La-Net

LIS421

DATABASE DESIGN AND MANAGEMENT

- **Course code**: LIS 421
- **Course title**: Database Design and Management
- **Credit load**: 2 Units (Lecture Hours 15; Practical Hours 45)
- **Series list**:
  1. Concepts and Foundations of Database Design and Management
  2. Types of Databases and Principles for Microcomputers
  3. Applications of Databases in Library and Information Fields
  4. Processes of Database Design, Creation, and Maintenance
  5. Advanced Database Systems and Practical Management

Proposed Outline for Series 1

- **Part 1.1 Key Concepts in Database Design and Management**
  - 1.1.1 Definition of data
  - 1.1.2 Definition of database
  - 1.1.3 Definition of database design
  - 1.1.4 Definition of database management
- **Part 1.2 Scope of Database Design and Management**
  - 1.2.1 Scope of database design
  - 1.2.2 Scope of database management
  - 1.2.3 Importance of database principles for microcomputers
- **Part 1.3 Principles of Database Systems**
  - 1.3.1 Relational database systems
  - 1.3.2 Database principles for microcomputers
- **Introduction**
- Databases are at the heart of modern information systems, and understanding their foundations is essential for anyone studying library and information science. In this first Series, we will explore the basic concepts that underpin database design and management. You will encounter definitions of key terms such as **data**, **database**, **database design**, and **database management**, and you will see how these concepts form the building blocks of more advanced topics.
- The aim of this Series is to provide you with a clear grounding in the principles of database systems, particularly relational databases, and to explain the scope of database design and management. By beginning here, you will be able to appreciate how databases

are structured, why they are important, and how they support the work of libraries and information centres.

- We will start by defining the core concepts, then move on to examine the scope of database design and management, and finally consider the principles of database systems with emphasis on relational models and microcomputer applications. This sequential approach ensures that you build a strong foundation before progressing to more complex aspects of database design and management in later Series.

Series Learning Outcomes

By the end of **Series 1: Foundations of Database Design and Management**, you should be able to:

- **SLO 1.1 Define** the key concepts of data, database, database design, and database management.
- **SLO 1.2 Explain** the scope of database design and database management in relation to information systems.
- **SLO 1.3 Analyse** the importance of database principles for microcomputers, with emphasis on relational database systems.
- **SLO 1.4 Evaluate** how foundational concepts and principles support later stages of database development and applications.

1.1 Key Concepts in Database Design and Management

Databases are built upon a set of fundamental ideas that guide their design and use. In this Part, we will define the core concepts that form the foundation of database design and management.

1.1.1 Definition of Data

Data refers to raw facts, figures, or symbols that represent information. Data can be numbers, text, images, or sounds. On its own, data has little meaning until it is organised and processed.

Fill in the blank:

- Raw facts, figures, or symbols that represent information are called __________.

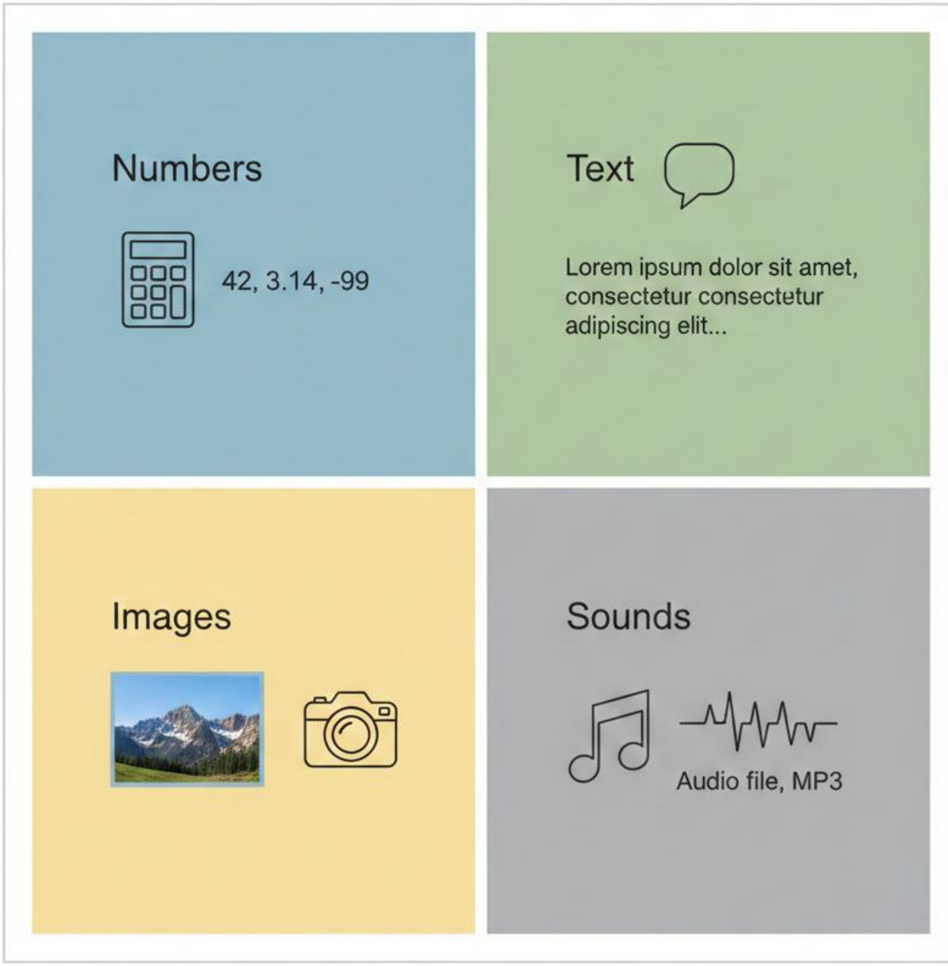


Figure 1.1 Representation of data in different forms

1.1.2 Definition of Database

A **database** is an organised collection of data that can be easily accessed, managed, and updated. Databases are designed to store information systematically so that users can retrieve and manipulate it efficiently.

Fill in the blank:

- An organised collection of data that can be accessed and updated is called a __________.

Box 1.1 Key features of a database

- organised
- accessible
- manageable
- updatable

Caption: Box 1.1 Key features of a database

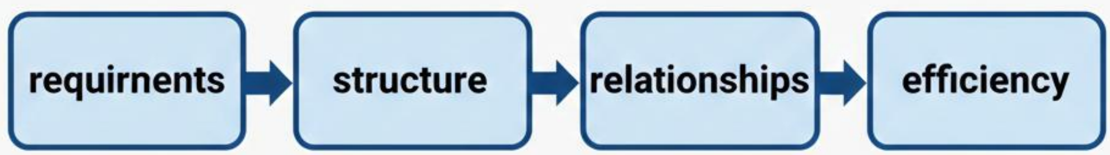
1.1.3 Definition of Database Design

Database design is the process of structuring a database to meet specific requirements. It involves deciding how data will be stored, organised, and related to ensure efficiency and accuracy.

Fill in the blank:

- The process of structuring a database to meet specific requirements is called __________.

Figure 1.2 Steps in database design



Caption: Figure 1.2 Steps in database design

1.1.4 Definition of Database Management

Database management refers to the activities involved in controlling and maintaining a database system. It includes tasks such as updating records, ensuring data security, and managing user access.

Fill in the blank:

- The activities involved in controlling and maintaining a database system are called __________.

Table 1.1 Functions of database management

Function	Description
Updating Records	Adding, modifying, and deleting data.
Security	Protecting data from unhahorized access.
User Access	Controlling who can view and edit data.

Caption: Table 1.1 Functions of management

Pilot questions 1.1

1. Define data.
2. What is a database?
3. What does database design involve?
4. List two functions of database management.
5. Fill in the blank: An organised collection of data that can be accessed and updated is called a ___________.

1.2 Scope of Database Design and Management

The **scope** of database design and management refers to the range of activities, responsibilities, and applications that these processes cover. It helps us understand not only what databases are, but also how they are planned, implemented, and maintained in different contexts.

