

**ICT2113: Software Modelling and Analysis
Library Management System Using Python
Project Specification
[2025/26 T2]**

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1. Project Description

1.1. Company Description

Name: Little Library

Logo:



Letterheads:



LITTLE LIBRARY

Phone: +65 8123 4567

Email: contact@littelibrary.sg

Website: www.littlelibrary.sg

Address: 101 Bukit Timah Road, Singapore 229899

Mission: Provide extensive and accessible reading materials to the public, ensuring equal opportunities for learning and knowledge acquisition across Singapore.

Vision: Future generations of Singapore are literate, informed and knowledgeable, contributing meaningfully to society as a whole.

Line of Business: Little Library operates under the purview of the Singapore Library Board

Commercial Sectors: Government Sector

Affiliated to: Singapore Library Board (SLB), Ministry of Innovation and Digital Information (MIDI), National Record-keeping of Singapore (NRKS)

Recent History: Little Library operates under the purview of the Singapore Library Board and manages community and neighbourhood libraries throughout the country. Recently, the increase in visitors in its libraries has placed greater pressure on its manual record-keeping systems. To improve efficiency, LittleLibrary is undergoing a digital transformation to improve efficiency and also to support the government's Smart Nation initiative. LittleLibrary is partnering with SoftwareSolutions to implement a web-based Library Management System.



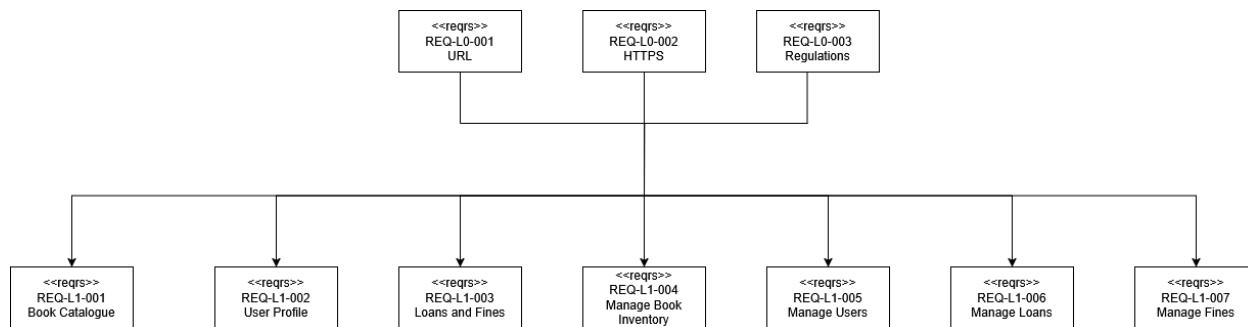
1.2. Project Information

Name: Web-based Library Management System (LMS) for Digitalising Community Library Operations in Singapore.

Context: LittleLibrary, operating under the Singapore Library Board (SLB), faces pressure from increased visitor numbers and inefficient manual record-keeping. Current processes for sorting, arranging, and monitoring loans are slow, making it impossible to generate a fast report. The project aligns with the Ministry of Innovation and Digital Information (MIDI) and the government's Smart Nation initiative to digitalise public institutional records.

Goal: To deploy an online web-based library management system that centralises the management of the book catalogue, inventory, users, book loans, and fines. The system must reduce the librarian's time spent in book cataloging and inventory management by 70%, user management by 99%, book loans by 90%, and fine calculation and collection by 95%.

2. Requirements Tree (Reqs Tree)



- Level 0 (System Goal):
 - **REQ-L0-001** URL
 - **REQ-L0-002** HTTPS
 - **REQ-L0-003** Regulations
- Level 1 (Functional Areas):
 - **REQ-L1-001** Book Catalogue
 - **REQ-L1-002** User Profile
 - **REQ-L1-003** Loans and Fines
 - **REQ-L1-004** Manage Book Inventory
 - **REQ-L1-005** Manage Users
 - **REQ-L1-006** Manage Loans
 - **REQ-L1-007** Manage Fines



