Library Management System

Complete Project Documentation

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Academic Year: 2025 – 2026

Table of Contents

Part I: Introduction

This section serves as the foundational overview for the Library Management System project. It outlines the essential aspects of the project, including its strategic objectives, functional scope, and the underlying architectural framework that guides its development and implementation. Understanding these core components is crucial for comprehending the subsequent detailed documentation.
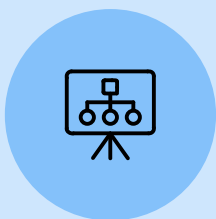
Project Overview

The Project Overview defines the purpose, goals, and scope of the Library Management System. It addresses the challenges faced by contemporary libraries and how this system provides a robust solution for efficient resource management, improved user access, and streamlined administrative tasks.
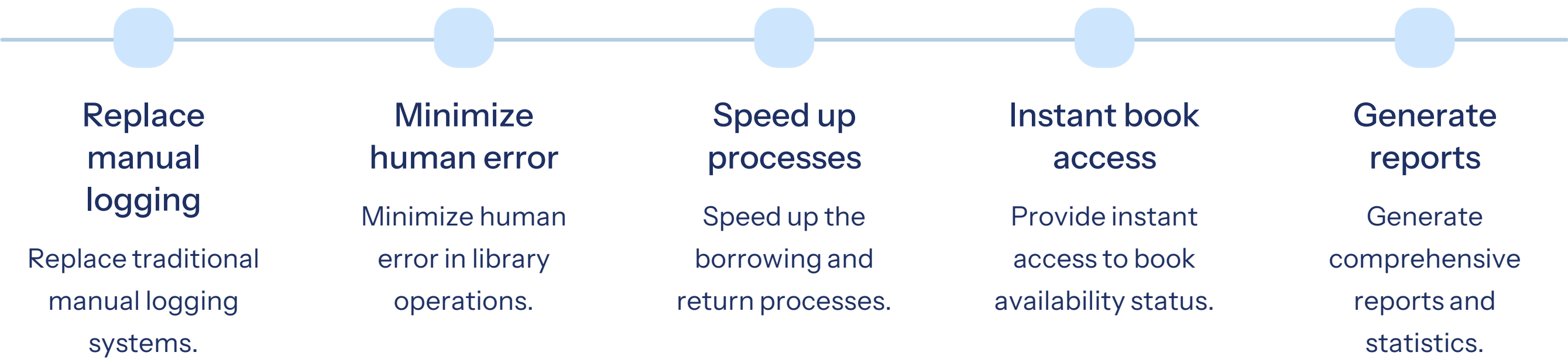
System Architecture

The System Architecture outlines the high-level design and organizational structure of the Library Management System. It details the various modules, components, and their interrelationships, ensuring a scalable, secure, and maintainable platform for library operations.

Project Overview

The Library Management System is a comprehensive desktop application developed using C# and .NET 6 with Windows Forms to modernize the operations of university and public libraries.
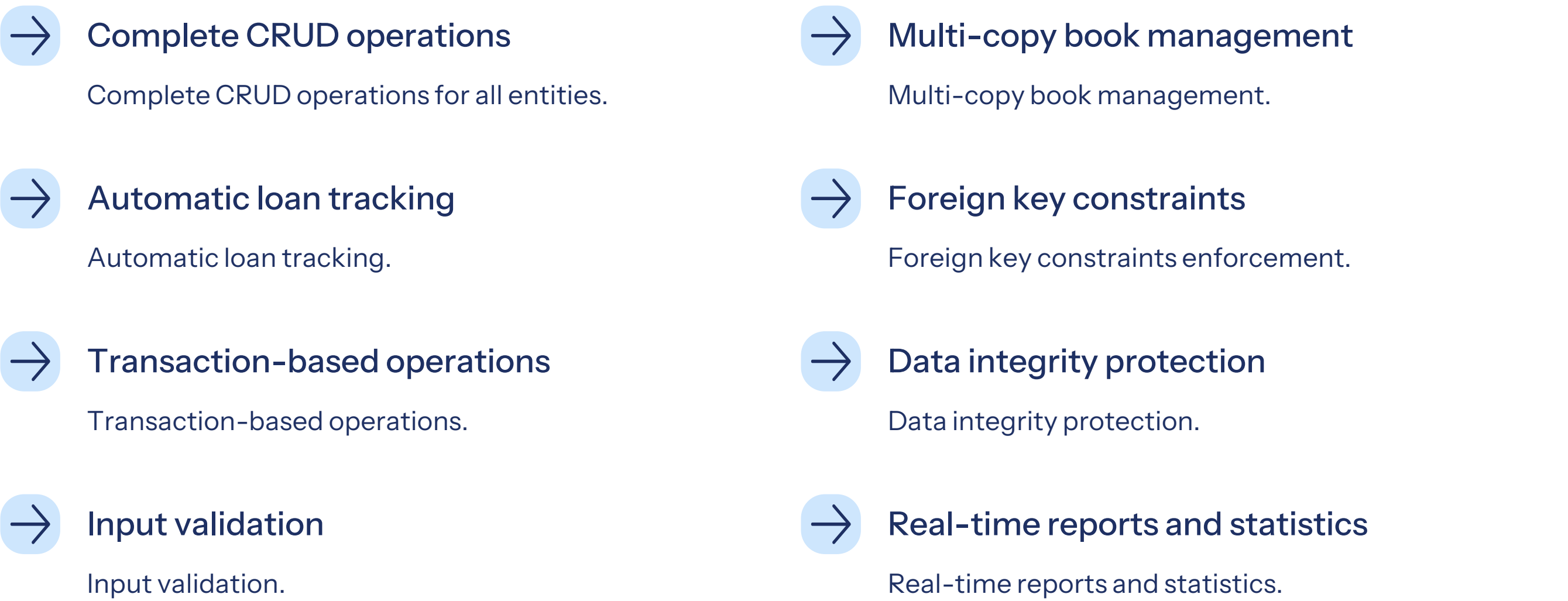

