

Relational Database Model Design to Support School Library Digitalization in Bekasi City Using Database Life Cycle

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Abstract

The digital transformation of school libraries in Bekasi City has become increasingly imperative to overcome the limitations of fragmented and non-integrated manual management systems currently implemented across educational institutions. Such conditions hinder efficient collection management, circulation monitoring, data reporting, and evidence-based decision-making, all of which are essential components in supporting school literacy programs. Library digitalization represents a strategic initiative to transform conventional library services into technology-enabled learning ecosystems. Through the integration of digital technologies, libraries can effectively manage both physical and electronic collections, provide seamless access to information resources, and foster students' digital literacy competencies in alignment with the demands of contemporary education. This study aims to develop a centralized and standardized relational database model capable of supporting integrated digital library operations across schools in Bekasi City. To achieve this objective, the Database Life Cycle (DBLC) methodology was adopted as the primary framework for database development. The research process comprised four sequential phases: (1) requirements analysis, (2) Entity Relationship Diagram (ERD) design and database normalization, (3) physical database implementation using a Database Management System (DBMS), and (4) functional testing and validation of the database. By employing this systematic approach, the study produces a robust, scalable, and maintainable database blueprint that can serve as the foundational infrastructure for the development of an integrated digital school library platform in Bekasi City.

Keywords : Database Life Cycle; Model Design; Digitization; School Library; Relational Database

1. INTRODUCTION

School libraries play a strategic role in supporting the learning process, developing information literacy competencies, and fostering reading culture among students. Beyond serving as repositories of educational resources, school libraries function as essential learning support facilities that promote student-centered learning and the development of twenty-first-century skills (1). However, the management of school libraries in Bekasi City remains largely dependent on manual systems that operate independently across schools. Core library activities, including collection management, borrowing and returning transactions, membership administration, and reporting processes, are predominantly conducted through conventional methods. Such practices may result in data duplication, recording errors, reporting delays, and overall inefficiencies in library information management (2).

This condition poses a significant challenge to the implementation of the School Literacy Movement (Gerakan Literasi Sekolah/GLS), which positions the library as a learning resource center capable of providing timely, accurate, and accessible information services. In response to rapid advancements in information technology, school libraries are increasingly expected to transform into digital service environments that are adaptive, integrated, and user-oriented (3). Library digitalization has emerged as a strategic initiative to improve service efficiency, expand access to information resources, and facilitate data-driven decision-making in educational management (4).

The success of library digitalization initiatives depends not only on application interfaces or the availability of digital collections but also on the quality of the underlying information system architecture. A fundamental component of any library information system is the database, which serves as the central mechanism for data storage, management, and integration (5). A centralized and standardized database infrastructure enables data consistency across institutions, simplifies information synchronization processes, enhances data security, and supports sustainable system development (6). Conversely, poorly designed database structures may lead to data redundancy, information inconsistency, and integration challenges when systems are expanded to a broader organizational scale (7).

Furthermore, centralized database architectures have been recognized as critical enablers of interoperability and long-term scalability in digital library ecosystems (8). The transformation of conventional libraries into digital environments requires integrated management of collections, users, and library services through technology-based

solutions (9). Moreover, future-ready school libraries increasingly rely on information systems capable of supporting evidence-based decision-making, resource optimization, and continuous adaptation to users' evolving needs (10).

Although numerous studies have examined web-based library information systems and digital library development, research specifically focusing on the design of a centralized relational database model for integrating school library management at the regional level remains limited. Therefore, this study aims to design a centralized relational database model to support the digital operation of school libraries in Bekasi City (11). The proposed database model is expected to provide a systematic and structured technical blueprint that can serve as the foundation for the development of an integrated digital school library platform. Ultimately, the implementation of such a platform is anticipated to enhance the effectiveness of library management and contribute to the sustainable advancement of school literacy programs.

2. RESEARCH METHODOLOGY

2.1 Research process flow

Based on the aforementioned background, the research problems addressed in this study are as follows: 1) To identify and collect the data requirements and information structures needed for a digital school library system in Bekasi City. 2) To design a standardized and normalized relational database model that supports the digital management of school libraries. 3) To implement and evaluate a database prototype using the Database Life Cycle (DBLC) approach as the foundational infrastructure for a digital school library system.

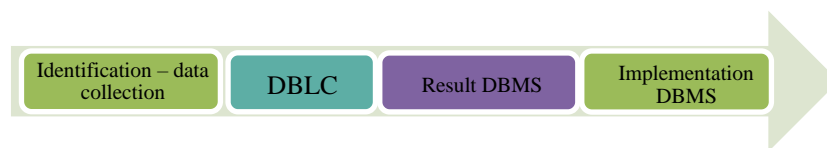


Figure 1. Research process flow

The urgency of this study stems from the need for a robust technical foundation to support the digital transformation of school libraries in Bekasi City. A centralized and standardized database design is expected to enhance data management efficiency, facilitate interoperability and integration among schools, and support data-driven decision-making processes. Furthermore, the findings of this study can serve as a technical reference for system developers and policymakers in establishing a scalable, sustainable, and integrated digital library platform that aligns with the growing demands of digital literacy within the school education environment (12).

