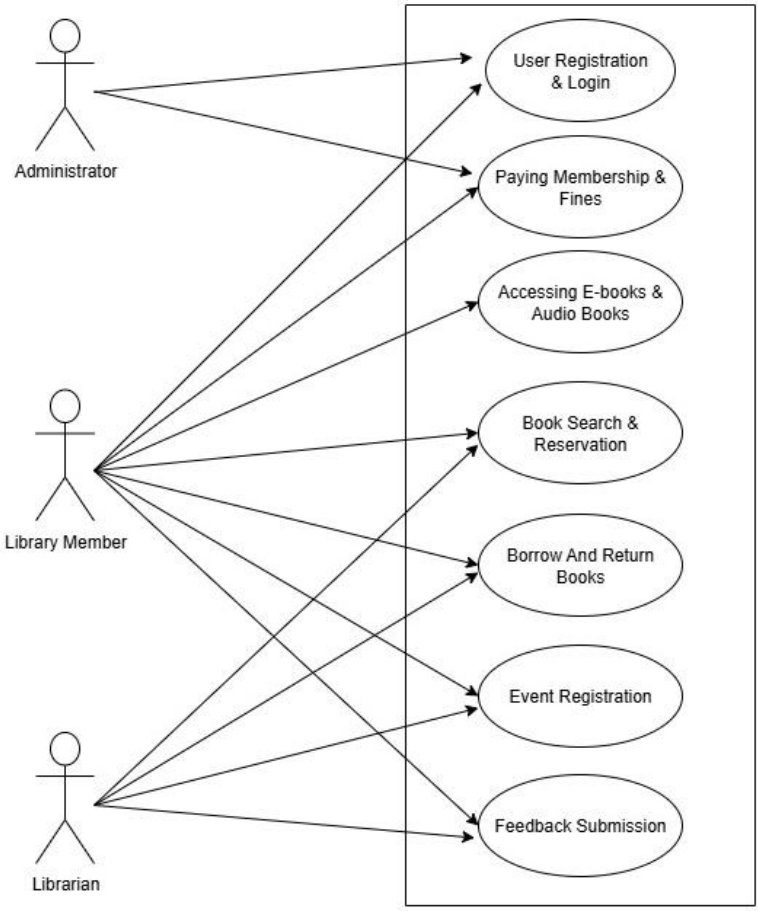
- Primary Goals:
  - Manage book inventory and availability across branches.
  - Approve reservations and track borrowed/returned books.
  - Manage event registrations and attendance.
  - Communicate with users regarding reservations and issues.
- Secondary Goals:
  - Monitor overdue books and apply fines.
  - Maintain updated catalog with metadata and cover images.

3.2.3 Administrators:

- Primary Goals:
  - Manage user accounts, memberships, and renewals.
  - Handle financial transactions (fees, fines) and generate invoices.
  - Oversee system security and user permissions.
- Secondary Goals:
  - Generate analytics reports on user activity, inventory, and usage trends.

- Configure and maintain system functionalities for scalability and security.

Overall system use case diagram



Services Provided:

The Smart Public Library System (SPLS) for the City Knowledge Resource Centre (CKRC) of Metrovale City offers the following services:

1. User Registration and Profile Management:

- Users can register online using their NIC and email address, with email verification.

- Users can update personal details, upload a profile picture, and link dependents to their account.

2. Membership Management:

EX:

Type	Cost (Rs.)	Borrowing Limit	Digital Access	Duration
Basic	500/year	3 books	No	1 year
Premium	1200/year	8 books	Yes (E-books + Audiobooks)	1 year
Family	2500/year	15 books (shared)	Yes (Multiple accounts)	1 year

- Users can apply for Basic, Premium, or Family membership online.
- Membership status (pending, approved, expired) is visible in the portal.
- Users can download a digital membership card with a QR code.

3. Book Search and Reservation:

- Users can search the catalog using filters (author, title, genre, year).
- Real-time availability across branches is displayed.
- Users can reserve books for pickup and set a hold duration (max 3 days).

4. Borrowing and Returning Books:

- Users can borrow physical books in person or request home delivery (Premium/Family members).
- Digital receipts are generated, and due dates are clearly shown.
- Late returns incur fines, and users can extend borrowing once per book**.**

Ex.

Item Type	Late Period (days)	Fine Rate (Rs.)	Max Fine (Rs.)
Regular Book	1–10	5/day	200
Reference Book	1–5	10/day	300
E-Book	1–7	2/day	50
Audiobook	1–7	3/day	75

5. Digital Content Access:

- Premium and Family members can stream or download e-books (PDF/ePub) and audiobooks (MP3).

- In-browser reader/audio player with bookmarking and annotation support.

Ex.

Format	Description	DRM Support	Max File Size
PDF	Standard e-books	Yes	50 MB
EPUB	Interactive text	Yes	30 MB
MP3	Audiobook audio	No	100 MB
M4B	Chaptered audio	Yes	120 MB

6. Events and Workshops Management:

- Users can browse and filter events by date/category.
- Online registration with limited seats and e-tickets with QR codes.
- Cancellation allowed up to 48 hours before the event.

Ex:

Category	Max Attendees	Registration Fee (Rs.)	Duration
Book Reading	50	Free	2 hrs
Workshop	30	500	Half day
Seminar	100	1000	Full day
Kids Program	40	200	2 hrs

7. Feedback and Reporting:

- Users can submit feedback on books or services.
- Reports can be filed for damaged/lost items.
- Direct messaging with librarians is supported.

8. Messaging System:

- Admins/librarians can send announcements (e.g., library closures, new arrivals).
- Users receive notifications for reservations, due dates, fines, and events.

Ex:

Notification Type	Trigger Event	Recipient	Delivery Method
Due Reminder	2 days before due date	Member	Email, SMS
Overdue Notice	After due date	Member	Email
Event Reminder	1 day before event	Registered Members	App, SMS
Payment Invoice	After payment	Member	Email

9. Fine Payment and Invoice Management:

- Online payment (card, UPI) or scanned bank slip upload for fines/fees.
- Invoices are generated and downloadable as PDF.

Ex.

Method	Processing Time	Supported Currencies
Cash	Instant	LKR only
Credit/Debit	1–2 days	LKR, USD
Bank Transfer	2–3 days	LKR only
Mobile Wallet	Instant	LKR only

10. Renewals and Expiry Notifications:

- Users are notified 30 days before membership expiry.
- Early renewal with discounts (if applicable).
- Grace period of 7 days before account deactivation.

11. Library Staff Portal:

- Librarians can manage inventory, approve reservations, and track issued/returned books.
- Event attendee management and custom messaging to users.

12. Inventory and Stock Management:

- Real-time tracking of book copies, conditions, and branch locations.
- Weekly automated reports for low-stock or damaged books.

13. User Analytics and Reports:

- Users can view reading statistics (books read, genres preferred).
- Admins can access anonymized analytics for decision-making.

Nonfunctional Requirements:

1. Security:
    - Secure role-based access control (RBAC) for users, librarians, and admins.
    - Two-factor authentication (2FA) for sensitive operations.
    - End-to-end encryption for all sensitive transactions and data.

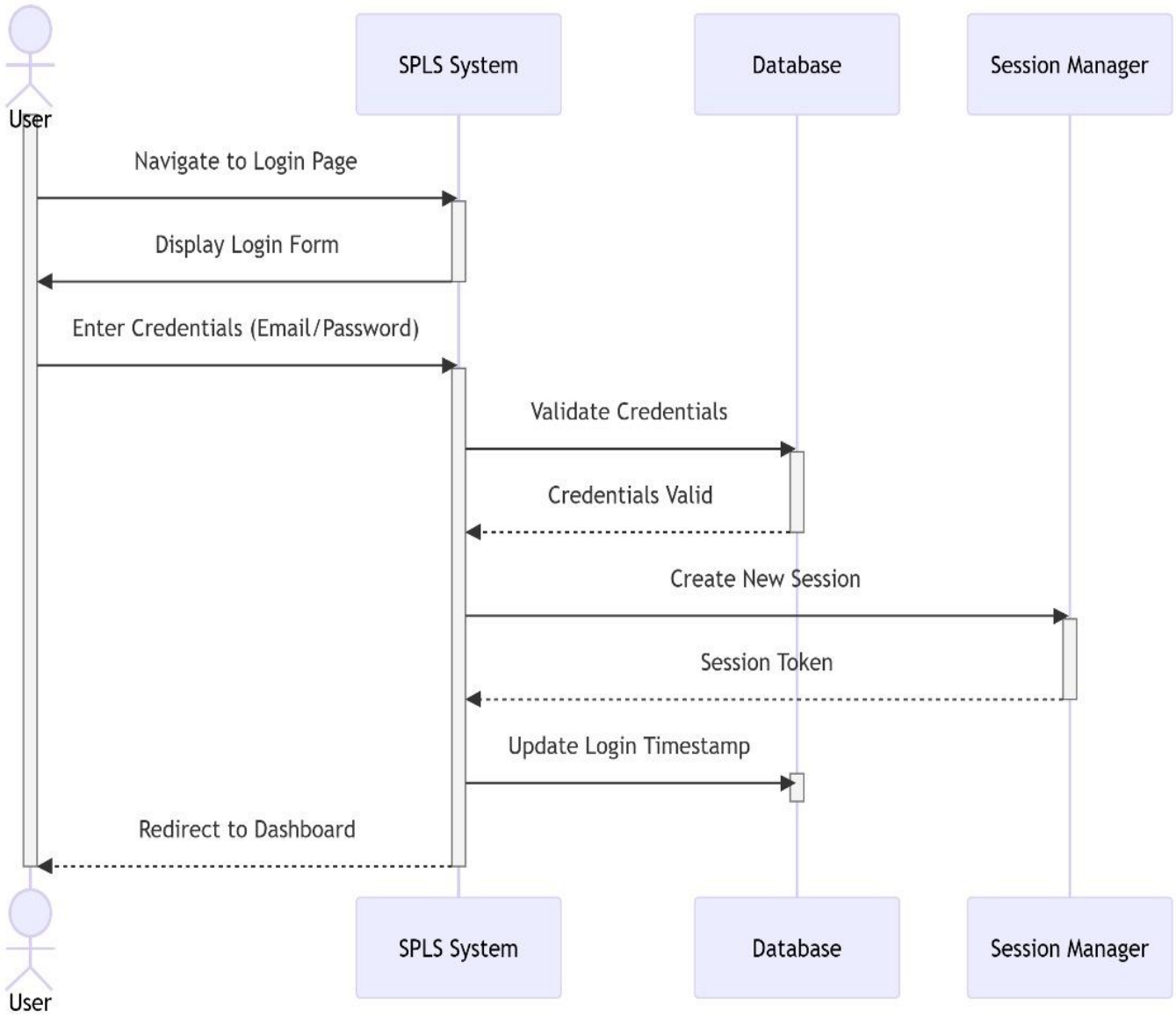
2. Performance:
    - System must support up to 10,000 concurrent users during peak hours.

- Search results must load within 2 seconds.
- Payment transactions must process within 5 seconds.

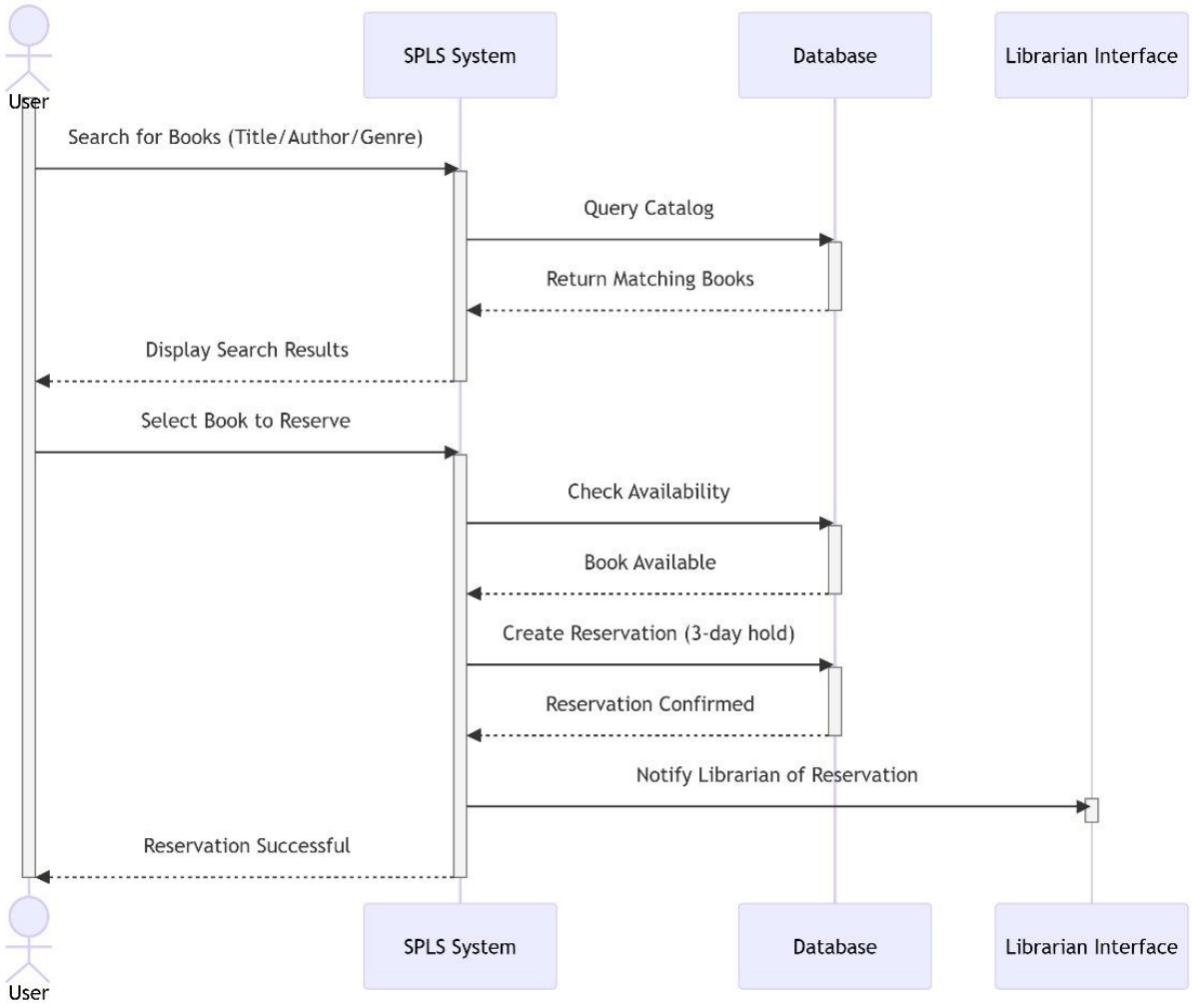
3. Usability:
    - Intuitive and responsive interface for both web and mobile users.
    - Support for Sinhala and English languages.
    - Accessibility features (screen reader support, high-contrast mode).
4. Reliability:
    - System uptime of 99.9% (excluding scheduled maintenance).
    - Automated daily backups and disaster recovery protocols.
5. Maintainability:
    - Modular architecture for easy updates and feature additions.
    - Comprehensive documentation for developers and administrators.
6. Compatibility:
    - Support for latest versions of Chrome, Firefox, Safari, and Edge browsers.
    - Mobile compatibility (iOS and Android) for responsive design.
7. Scalability:
    - Ability to scale horizontally to accommodate future growth in users and data.
    - Cloud-ready architecture (e.g., AWS, Azure) for elastic resource allocation.