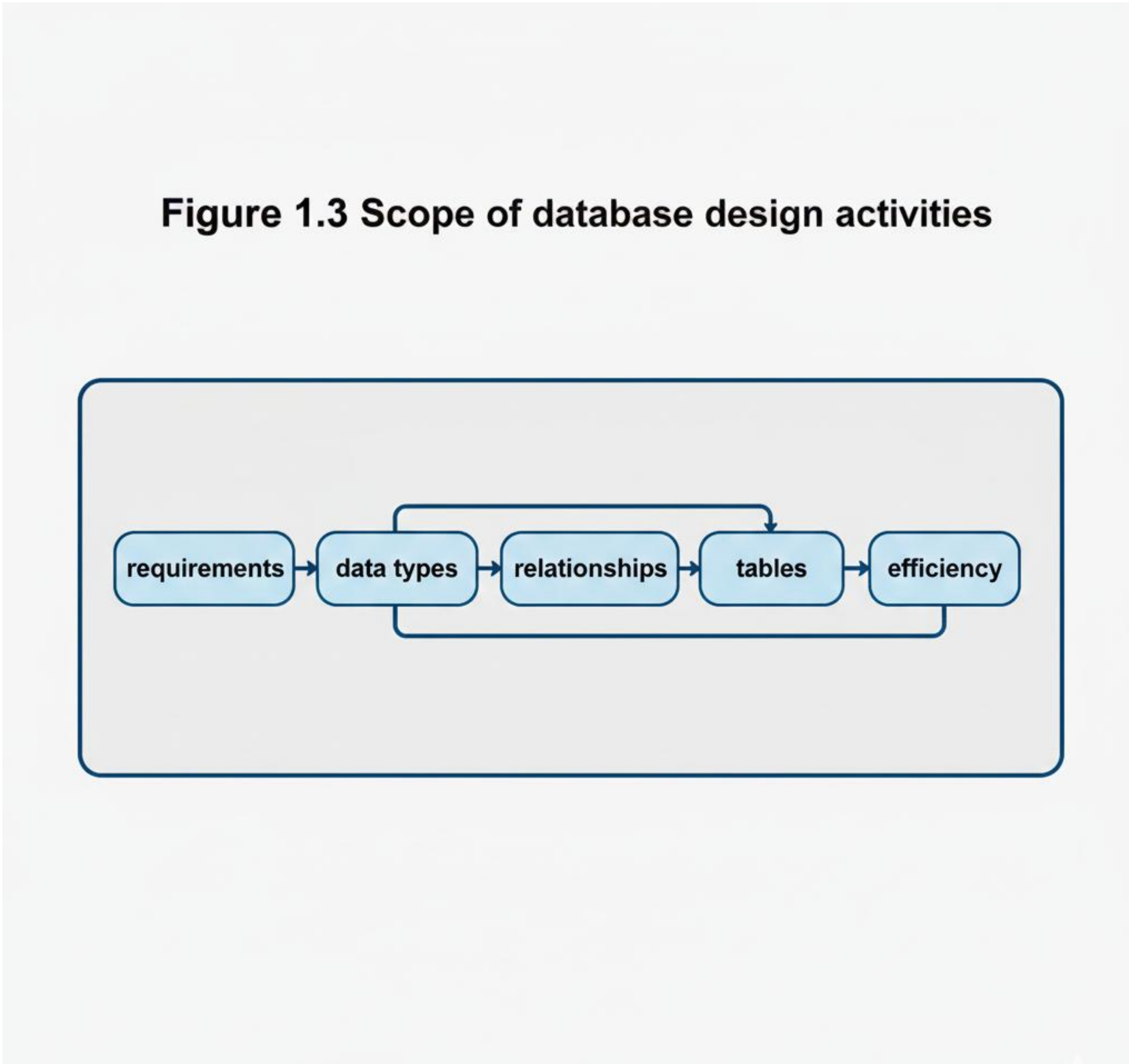
1.2.1 Scope of Database Design

Database design involves determining how data will be structured, stored, and related. Its scope includes:

- Identifying user requirements.
- Defining data types and relationships.
- Designing tables, fields, and keys.
- Ensuring efficiency, accuracy, and scalability.

Fill in the blank:

- The process of determining how data will be structured, stored, and related is called __________.



Caption: Figure 1.3 Scope of database design activities

1.2.2 Scope of Database Management

Database management covers the activities required to operate and maintain a database system. Its scope includes:

- Updating and modifying records.
- Ensuring data integrity and security.
- Managing user access and permissions.
- Backing up and recovering data.

Fill in the blank:

- Ensuring data integrity and security is part of the scope of __________ management.

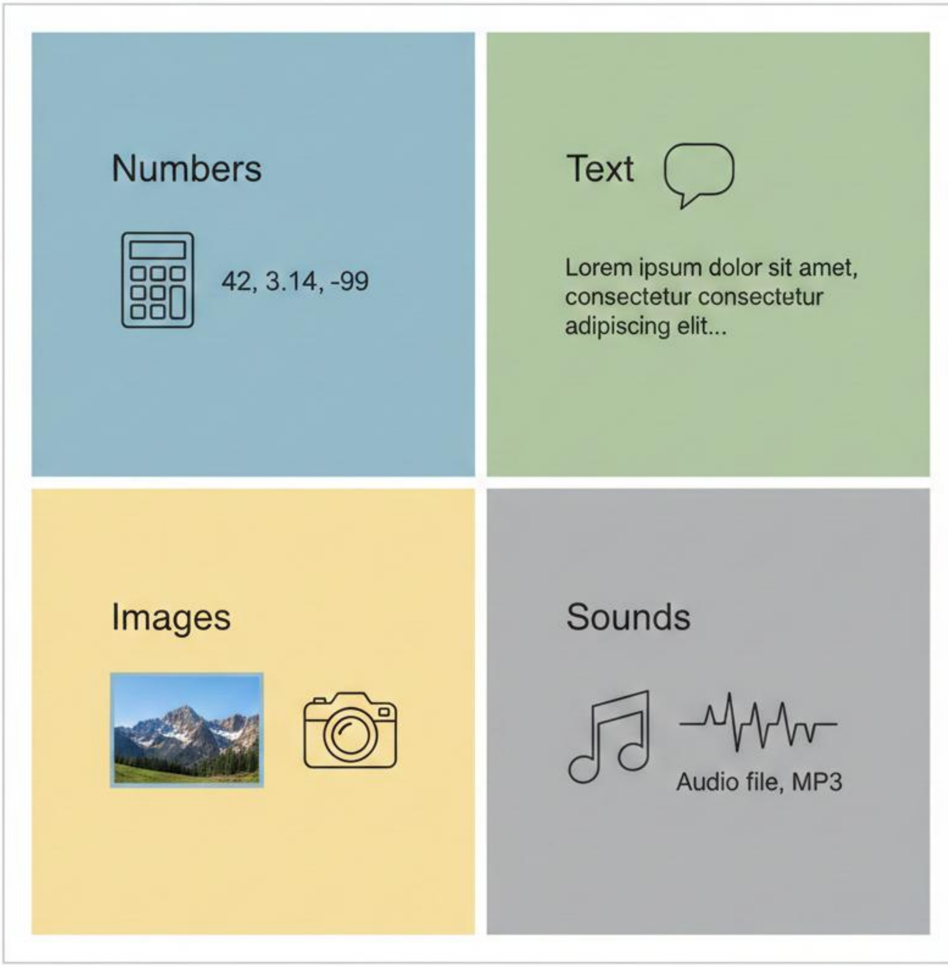


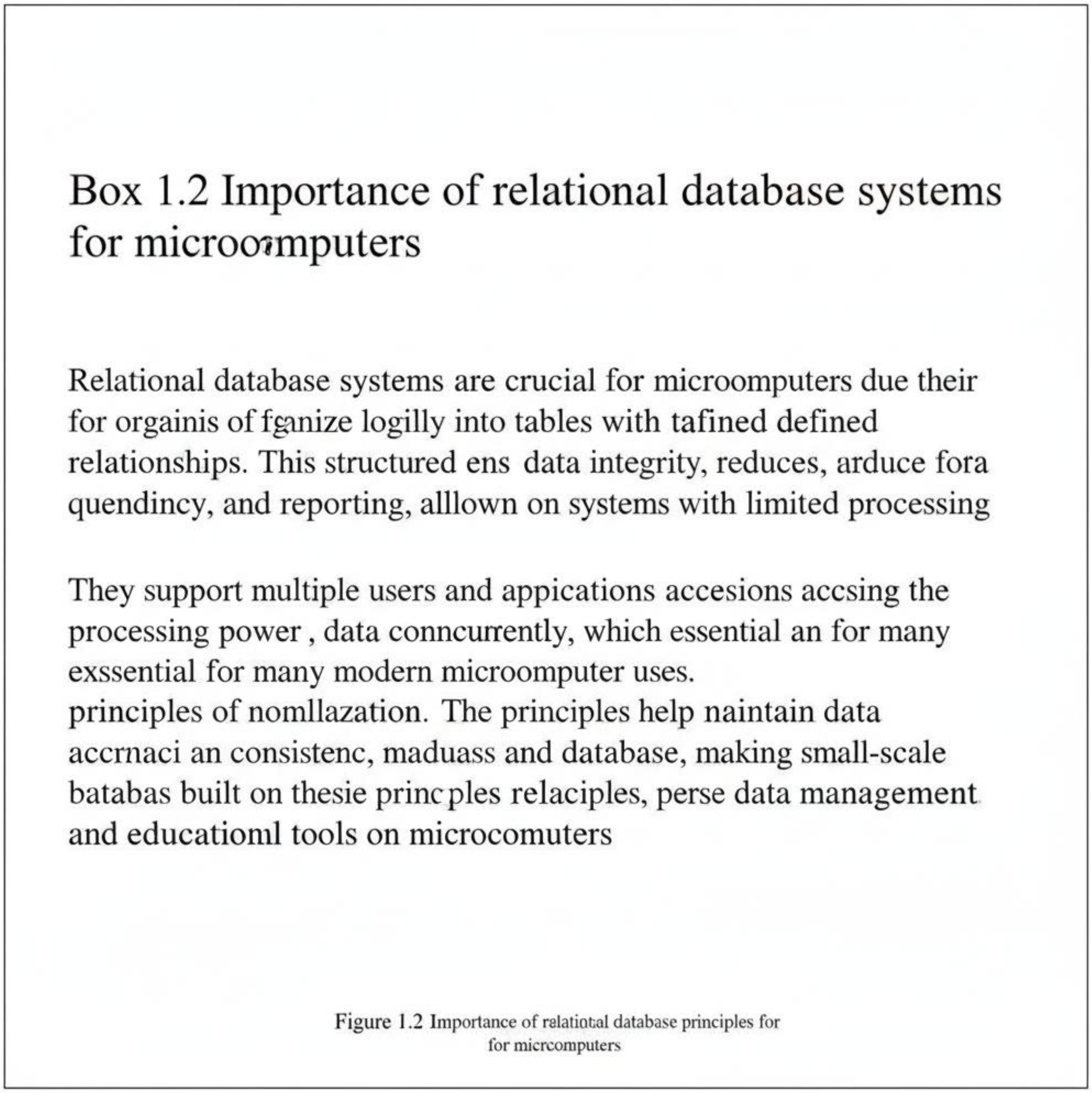
Figure 1.1 Representation of data in different forms