Project Goals

Replace manual logging
Replace traditional manual logging systems.

Minimize human error
Minimize human error in library operations.

Speed up processes
Speed up the borrowing and return processes.

Instant book access
Provide instant access to book availability status.

Generate reports
Generate comprehensive reports and statistics.

Technologies Used

Programming Language: C# (.NET 6)

UI Framework: Windows Forms

Database: SQLite

Architecture Pattern: Repository Pattern

Data Access: ADO.NET with Microsoft.Data.Sqlite

Key Features

→ **Complete CRUD operations**
Complete CRUD operations for all entities.

→ **Multi-copy book management**
Multi-copy book management.

→ **Automatic loan tracking**
Automatic loan tracking.

→ **Foreign key constraints**
Foreign key constraints enforcement.

→ **Transaction-based operations**
Transaction-based operations.

→ **Data integrity protection**
Data integrity protection.

→ **Input validation**
Input validation.

→ **Real-time reports and statistics**
Real-time reports and statistics.

System Architecture

The system follows a three-layer architecture:

Presentation Layer (Forms/)

- User interface components
- Input validation
- User interaction handling

Business Logic Layer (Data/)

- Repository pattern implementation
- Database operations
- Transaction management

Data Layer (Models/)

- Entity definitions
- Data models

Part II: User Interface & Features

This section covers all the user interface modules and features of the Library Management System including Main Menu, Book Management, Author Management, Publisher Management, Category Management, Member Management, Loan Management, and Reports & Statistics.
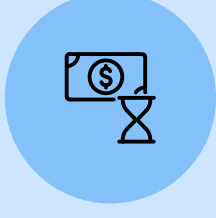
Main Menu

Book Management

Author Management

Publisher Management

Category Management

Member Management

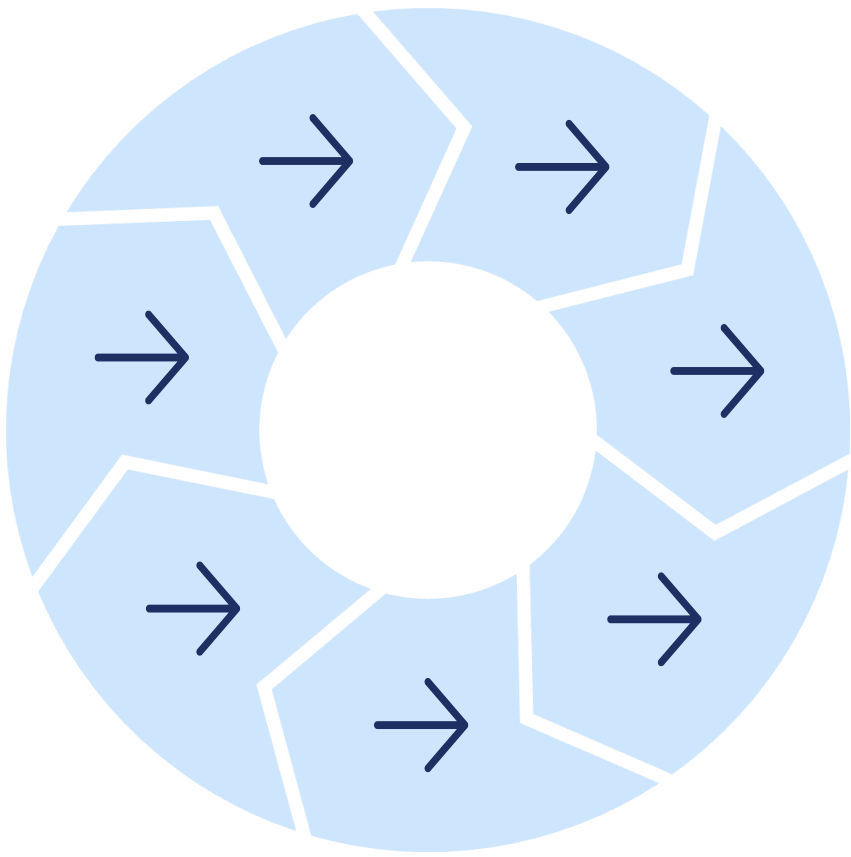**Loan Management**

Reports & Statistics

Main Menu

The main menu provides a clean, intuitive interface with large, accessible buttons for navigating to different modules of the system.