2.2 Needs Analysis

The research process commenced with a problem identification phase aimed at analyzing the existing school library management practices, which are predominantly manual and fragmented across institutions. This phase was followed by an extensive literature review to establish the theoretical and conceptual framework underpinning library digitalization and relational database design. Subsequently, field data collection was conducted to gather empirical evidence regarding operational workflows, data characteristics, and user requirements within the school library ecosystem. The findings from this stage were utilized to define the core requirements for the proposed digital library system, including infrastructure, security, and system-related specifications. These requirements serve as the foundation for designing a centralized and standardized relational database model and are summarized in the following table.

Table 1. Types of database types

Name	Category	Available
Cloud server	Infrastructure	1
MySQL	System	1
Back up and recovery	Safety	1

The database design process was conducted using the Database Life Cycle (DBLC) framework. This phase included database planning, which aimed to determine the scope and objectives of the database development, and system definition, which focused on defining the system boundaries and operational context. Subsequently, the requirements collection and analysis phase was carried out to identify and structure the data requirements needed to support the digital school library system.

The process continued with database design, encompassing both conceptual and logical design stages, to develop a normalized relational database model capable of supporting library operations efficiently. In addition, the DBMS selection phase was performed to identify the most appropriate Database Management System based on the system requirements and anticipated operational needs. The primary outcome of this phase was a comprehensive database design, including an Entity Relationship Diagram (ERD) that illustrates the entities, attributes, and relationships within the proposed system.

At the current stage of the research, activities have focused on the preliminary database planning phase, involving an initial analysis and comparison of general library database system processes and structures. This analysis serves as the foundation for identifying core data entities, business processes, and system requirements that will guide the subsequent stages of database design and implementation (13)(14)(15).

3. RESULTS AND DISCUSSION

3.1 Database Implementation

This phase represents the final outcome of the study, involving the implementation of the relational database design into the selected DBMS and subsequent functional testing. The testing process aimed to verify data integrity, relationship consistency, and database readiness as the foundation of an integrated digital school

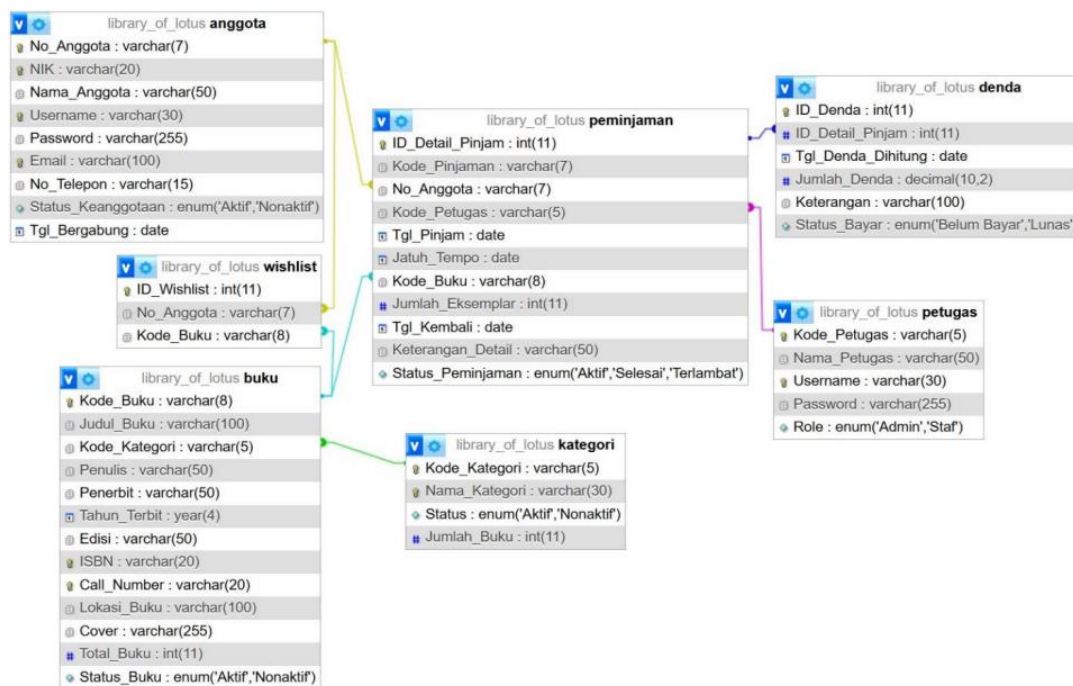


Figure 2. Database result

The implementation of the relational database successfully produced an integrated library management database consisting of seven interconnected entities, namely anggota (members), buku (books), kategori (categories), peminjaman (borrowing transactions), denda (fines), petugas (staff), and wishlist. Each entity was designed based on the operational requirements of the school library and connected through primary and foreign key relationships to ensure data consistency and integrity.