1.2.3 Importance of Database Principles for Microcomputers

Microcomputers, such as personal computers, rely on **database principles** to manage information effectively. Relational database systems are especially important because they allow data to be organised into tables and linked through relationships. This makes data retrieval faster and more reliable.

Fill in the blank:

- Relational database systems organise data into __________ and link them through relationships.



Box 1.2 Importance of relational database systems for microo?mputers

Relational database systems are crucial for microompputers due their for orgainis of fganize logilly into tables with tafined defined relationships. This structured ens data integrity, reduces, arduce fora quendincy, and reporting, alllown on systems with limited processing

They support multiple users and appications accesions accsing the processing power , data conncurrently, which essential an for many exssential for many modern microompputer uses.
principles of nomllazation. The principles help naintain data accrnaci an consistenc, maduass and database, making small-scale batabas built on thesie princ ples relaciples, perse data management and educationl tools on microcomuters

Figure 1.2 Importance of relatiotal database principles for for micrcomputers

Pilot questions 1.2

1. What does the scope of database design include?
2. List two activities within the scope of database management.
3. Why is data integrity important in database management?
4. Fill in the blank: Relational database systems organise data into __________.
5. Explain why database principles are important for microcomputers.

1.3 Principles of Database Systems

Database systems are built on a set of guiding principles that ensure data is stored, organised, and retrieved efficiently. In this Part, we will focus on relational database systems and their application to microcomputers.

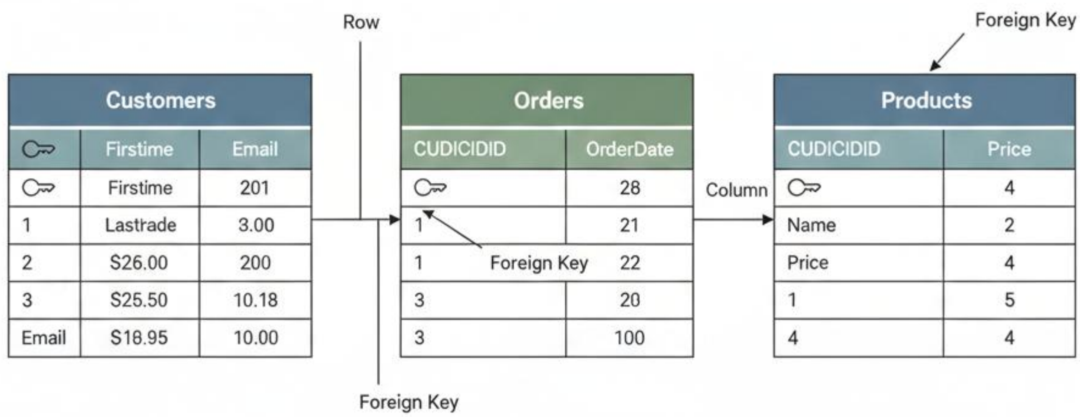
1.3.1 Relational Database Systems

A **relational database system** is a type of database that organises data into tables, also called relations. Each table consists of rows (records) and columns (fields). Relationships between tables are established using keys, such as primary keys and foreign keys. This structure makes it easier to manage large amounts of data and ensures consistency.

Fill in the blank:

- In a relational database, data is organised into __________ consisting of rows and columns.

Figure 1.4 Structure of a Relational Database System



1.3.2 Database Principles for Microcomputers

Microcomputers, such as personal computers, rely on relational database systems to manage information effectively. The principles applied include:

- **Data integrity**: ensuring accuracy and consistency of data.
- **Data security**: protecting data from unauthorised access.
- **Efficiency**: enabling fast retrieval and updates.
- **Scalability**: allowing the database to grow as needs expand.

Fill in the blank:

- Ensuring accuracy and consistency of data in a database is known as data __________.

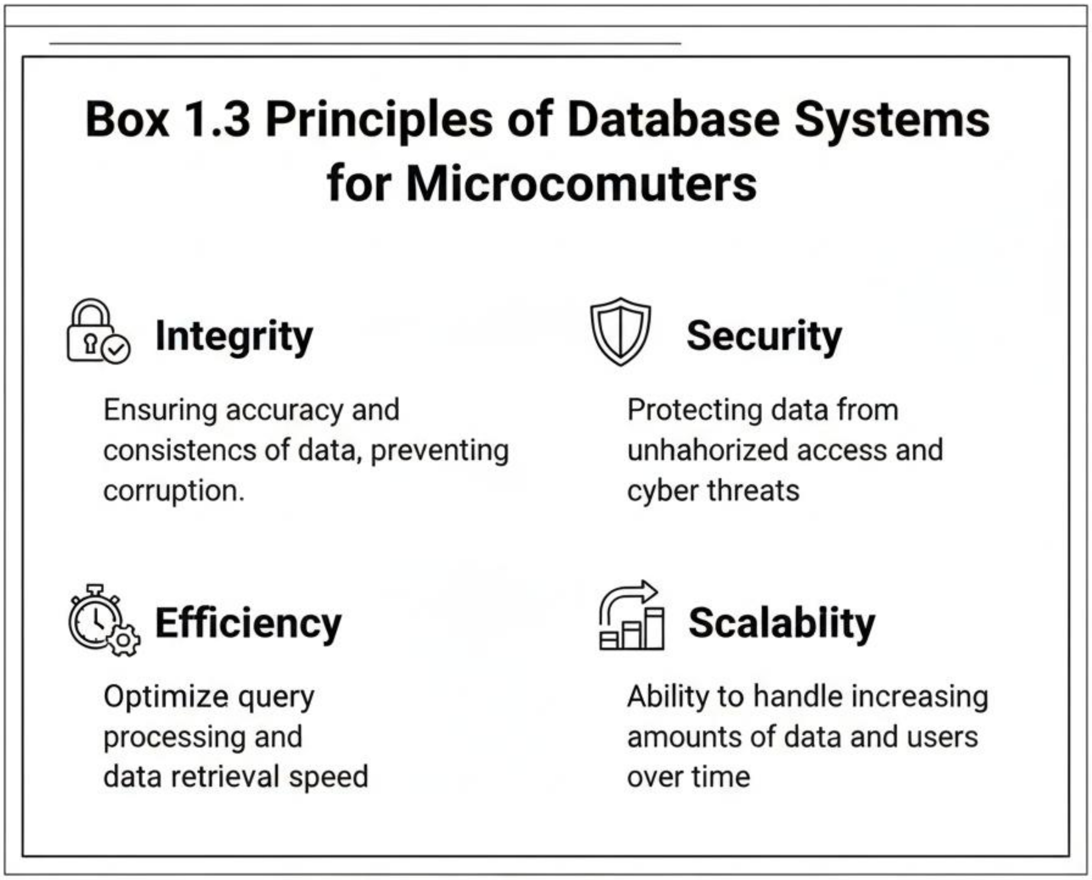


Figure 1.3 Principles of database systems for microcomuters.

Pilot questions 1.3

1. What is a relational database system?
2. List two principles of database systems for microcomputers.
3. Fill in the blank: Ensuring accuracy and consistency of data in a database is known as data __________.
4. Why are relational database systems important for microcomputers?

Series Summary

In this first Series, you have explored the foundations of database design and management. We began by defining the essential concepts of **data**, **database**, **database design**, and **database management**, which form the building blocks of the subject. You then examined the **scope of database design and management**, including the activities involved in structuring, maintaining, and securing databases, as well as their importance for microcomputers. Finally, you studied the **principles of database systems**, with emphasis on relational databases and the key ideas of integrity, security, efficiency, and scalability.

By completing this Series, you should now be able to:

- **Define** the core concepts of database design and management.
- **Explain** the scope of database design and management activities.
- **Analyse** the importance of relational database systems and their principles for microcomputers.
- **Evaluate** how these foundational ideas support later stages of database development and applications.