3.3 Sequence diagrams

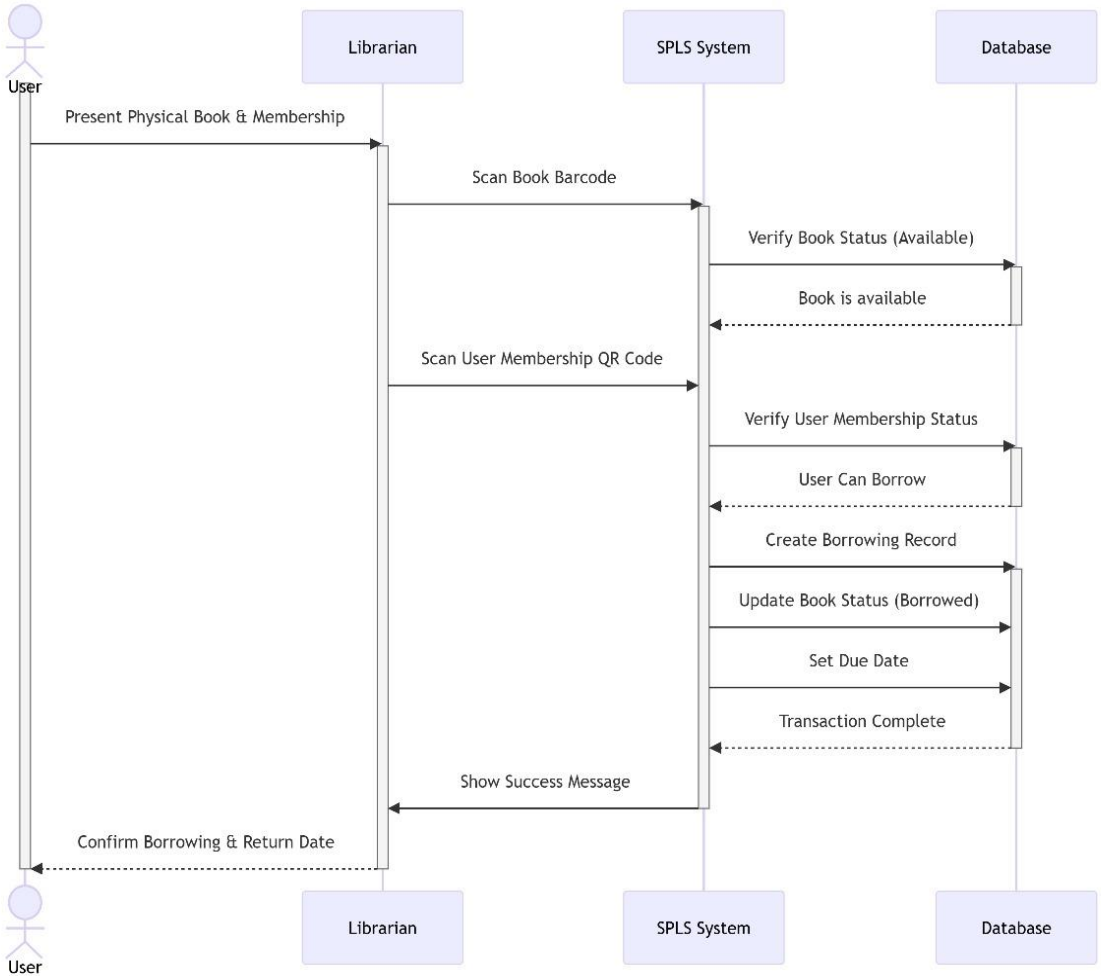
1. User Login



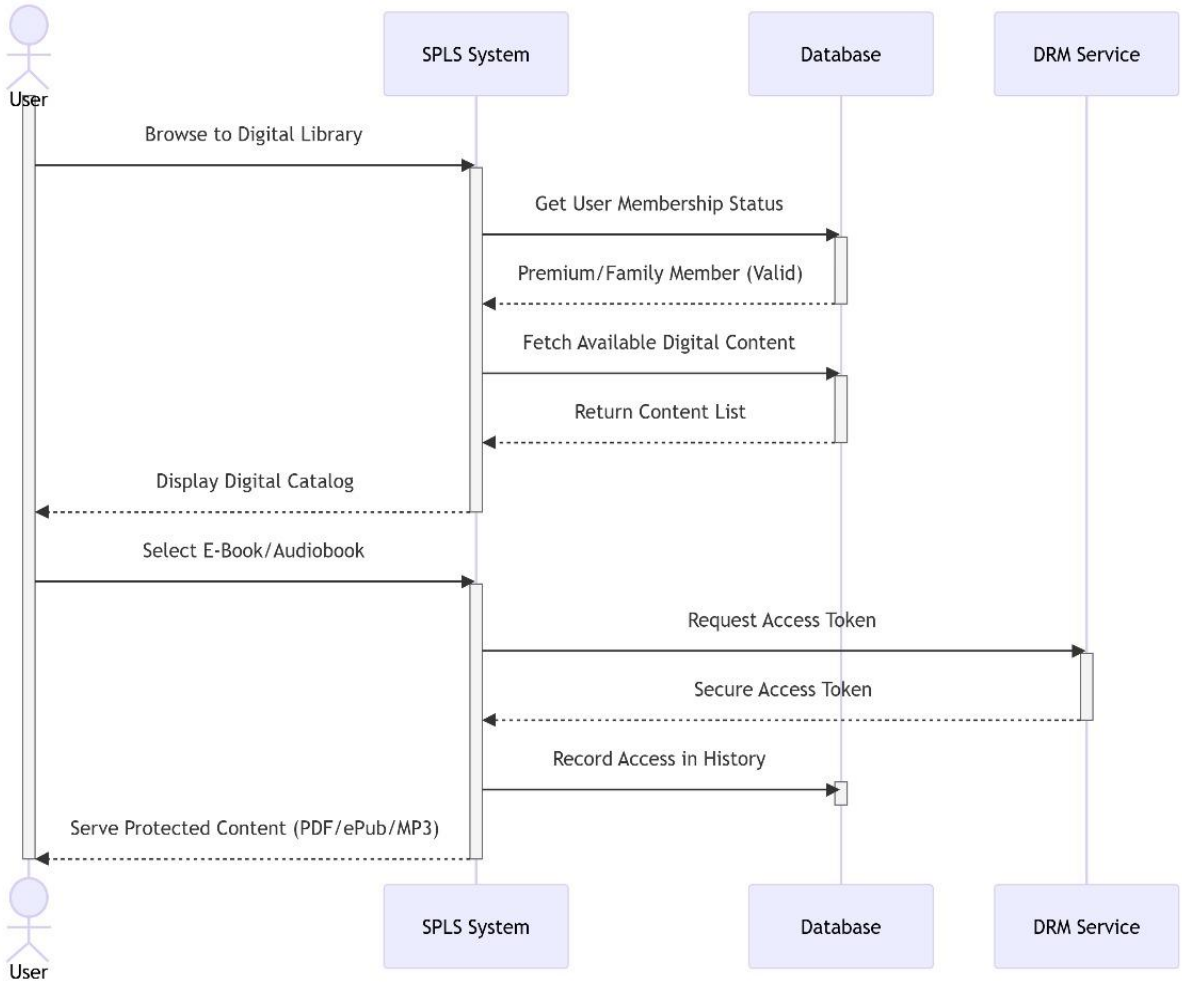
2. Book search and reservation



3. Borrow a book

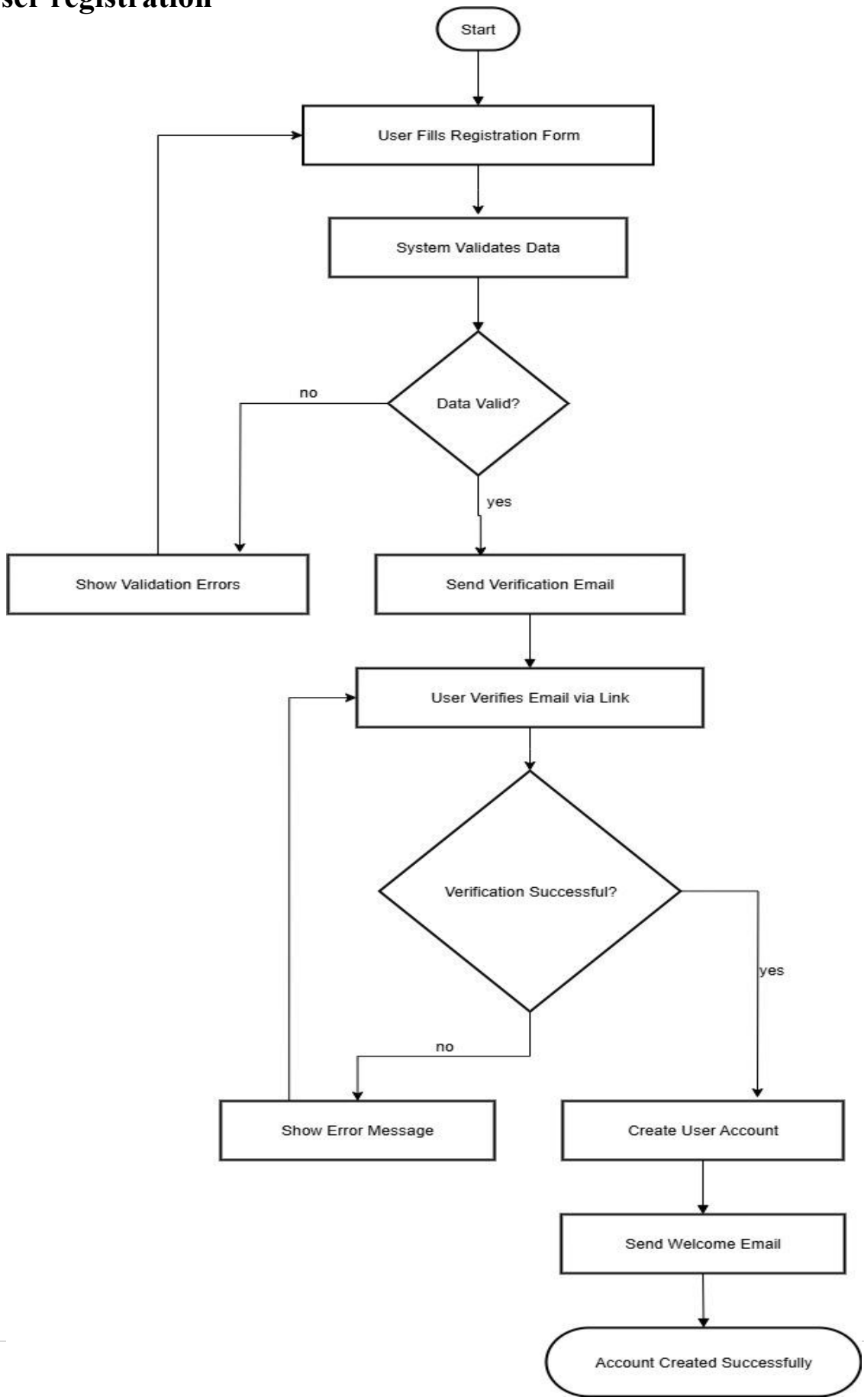


4. Access E-book/audio book

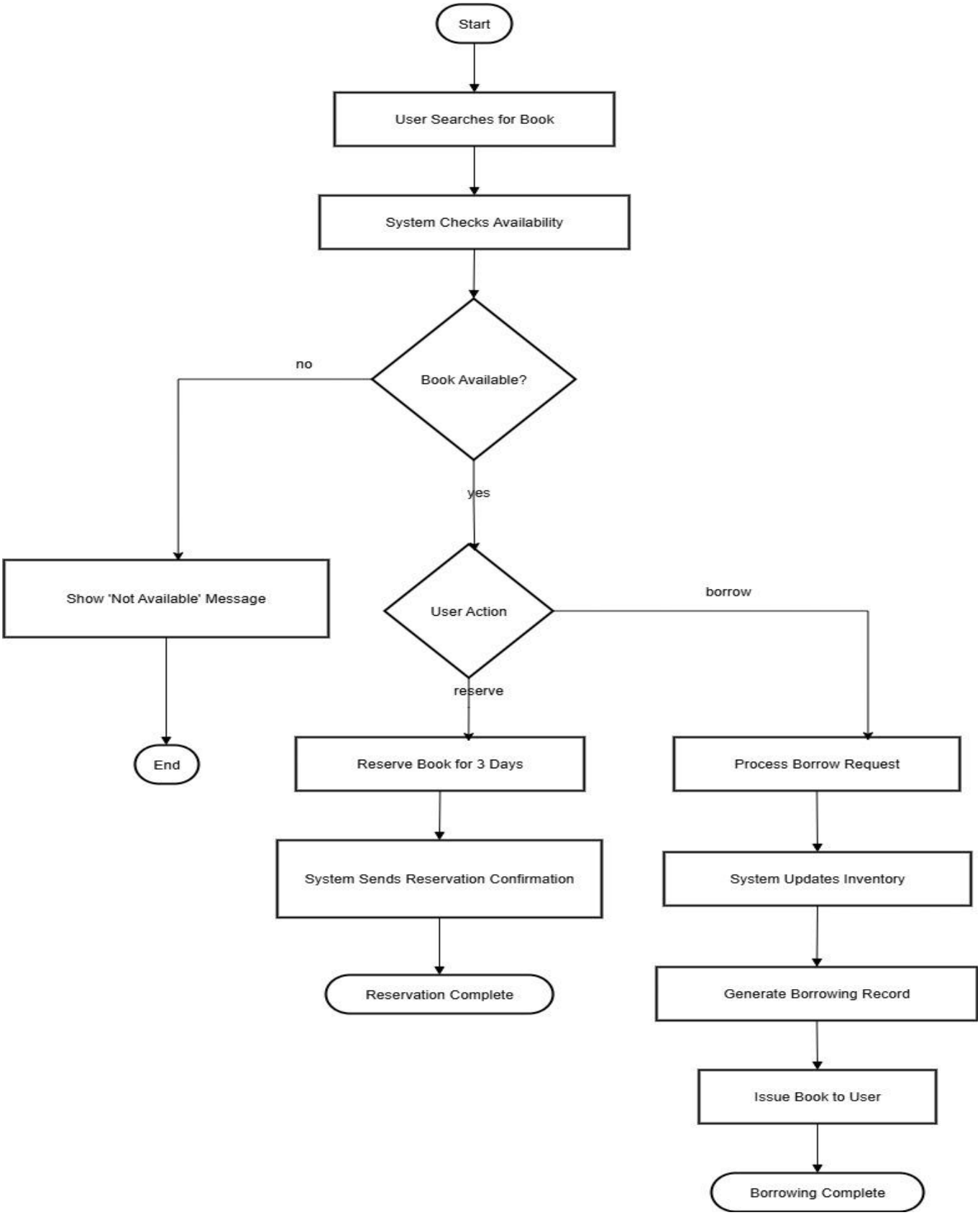


Activity diagarms

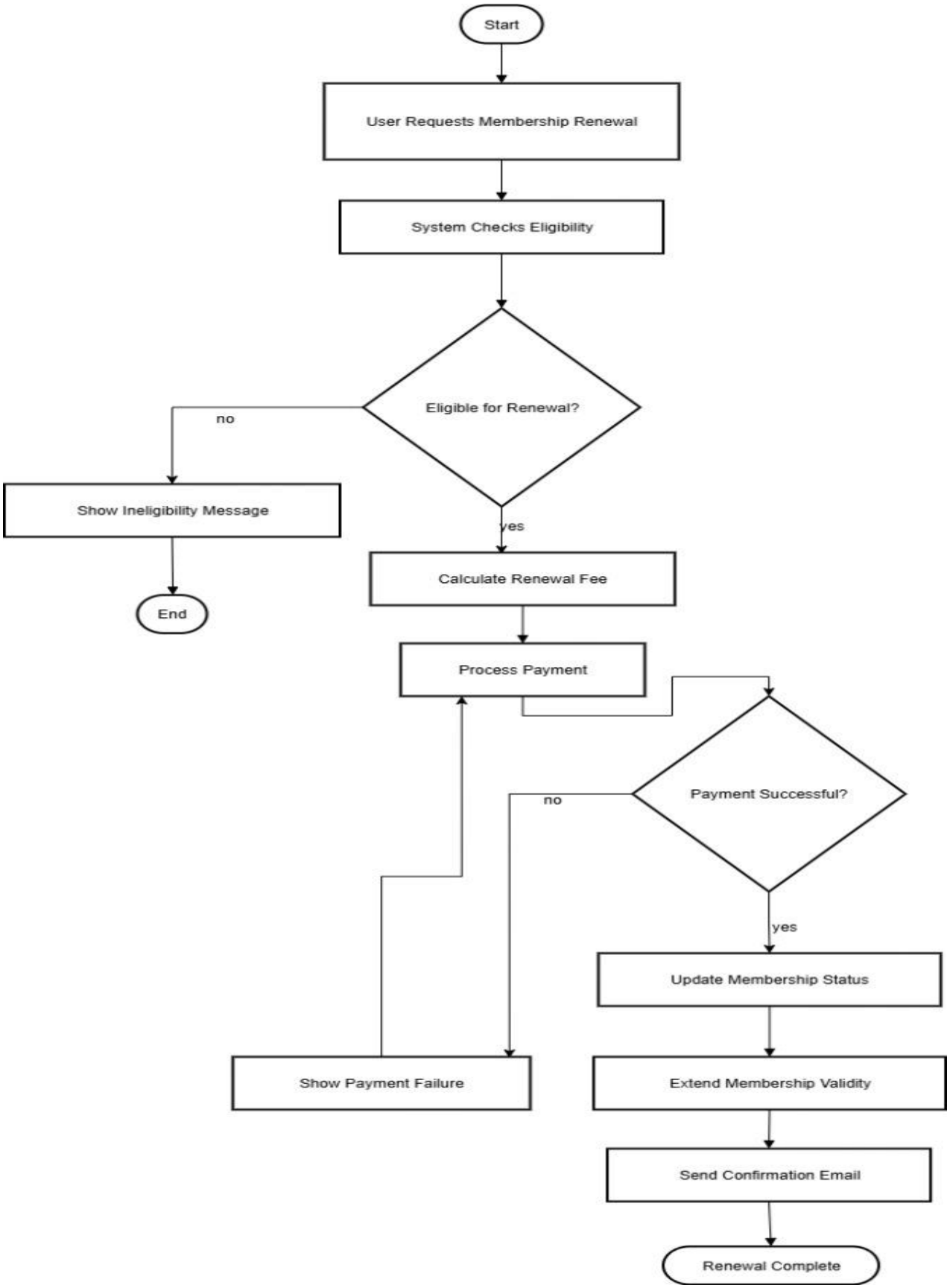
1. User registration



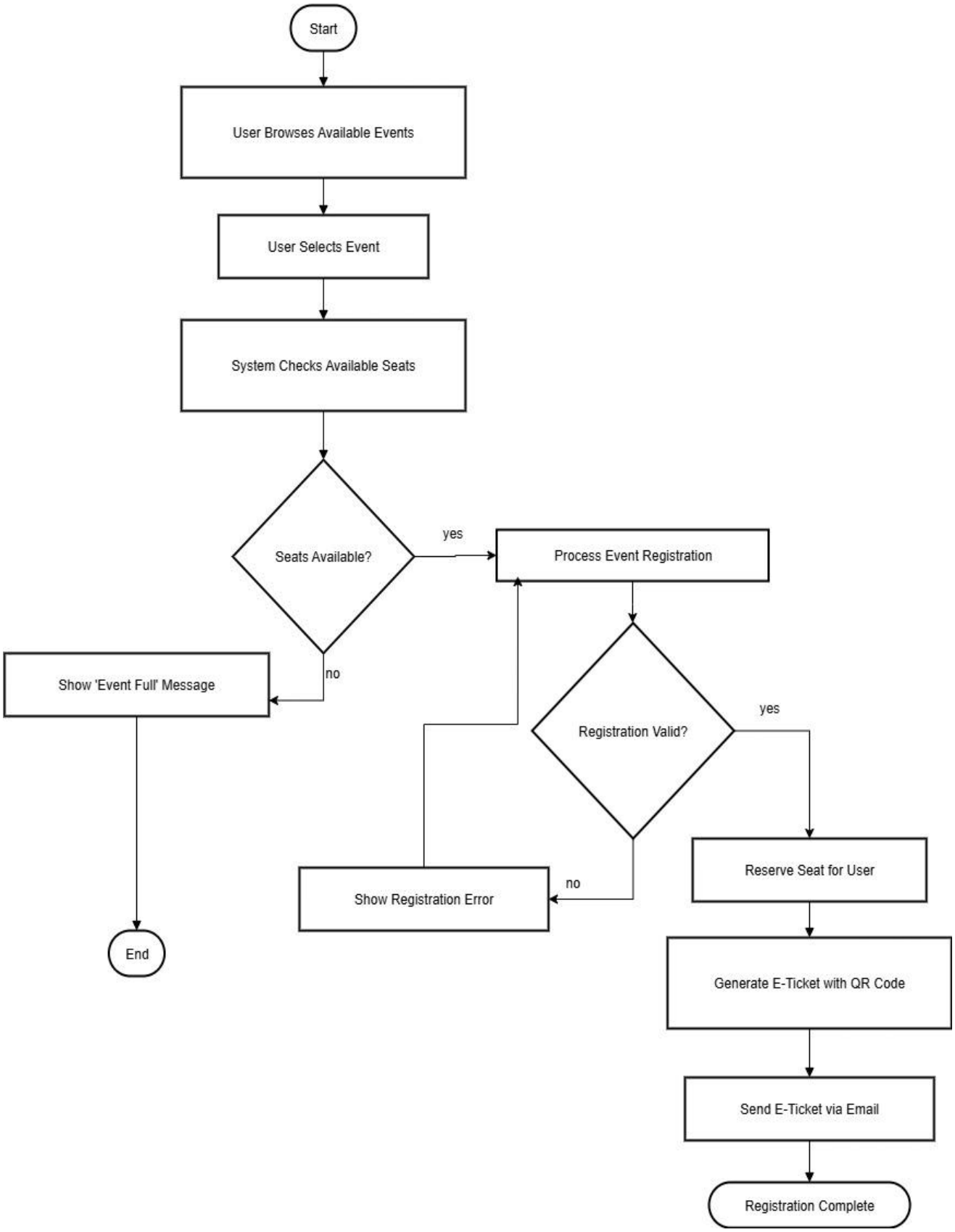
2. Book Borrowing



3. Membership Renewal Activity Diagram

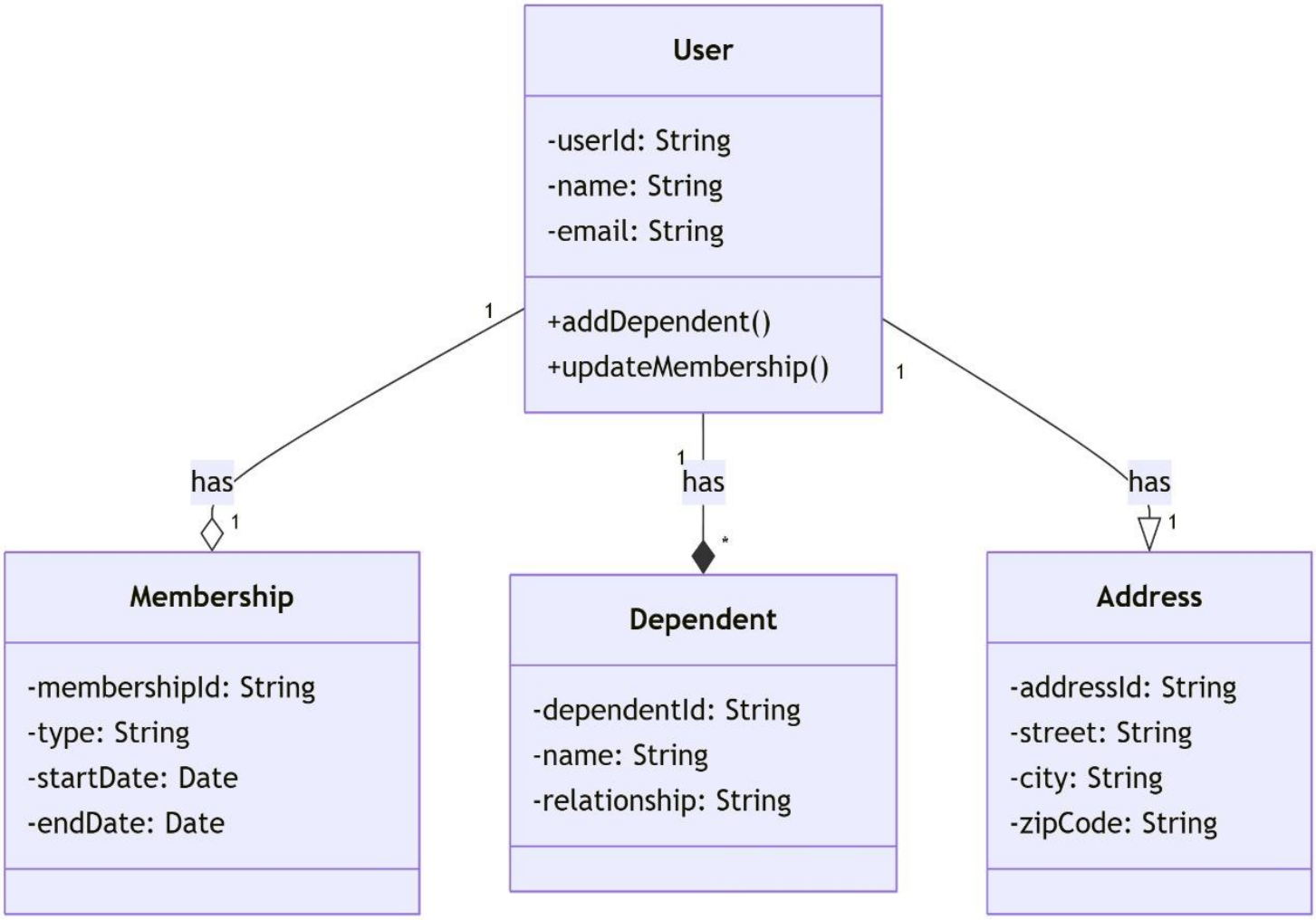


4. Event Registration Activity Diagram

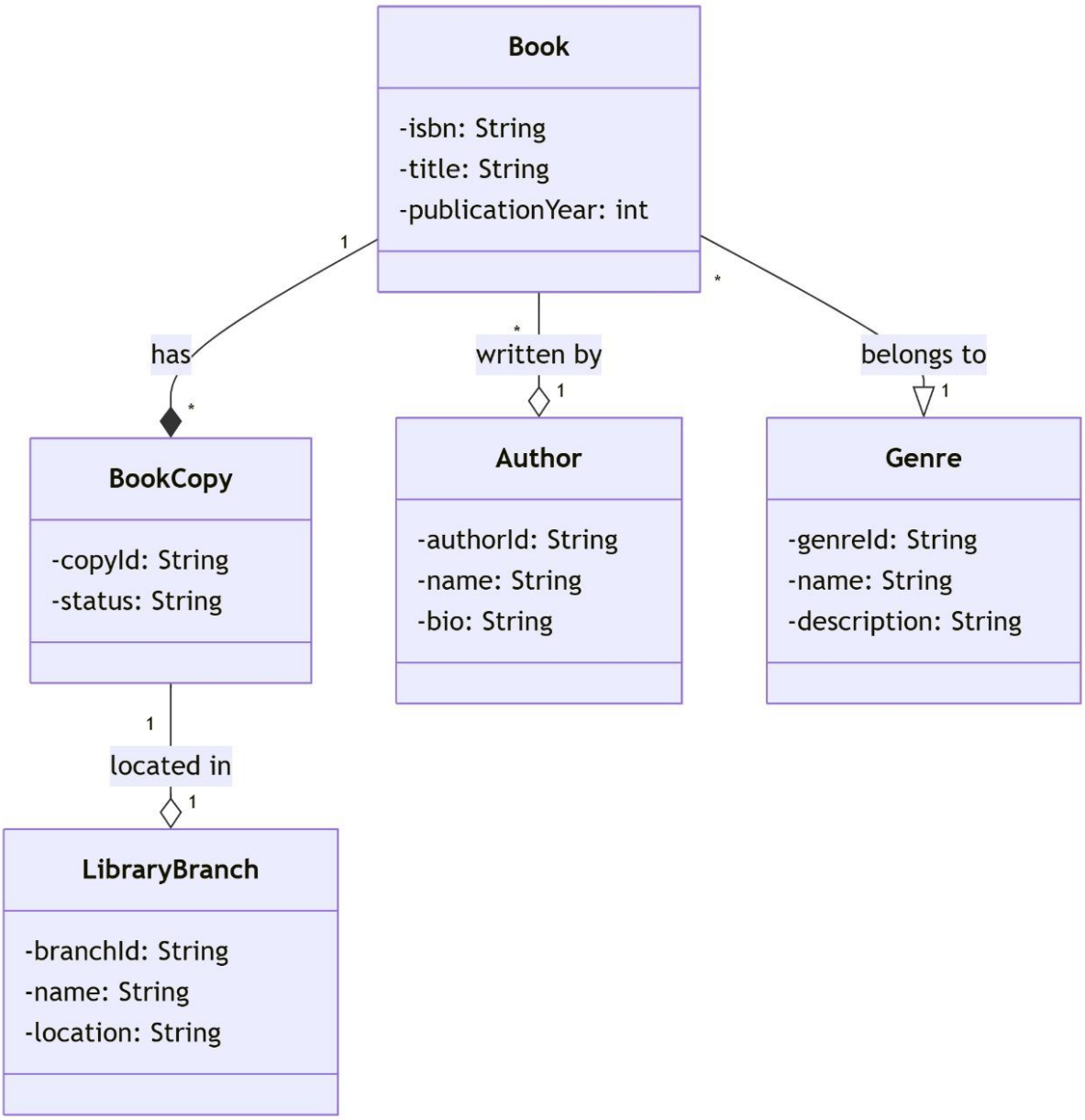


Class diagram

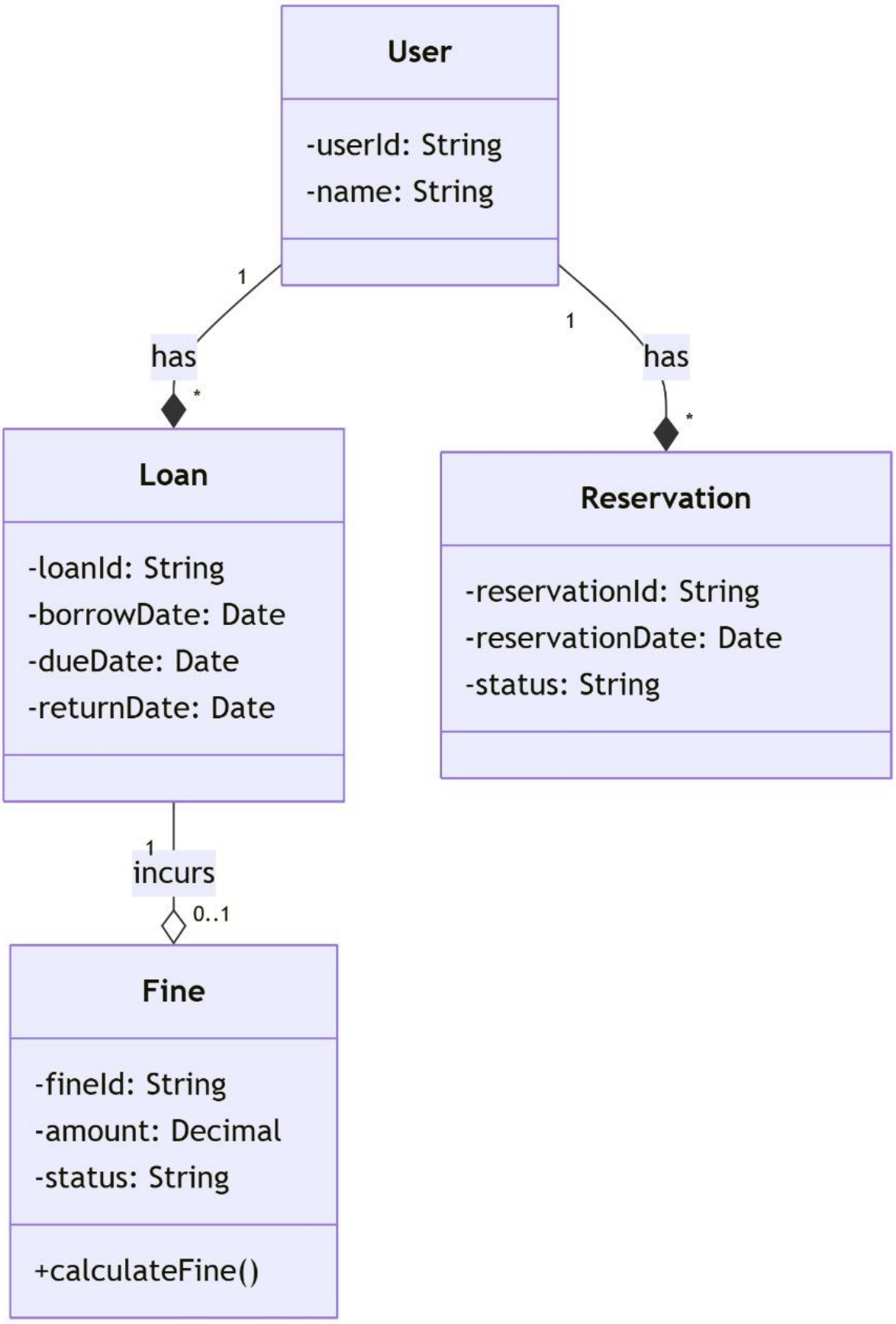
1.User Management Class Diagram



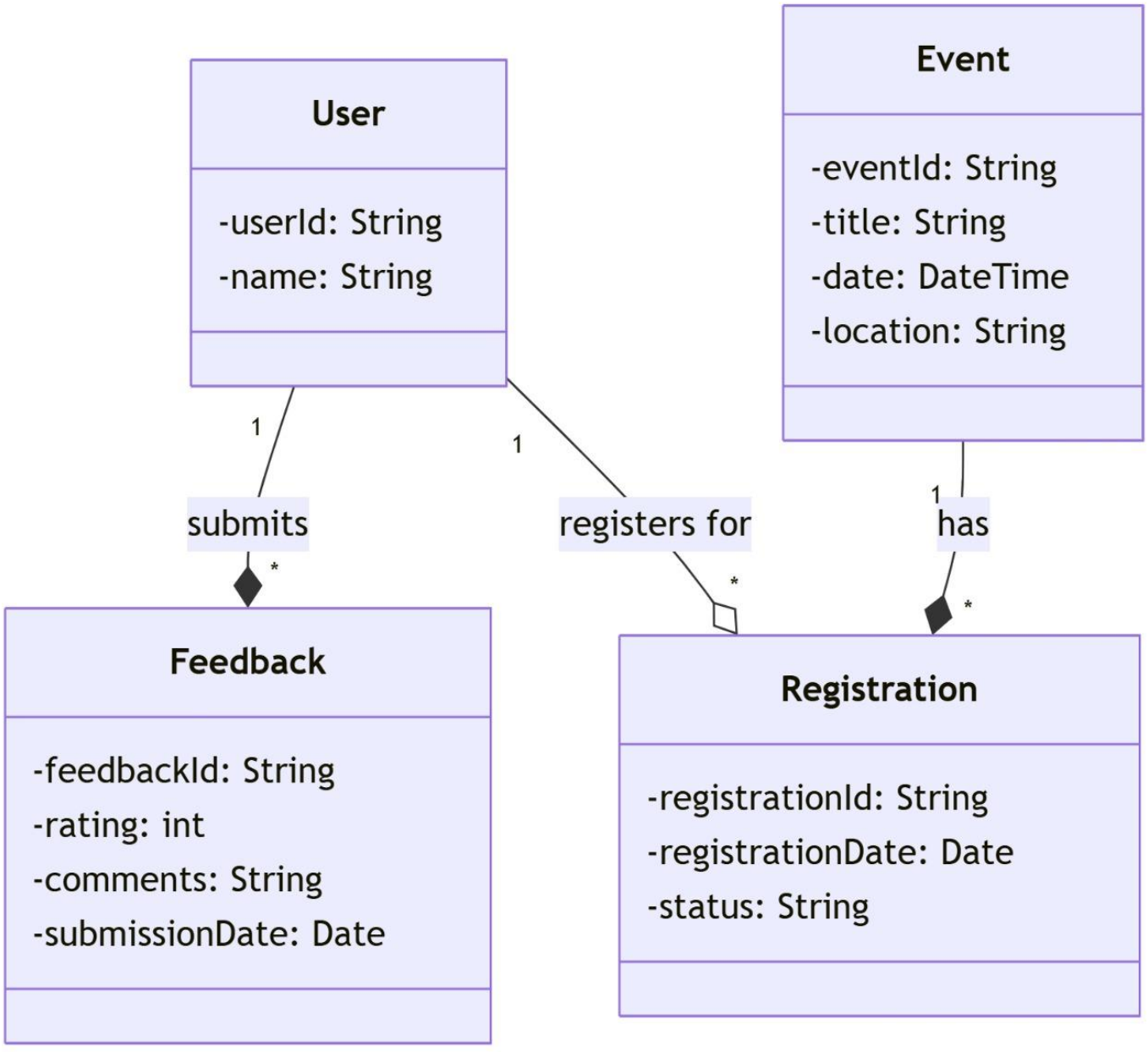
2. Book and Inventory Class Diagram



3. Borrowing and Reservation Class Diagram



4. Events and Feedback Class Diagram



4. System Requirements Definition

An effective Smart Public Library System (SPLS) is crucial for modernizing the operations of the City Knowledge Resource Centre (CKRC) and providing seamless access to library services for its members and staff. Defining the system's requirements clearly is essential to achieve this goal. This section of the document outlines the system's functionality, performance expectations, and operational characteristics to meet the needs of users, librarians, and administrators. The key elements of the system requirements definition for the SPLS include:

- Functional Requirements: These detail the specific features and functions the system must perform to meet the business needs, such as user registration, book search and reservation, and fine payment.