3.2 Database Relationship Analysis

The anggota table serves as the master data repository for library members, storing membership information such as member identification number, personal details, contact information, account credentials, membership status, and registration date. The primary key *No_Anggota* is referenced by both the peminjaman and wishlist tables, enabling the system to track borrowing activities and book interests of individual members.

The buku table functions as the central repository for library collections. It contains bibliographic information including title, author, publisher, publication year, ISBN, call number, book location, and inventory quantity. The table is linked to the kategori table through the foreign key *Kode_Kategori*, creating a one-to-many relationship where a single

category can contain multiple books. This relationship facilitates efficient cataloging and classification of library resources.

The *peminjaman* table represents the core transactional entity within the database. It records all borrowing activities by linking members, books, and library staff through the attributes *No_Anggota*, *Kode_Buku*, and *Kode_Petugas*. The table also stores borrowing dates, due dates, return dates, number of borrowed copies, and borrowing status. This design enables complete tracking of the borrowing lifecycle from checkout to return.

The *denda* table was implemented to support overdue management. Each fine record is associated with a specific borrowing transaction through the foreign key *ID_Detail_Pinjam*. This one-to-one relationship ensures that penalties are directly linked to borrowing records, allowing automatic calculation and monitoring of overdue fines. The *petugas* table stores authentication and authorization information for library staff. Through its relationship with the *peminjaman* table, every transaction can be traced to the responsible staff member, supporting accountability and auditability within the system. Additionally, the *wishlist* table was implemented as a supporting feature that records books desired by members. This relationship between members and books provides valuable insights into user preferences and can assist librarians in future collection development decisions.

Table 2. Types of database types

Aspect	Result
Total entities	7
Master tables	Anggota, Buku, Kategori, Petugas
Transaction tables	Peminjaman, denda
Supporting table	Wishlist
Normalization Level	Third Normal Form (3NF)
Primary key	7
Foreign key relationship	6
Referential integrity	Implemented
Borrowing traceability	Supported
Fine management	Supported
User preference analysis	Supported through Wishlist

From table 2, Analysis of the Entity Relationship Diagram (ERD) identified several important relationships. The relationship between *kategori* and *buku* is categorized as one-to-many (1:M), where one category may contain multiple books. Similarly, the relationship between *anggota* and *peminjaman* follows a one-to-many structure because a member can borrow multiple books over time. The relationship between *petugas* and *peminjaman* is also one-to-many, allowing a single staff member to process numerous transactions.

Furthermore, the relationship between *peminjaman* and *denda* ensures transaction traceability by associating each fine record with a specific borrowing transaction. The *wishlist* entity acts as a bridge between members and books, representing users' reading interests while maintaining relational consistency.

3.3 Normalization and Data Integrity

The database was normalized to the Third Normal Form (3NF), reducing data redundancy and ensuring efficient data management. Referential integrity was maintained through foreign key constraints, preventing invalid or orphan records and ensuring consistency across all entities.

The implemented relational database effectively supports integrated library operations, including member management, book collections, borrowing transactions, and fine administration. Compared to manual processes, the system improves data accuracy, transaction tracking, and reporting efficiency. Furthermore, the *wishlist* feature provides insights into user preferences, while the scalable database architecture supports future enhancements such as digital collections, OPAC services, mobile applications, and inter-school library integration.

4. CONCLUSION

This study successfully developed a centralized and standardized relational database model to support the digital transformation of school libraries in Bekasi City. Using the Database Life Cycle (DBLC) methodology, the database was systematically designed, implemented, and tested to ensure its functionality, integrity, and scalability. The resulting database consists of seven interconnected entities that effectively support core library operations, including collection

management, member administration, borrowing transactions, fine management, and user preference tracking. The database was normalized to the Third Normal Form (3NF) and implemented with primary and foreign key constraints, ensuring data consistency, minimizing redundancy, and maintaining referential integrity. Functional testing demonstrated that the proposed database can reliably support integrated library processes and improve the efficiency of information management compared to conventional manual systems. Overall, the proposed relational database provides a robust and maintainable foundation for the development of an integrated digital school library platform. The database model can serve as a technical blueprint for future library digitalization initiatives, enabling more effective data management, supporting evidence-based decision-making, and contributing to the advancement of digital literacy programs within educational institutions.

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