Key features accessible from the main menu include:

Member Management

Book Management

Loan Management

Category Management

Reports

Publisher Management

Author Management

Library Management System	— □ ✕

إدارة الكتب	إدارة الأعضاء
إدارة الإعارات	التقارير
إدارة المؤلفين	إدارة الناشرين
إدارة الفئات	

Book Management

1

Key Functionalities
Add Books

Librarians can add new book entries by providing comprehensive details, ensuring a complete record for each title. Required fields include:

- ISBN
- Title
- Publication Year
- Edition
- Publisher
- Author
- Category
- Number of available Copies

2

Update Books

This functionality allows modification of existing book information such as title, publication year, edition, publisher, author, category, and quantity of copies. Users can update associations with authors, publishers, and categories. **Note:** The ISBN cannot be modified once a book entry is created, as it serves as a unique identifier.

3

Delete Books

Enables the removal of book entries from the system. When a book is deleted, the system handles cascading deletions to maintain data integrity, removing all associated loan records and other related data. A confirmation step is required to prevent accidental deletions.

Features

- **Multi-Copy Support** Efficiently manage multiple copies of the same book title, tracking each individual copy's status and location.
- **Relationship Management** Establish and maintain clear relationships between books and their respective authors, publishers, and categories for a highly organized and easily searchable catalog.
- **Search & Filter** Robust search and filter options allow for quick retrieval of books based on various criteria like title, author, ISBN, category, and availability status.
- **Validation** Implement data validation rules to ensure the accuracy and consistency of all book information entered into the system.

Manage Books — □ ✕

Book Details

ISBN:	978-0007119318
Year:	1934
Publisher:	HarperCollins
Author:	
Category:	Mystery

Title:	Murder on the Orient Express
Edition:	1st
Copies:	1

[Add] [Update] [Delete] [Clear]

ISBN	Title	Year	Edition	Publisher	Category
978-0007119318	Murder on the Ori...	1934	1st	HarperCollins	Mystery
978-0553103540	A Game of Thrones	1996	1st	Bantam Books	Fantasy
978-0618640157	The Fellowship of t...	1954	1st	Allen & Unwin	Fantasy
978-0747532743	Harry Potter and t...	1997	1st	Bloomsbury	Fantasy
978-1501142970	It	1986	1st	Scribner	Horror

Author Management

This module maintains a comprehensive database of authors, ensuring that book records are linked to valid, existing author profiles.

Author Information

Author ID	Name	Biography	Birth Date
Auto-generated unique identifier	Author's full name (required)	Detailed author background	Author's date of birth

Operations

1	2	3	4
Add	**Update**	**Delete**	**Clear**
Create new author profiles	Modify existing author information	Remove authors (protected if linked to books)	Reset form fields

Delete Protection: Cannot delete authors who have books in the library.

Publisher Management

Tracks publishing houses to facilitate book acquisition and inventory organization.

Publisher ID			Name
Auto-generated unique identifier			Publisher name - required

Contact Info			Address
Email or phone contact			Publisher's physical address
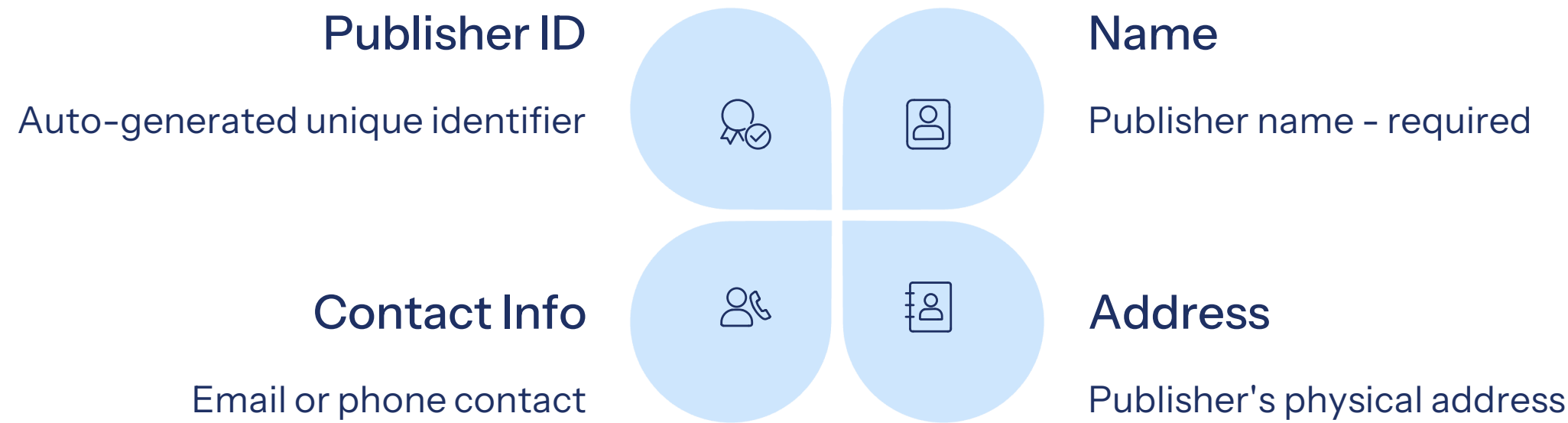
Operations

Add

Register new publishers

Update

Modify publisher details

Delete

Remove publishers (protected if linked to books)

Clear

Reset form

📝 **Delete Protection:** Cannot delete publishers who have books in the library catalog.