This Series has laid the groundwork for the rest of the course. The knowledge gained here will help you understand more advanced topics in subsequent Series, such as types of databases, applications in library and information fields, and practical processes of design and maintenance.

Glossary of Terms

Data Raw facts, figures, or symbols that represent information. Data can be numbers, text, images, or sounds, and only become meaningful when organised and processed.

Database An organised collection of data that can be easily accessed, managed, and updated. Databases store information systematically to support efficient retrieval and manipulation.

Database Design The process of structuring a database to meet specific requirements. It involves deciding how data will be stored, organised, and related to ensure efficiency and accuracy.

Database Management The activities involved in controlling and maintaining a database system. This includes updating records, ensuring data security, and managing user access.

Data Integrity The principle of ensuring accuracy and consistency of data within a database.

Data Security The protection of data from unauthorised access, modification, or loss.

Microcomputer A small, relatively inexpensive computer, such as a personal computer, that can run database systems and applications.

Relational Database System A type of database that organises data into tables consisting of rows and columns, with relationships established through keys such as primary keys and foreign keys.

Scalability The ability of a database system to grow and handle increasing amounts of data or users without losing efficiency.

Scope The range of activities, responsibilities, and applications covered by database design and management.

Concept Check Questions 1

Objective Questions

1. Raw facts, figures, or symbols that represent information are called __________. *(Linked to SLO 1.1)*
2. An organised collection of data that can be accessed, managed, and updated is called a __________. *(Linked to SLO 1.1)*
3. The process of structuring a database to meet specific requirements is called __________. *(Linked to SLO 1.1)*
4. The activities involved in controlling and maintaining a database system are called __________. *(Linked to SLO 1.1)*
5. Relational database systems organise data into __________ consisting of rows and columns. *(Linked to SLO 1.3)*

Short-Answer Questions

6. Define database design. *(Linked to SLO 1.1)*

7. List two activities within the scope of database management. *(Linked to SLO 1.2)*

8. Explain why relational database systems are important for microcomputers. *(Linked to SLO 1.3)*

9. What is data integrity, and why is it important? *(Linked to SLO 1.3)*

10. Describe the scope of database design in one sentence. *(Linked to SLO 1.2)*

Long-Answer Questions

11. Analyse the differences between database design and database management, giving examples of their scope. *(Linked to SLO 1.2)*

12. Evaluate the principles of relational database systems, including integrity, security, efficiency, and scalability. *(Linked to SLO 1.3)*

13. Discuss how foundational concepts of data, database, design, and management support later stages of database applications. *(Linked to SLO 1.4)*

Answers to Pilot Questions 1

Pilot questions 1.1 (Key Concepts in Database Design and Management)

1. **Data** are raw facts, figures, or symbols that represent information.
2. A **database** is an organised collection of data that can be accessed, managed, and updated.
3. **Database design** involves structuring a database to meet specific requirements, including how data is stored and related.

4. Functions of **database management** include updating records, ensuring data security, and managing user access.
5. An organised collection of data that can be accessed and updated is called a **database**.

Pilot questions 1.2 (Scope of Database Design and Management)

1. The scope of database design includes identifying user requirements, defining data types and relationships, and designing tables and keys.
2. Activities within the scope of database management include updating records and ensuring data integrity and security.
3. Data integrity is important because it ensures accuracy and consistency of stored information.
4. Relational database systems organise data into **tables**.
5. Database principles are important for microcomputers because they enable efficient storage, retrieval, and management of information.

Pilot questions 1.3 (Principles of Database Systems)

1. A **relational database system** organises data into tables consisting of rows and columns.
2. Relationships between tables are established using **primary keys** and **foreign keys**.
3. Principles of database systems for microcomputers include **data integrity**, **data security**, **efficiency**, and **scalability**.
4. Ensuring accuracy and consistency of data in a database is known as **data integrity**.
5. Relational database systems are important for microcomputers because they allow efficient organisation, retrieval, and management of data.

References and Attributions 1

General References

- Connolly, T., & Begg, C. (2015). *Database systems: A practical approach to design, implementation, and management*. Pearson Education.
- Elmasri, R., & Navathe, S. B. (2016). *Fundamentals of database systems*. Pearson.
- Coronel, C., & Morris, S. (2018). *Database systems: Design, implementation, and management*. Cengage Learning.
- Date, C. J. (2004). *An introduction to database systems*. Addison-Wesley.

Illustrations

- *Figure 1.1 Representation of data in different forms*
    - AI-generated using prompt: “Generate a diagram showing examples of data: numbers, text, images, and sounds.”
    - Tool/platform: Microsoft Copilot Image Gen.
- *Box 1.1 Key features of a database*

- AI-generated using prompt: "Generate a text box listing key features of a database: organised, accessible, manageable, updatable."
- Tool/platform: Microsoft Copilot Image Gen.

- *Figure 1.2 Steps in database design*
  - AI-generated using prompt: "Generate a diagram showing steps in database design: requirements, structure, relationships, efficiency."
  - Tool/platform: Microsoft Copilot Image Gen.
- *Table 1.1 Functions of database management*
  - AI-generated using prompt: "Generate a table listing functions of database management: updating records, security, user access."
  - Tool/platform: Microsoft Copilot Image Gen.
- *Figure 1.3 Scope of database design activities*
  - AI-generated using prompt: "Generate a diagram showing the scope of database design: requirements, data types, relationships, tables, efficiency."
  - Tool/platform: Microsoft Copilot Image Gen.
- *Table 1.2 Scope of database management activities*
  - AI-generated using prompt: "Generate a table listing activities in database management: updating records, security, user access, backup."
  - Tool/platform: Microsoft Copilot Image Gen.
- *Box 1.2 Importance of database principles for microcomputers*
  - AI-generated using prompt: "Generate a text box explaining why relational database systems are important for microcomputers."
  - Tool/platform: Microsoft Copilot Image Gen.
- *Figure 1.4 Structure of a relational database system*
  - AI-generated using prompt: "Generate a diagram showing a relational database with tables, rows, columns, primary key, and foreign key."
  - Tool/platform: Microsoft Copilot Image Gen.
- *Box 1.3 Principles of database systems for microcomputers*
  - AI-generated using prompt: "Generate a text box listing principles of database systems for microcomputers: integrity, security, efficiency, scalability."
  - Tool/platform: Microsoft Copilot Image Gen.

Course code: LIS 421

- **Course title**: Database Design and Management
- **Credit load**: 2 Units (Lecture Hours 15; Practical Hours 45)
- **Series list**:
    1. Concepts and Foundations of Database Design and Management
    2. Types of Databases and Principles for Microcomputers
    3. Applications of Databases in Library and Information Fields
    4. Processes of Database Design, Creation, and Maintenance
    5. Advanced Database Systems and Practical Management

Series2:Types of Databases and Principles for Microcomputers

Proposed Outline for Series 2

- **Part 2.1 Types of Databases**
    - 2.1.1 Hierarchical databases
    - 2.1.2 Network databases
    - 2.1.3 Relational databases
    - 2.1.4 Object-oriented databases
- **Part 2.2 Principles of Database Systems for Microcomputers**
    - 2.2.1 Importance of relational database systems
    - 2.2.2 Data integrity and security
    - 2.2.3 Efficiency and scalability
- **Part 2.3 Practical Relevance of Database Principles**
    - 2.3.1 Application in personal computing
    - 2.3.2 Role in library and information systems
    - 2.3.3 Examples of microcomputer-based database packages

Introduction

Databases come in different forms, each designed to meet specific needs. In this Series, we will explore the **types of databases** and the **principles that guide their use in microcomputers**. Understanding these variations is important because it allows you to recognise which database model is most suitable for a given situation, and how microcomputers apply these principles to manage information effectively.

The aim of this Series is to help you identify the major types of databases, explain their structures, and analyse their relevance to microcomputer environments. You will also examine the principles that ensure databases function efficiently, securely, and reliably on personal computing systems.

We will begin by studying the different types of databases, including hierarchical, network, relational, and object-oriented models. Next, we will consider the principles of database systems for microcomputers, focusing on relational systems, data integrity, security, efficiency, and scalability. Finally, we will connect these ideas to practice by looking at how microcomputers apply database principles in library and information systems, with examples of common packages.

This sequential approach ensures that you first gain knowledge of database types, then understand the guiding principles, and finally see how these principles are applied in real-world contexts.

Series Learning Outcomes

By the end of **Series 2: Types of Databases and Microcomputer Principles**, you should be able to:

- **SLO 2.1 Identify** and **differentiate** between major types of databases, including hierarchical, network, relational, and object-oriented models.
- **SLO 2.2 Explain** the principles of relational database systems and their importance for microcomputers.
- **SLO 2.3 Analyse** the role of data integrity, security, efficiency, and scalability in microcomputer database systems.
- **SLO 2.4 Evaluate** the practical relevance of database principles in personal computing and library information systems.

2.1 Types of Databases

Databases are not all the same. Over time, different models have been developed to meet varying needs in storing and managing information. In this Part, we will examine four major types: hierarchical, network, relational, and object-oriented databases.