3. Business Operations Requirements

PRECEDENCE LEVELS (MOST TO LEAST): Essential - 3, Desirable - 2, Acceptable - 1

3.1. REQ-L0-003 Regulation

- a. **REQ-L0-003.1** (Record Keeping): As a project under the Singapore Library Board (SLB), the system must maintain logs compliant with the National Record-keeping of Singapore (NRKS).
 - i. Precedence: Essential
- b. **REQ-L0-003.2** (Data Privacy): While basic details are shown on profiles, the system must ensure no sensitive personal financial data is exposed publicly, mitigating the risk that "information stored can be susceptible to cyber hacks".
 - i. Precedence: Essential

3.2. REQ-L1-001 Book Catalogue

- a. **REQ-L1-001.1** (Search & Preview): The search function (by book or author name) must allow users to preview the cover page of the book before borrowing.
 - i. Constraint: The interface must resolve the ambiguity of display by utilizing a standard vertical scrolling mechanism for mobile responsiveness and grid view for desktop.
 - ii. Precedence: Desirable
- b. **REQ-L1-001.2** (Catalogue Display Standard): To resolve perceived incongruities regarding display formats, the catalogue interface must utilize a standard vertical scrolling mechanism for browsing books.
 - i. Rationale: This addresses the "unclear description" in the project documentation and ensures consistency across devices.
- c. Precedence: Desirable

3.3. REQ-L1-002 User Profile

- a. **REQ-L1-002.1** (Registration & ID Verification): The system must enforce ID verification during the registration process.
 - i. Business Rule: This is mandatory to "prevent misuse if there is no deposit paid" and to stop users from creating new accounts to evade fines.
 - ii. Precedence: Essential
- b. **REQ-L1-002.2** (Profile Management): Users shall be able to manage and view their profile, which must explicitly display:
 - i. User Name.
 - ii. Account Age.
 - iii. Preference settings for book genres.



- c. **REQ-L1-002.3** (Recommendation Engine): The system shall recommend books to the user based on the "preferences for genres" selected in their profile.
 - i. Precedence: Acceptable
 - ii. Precedence: Desirable

3.4. **REQ-L1-003 Loans and Fines**

- a. **REQ-L1-003.1** Reporting Latency (The "Fast Report" Rule): To address the current problem where it is "impossible to generate a fast report," the Admin module must generate inventory and fine reports in real-time.
 - i. Rationale: Reports must be exportable or printable for library staff meetings.
 - ii. Precedence: Desirable

3.5. **REQ-L1-004 Manage Book Inventory**

- a. **REQ-L1-004.1** (Inventory Management): Admins must be able to add, update, view, and delete books in the system to ensure real-time inventory accuracy.
 - i. Precedence: Essential

3.6. **REQ-L1-005 Manage Users**

- a. **REQ-L1-005.1** (Manual User Management): Admins must be able to manually manage user accounts, including the ability to intervene in account lockouts or profile disputes.
 - i. Rationale: To resolve issues where users cannot delete accounts due to system constraints.
 - ii. Precedence: Desirable
- b. **REQ-L1-005.2** Role-Based Access Control (RBAC): The system must enforce strict separation between Admin and User modules using distinct credentials.
 - i. Rationale: Admins have full CRUD (Create, Read, Update, Delete) rights over inventory, whereas Users are restricted to read-only access for inventory and write access only for their own profile/orders.
 - ii. Precedence: Essential
- c. **REQ-L1-005.3** (The "Blocking" Rule): Users shall not be able to place more orders (borrow new books) while there are unpaid outstanding fines on their account.
 - i. Precedence: Essential
- d. **REQ-L1-005.4** (Account Deletion Rule): Users shall be permitted to delete their accounts only after all outstanding fines and loans have been successfully cleared.
 - i. Precedence: Desirable



3.7. REQ-L1-006 Manage Loans

- a. **REQ-L1-006.1** (Order Filtering): To generate "fast reports," the system must allow Admins to filter orders by:
 1. Date of transaction.
 2. Return status (Returned vs. Not Returned).
 3. Expiration status (Overdue).
- ii. Precedence: Essential

3.8. REQ-L1-007 Manage Fines

- a. **REQ-L1-007.1** (Fine Calculation): The system shall automatically calculate and apply a fine of \$0.20 per day for EACH overdue book.
 - i. Precedence: Essential
- b. **REQ-L1-007.2** (Damage/Loss Fee): The system shall support the application of a one-time fee of \$10.00 for each book marked as damaged or lost
 - i. Precedence: Essential