■🖳 Manage Publishers   — ▢ ✕

Publisher Details

ID: 1
Name: Bloomsbury
Address: London, UK
Contact: contact@bloomsbury.com

[Add] [Update] [Delete] [Clear]

PublisherId	Name	Address	ContactInfo
1	Bloomsbury	London, UK	contact@bloomsbury.c...
2	Bantam Books	New York, USA	info@bantam.com
3	Allen & Unwin	Sydney, Australia	support@allenandunwi...
4	HarperCollins	New York, USA	help@harpercollins.com
5	Scribner	New York, USA	contact@scribner.com

Category Management

Organizes books into genres and categories for easier browsing and classification.

①   ②   ③

Category Information

- **Category ID:** Auto-generated unique identifier
- **Name:** Category name e.g., Fantasy, Science Fiction, Mystery.

Pre-loaded Categories

1. Fantasy
2. Science Fiction
3. Mystery
4. Horror
5. Adventure

Operations

Add
Create new categories

Update
Modify category names

Delete
Remove categories - protected if linked to books

Clear
Reset form

Delete Protection: Cannot delete categories that are assigned to books in the library.

Manage Categories   — □ ✕

Category Details

ID: 1

Name: Fantasy

[Add] [Update] [Delete] [Clear]

CategoryId	Name
1	Fantasy
2	Science Fiction
3	Mystery
4	Horror
5	Adventure

Member Management

Manages the library's patron database, storing contact information and membership status.

Member ID	**First Name**	**Last Name**	**Email**
Auto-generated unique identifier	Member's first name - required	Member's last name - required	Email address - validated

Phone	**Address**	**Join Date**
Contact phone number	Physical address	Automatically set to current date

Operations

Add (Register new members)	Update (Modify member information)
Delete (Remove members - protected if they have active loans)	Clear (Reset form)

Additional Rules

📝 **Email Validation:** Basic email format validation (must contain @ and .).

📝 **Delete Protection:** Cannot delete members with active (unreturned) loans.

■ Manage Members   — ☐ ✕

Member Details

Member ID: `1`

First Name: `John`   Last Name: `Doe`

Email: `john.doe@email.com`   Phone: `555-0101`

Address:

[**Add**] [**Update**] [**Delete**] [**Clear**]

MemberId	FirstName	LastName	Email	Phone	Address	JoinDate
1	John	Doe	john.doe@e...	555-0101		1/15/2023
2	Jane	Smith	jane.smith@e...	555-0102		2/20/2023
3	Alice	Johnson	alice.j@email....	555-0103		3/10/2023
4	Bob	Wilson	bob.w@email...	555-0104		4/5/2023
5	Eva	Brown	eva.b@email....	555-0105		5/12/2023

Loan Management

The circulation engine of the system, handling the complete check-out and check-in processes.

Loan Workflow

Issue Loan

1. Select member from dropdown
2. Select available book from dropdown (only books with available copies shown)
3. Set issue date (default: today)
4. Set due date (default: 14 days from issue date)
5. Click "Issue Loan"
6. System automatically selects first available copy, creates loan record, updates copy status to "Loaned"

Return Book

1. Select loan from the grid
2. Click "Return"
3. System automatically sets return date, updates copy status to "Available", marks loan as "Returned"

Key Features

Automatic Copy Selection

Streamlines the process of assigning available book copies.

Status Tracking

Monitors the real-time status of all loaned books.

Date Management

Handles issue and due dates with default settings for efficiency.

Add Copy Button

Allows for easy addition of new book copies to the system.
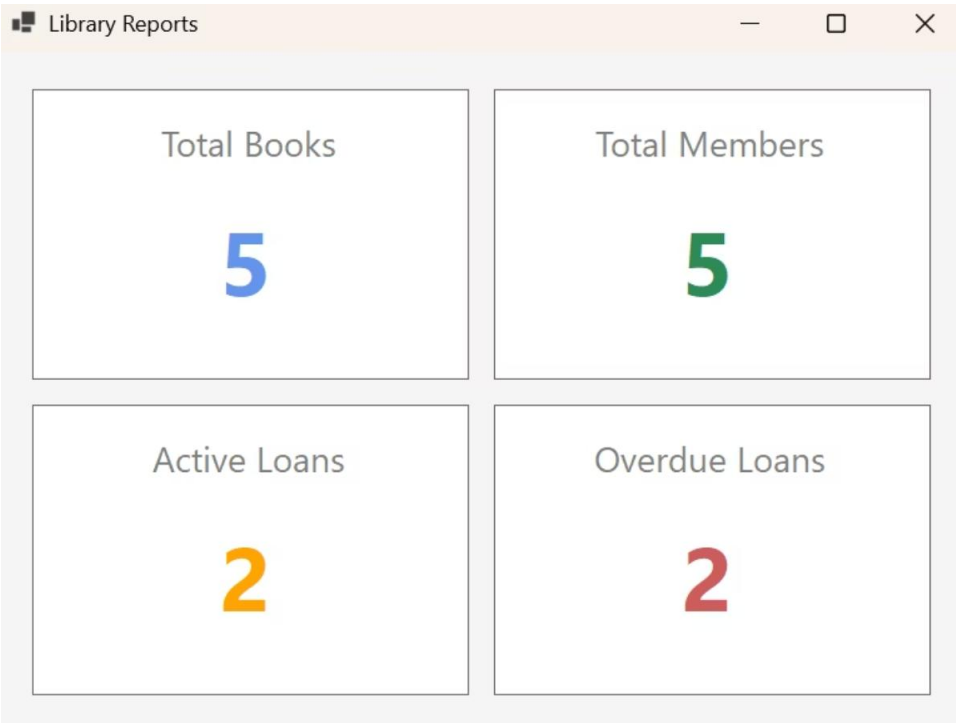
Reports & Statistics

Provides visual insights into library operations to aid in decision-making.