2.1.1 Hierarchical Databases

A **hierarchical database** organises data in a tree-like structure, with records connected through parent-child relationships. Each child record has only one parent, but a parent can have multiple children. This model is efficient for applications where data is naturally hierarchical, such as organisational charts.

Fill in the blank:

- A database model that organises data in a tree-like structure is called a __________ database.

Figure 2.1 Tree-like Structure of a Hierrahical Database

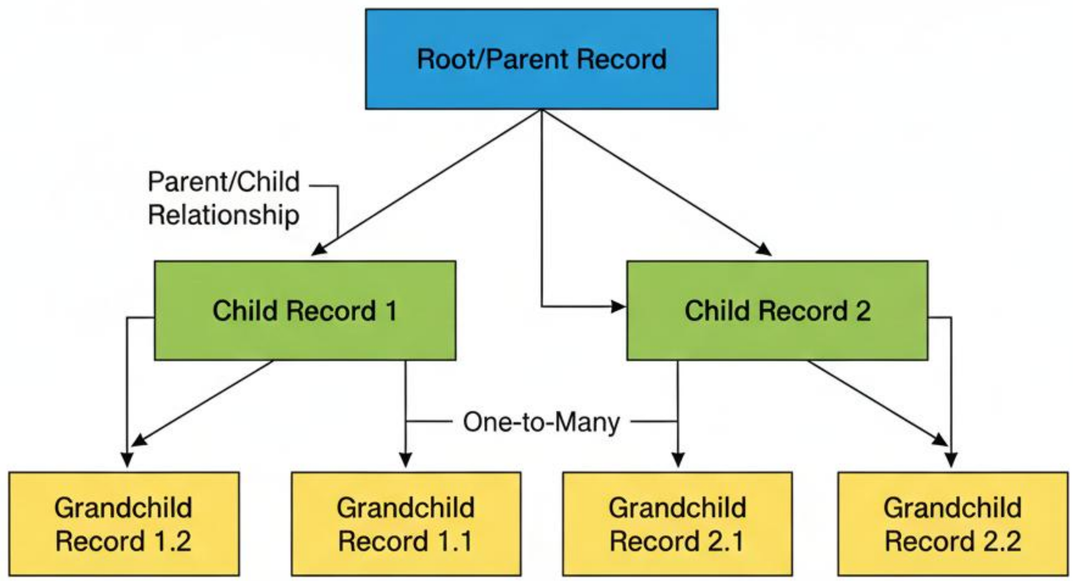


Figure 2.1 Tree-like structure of a hierrahical database

2.1.2 Network Databases

A **network database** uses a graph structure, allowing records to have multiple parent and child relationships. This model is more flexible than the hierarchical model and is useful for complex applications such as airline reservation systems.

Fill in the blank:

- A database model that allows records to have multiple parent and child relationships is called a __________ database.

Figure 2.2 Graph Structure of a Network Database System

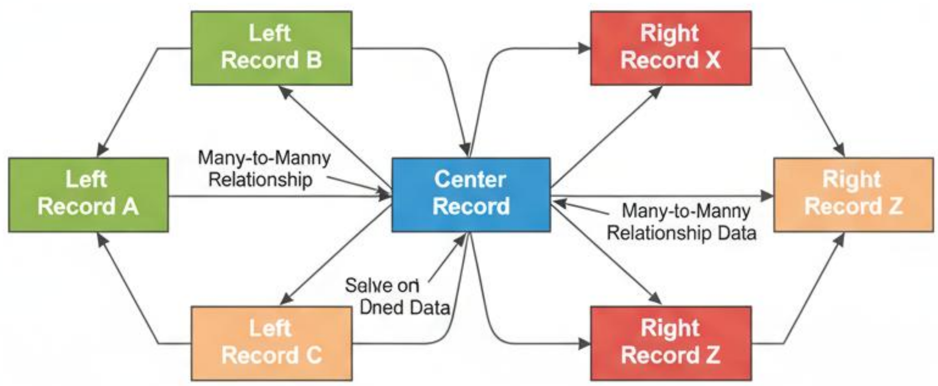


Figure 2.2 Graph structure of a network database

2.1.3 Relational Databases

A **relational database** organises data into tables consisting of rows and columns. Relationships between tables are established using keys, such as primary keys and foreign keys. This model is widely used because of its simplicity and efficiency in handling large amounts of data.

Fill in the blank:

- In a relational database, data is organised into __________ consisting of rows and columns.

[

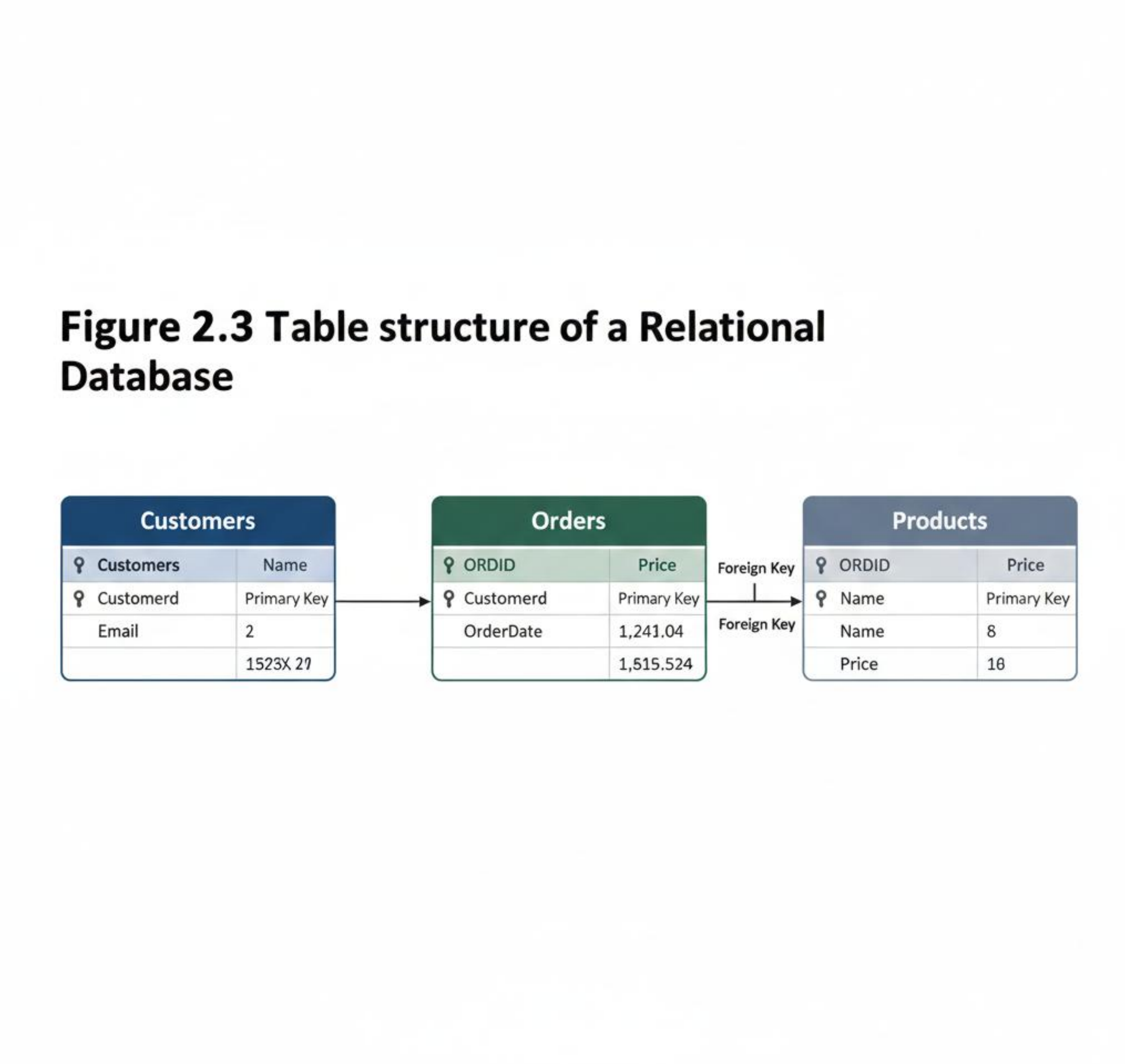


Figure 2.3 Table structure of a relational database

2.1.4 Object-Oriented Databases

An **object-oriented database** stores data in the form of objects, similar to how programming languages like Java or C++ represent data. Objects can contain both data and methods, making this model suitable for applications that require complex data types, such as multimedia systems.

Fill in the blank:

- A database model that stores data in the form of objects is called an __________ database.