- Non-Functional Requirements: These specify the quality attributes of the system, such as its security, performance, and usability.
- User Characteristics: This section describes the different types of users who will interact with the system.
- Data Requirements: These define the data the system needs to collect, store, and manage.
- Testing Requirements: This outlines the criteria for ensuring the system functions as expected.
- Documentation Requirements: This specifies the necessary documentation for the system.

The following sections provide further details on these system requirements.

4.1 Functional Requirements:

Here are the primary and secondary functional requirements for the Smart Public Library System (SPLS), as derived from the business requirements.

1. User Registration and Profile Management
    - The system must allow any resident of Metrovale City to register for a library account online using their NIC and email address.
    - The system shall send a verification email during registration.
    - Once registered, users can view and update their personal details, such as their address and contact information.
    - Users can upload a profile picture in a specified format and dimensions.
    - The system must allow users to change their password securely.
    - Users can link dependents (e.g., children) to their main account for joint family accounts.

2. Library Membership Management
    - The system must allow registered users to apply for a membership type: Basic (Free), Premium (Paid), or Family (Paid).
    - The system shall support both online and offline (via voucher upload) payment methods for paid memberships.
    - The user portal shall display the membership status (e.g., pending, approved, expired).
    - Upon approval, a PDF membership card with a QR code can be downloaded.
3. Book Search and Reservation
    - Users can search the library catalog using various filters such as author, title, genre, or year.
    - The system shall display real-time book availability at nearby branches.
    - Users can reserve a book for pickup at a preferred branch.
    - A "Hold Duration" of a maximum of three days can be set for a reservation, after which it is automatically canceled if the book is not collected.
    - Users can view their reservation history and status.
    - Librarians are automatically notified to hold the book when a reservation is made.
4. Borrowing and Returning Books
    - Users can borrow physical books in person or request home delivery (premium and family members only).
    - A digital receipt is generated for each transaction.
    - Due dates are clearly shown to the user.
    - Late returns will incur fines, which are visible on the user dashboard.
    - Users can extend the borrowing period for a book once.
5. E-Books and Audiobooks Access
    - Premium and Family members can stream or download digital content in PDF, ePub, or MP3 formats.
    - The system shall provide an in-browser reader and audio player.
    - Users can bookmark and annotate digital content, and this data is saved per user.
    - Users can access their digital library history.

- Digital content access is protected via DRM integration and limited by the membership duration.