Key Performance Indicators

Total Books

Count of unique book titles in the library (Current value: **5 books**).

Total Members

Count of registered library members (Current value: **5 members**).

Active Loans

Count of currently unreturned loans (Current value: **2 active loans**).

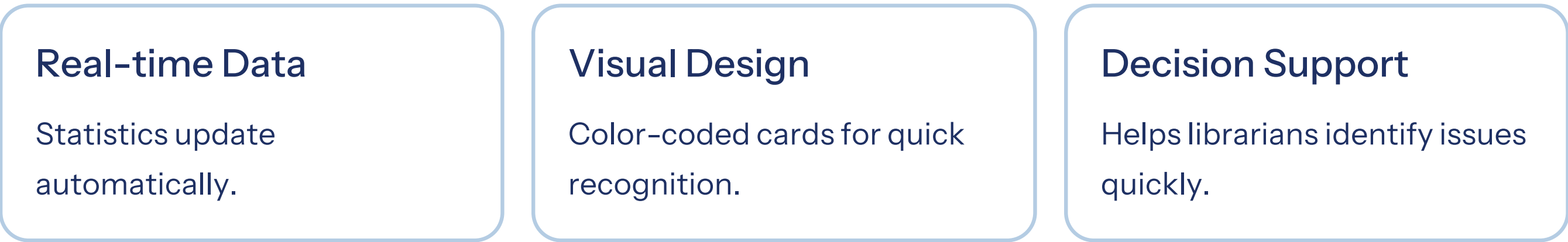### Overdue Loans

Count of loans past their due date (Current value: **2 overdue loans**).
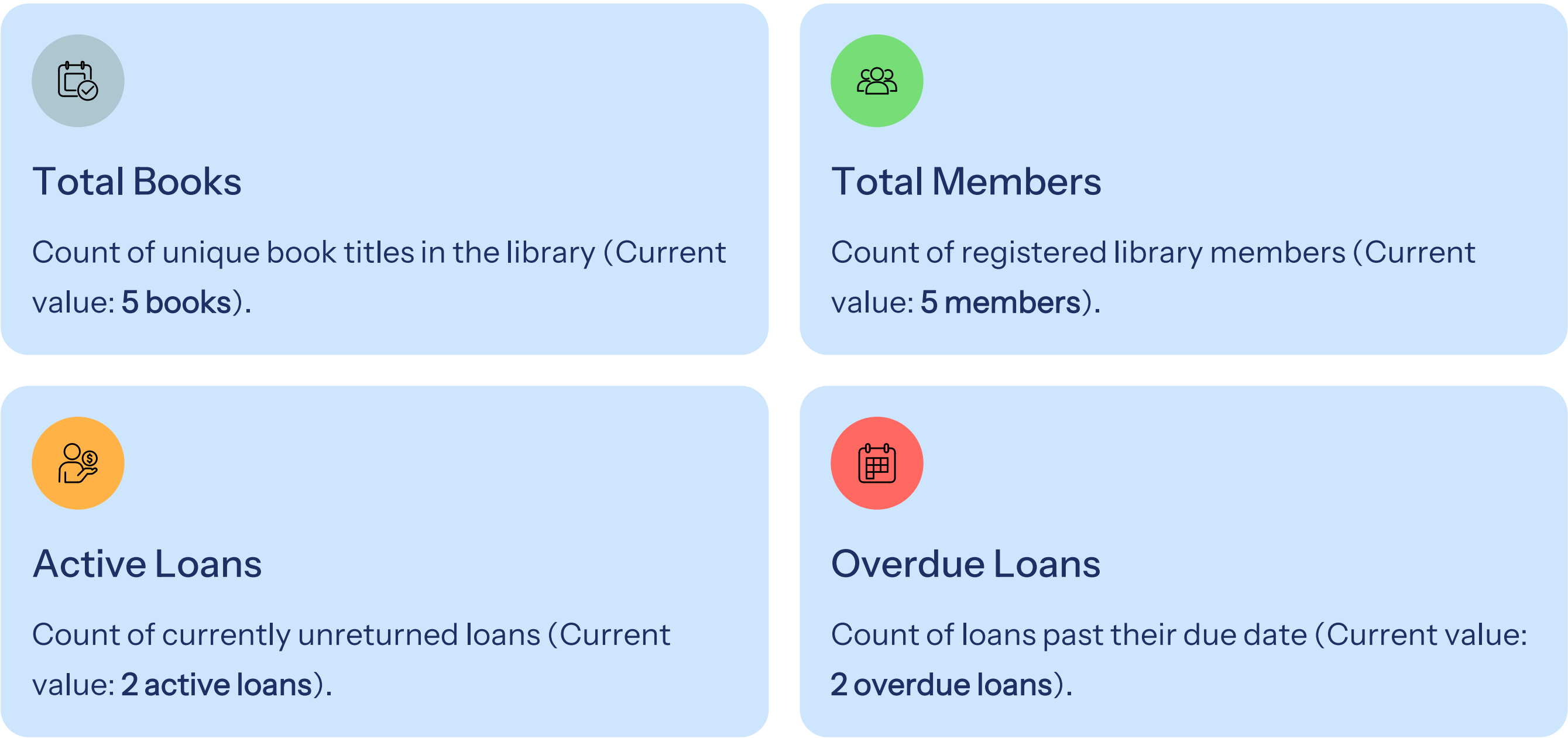
The library's key performance indicators provide a snapshot of its current operational status, offering valuable data for strategic planning.