4. IT Technical Requirements

4.1. REQ-TECH-001 Hosting Solution

- a. **REQ-TECH-001.1** (Cloud Platform): The system shall be deployed on Amazon Web Services (AWS) using either:
 - i. EC2 (t3.medium or higher) for application hosting, and
 - ii. Amazon RDS (MySQL 8.0) for managed database hosting.
- iii. **REQ-TECH-001.2** (Server OS & Runtime): The application server shall run on
 - iv. Ubuntu Server 22.04 LTS
 - v. Python 3.11+
 - vi. Gunicorn as the WSGI server for Django
- b. **REQ-TECH-001.3** (Deployment Method): The system shall support deployment via Docker using:
 - i. A Dockerfile for the Django application
 - ii. A docker-compose.yml for multi-service orchestration (Django + MySQL in dev; Django + RDS in prod)

4.2. REQ-TECH-002 Software Configuration & Architecture

- a. **REQ-TECH-002.1** (Language & Framework): The application shall be built using Python as the core programming language, utilising the Django web framework for robust backend logic.



- b. **REQ-TECH-002.2** (Frontend Specifications): The user interface shall be constructed using HTML, CSS, and JavaScript.
 - i. Specification: The frontend must be responsive to support the "vertical/horizontal" scrolling requirements for the catalogue.
- c. **REQ-TECH-002.3** (Database Schema): The system shall utilise a MySQL Database. The schema must be designed to support:
 - i. A UserAccount, Book, AdminAccount, Fine and Loan table.
- d. **REQ-TECH-002.4** (Development Tools): The development team shall utilise Sublime Text Editor for code editing and version control management.

4.3. **REQ-TECH-003 Hosting, Performance & Scalability**

- a. **REQ-TECH-003.1** (Concurrency Load): The hosted webpage must be capable of handling up to 20,000 concurrent users under maximum load conditions.
 - i. Rationale: To support high traffic during school terms and community events.
- b. **REQ-TECH-003.2** (Surge Handling): The server architecture must be provisioned to handle activity surges of 10% over the maximum estimation (approx. 22,000 users peak) without service degradation.
- c. **REQ-TECH-003.3** (Server Response): The system must generate "fast reports" regarding issues and fines, improving upon the slow progress of the current manual system.

4.4. **REQ-TECH-004 Client-Side Hardware Requirements**

- a. **REQ-TECH-004.1** (OS Compatibility): The web application must be fully functional on client devices running Windows 7 or higher.
- b. **REQ-TECH-004.2** (Hardware Specs): The software must be optimised to run smoothly on machines with minimum specifications of:
 - i. Processor: i3 processor or higher.
 - ii. Memory: 4 GB RAM or higher.
 - iii. Storage: 100 GB ROM or higher.
- c. **REQ-TECH-004.3** (Browser Versions): The web application shall be fully functional on:
 - i. Chrome (latest 2 versions)
 - ii. Microsoft Edge (latest 2 versions)
 - iii. Firefox (latest 2 versions)



4.5. REQ-TECH-005 Network Integration & APIs

- a. **REQ-TECH-005.1** (Payment Gateway): The system must integrate with external payment APIs, specifically PayPal and PayNow, to facilitate the immediate settlement of fines.
 - i. Technical Constraint: The API handshake must return a "Success" token before the "Blocking Rule" (REQ-FIN-003) is lifted.
- b. **REQ-TECH-005.2** (Local Environment): For development and testing prior to deployment, the team shall use XAMP Server to simulate the network environment.

4.6. REQ-TECH-006 Security & Data Integrity

- a. **REQ-TECH-006.1** (Vulnerability Mitigation): Acknowledging that the system is "susceptible to cyber hacks", the IT implementation must include:
 - i. Django's built-in CSRF (Cross-Site Request Forgery) protection.
 - ii. SQL Injection prevention via Django ORM.
- b. **REQ-TECH-006.2** (ID Verification Logic): The registration module must implement a verification check (e.g., via email token or manual Admin approval) to satisfy the ID verification requirement.

4.7. REQ-TECH-007 Documentation & Maintenance

- a. **REQ-TECH-007.1:** Technical deliverables must include comprehensive documentation to ensure the system remains "easy to maintain" after the handover to SLB staff.