Figure 2.4 Object-Oriented Database Storing Data as Objects

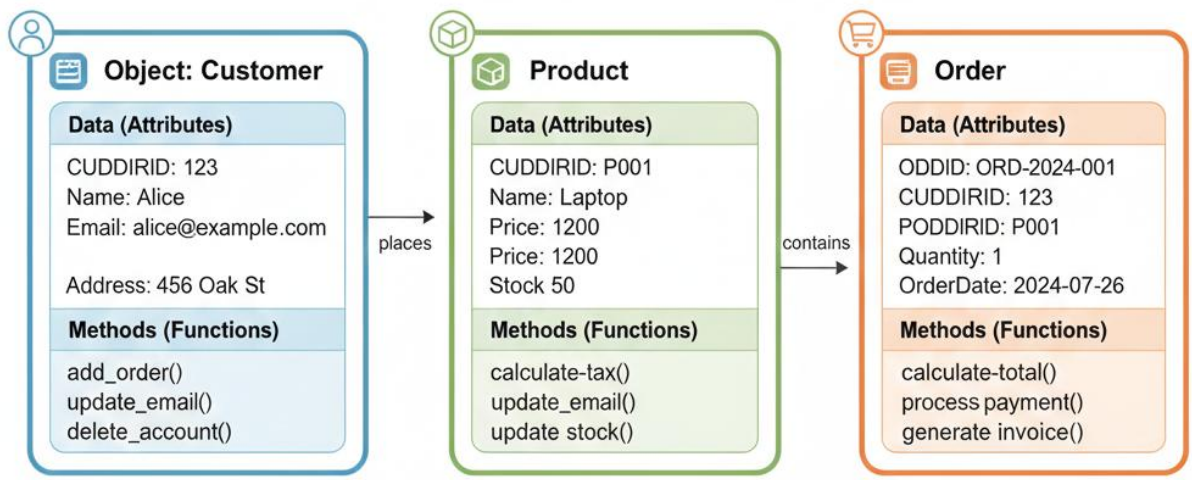


Figure 2.4 Object-oriented database storing data as objects

Pilot questions 2.1

1. What is the main structure used in hierarchical databases?
2. How does a network database differ from a hierarchical database?
3. Fill in the blank: In a relational database, data is organised into __________.
4. What type of database stores data in the form of objects?
5. Give one example of an application where a network database would be useful.

2.2 Principles of Database Systems for Microcomputers

Microcomputers, such as personal computers, rely heavily on database systems to manage information effectively. The principles guiding these systems ensure that data is accurate, secure, efficient, and scalable. In this Part, we will examine these principles in detail.

2.2.1 Importance of Relational Database Systems

Relational database systems are the most widely used on microcomputers because they organise data into tables consisting of rows and columns. Relationships between tables are established using keys, which allow data to be linked and retrieved efficiently.

Fill in the blank:

- Relational database systems organise data into __________ consisting of rows and columns.

Figure 2.5 Relational Database System Structure for Microcomuters

Figure 2.5 Relational database system structure for microcomuters

2.2.2 Data Integrity and Security

Data integrity ensures that information stored in a database remains accurate and consistent. For example, if a student's record is updated, all related tables must reflect the change correctly.

Data security protects information from unauthorised access, modification, or loss. Security measures include passwords, encryption, and user permissions.

Fill in the blank:

- The principle that ensures accuracy and consistency of data is called data __________.

Box 2.1 Principles of Data Integrity and Security

Data Integrity

Ensuring accuracy, consistency, and reliabilty of data over its entire lifecycle.

Importance:

1. Prevents errors in financial records.
2. Guarantees correct customer information

Data Security

Protecting data from unhahorized access, modifcation, and destruction

Importance:

Importance:

1. Safagards sensitive personal data
2. Protects business intelectual property

Figure 2.1 Principles of data integrity and security

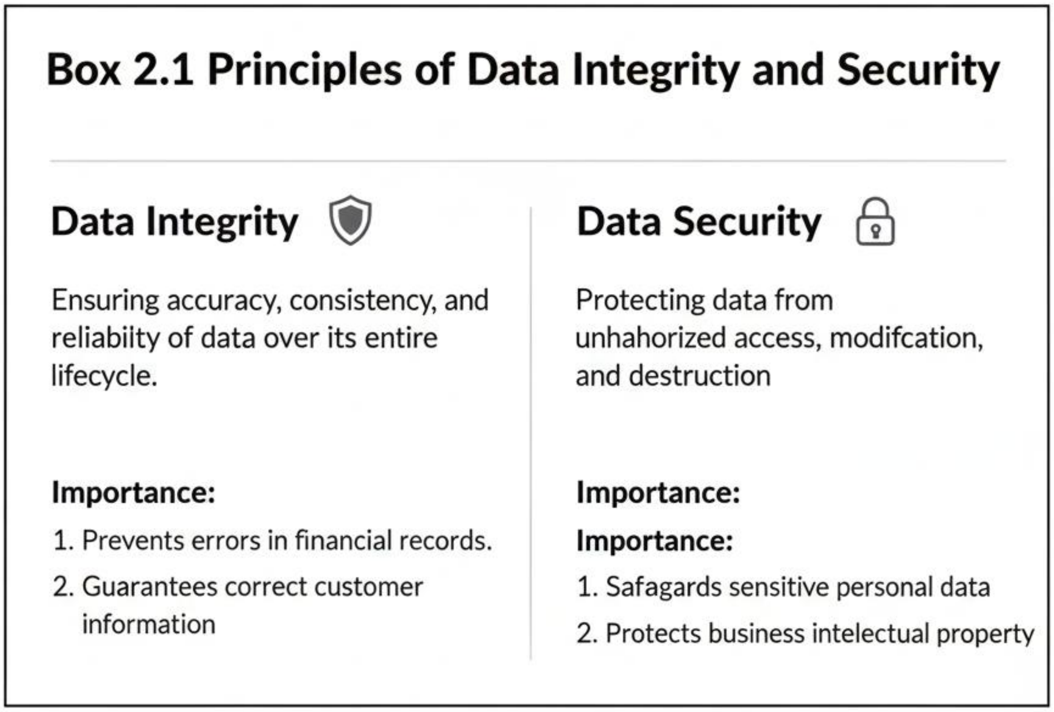


Figure 2.1 Principles of data integrity and security

2.2.3 Efficiency and Scalability

Efficiency refers to the ability of a database system to retrieve and update information quickly. This is crucial for microcomputers, which often handle multiple tasks simultaneously. **Scalability** means that the database can grow to accommodate more data or users without losing performance. For example, a library database may start with a few hundred records but expand to thousands while still functioning smoothly.

Fill in the blank:

- The ability of a database to grow and handle more data without losing performance is called __________.

Figure 2.6 Efficiency and Scalability in Database Systems

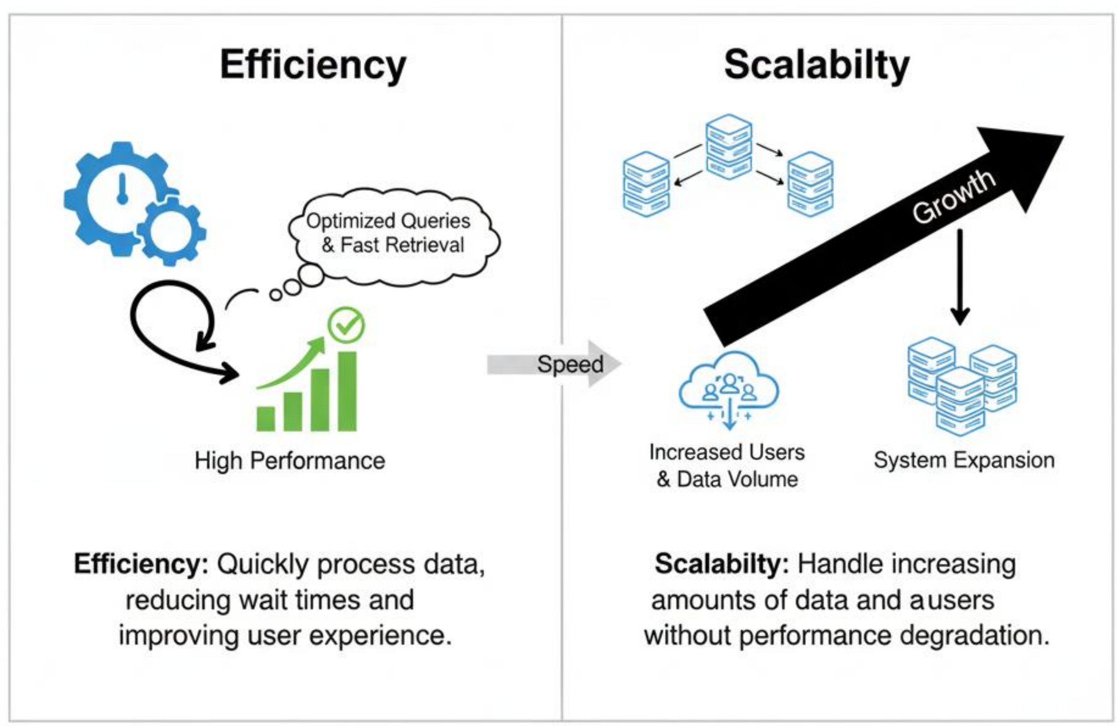


Figure 2.6 Efficiency and scalability in database systems

Pilot questions 2.2

1. Why are relational database systems important for microcomputers?
2. Fill in the blank: The principle that ensures accuracy and consistency of data is called data __________.
3. What is the difference between data integrity and data security?
4. Define scalability in the context of database systems.
5. Give one example of how efficiency benefits microcomputer database systems.