This bar chart visually represents the current values for each key performance indicator, making it easy to compare and understand the library's metrics at a glance.

Benefits

Real-time Data

Statistics update automatically.

Visual Design

Color-coded cards for quick recognition.

Decision Support
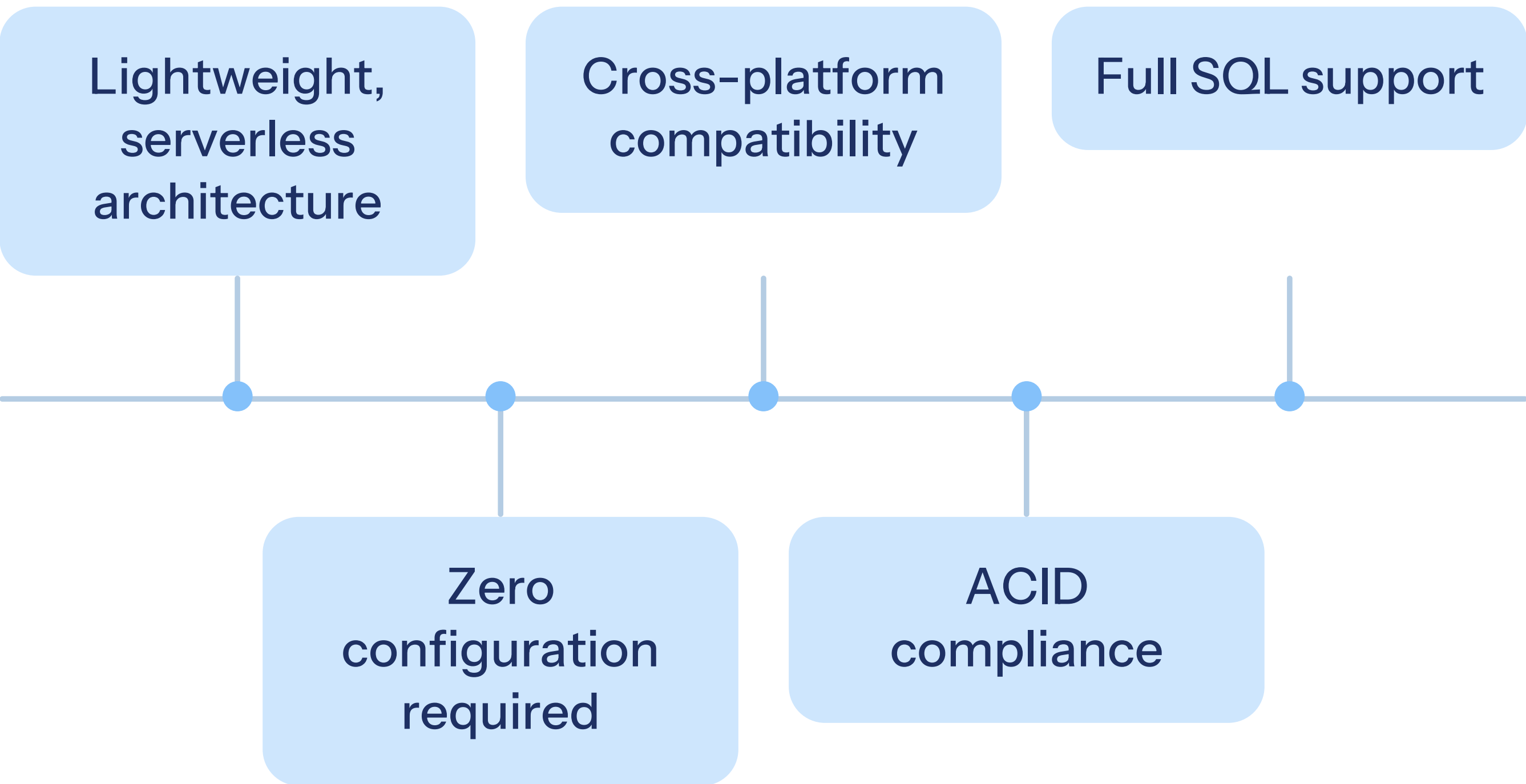
Helps librarians identify issues quickly.

The reporting features empower library staff with immediate, clear, and actionable data to maintain efficient operations and improve user experience.