4.8. REQ-TECH-008 Administrative Tools

- a. **REQ-TECH-008.1** (Admin Portal): The system shall provide administrator functions using:
 - i. Django Admin Panel (/admin) as the primary administration interface.
- b. **REQ-TECH-008.2 (Role Control):** Administrative access shall be restricted using
 - i. Django is_staff and is_superuser
 - ii. Role-based permissions using Django Groups & Permissions
- c. **REQ-TECH-008.3** (Operational Controls): Administrators shall be able to perform:
 - i. Book CRUD management (create/update/remove books)
 - ii. User verification status updates (ID_Verification_Status)



- iii. Fine adjustments (authorized staff only)
- iv. Audit viewing of payment transactions and fines history

4.9. REQ-TECH-009 Maintenance & Support

- a. **REQ-TECH-009.1** (Backups): The system shall support automated backups via:
 - i. Amazon RDS automated backups (daily, retain 7 days minimum)
 - ii. Application server snapshots (weekly)
- b. **REQ-TECH-009.2** (Monitoring): The hosted environment shall support monitoring using:
 - i. AWS CloudWatch for CPU, memory, disk, and network
 - ii. Alerts via email when thresholds are exceeded (e.g. CPU > 80% for 5 min)
- c. **REQ-TECH-009.3** (Updates): The system shall allow upgrades through:
 - i. A version-controlled deployment pipeline (Git repo)
 - ii. A staging environment for testing before production deployment



5. Financials

5.1. Project Cost Structure (Total Budget: \$250,000)

The total project value is set at \$250,000, funded via the Singapore Library Board (SLB) and Ministry of Innovation and Digital Information (MIDI) budgets to support the Smart Nation initiative.

A. Software Development Fees: \$150,000

This covers the labour for the "Project Life Cycle" following the Waterfall model (Requirements, Analysis, Design, Coding, Testing, Implementation).

1. Requirements Analysis & System Architecture: \$40,000
 - 1.1. Includes gap analysis for "horizontal vs vertical scrolling" catalogue interfaces and user profile specifics.
2. UI/UX Design & Database Modelling: \$35,000
 - 2.1. Includes MySQL database schema design for inventory and user records.
3. Backend Coding (Python/Django): \$50,000
 - 3.1. Core development of Admin (inventory management) and User (search/borrow) modules.
4. Frontend Development (HTML/CSS/JS): \$25,000
 - 4.1. Development of responsive interfaces for "Windows 7 or higher" compatibility.

B. Infrastructure & Technical Setup (\$70,000)

This allocation addresses the high-performance requirements to replace the manual system.

1. High-Performance Server Provisioning: \$50,000
 - 1.1. Provisioning server hardware capable of handling 20,000 concurrent users and activity surges 10% over maximum estimation.
2. Security Implementation: \$15,000
 - 2.1. Mitigation measures for cyber hack susceptibility, including encryption for user passwords and data.
3. Local Testing Environment Setup: \$5,000
 - 3.1. Configuration of XAMP Server and staging environments.

C. Integration & Services (\$30,000)

1. Payment Gateway Integration: \$15,000
 - 1.1. API integration for PayPal and PayNow to enable online fine settlement.
2. Quality Assurance (Load Testing): \$10,000
 - 2.1. Rigorous testing to ensure server response times meet "fast report" generation needs.,
3. Documentation & Training: \$5,000
 - 3.1. Creation of user manuals to ensure the system remains "easy to maintain".



5.2. Commercial Rules (System Logic Requirements)

While not a development cost, these financial rules must be hard-coded into the system logic to generate revenue for the library:

- A. Overdue Fines: The system shall automatically calculate a fine of \$0.20 per day for each overdue book.
- B. Damage/Loss Fees: The system shall apply a one-time fee of \$10.00 for each book marked as damaged or lost.
- C. Blocking Logic: The system must enforce a rule where users cannot place new orders (borrow books) if they have unpaid outstanding fines.

5.3. Payment Schedule

Payments are pegged to the delivery milestones defined in the Waterfall methodology.