6. Events and Workshops
    - Users can browse and filter upcoming events by date or category.
    - Users can register online for events with limited seats.
    - The system shall provide e-tickets with QR codes for registered users.
    - Users can cancel their attendance up to 48 hours before the event.
    - Admins can manage event capacity and send confirmation messages to attendees.
7. Feedback and Reporting System
    - Users can submit feedback on books or library services.
    - Users can report damaged or lost items.
    - Users can submit suggestions for new books or events.
    - The feedback module shall support direct messaging between users and librarians.
8. Messaging System
    - Admins and librarians can send general announcements (e.g., library closures, new arrivals).
    - The system shall notify users about reservations, due dates, fines, and events.
    - Admins can send group messages to specific categories of users (e.g., premium users, members of a specific branch).
    - Messages will be visible in the user's portal and sent to their email.
9. Fine Payment and Invoice Management
    - The system must allow payment for fines and membership fees via an online payment gateway (card, UPI) or by uploading a scanned copy of a bank deposit slip.
    - The system shall generate and allow the download of invoices in PDF format.
    - Users can view their payment history, including invoice numbers, dates, and descriptions.
10. Renewals and Expiry Notifications
    - The system must notify users 30 days before their one-year membership expires.
    - The system shall allow early renewal and automatically apply any applicable discounts.

- After a membership expires, the system will block book reservations and digital content access until the membership is renewed.
- A grace period of seven days will be given before the account is deactivated.

11. Library Staff Portal

- Librarians can manage the physical inventory of books.
- The portal must allow librarians to view and approve book reservations.
- Librarians can track books that have been issued or returned.
- The system must allow staff to register and manage event attendees.
- Librarians can send custom messages to users.
- Staff can add new books to the catalog, including metadata and a cover image.
- Staff must log in with staff credentials, and certain roles (e.g., head librarian, admin) will have additional permissions.

12. Inventory and Stock Management

- The system shall maintain a real-time inventory of total copies available per title, book conditions (good, damaged, needs repair), and locations across branches.
- Automated reports must be generated weekly to flag low-stock or damaged books.

13. User Analytics and Reports

- Users can view their reading statistics (number of books read, preferred genres).
- The system shall track and display time spent on digital resources.
- Users can view their monthly borrowing history.
- Admins can use anonymized analytics for decision-making and system improvements.

14. System Notifications and Alerts

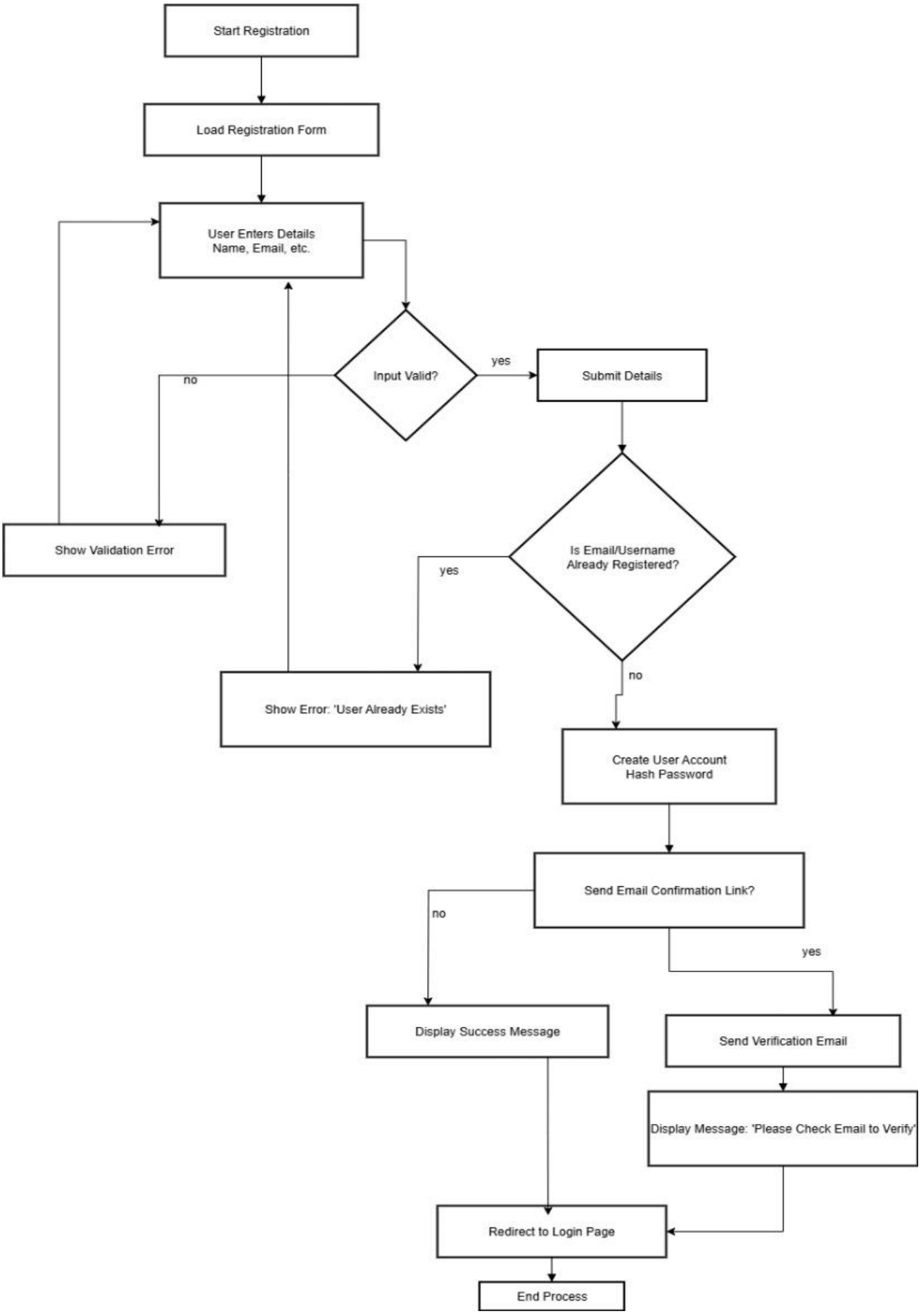
- The system shall send alerts for overdue books, fines, reserved books, event reminders, system downtime, and new feature launches.
- Alerts must be visible in the user dashboard and also sent via email.

Module	Requirement ID	Requirement Description	Priority
User Management	FR1	The system shall allow users to register online using NIC and email, with email verification.	High
	FR2	The system shall allow users to link dependent accounts to a main account for Family membership.	Medium
Membership	FR3	The system shall allow users to apply and pay for different membership types online/offline.	High
	FR4	The system shall generate a downloadable PDF membership card with a QR code upon approval.	Medium
Search & Reserve	FR5	The system shall allow searching the catalog with filters (author, title, genre, year).	High
	FR6	The system shall display real-time availability of items across all library branches.	High
	FR7	The system shall allow a user to reserve a book for a maximum "Hold Duration" of 3 days	High
Borrowing	FR8	The system shall automatically calculate and assign fines for late returns.	High
	FR9	The system shall allow a user to extend the borrowing period once per book.	Medium
Digital Access	FR10	The system shall allow streaming/downloading of digital content (PDF, ePub, MP3) for premium tiers.	High

Events	FR11	The system shall allow users to browse, filter, and register for events with limited seats.	High
	FR12	The system shall allow event cancellation by users up to 48 hours before the event.	Medium
Feedback	FR13	The system shall provide a module for submitting feedback and reports, with direct messaging to librarians.	Low
Messaging	FR14	The system shall allow staff to send announcements and notifications via portal and email.	High
Payment	FR15	The system shall integrate with a payment gateway for online transactions (card, UPI).	High
		The system shall allow offline payment via upload of a scanned bank deposit slip.	Medium
Inventory	FR17	The system shall maintain a real-time inventory, tracking total copies, condition, and branch location.	High

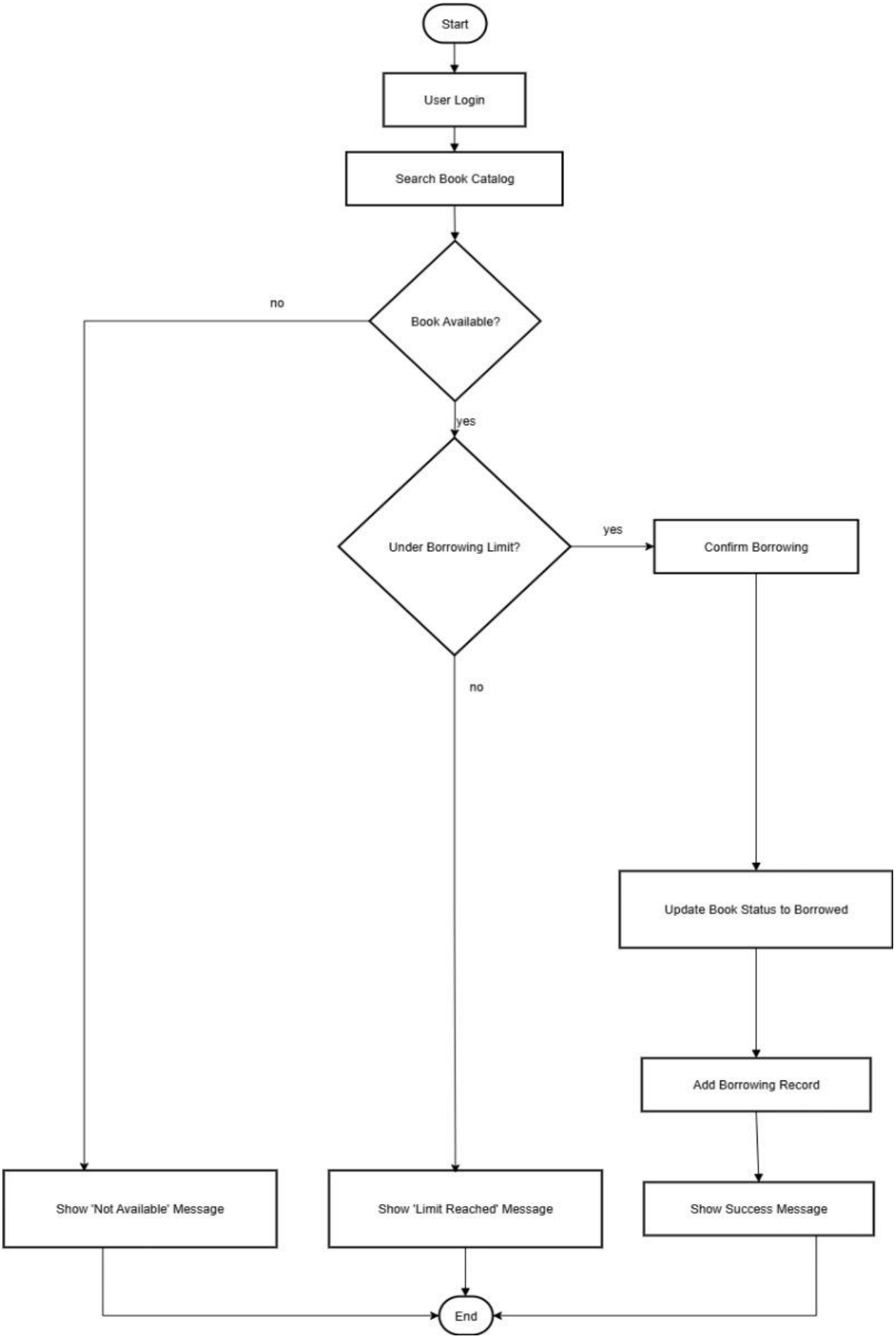
4.1.1 Use Case Diagrams with their Descriptions

1. User Registration Process



- Name and ID: UC-01: Register User
- Scope: Smart Public Library System (SPLS)
- Primary Actor: Prospective Member (User)
- Stakeholders and Interests:
    - User: Wants to create an account quickly and easily.
    - CKRC: Wants to collect valid user data and verify identity.
    - System Administrator: Requires accurate data for system management.
- Preconditions: User has a valid NIC number and email address.
- Trigger: User selects "Register" on the application.
- Main Flow:
    1. User enters NIC, email, and personal details.
    2. System validates NIC format and email format.
    3. System checks that email and NIC are not already registered.
    4. System sends a verification email to the provided address.
    5. User clicks the verification link in the email.
    6. System activates the account and confirms successful registration.
- Alternative Flows:
    - A1: User already exists: System informs user and suggests password recovery.
- Exception Flows:
    - E1: Invalid email format: System prompts user to enter a valid email.
    - E2: Verification email fails to send: System logs the error and alerts an administrator.
- Success Endings: User receives a confirmation message and can now log in.
- Failure Endings: User remains on the registration form with appropriate error messages.
- Special Requirements: Email verification link must expire after 24 hours.