2.3 Practical Relevance of Database Principles

Database principles are not just theoretical, they have direct applications in everyday computing and in professional environments such as libraries and information centres. In this Part, we will explore how these principles are applied in practice.

2.3.1 Application in Personal Computing

Microcomputers, such as laptops and desktops, rely on database systems to manage information. Examples include:

- Contact lists stored in email applications.
- Music libraries organised by media players.
- Financial records maintained in accounting software.

Fill in the blank:

- Microcomputers such as laptops and desktops rely on __________ systems to manage information.

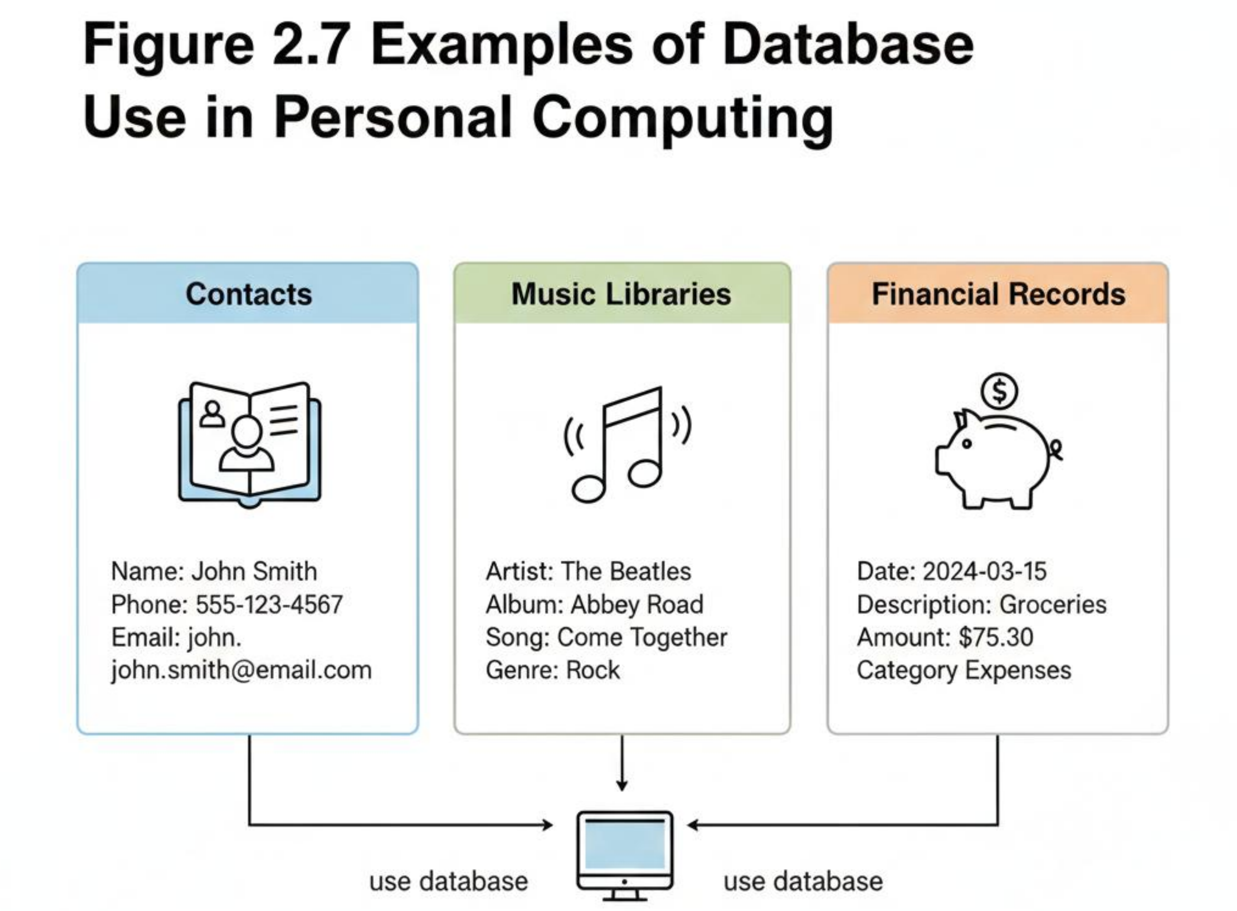


Figure 2.7 Examples of database use in personal computing

2.3.2 Role in Library and Information Systems

Libraries depend on database systems to organise and retrieve information efficiently. Principles such as relational structures, integrity, and scalability ensure that catalogues, circulation records, and digital repositories function smoothly.

Fill in the blank:

- Libraries depend on __________ systems to organise and retrieve information efficiently.

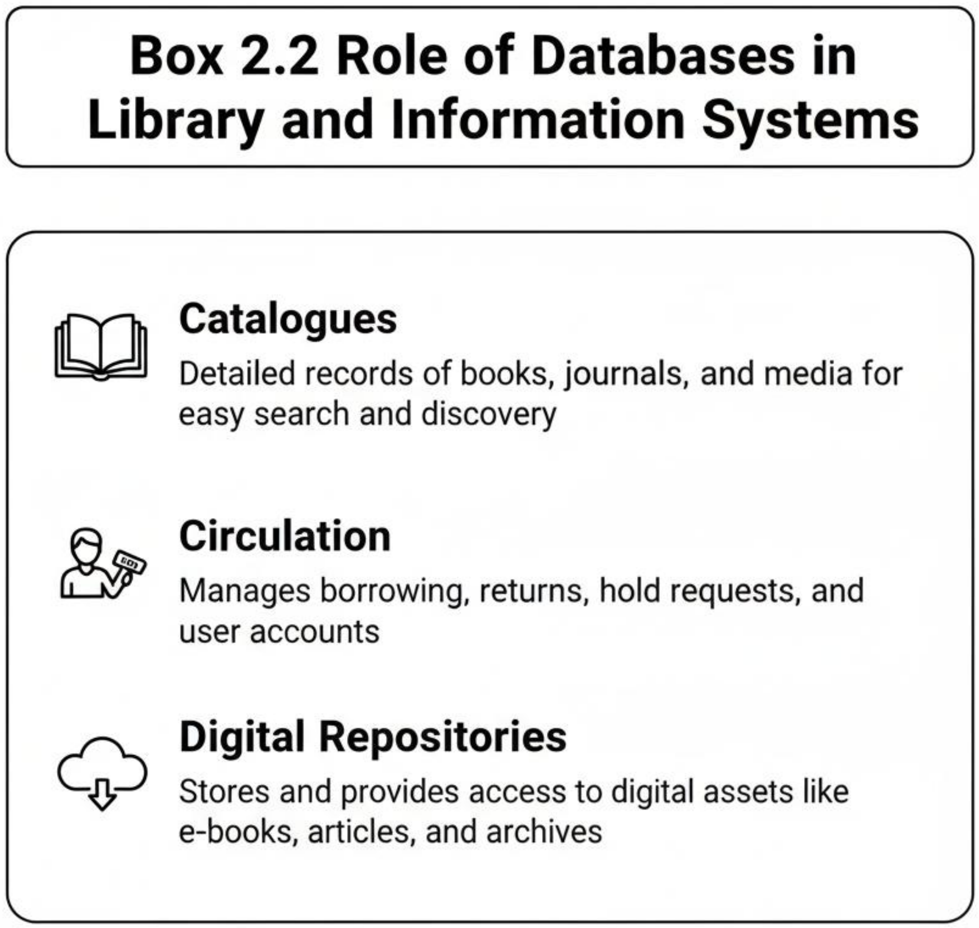


Figure 2.2 Role of databases in library and information systems

2.3.3 Examples of Microcomputer-Based Database Packages

Several database packages are commonly used on microcomputers, especially in library and information science. Examples include:

- **Koha**: an open-source integrated library system.
- **Greenstone**: a digital library software package.
- **DSpace**: a repository software for digital content.
- **EPrints**: software for building open access repositories.

Fill in the blank:

- An open-source integrated library system commonly used in libraries is called __________.

Table 2.1 Examples of Microcomuter-Based Database Packages

Package	Main Functions
Koha	Library Management System (LMS) for cataloging, circulation, and patron management.
Greenstone	Digital Library Software for building and distribute digital collections.
DSpace	Institutional Repostory Software for managing and preserving digital assets.
EPrints	Open Access Repostory Software for research papers publications.

Table 2.1 Examples of microcomuter-based database packages

Pilot questions 2.3

1. Give one example of how databases are used in personal computing.
2. Fill in the blank: Libraries depend on __________ systems to organise and retrieve information efficiently.
3. Name two database packages commonly used in libraries.
4. What principle ensures that library catalogues remain accurate and consistent?
5. Explain why scalability is important for library databases.

Series Summary

In **Series 2: Types of Databases and Microcomputer Principles**, you explored the different models of databases and the guiding principles that make them effective in microcomputer environments.