Milestone Event	Percentage	Amount	Deliverable
Project kick-off	20%	\$50,000	Signed project specification & requirements sign-off.
Design sign-off	30%	\$75,000	Completion of UI prototypes and MySQL database schema
Beta Delivery	30%	\$75,000	Delivery of functional Python/Django code with payment API integration.
Final Acceptance	20%	\$50,000	Successful load testing, soft launch, and handover.
Total	100%	\$250,000	

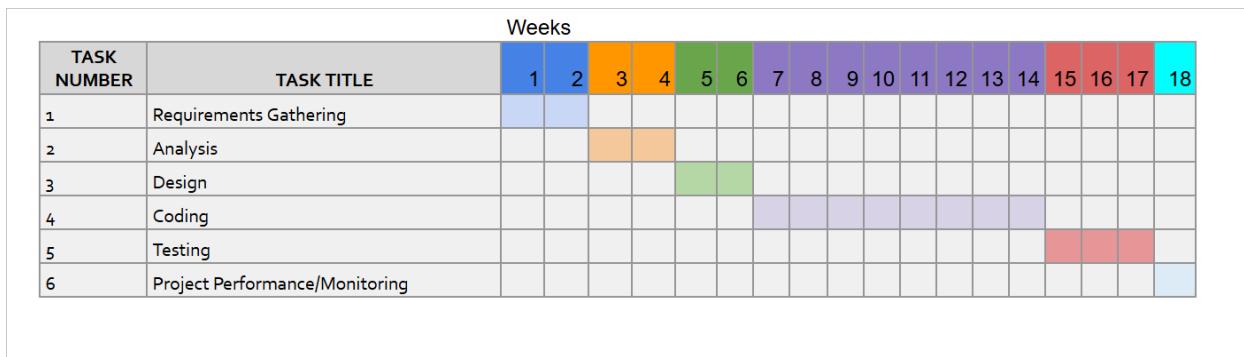


6. Scheduling

6.1. Deliverable Timeline

Phase	Activity	Duration	Key Deliverables
1	Requirements Gathering	Week 1-2	Requirements specification, stakeholder needs
2	Analysis	Week 3-4	Feasibility analysis, system architecture
3	Design	Week 5-6	UI/UX designs, database schema
4	Coding	Week 7-14	Python/Django application development
5	Testing	Week 15-17	Functional testing, load testing (20,000 users)
6	Implementation	Week 18	Soft launch and deployment

6.2. Gantt Chart



Progress Reporting:

Weekly status reports during the Coding phase

Bi-weekly status reports during the Analysis and Design phases



7. Sign-off

Authenticator:

_____ (Project Manager, SoftwareSolutions)

Approvers:

_____ (Representative, LittleLibrary / SLB)

_____ (Financial Officer, MIDI)

Date: ____ / ____ / 2026

8. Requirements Modeling

8.1. USE CASE DIAGRAM

The following use cases are in the Use Case Diagram ([Addendum A](#)). They describe the high level goals that deliver value to the actors of the Library Management System. This aligns with the goal, purpose, value (GPV) principle as each use case represents a meaningful outcome from the actor's perspective.

- UC-01: Locate Available Item to Borrow
 - Allows members to find books they can check-out.
- UC-02: Borrow Item and Start Loan Period
 - Allows a member to check-out a book and begin a loan with an end of loan date.
- UC-03: Return Item and Close Loan
 - Allows a member to return a book that was checked-out by them
- UC-04: Review Loans, Due Dates, and Fines
 - Allows a member to view all books they have checked out, their due dates, and any overdue fine amount.
- UC-05: Maintain Accurate Catalogue and Inventory
 - Allows librarians to maintain accurate records about each book in the library catalogue.
- UC-06: Manage Loans and Overdue Returns
 - Allows librarians to keep track of what books have been loaned out to whom and when they are due back.
- UC-07: Manage Users



- Allows librarians to manage which member is currently registered and to update information about the member's account.
- UC-08: Pay Fines
 - Allows a member to settle any outstanding fines on their account.