2. Book Borrowing Process



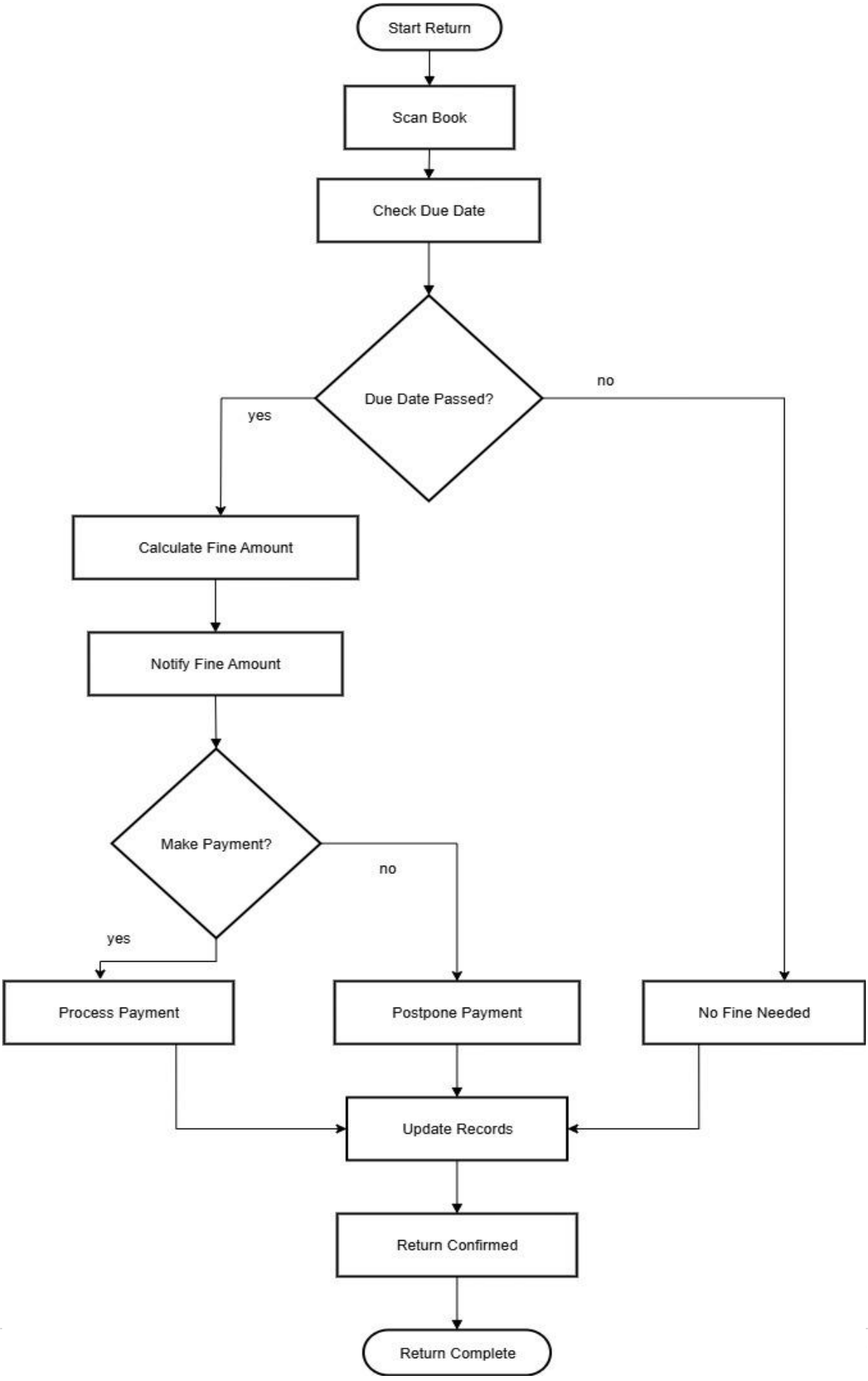
- Name and ID: UC-03: Borrow Book
- Scope: Smart Public Library System (SPLS)
- Primary Actor: Library Member (User)
- Stakeholders and Interests:
    - User: Wants to borrow a book successfully.
    - Librarian: Needs the process to be efficient and the inventory to update accurately.

- Preconditions: User is logged in and has a valid, active membership.
- Trigger: User selects a book to borrow from the search results.
- Main Flow:
    1. User requests to borrow a book.
    2. System checks the user's membership status and current borrowing count against their limit.
    3. System checks the book's availability status.
    4. System creates a loan record, sets the due date, and updates the book's status to "Borrowed".
    5. System generates a digital receipt for the user.

- Alternative Flows:
    - A1: Book is available but not on shelf: User can choose to reserve the book.
- Exception Flows:
    - E1: User has exceeded borrowing limit: System blocks the transaction and notifies the user.
    - E2: Membership is expired: System blocks the transaction and prompts for renewal.

- Success Endings: User receives a confirmation message and a digital receipt.
- Failure Endings: User is informed why the borrowing failed (e.g., limit reached, book unavailable).
- Special Requirements: The due date must be calculated based on the membership type.

3. Book Return & Fine Calculation Process



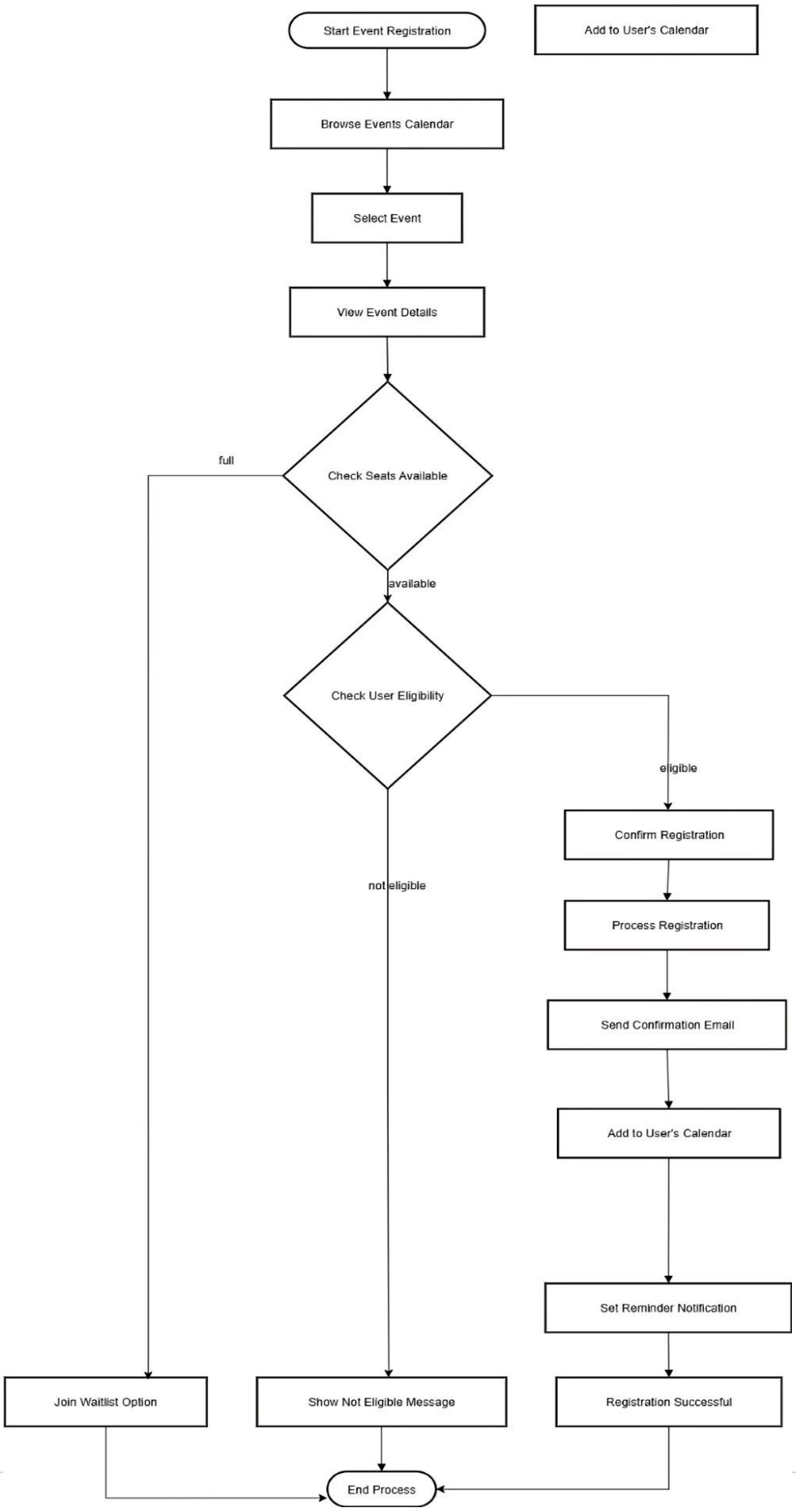
- Name and ID: UC-04: Return Book
- Scope: Smart Public Library System (SPLS)
- Primary Actor: Library Member (User)
- Stakeholders and Interests:
    - User: Wants to return a book and avoid fines.
    - Librarian: Needs to efficiently process returns and manage fines.
    - CKRC: Wants to recover costs from late returns.

- Preconditions: User has at least one currently borrowed book.
- Trigger: User or Librarian scans the book's barcode to initiate return.
- Main Flow:
    1. System records the return date and time.
    2. System checks if the book is returned after the due date.
    3. If late, system automatically calculates the fine based on the number of days overdue.
    4. System updates the book's status to "Available" and the loan record to "Closed".
    5. System notifies the user of the successful return and any fine incurred.

- Alternative Flows: None.
- Exception Flows:
    - E1: Book is damaged: Librarian flags the book as damaged, and a different fine may be applied.

- Success Endings: Book is successfully returned. User can see any fine in their dashboard.
- Failure Endings: Return is not processed (e.g., barcode scan error).
- Special Requirements: Fine calculation rules must be configurable by an administrator (e.g., Rs. 10 per day).

4. Event Registration Process



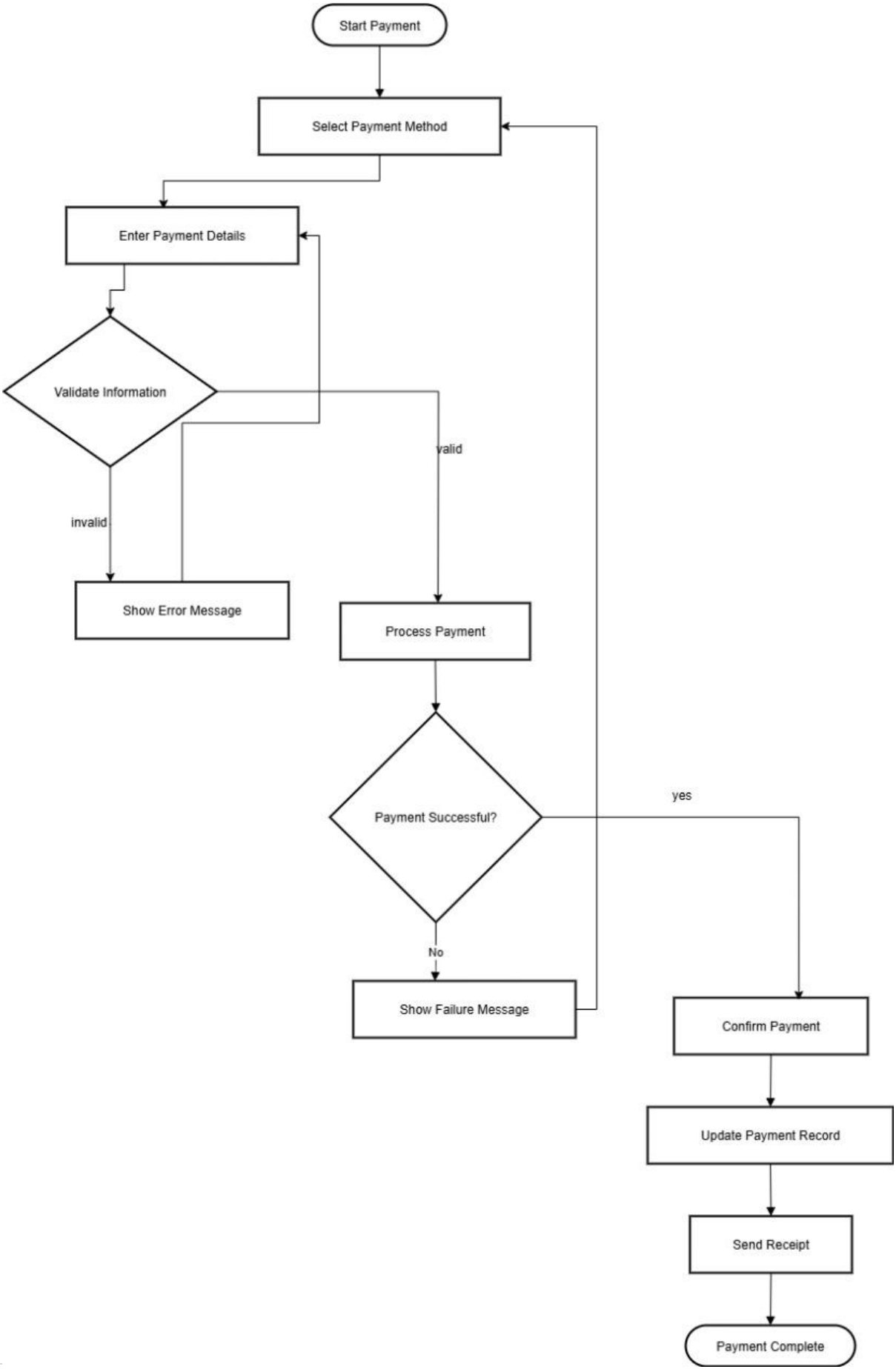
- Name and ID: UC-08: Register for Event
- Scope: Smart Public Library System (SPLS)
- Primary Actor: Library Member (User)
- Stakeholders and Interests:
    - User: Wants to secure a spot at a library event.
    - Librarian: Needs to manage attendance and avoid overbooking.

- Preconditions: User is logged in. The event is published and has available seats.
- Trigger: User selects "Register" for an event.
- Main Flow:
    1. User views available events and selects one.
    2. System checks if the event has available capacity.
    3. System adds the user to the event attendees list and reduces the available capacity by one.
    4. System generates and sends an e-ticket (with QR code) to the user via email.
    5. User receives a confirmation message.

- Alternative Flows: None.
- Exception Flows:
    - E1: Event is full: System informs the user and offers to add them to a waitlist.

- Success Endings: User is registered and receives an e-ticket.
- Failure Endings: User is not registered and is informed why.
- Special Requirements: Users must be able to cancel their registration up to 48 hours before the event.

6. Online Payment Process



- Name and ID: UC-11: Pay Online
- Scope: Smart Public Library System (SPLS)
- Primary Actor: Library Member (User)
- Stakeholders and Interests:
    - User: Wants to pay fines/fees securely and conveniently.
    - CKRC: Needs to receive payments accurately and securely.
    - Payment Gateway: Must process transactions reliably.

- Preconditions: User is logged in and has a pending fine or membership fee.
- Trigger: User selects "Pay Now" for an invoice in their dashboard.
- Main Flow:
    1. User selects the payment amount and method (e.g., credit card, debit card, UPI).
    2. System redirects the user to the secure payment gateway page.
    3. User enters their payment details and confirms the payment.
    4. Payment gateway processes the transaction and sends a success/failure response back to the system.
    5. If successful, system updates the invoice status to "Paid" and clears the user's debt.
    6. System generates and makes a downloadable receipt available to the user.

- Alternative Flows:
    - A1: Offline Payment: User chooses to upload a bank deposit slip for manual verification.

- Exception Flows:
    - E1: Payment declined: System informs the user and prompts to try a different payment method.
    - E2: Network failure: System logs the error and places the transaction in a "Pending" state for review.

- Success Endings: Payment is confirmed, and the user's balance is cleared. A receipt is generated.

- Failure Endings: Payment fails, and the user's balance remains. User is returned to the payment page.
- Special Requirements: All payment transactions must be encrypted. The system must integrate with the municipal payment gateway API.