Part III: Technical Architecture

Database Design

The system uses SQLite as its database engine, providing:

Lightweight, serverless architecture	Cross-platform compatibility	Full SQL support

Zero configuration required	ACID compliance

Database Features

Foreign Key Constraints	Auto-increment Primary Keys	Check Constraints
Enabled to enforce referential integrity	For all ID fields	For status fields e.g., Available, Loaned, Lost

Default Values	NOT NULL Constraints
For join dates and timestamps	For required fields

Entity Relationship Diagram
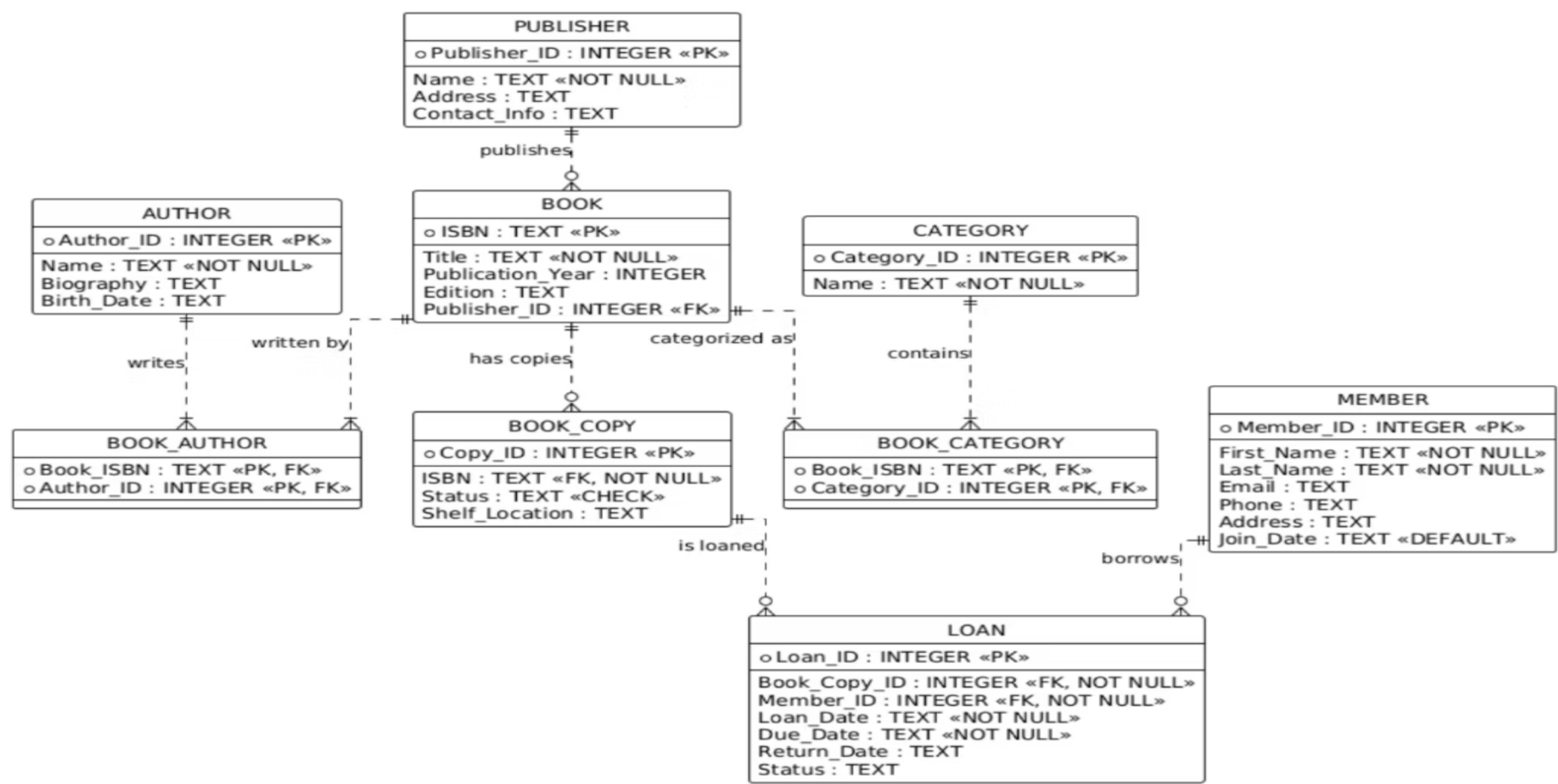
The following ERD illustrates the complete database structure with all 9 tables and their relationships.

Relationship Summary

One-to-Many Relationships

- **PUBLISHER → BOOK:** One publisher can publish many books
- **BOOK → BOOK_COPY:** One book can have many physical copies
- **BOOK_COPY → LOAN:** One copy can be loaned multiple times
- **MEMBER → LOAN:** One member can have multiple loans

Many-to-Many Relationships

- **BOOK ⇔ AUTHOR:** Books can have multiple authors, authors can write multiple books via BOOK_AUTHOR junction table
- **BOOK ⇔ CATEGORY:** Books can belong to multiple categories, categories can contain multiple books via BOOK_CATEGORY junction table

Database Tables – Complete Schema

The library management system is built upon a robust relational database comprising 9 interconnected tables, each designed to store specific information essential for library operations. Below is a detailed overview of each table, including its primary function, key identifiers, and constraints.

1

PUBLISHER Table

Stores publishing house information.

- **Primary Key:** Publisher_ID
- **Required Fields:** Name

2

AUTHOR Table

Stores author information and biographies.