8.2. DATA DICTIONARY

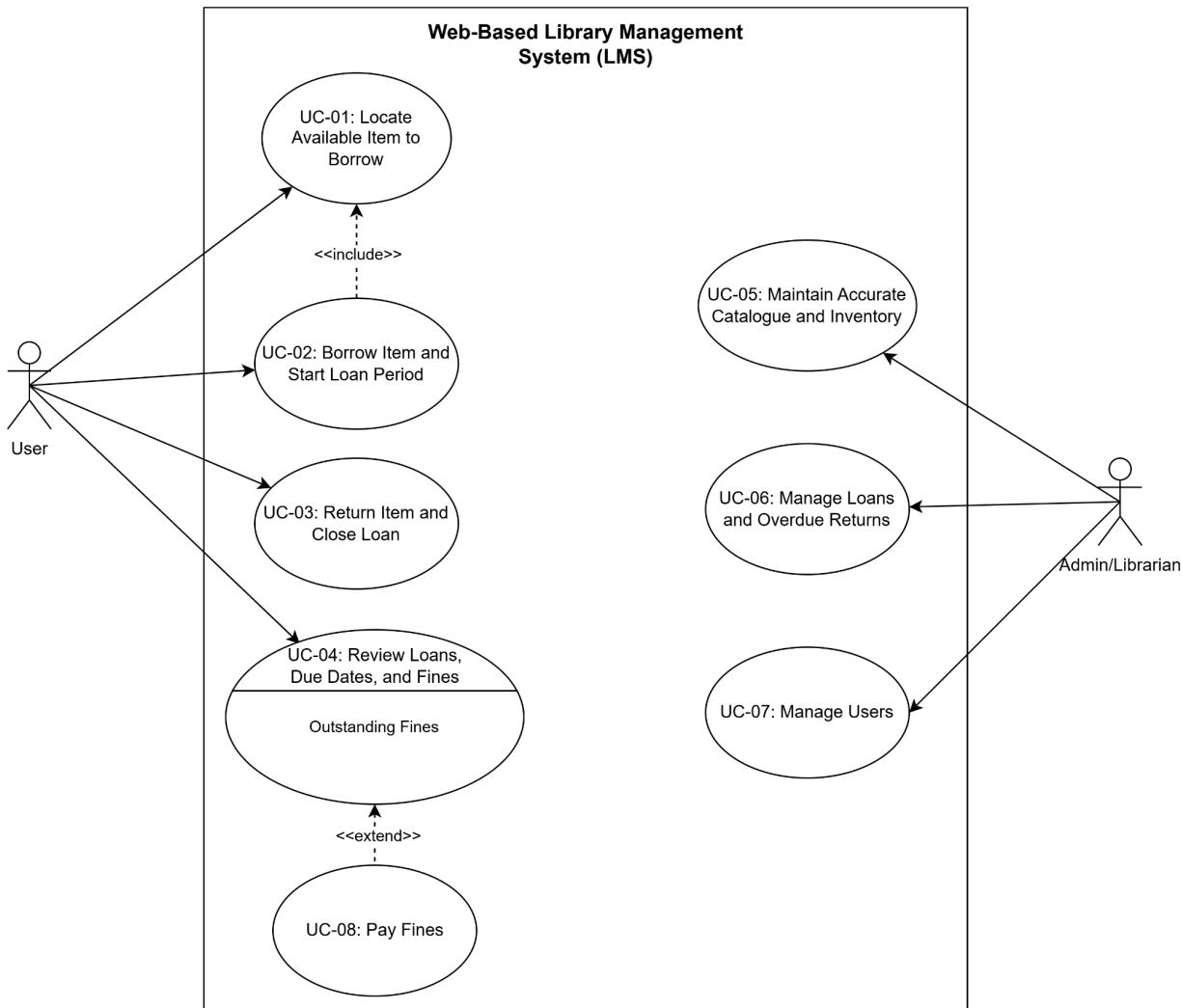
The Data Dictionary ([Addendum B](#)) identifies and describes the principal data entities and data attributes needed to facilitate the basic functions of the Library Management System. It also provides an organized and unambiguous definition of all data stored within the system, which will ensure that all parties have a consistent understanding of this data and will serve as a source document for future design and development activities.

The data entities identified in the Data Dictionary define the primary business concepts of the library domain (users, books, loans, fines, inventory, user preference) and maintain member/staff identity information separately so that there can be a clear distinction made between the types of people using the library and the administrative personnel managing it.