4.2 Non functional requirements

NFR Category	Requirement
Security	The system shall implement Role-Based Access Control (RBAC). The system shall use Two-Factor Authentication (2FA) for staff logins. All sensitive transactions shall use end-to-end encryption.
Integrability	The system shall integrate with the National ID verification API. The system shall integrate with the municipal payment gateway. The system shall integrate with the CKRC internal HR system.
Usability	The user interface shall be intuitive for users of all ages and technical abilities.
Reliability	The system shall provide clear system status and downtime notifications to users.

4.2.1 Performance Requirements

NFR-001: The system shall respond to user login requests within 2 seconds under normal load conditions (up to 500 concurrent users). *Justification: Quick authentication is critical for user satisfaction and system accessibility.*

NFR-002: Book search operations shall return results within 3 seconds for queries against a database of up to 500,000 records, with response time not exceeding 5 seconds for complex multi-filter searches.

NFR-003: The system shall support a minimum throughput of 100 concurrent book reservations per minute during peak hours (9 AM - 12 PM and 5 PM - 8 PM).

NFR-004: Payment processing transactions shall complete within 5 seconds, excluding third-party payment gateway processing time.

NFR-005: Digital content (e-books/audiobooks) streaming shall begin within 3 seconds of user request, with adaptive bitrate streaming to maintain continuous playback.

Metric	Required Value	Condition
User Login Response Time	< 2 seconds	1000
Book Search Results Load Time	< 3 seconds	-
System Uptime Availability	99.9%	Monthly

4.2.2 Security Requirements

NFR-006: The system shall implement two-factor authentication (2FA) for all administrative accounts and shall provide optional 2FA for member accounts using email or SMS verification. Justification: Critical for protecting sensitive library operations and user data.

NFR-007: The system shall enforce role-based access control (RBAC) with a minimum of four distinct roles: Member, Librarian, Administrator, and System Administrator, each with clearly defined permissions.

NFR-008: All sensitive data shall be encrypted using AES-256 encryption at rest and TLS 1.3 or higher for data in transit. Justification: Compliance with data protection standards and protection of personal information.

NFR-009: User passwords shall meet the following criteria:

- Minimum 8 characters length
- Must contain at least one uppercase letter, one lowercase letter, one number, and one special character
- Password history of last 5 passwords shall be maintained
- Passwords shall expire every 90 days for staff accounts

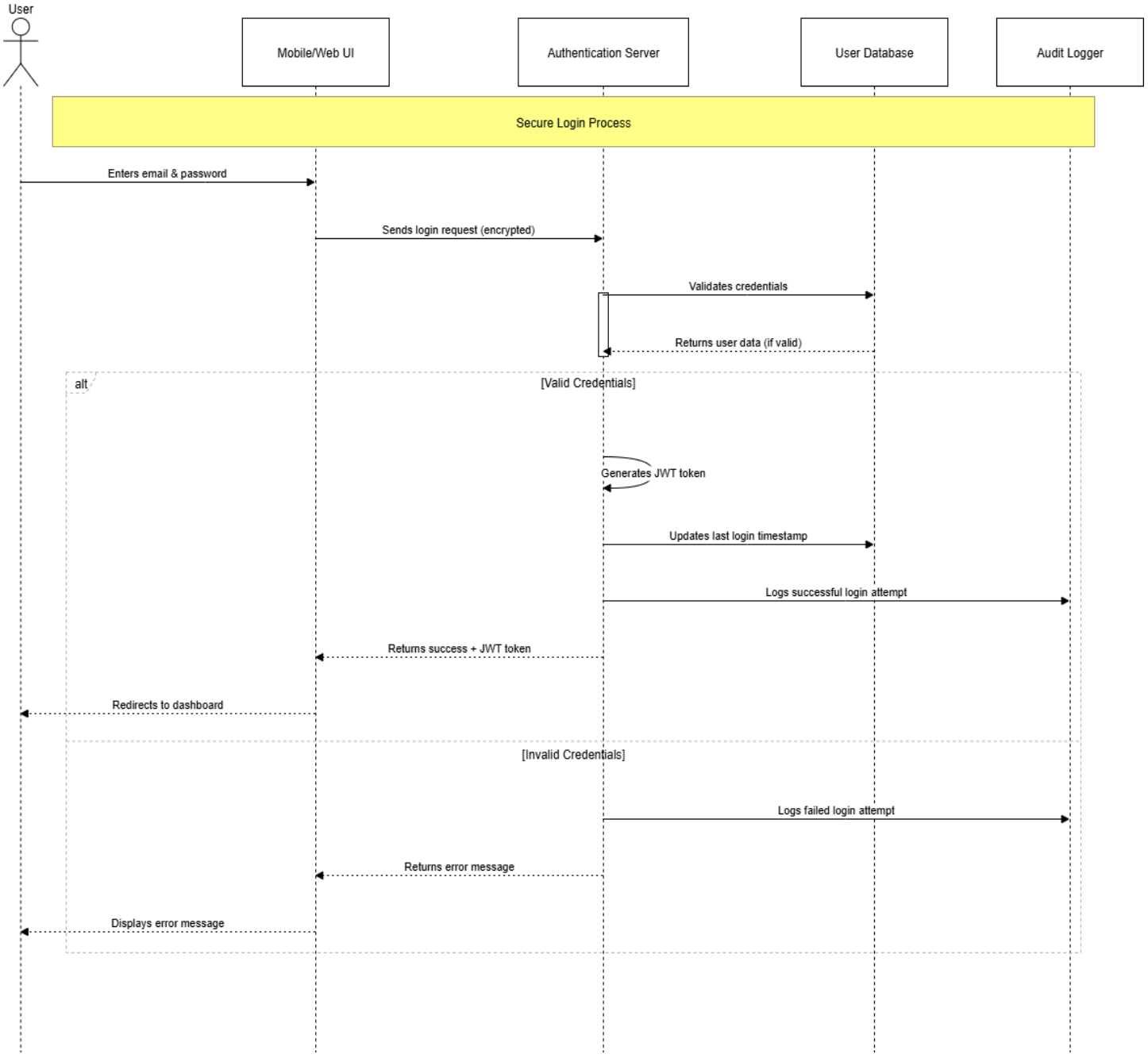
NFR-010: The system shall implement comprehensive audit logging for all critical operations including:

- User authentication attempts (successful and failed)
- Payment transactions
- Administrative actions
- Data modifications
- Access to personal information

NFR-011: Digital content shall be protected using industry-standard DRM (Digital Rights Management) with time-based access control linked to membership validity.

NFR-012: Session timeout shall occur after 30 minutes of inactivity for regular users and 15 minutes for administrative users, with automatic session termination after 2 hours regardless of activity.

- User Login Sequence Diagram (with authentication steps)



4.2.3 Reliability and Availability Requirements

NFR-013: The system shall maintain 99.5% uptime during operational hours (6 AM to 11 PM daily), calculated monthly. Justification: Balances high availability needs with realistic maintenance windows for a public sector system.

NFR-014: The Mean Time Between Failures (MTBF) shall be at least 720 hours (30 days) for critical system components.

NFR-015: The Mean Time To Repair (MTTR) shall not exceed 2 hours for critical failures and 8 hours for non-critical issues during operational hours.

NFR-016: The system shall perform automated backups:

- Full database backup: Daily at 2 AM
- Incremental backups: Every 4 hours
- Transaction log backups: Every 30 minutes
- Backup retention: 30 days for daily, 7 days for incremental

NFR-017: The system shall implement automatic failover to a standby server within 5 minutes of primary server failure detection.

NFR-018: Data integrity checks shall be performed daily, with automatic correction of minor inconsistencies and alerts for issues requiring manual intervention.

4.2.4 Usability Requirements

NFR-019: The user interface shall comply with WCAG 2.1 Level AA accessibility standards to ensure access for users with disabilities. Justification: Legal compliance and inclusive access to public services.

NFR-020: The system shall be compatible with the following browsers (current version and one version back):

- Google Chrome
- Mozilla Firefox
- Microsoft Edge
- Safari
- Mobile browsers (Chrome Mobile, Safari Mobile)

NFR-021: The system shall provide a fully responsive design that adapts to screen sizes from 320px to 2560px width, with optimized layouts for mobile, tablet, and desktop devices.

NFR-022: All error messages shall be user-friendly, providing:

- Clear description of the error
- Suggested corrective action
- Error code for technical support reference
- Available in both English and the local language

NFR-023: The system shall provide context-sensitive help documentation accessible within 2 clicks from any page, with search functionality and video tutorials for key operations.

NFR-024: The average user should be able to complete core tasks (search, reserve, renew) within 3 clicks from the main dashboard.

4.2.5 Scalability Requirements

NFR-025: The system shall support a minimum of 1,000 concurrent users with provisions to scale up to 5,000 concurrent users through horizontal scaling. *Justification: Accommodates current membership with room for 5x growth.*

NFR-026: The database shall be designed to efficiently handle:

- Up to 1 million book records
- 100,000 active member accounts
- 10 million transaction records
- Annual data growth of 20%

NFR-027: The system architecture shall support horizontal scaling through load balancing across multiple application servers with automatic load distribution.

NFR-028: System resource utilization shall trigger scaling alerts when:

- CPU usage exceeds 70% for 5 minutes
- Memory usage exceeds 80%
- Database connections exceed 85% of the pool

NFR-029: The system should support adding new library branches without system downtime or major architectural changes.

4.2.6 Maintainability Requirements

NFR-030: All custom code shall include inline documentation following standard commenting practices, with a minimum comment-to-code ratio of 1:5 for complex logic.

NFR-031: The system shall follow a microservices or modular architecture pattern allowing independent deployment of major components (user management, catalog, payments, etc.).

NFR-032: System updates and patches shall be deployable during scheduled maintenance windows (2 AM - 5 AM) with rollback capability within 30 minutes.

NFR-033: The system shall implement comprehensive logging using structured log formats (JSON) with the following log levels:

- ERROR: System errors requiring immediate attention
- WARNING: Potential issues requiring investigation
- INFO: Normal operational events
- DEBUG: Detailed diagnostic information (disabled in production)

NFR-034: The system shall integrate with application performance monitoring (APM) tools providing:

- Real-time performance metrics
- Error tracking and alerting
- User session replay for debugging
- Custom dashboard for key metrics

NFR-035: All APIs shall be versioned and documented using OpenAPI/Swagger specifications with backward compatibility maintained for at least 2 major versions.

4.2.7 System Constraints

- **Hardware Requirements**

NFR-036: The production environment shall meet minimum specifications:

- Application Servers: 2x servers with 8 CPU cores, 16GB RAM, 500GB SSD
- Database Server: 16 CPU cores, 32GB RAM, 1TB SSD with RAID 10
- Load Balancer: Dedicated hardware or cloud-based solution

- Network: Minimum 1 Gbps connection with redundant links

➢ Software Compatibility

NFR-037: The system shall be compatible with:

- Operating System: Ubuntu Server 20.04 LTS or RHEL 8+
- Database: PostgreSQL 13+ or MySQL 8+
- Web Server: Nginx 1.18+ or Apache 2.4+
- Runtime: Node.js 16+ or Java 11+ or Python 3.8+

➢ Integration Constraints

NFR-038: External API integrations shall implement:

- Timeout of 30 seconds for all external calls
- Retry logic with exponential backoff (max 3 retries)
- Circuit breaker pattern for handling service failures
- Response caching where appropriate (minimum 5 minutes for static data)

NFR-039: The National ID Verification API integration shall handle up to 50 requests per minute with graceful degradation if the service is unavailable.

➢ Regulatory Compliance

NFR-040: The system shall comply with:

- Local data protection regulations
- Municipal IT security policies
- Public sector accessibility requirements
- Financial transaction regulations for online payments

NFR-041: Personal data retention shall follow these policies:

- Active member data: Retained indefinitely while account is active
- Inactive member data: Archived after 2 years, deleted after 5 years
- Transaction logs: Retained for 7 years for audit purposes
- System logs: Retained for 90 days

- **Network Requirements**

NFR-042: The system shall function adequately on connections with:

- Minimum bandwidth: 256 Kbps for basic operations
- Recommended bandwidth: 2 Mbps for optimal experience
- Maximum latency: 200ms for local users
- Packet loss tolerance: Up to 1% without significant degradation

4.2.8 Environmental Requirements

NFR-043: The system deployment environment should maintain:

- Temperature: 18-24°C (server room)
- Humidity: 40-60% relative humidity
- Uninterruptible Power Supply (UPS) with minimum 2-hour backup
- Generator backup for extended outages

NFR-044: The system shall support green IT initiatives by:

- Implementing auto-scaling to reduce resource usage during off-peak hours
- Supporting paperless operations where possible
- Enabling power-saving modes for idle components

4.2.9 Monitoring and Alerting Requirements

NFR-045: The system shall implement real-time monitoring for:

- System health (CPU, memory, disk, network)
- Application performance metrics
- Database performance and query execution time
- API response times and error rates
- Security events and anomalies

NFR-046: Automated alerts shall be configured for:

- System downtime or component failures
- Performance degradation (response time > threshold)
- Security breaches or suspicious activities
- Capacity thresholds (storage, users, transactions)
- Failed backup operations

NFR-047: The monitoring dashboard shall be accessible to system administrators 24/7 via web interface and mobile application with role-based access to different metrics.

4.3 Data Requirements:

Data Types and Formats

Data Entity	Key Attributes and Notes
User Account	NIC (Unique), Email (Unique, Verified), Password (Hashed), Address, Contact Info, Profile Picture.
Membership	Type (Basic, Premium, Family), Status (Pending, Approved, Expired), Start Date, Expiry Date.
Book Copy	Unique Copy ID, ISBN, Branch Location, Condition (Good, Damaged, Needs Repair).
Transaction	Transaction ID, User ID, Copy ID, Borrow Date, Due Date, Return Date, Fine Amount.
Digital Content	Title, Author, Format (PDF, ePub, MP3), DRM Protection, File Size.