- **Primary Key:** Author_ID
- **Required Fields:** Name

3

CATEGORY Table

Stores book categories/genres.

- **Primary Key:** Category_ID
- **Required Fields:** Name

4

BOOK Table

Stores core book information.

- **Primary Key:** ISBN
- **Foreign Keys:** Publisher_ID → PUBLISHER
- **Required Fields:** ISBN, Title

5

BOOK_AUTHOR Table (Junction)

Many-to-many relationship between books and authors.

- **Composite Primary Key:** (Book_ISBN, Author_ID)

6

BOOK_CATEGORY Table (Junction)

Many-to-many relationship between books and categories.

- **Composite Primary Key:** (Book_ISBN, Category_ID)

7

BOOK_COPY Table

Tracks individual physical copies of books.

- **Primary Key:** Copy_ID
- **Foreign Keys:** ISBN → BOOK
- **Check Constraint:** Status must be 'Available', 'Loaned', or 'Lost'.

8

MEMBER Table

Stores library member information.

- **Primary Key:** Member_ID
- **Required Fields:** First_Name, Last_Name
- **Default Value:** Join_Date = current date

9

LOAN Table

Tracks book loans and returns.

- **Primary Key:** Loan_ID
- **Foreign Keys:** Book_Copy_ID → BOOK_COPY, Member_ID → MEMBER
- **Required Fields:** Book_Copy_ID, Member_ID, Loan_Date, Due_Date

Part IV: Security & Data Integrity

Security Features

1 · **Foreign Key Enforcement**

SQLite foreign key constraints are explicitly enabled to prevent invalid references between tables, orphaned records, and data inconsistencies.

`Connection string: Data Source=LibraryDB.sqlite;Foreign Keys=True;.`

2 · **Delete Protection**

The system implements intelligent delete protection.

- **Members:** Cannot delete members with active loans. Returned loans are automatically deleted.
- **Authors:** Cannot delete authors with books in the library.
- **Publishers:** Cannot delete publishers with books.
- **Categories:** Cannot delete categories with books.

3 · **Transaction-Based Operations**

All multi-step operations use database transactions for atomicity, consistency, isolation, and durability.

4 · **Input Validation**

Email validation (must contain @ and .), Required field validation for ISBN, Title, First Name, Last Name, Name.

5 · **Cascading Deletes**

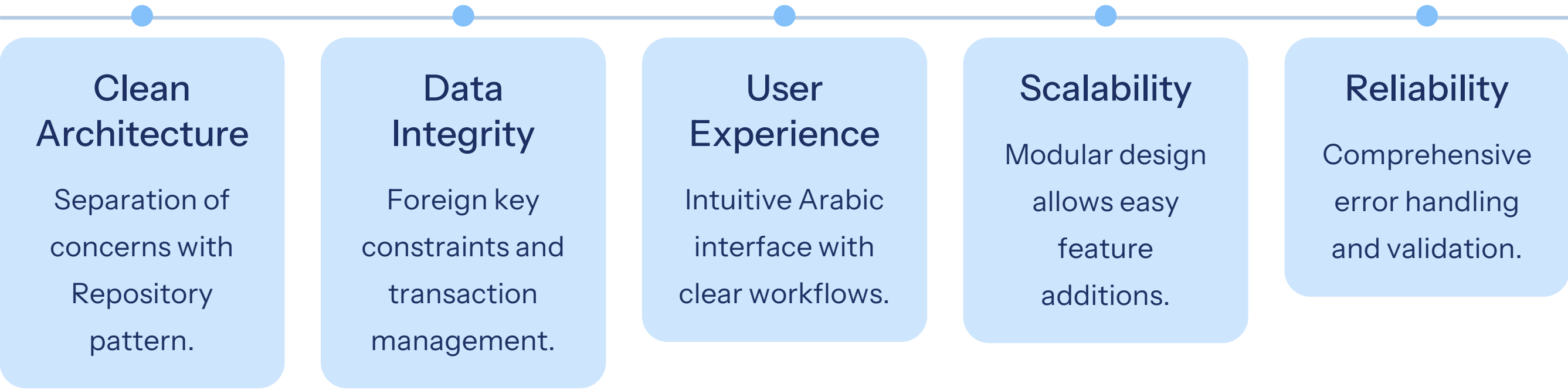When deleting a book, system automatically deletes all loans, copies, author associations, and category associations.

Part V: Conclusion

Conclusion & Future Enhancements

The Library Management System successfully achieves its primary objectives:

Automation
Eliminates manual record-keeping

Efficiency
Speeds up borrowing and return processes

Accuracy
Minimizes human error through validation

Integrity
Maintains data consistency through constraints

Insights
Provides real-time reports and statistics

Technical Achievements

Clean Architecture
Separation of concerns with Repository pattern.

Data Integrity
Foreign key constraints and transaction management.

User Experience
Intuitive Arabic interface with clear workflows.

Scalability
Modular design allows easy feature additions.

Reliability
Comprehensive error handling and validation.

System Statistics

Database Tables
Fully normalized schema

User Interfaces
Complete CRUD operations

Modules
Books, Authors, Publishers, Categories, Members, Loans, Reports

Security Features
Foreign keys, delete protection, transactions, validation

Prepared by: [Student Name] For: [University Name] Academic Year: 2025 - 2026