9. Addenda

A. Use Case Diagram





B. Data Dictionary

UserAccount						
Column Name	Data Type	Field Size	Required	Example	Description	
user_id	Int	8	Yes	12345678	Primary Key	
full_name	Varchar	255	Yes	John Doe	Member name	
nric	Varchar	9	Yes	S1234567A	NRIC for verification (must be unique)	
email	Varchar	255	Yes	johndoe@email.com	User email (must be unique)	
password_hash	Varchar	255	Yes	\$2b\$...	Store hashed password only	
phone	Int	8	No	94821231	Optional contact	
status	Enum	20	Yes	Active	Admin may suspend user (Active/Suspended)	
created_at	DateTime	-	Yes	1/28/2026 10:00	Audit trail	

Book						
Column Name	Data Type	Field Size	Required	Example	Description	
book_id	Int	11	Yes	123456	Primary Key	
isbn	Varchar	20	Yes	306406152	ISBN identifier	
title	Varchar	255	Yes	Higher Education 4.0	Book Title	
author	Varchar	255	Yes	Kevin Anthony Jones	Book Author (for searching)	
publisher	Varchar	255	Yes	Springer Publishing	Book Publisher	
publication_year	Int	4	Yes	2021	Year of publication	
cover_image_url	Varchar	255	No	kevin.com/images	Link/path to cover image	
category	Varchar	255	Yes	Fantasy	Category/genre label	
created_at	DateTime	-	Yes	1/28/2026 10:00	Audit trail	

Loan						
Column Name	Data Type	Field Size	Required	Example	Description	
loan_id	Int	11	Yes	7001	Primary Key	
user_id	Int	11	Yes	12345678	Foreign Key (UserAccount.user_id)	
book_id	Int	11	Yes	123456	Foreign Key (Book.book_id)	
loan_start_datetime	DateTime	-	Yes	2/12/2026 12:00	Borrow date/time	
due_datetime	DateTime	-	Yes	2/12/2026 12:00	Return due date/time	
return_datetime	DateTime	-	No	2026	Actual return date/time	
loan_status	Enum	-	Yes	Borrowed	Status (Borrowed/Returned/Overdue)	
created_at	DateTime	-	Yes	1/28/2026 10:00	Audit trail	



AdminAccount						
Column Name	Data Type	Field Size	Required	Example	Description	
admin_id	int	8	Yes	50000012	Primary Key	
staff_email	Varchar	255	Yes	librarian12@littlelibrary.edu.sg	Staff Email (unique)	
password_hash	Varchar	255	Yes	\$2b\$...	Store hashed password only	
status	Enum	20	Yes	Active	Former staff should have their status disabled (ACTIVE/DISABLED)	
created_at	DateTime	-	Yes	1/28/2026 10:00	Audit trail	

Fine						
Column Name	Data Type	Field Size	Required	Example	Description	
fine_id	Int	11	Yes	7001	Primary Key	
user_id	Int	11	Yes	12345678	Foreign Key (UserAccount.user_id)	
loan_id	Int	11	Yes	123456	Foreign Key (Loan.loan_id)	
fine_reason	Enum	-	Yes	OVERDUE	Reason for fine (OVERDUE, DAMAGE, LOST)	
fine_amount	Decimal	8.2	Yes	5.2	Fine amount issued	
fine_status	Enum	-	No	2026	Status (Unpaid/Paid/Waived)	
issued_datetime	DateTime	-	Yes	1/28/2026 10:00	Date fine issued	
last_updated_datetime	DateTime	-	Yes	1/28/2026 10:00	Last status update time	

Inventory						
Column Name	Data Type	Field Size	Required	Example	Description	
inventory_id	Int	5	Yes	10016	Keeps track of the copies of a given book (Primary Key)	
book_id	Int	11	Yes	123456	Foreign Key (Book.book_id)	
total_copies	Int	4	Yes	12	Total copies of specific book owned by the library	
available_copies	int	4	Yes	12	Total copies of specific book available for borrowing	
last_updated_at	DateTime	-	Yes	1/28/2026 10:00	Audit trail	

UserCategoryPreference						
Column Name	Data Type	Field Size	Required	Example	Description	
preference_id	Int	5	Yes	30012	Primary Key	
user_id	Int	8	Yes	12345678	Foreign Key (UserAccount.user_id)	
category	Varchar	255	Yes	Fantasy	Category/genre label(Book.category)	
last_updated_at	DateTime	-	Yes	1/28/2026 10:00	Audit trail	