1 User Information

- Personal details: Name, NIC, email, address, phone number, date of birth, etc.
- Data format: Text, Date, Email, Integer (NIC)

2 Membership Information

- Membership ID, type (Basic/Premium/Family), start date, expiry date, status.
- Data format: Integer, Enum (Type, Status), Date

3 Book Information

- Book ID, ISBN, title, author, genre, published year, language, format.
- Data format: Text, Integer, Date, Enum (Genre, Format)

4 Loan and Reservation Information

- Loan ID, reservation ID, borrow date, due date, return date, status.
- Data format: Integer, Date, Enum (Status)

5 Fine and Payment Information

- Fine ID, amount, issue date, payment status, invoice number.
- Data format: Integer, Float, Date, Enum (Status)

6 Event Information

- Event ID, title, description, date, time, capacity, category.
- Data format: Integer, Text, Date/Time, Enum (Category)

7 Digital Content Information

- Content ID, title, format (ePub/PDF/MP3), file size, access URL.
- Data format: Integer, Text, Enum (Format), Float (File Size)

8 Message and Notification Information

- Message ID, content, type, sender, receiver, timestamp.
- Data format: Integer, Text, Enum (Type), Timestamp

Storage and Retrieval

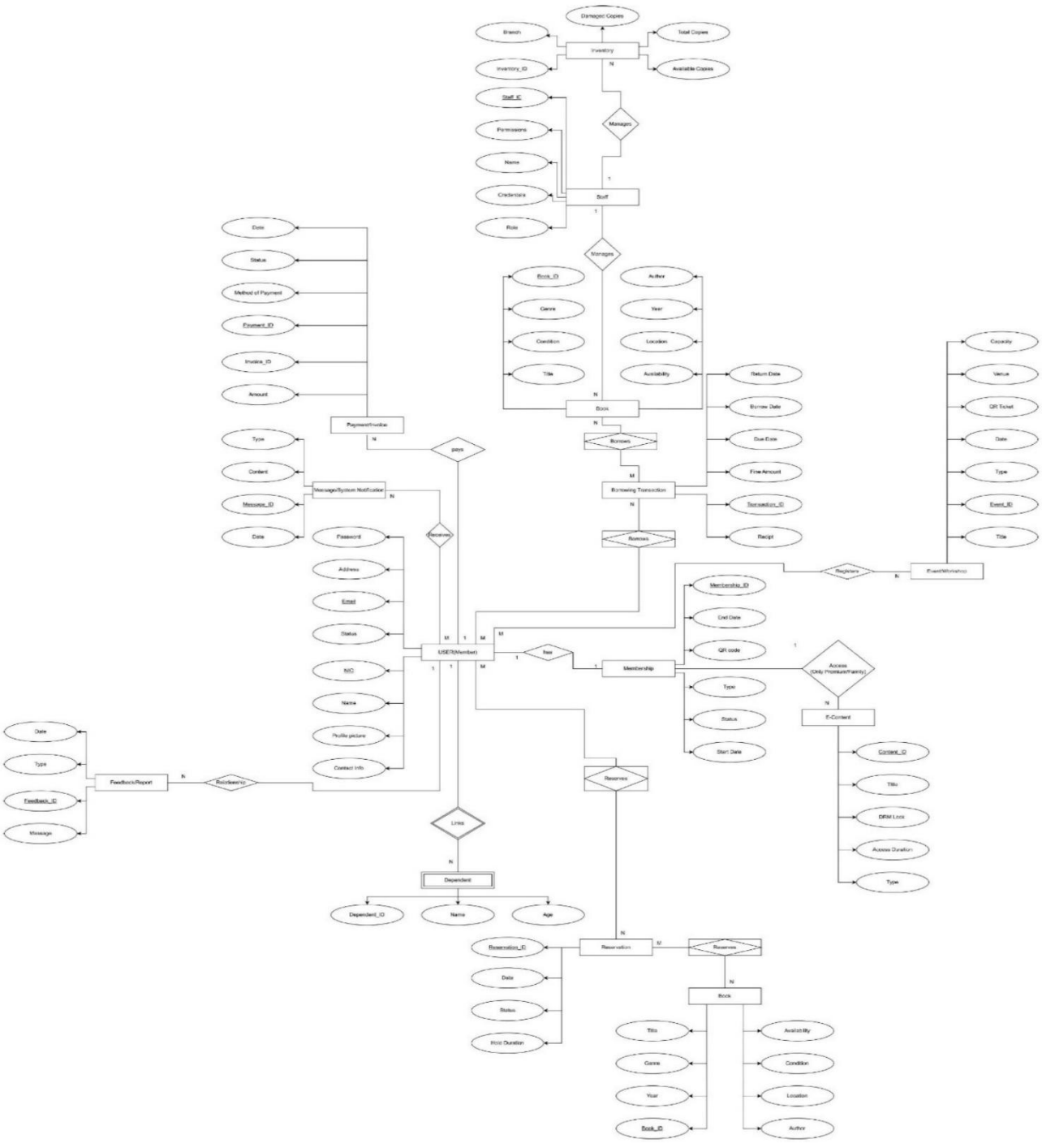
- Database Management System
  - Relational Database (SQL): MySQL / PostgreSQL for structured data (Users, Books, Loans, Payments).
  - NoSQL Database: MongoDB / Firebase for unstructured data (Notifications, Messages, Logs).
- File Storage System
  - Cloud storage (AWS S3 / Google Cloud Storage) for profile pictures, digital books (ePub, PDF), audiobooks (MP3), and scanned payment vouchers.

Data Processing Requirements

- Validation
    - Validate NIC format, email addresses, and file formats (JPG/PNG for images, PDF for documents).
    - Ensure all mandatory fields (e.g., NIC, email) are completed during registration.
- CRUD Operations
    - Create, Read, Update, Delete operations for user profiles, book records, loan transactions, event registrations, and payment records.
- Notification System
    - Send emails and SMS for reservations, due date reminders, fine alerts, and event notifications.
    - Send in-app notifications for new messages and system updates.
- Security
    - Implement role-based access control (RBAC) for users, librarians, and admins.
    - Encrypt sensitive data (passwords, payment information) both in transit and at rest.
- Reporting
    - Generate PDF receipts for payments, membership cards, and event tickets.
    - Provide admin dashboards for library analytics (borrowing trends, user activity, revenue from fines).

- Data Integration
    - Integrate with National ID verification API to validate user identities.
    - Integrate with payment gateway API (e.g., PayPal, Stripe) for processing online payments.

To show the data entities and their relationships.(system)



ER Diagram:

https://drive.google.com/file/d/1aL0LhvsMUYu1Xc3T1CZrieYH2j7fL6OZ/view?usp=drive_link

4.4 User Characteristics:

Understanding the diverse attributes of the library system's users is vital for customizing its features and ensuring a positive user experience. Here's a breakdown of the primary user groups:

1. Unregistered Users (Visitors)
2. Registered Library Members
3. Librarians
4. System Administrators

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1. Unregistered Users (Visitors)

Description:

Unregistered users are individuals who access the Smart Public Library System (SPLS) to browse available books, events, or services but have not yet created an account.

Characteristics:

- Technical Proficiency:
  Users demonstrate varying degrees of technological proficiency, ranging from adept digital natives to those who prefer straightforward interfaces with clear instructions.
- User Requirements and Expectations:
  Unregistered users are looking for a platform that is easy to navigate and user-friendly, offering seamless access to information like book catalogs and event schedules without mandatory login. Transparent communication from the library and accommodating diverse preferences are also key expectations.

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2. Registered Library Members

Description:

Registered members are individuals who have completed the registration process and hold an

active membership (Basic, Premium, or Family) with the City Knowledge Resource Centre (CKRC). They use the portal to borrow books, access digital content, and manage their accounts.

Characteristics:

- Technical Proficiency:

  Generally proficient in using digital platforms for browsing, borrowing, and making online payments.

- User Requirements and Expectations:

  Members expect a user-friendly interface, transparent communication from librarians, timely notifications (e.g., due date reminders), and strict privacy and security of their personal and payment information.

3. Librarians

Description:

Librarians at CKRC manage day-to-day operations such as book inventory, member registrations, fine collections, event coordination, and customer support. They ensure smooth functioning of both physical and digital library services.

Characteristics:

- Technical Proficiency:
  Librarians must be proficient in using the SPLS dashboard for managing books, members, and transactions.

- Communication Skills:
  Must effectively communicate with members—both in person and through the messaging system—and provide support as needed.

- Data Management:
  Required to handle and process member data, book records, and financial transactions accurately.

- User Requirements and Expectations:
  Need an efficient, intuitive, and reliable system to manage operations, generate reports, and communicate with members seamlessly.

4. System Administrators

Description:

System administrators are responsible for maintaining the SPLS's functionality, ensuring security, managing user roles, performing backups, and deploying system updates.

Characteristics:

- Technical Proficiency:
  High level of technical expertise in system maintenance, database management, network security, and troubleshooting.

- Security Awareness:
  Strong awareness of security protocols and compliance requirements to protect sensitive member and operational data.

- User Requirements and Expectations:
  Require advanced tools for user management, audit logging, performance monitoring, and system configuration. Expect high reliability, scalability, and ease of maintenance from the system.

4.5 Testing Requirements:

Software testing is necessary because we all make mistakes. Some of those mistakes are unimportant, but some can be expensive or dangerous. Therefore, we need to check everything produced, as things can always go wrong. The testing requirements for the Smart Public Library System (SPLS) can be outlined as follows:

1. User Registration and Profile Management:

- Test the registration process with both valid and invalid data (e.g., invalid NIC, invalid email).

- Verify email address uniqueness and validation during registration.
- Test profile update functionality, including uploading a profile picture within specified dimensions and format.
- Verify that users can link and manage dependents under their accounts.

2. Membership Management:

- Test the membership application process for all types (Basic, Premium, Family).
- Verify online and offline payment methods for premium memberships.
- Test membership renewal process, including early renewal discounts and grace period handling.
- Ensure membership status (active, expired, pending) is correctly displayed and enforced.

3. Book Search and Reservation:

- Test search functionality with various filters (author, title, genre, year).
- Verify real-time availability status across different library branches.
- Test book reservation process, including hold duration (max 3 days) and automatic cancellation.
- Ensure users can view their reservation history and status.

4. Book Borrowing and Returning:

- Test physical book borrowing process for in-person and home delivery (for premium members).
- Verify digital receipt generation and due date tracking.
- Test late return fine calculation and notification.
- Test book return process and inventory update functionality.

5. Digital Content Access:

- Verify that only premium and family members can access e-books and audiobooks.
- Test streaming and downloading functionality for digital content (PDF, ePub, MP3).

- Test in-browser reader and audio player features, including bookmarking and annotations.
- Ensure digital rights management (DRM) integration works correctly.

6. Event Management:

- Test event browsing and filtering by date and category.
- Verify online registration process with seat availability checks.
- Test e-ticket generation and download (with QR code).
- Test event cancellation functionality up to 48 hours before the event.

7. Feedback and Reporting:

- Test submission of feedback on books and services.
- Test reporting process for damaged or lost items.
- Verify direct messaging functionality between users and librarians.

8. Notification System:

- Test all automated notifications (reservations, due dates, fines, events).
- Verify that notifications appear in the portal and are sent via email.
- Test group messaging to specific user categories (e.g., all premium members).

9. Fine and Payment Processing:

- Test online payment integration (card, UPI) for fines and fees.
- Test offline payment process using scanned bank slip upload.
- Verify invoice generation and download (PDF format).
- Test payment history tracking and display.

10. Librarian and Admin Functions:

- Test librarian functions (manage inventory, approve reservations, track books).
- Test admin functions (generate reports, manage users, configure system settings).

- Verify role-based access control (e.g., librarians cannot access financial reports).

11. Security and Integration:

- Test integration with National ID verification API.
- Test integration with municipal payment gateway.
- Verify two-factor authentication (2FA) and encryption for sensitive transactions.
- Test system security against common vulnerabilities (e.g., SQL injection, XSS).

12. Performance and Usability:

- Test system performance under load (e.g., multiple concurrent users).
- Verify responsiveness on both web and mobile interfaces.
- Test accessibility features for users with disabilities.

4.6 Documentation Requirements:

Documentation Standards

1. Consistency: There should be consistency in format, style, and terminology across all documentation.
2. Clarity: Information should be clear, concise, and easily understandable for the target audience.
3. Accuracy: All documentation must be kept up-to-date with the current status and features of the system.
4. Accessibility: Documentation should be easily accessible by all relevant stakeholders (users, librarians, admins, developers).
5. Version Control: Version control must be implemented to track all changes and updates made to the documents.

Types of Documents to be Prepared

1. User Manuals:

- Purpose: To help end-users (library members) use the Smart Public Library System (SPLS).
- Content:
  - Overview of system features and capabilities.
  - Step-by-step instructions for registration, book search, reservation, borrowing, digital access, event registration, and payment.
  - Troubleshooting common issues (e.g., login problems, payment failures).
  - Frequently Asked Questions (FAQs).

2. Librarian and Administrator Guides:
   - Purpose: To assist library staff and administrators in managing the system.
   - Content:
     - Procedures for managing user accounts and memberships.
     - Instructions for inventory management, book issue/return, and fine handling.
     - Guidelines for generating reports and managing events.
     - Configuration of system settings and notifications.
3. Technical Documentation:
   - Purpose: To inform developers and IT staff involved in maintenance and future development.
   - Content:
     - System architecture and design overview.
     - Database schema and entity-relationship diagrams (ERD).
     - API documentation (National ID verification, payment gateway integration).
     - Configuration settings and deployment instructions.

        - Code documentation and version control repository details.

4. Training Materials:

    - Purpose: To train new users, librarians, and administrators on system functionalities.
    - Content:
        - Interactive video tutorials for common tasks.
        - Quick reference guides (cheat sheets) for librarians.
        - Hands-on exercises and practice scenarios.
        - Presentation slides for group training sessions.

Legal and Compliance Requirements

- Privacy Policy: Document how user data (personal details, reading history, payment information) is collected, used, stored, and protected.
- Data Security: Describe security measures implemented (encryption, access controls, authentication) to protect sensitive user and operational data.
- Accessibility Compliance: Ensure all documentation (especially user manuals) adheres to accessibility standards (e.g., WCAG) to be usable by people with disabilities.
- Regulatory Compliance: Ensure all documentation meets relevant library management regulations, data protection laws (e.g., GDPR, local data protection acts), and municipal guidelines.

These documentation requirements ensure that all stakeholders—library members, librarians, administrators, and technical staff—have the necessary resources to use, manage, and maintain the Smart Public Library System effectively.