- You learned about **hierarchical databases**, which use tree-like structures; **network databases**, which allow multiple parent-child relationships; **relational databases**, which organise data into tables with keys; and **object-oriented databases**, which store data as objects containing both data and methods.
- You examined the **principles of relational database systems**, focusing on their importance for microcomputers.
- You studied the roles of **data integrity, security, efficiency, and scalability**, which ensure that databases remain accurate, protected, fast, and adaptable.
- Finally, you connected theory to practice by looking at how these principles are applied in **personal computing** and **library information systems**, with examples of microcomputer-based packages such as Koha, Greenstone, DSpace, and EPrints.

By completing this Series, you should now be able to:

- **Identify** and **differentiate** between major types of databases.
- **Explain** the principles of relational database systems for microcomputers.
- **Analyse** the importance of integrity, security, efficiency, and scalability.
- **Evaluate** the practical relevance of database principles in personal and library information systems.

This Series builds directly on the foundations from Series 1 and prepares you for deeper exploration of database applications in specialised fields.

Glossary of Terms – Series 2

Efficiency The ability of a database system to retrieve and update information quickly, ensuring smooth performance.

Greenstone An open-source digital library software package used to build and distribute digital collections.

Hierarchical Database A database model that organises data in a tree-like structure, with parent-child relationships.

Koha An open-source integrated library system widely used in libraries for cataloguing and circulation.

Network Database A database model that uses a graph structure, allowing records to have multiple parent and child relationships.

Object-Oriented Database A database model that stores data in the form of objects, which can contain both data and methods.

Relational Database A database model that organises data into tables consisting of rows and columns, with relationships established through keys.

Scalability The ability of a database to grow and handle more data or users without losing performance.

Security Measures taken to protect data from unauthorised access, modification, or loss, such as passwords and encryption.

Data Integrity The principle of ensuring accuracy and consistency of data within a database.

DSpace A repository software package used to manage and provide access to digital content.

EPrints Software for building open access repositories, often used in academic institutions.

Concept Check Questions 2

Objective Questions

1. A database model that organises data in a tree-like structure is called a __________ database. *(Linked to SLO 2.1)*
2. A database model that allows records to have multiple parent and child relationships is called a __________ database. *(Linked to SLO 2.1)*
3. In a relational database, data is organised into __________ consisting of rows and columns. *(Linked to SLO 2.1)*
4. The principle that ensures accuracy and consistency of data is called data __________. *(Linked to SLO 2.3)*
5. The ability of a database to grow and handle more data without losing performance is called __________. *(Linked to SLO 2.3)*

Short-Answer Questions

6. Define an object-oriented database. *(Linked to SLO 2.1)*

7. Why are relational database systems important for microcomputers? *(Linked to SLO 2.2)*

8. List two differences between hierarchical and network databases. *(Linked to SLO 2.1)*

9. Explain the difference between data integrity and data security. *(Linked to SLO 2.3)*

10. Name two microcomputer-based database packages used in libraries. *(Linked to SLO 2.4)*

Long-Answer Questions

11. Analyse the strengths and weaknesses of hierarchical, network, relational, and object-oriented databases. *(Linked to SLO 2.1)*

12. Evaluate the importance of efficiency and scalability in microcomputer database systems, giving practical examples. *(Linked to SLO 2.3)*

13. Discuss how database principles are applied in personal computing and library information systems, with examples of packages. *(Linked to SLO 2.4)*

Answers to Pilot Questions 2

Pilot questions 2.1 (Types of Databases)

1. The main structure used in hierarchical databases is a **tree-like structure** with parent-child relationships.
2. A network database differs from a hierarchical database because it allows **multiple parent and child relationships**, whereas hierarchical databases restrict each child to a single parent.
3. In a relational database, data is organised into **tables** consisting of rows and columns.
4. A database that stores data in the form of objects is called an **object-oriented database**.
5. An example of an application where a network database would be useful is an **airline reservation system**.

Pilot questions 2.2 (Principles of Database Systems for Microcomputers)

1. Relational database systems are important for microcomputers because they **organise data into tables and allow efficient linking and retrieval**.
2. The principle that ensures accuracy and consistency of data is called data **integrity**.
3. Data integrity ensures accuracy and consistency of information, while data security protects information from **unauthorised access, modification, or loss**.
4. Scalability in database systems means the ability to **grow and handle more data or users without losing performance**.
5. Efficiency benefits microcomputer database systems by enabling **fast retrieval and updates**, which is crucial when handling multiple tasks.

Pilot questions 2.3 (Practical Relevance of Database Principles)

1. An example of database use in personal computing is a **contact list stored in an email application**.
2. Libraries depend on **database systems** to organise and retrieve information efficiently.
3. Two database packages commonly used in libraries are **Koha** and **Greenstone** (others include DSpace and EPrints).
4. The principle that ensures library catalogues remain accurate and consistent is **data integrity**.
5. Scalability is important for library databases because it allows them to **expand from hundreds to thousands of records while maintaining performance**.

References and Attributions 2

General References

- Connolly, T., & Begg, C. (2015). *Database systems: A practical approach to design, implementation, and management*. Pearson Education.
- Elmasri, R., & Navathe, S. B. (2016). *Fundamentals of database systems*. Pearson.
- Coronel, C., & Morris, S. (2018). *Database systems: Design, implementation, and management*. Cengage Learning.
- Date, C. J. (2004). *An introduction to database systems*. Addison-Wesley.

Illustrations

- *Figure 2.1 Tree-like structure of a hierarchical database*
    - AI-generated using prompt: “Generate a diagram showing a hierarchical database with parent and child records in a tree structure.”
- *Figure 2.2 Graph structure of a network database*
    - AI-generated using prompt: “Generate a diagram showing a network database with multiple parent and child relationships.”
- *Figure 2.3 Table structure of a relational database*
    - AI-generated using prompt: “Generate a diagram showing relational database tables with rows, columns, primary key, and foreign key.”
- *Figure 2.4 Object-oriented database storing data as objects*
    - AI-generated using prompt: “Generate a diagram showing an object-oriented database with objects containing data and methods.”
- *Figure 2.5 Relational database system structure for microcomputers*
    - AI-generated using prompt: “Generate a diagram showing relational database tables with rows, columns, primary key, and foreign key.”
- *Box 2.1 Principles of data integrity and security*
    - AI-generated using prompt: “Generate a text box explaining data integrity and security with examples of their importance.”
- *Figure 2.6 Efficiency and scalability in database systems*
    - AI-generated using prompt: “Generate a diagram showing efficiency and scalability in a database system, with arrows indicating growth and speed.”
- *Figure 2.7 Examples of database use in personal computing*
    - AI-generated using prompt: “Generate a diagram showing personal computing applications using databases: contacts, music libraries, financial records.”
- *Box 2.2 Role of databases in library and information systems*
    - AI-generated using prompt: “Generate a text box explaining how libraries use databases for catalogues, circulation, and repositories.”

- *Table 2.1 Examples of microcomputer-based database packages*
    - AI-generated using prompt: "Generate a table listing Koha, Greenstone, DSpace, and EPrints with their main functions."

Course code: LIS 421

- **Course title**: Database Design and Management
- **Credit load**: 2 Units (Lecture Hours 15; Practical Hours 45)
- **Series list**:

1. Concepts and Foundations of Database Design and Management
2. Types of Databases and Principles for Microcomputers
3. Applications of Databases in Library and Information Fields
4. Processes of Database Design, Creation, and Maintenance
5. Advanced Database Systems and Practical Management

Series:3 Applications of Databases in Library and Information Fields

Proposed Outline for Series 3

- **Part 3.1 Database Applications in Libraries**
    - 3.1.1 Cataloguing and classification
    - 3.1.2 Circulation and user services
    - 3.1.3 Digital repositories and archives
- **Part 3.2 Database Applications in Information Systems**
    - 3.2.1 Information retrieval systems
    - 3.2.2 Bibliographic databases
    - 3.2.3 Full-text and multimedia databases
- **Part 3.3 Case Studies of Database Packages**
    - 3.3.1 Koha (integrated library system)
    - 3.3.2 Greenstone (digital library software)
    - 3.3.3 DSpace and EPrints (repository software)

Introduction

In the last Series, we explored the different types of databases and the principles that guide their use in microcomputer environments. Building on that foundation, we now turn to the practical side of database systems, focusing on how they are applied in libraries and information systems. These applications are central to the work of information professionals, as they enable efficient organisation, retrieval, and management of vast collections of resources.

The aim of this Series is to equip you with an understanding of how databases are applied in library and information contexts, and to help you appreciate the role of specific packages and systems in supporting cataloguing, circulation, information retrieval, and digital repositories.

We shall commence this Series by examining how databases are applied in libraries, with emphasis on cataloguing, classification, circulation, and digital archives. Next, we will explore their use in information systems, including bibliographic databases, full-text resources, and multimedia collections. Finally, we will wrap up by studying case examples of widely used database packages such as Koha, Greenstone, DSpace, and EPrints, showing how theory translates into practice.

Series Learning Outcomes

Upon completing **Series 3: Database Applications in Libraries and Information Systems**, you should be able to:

- **SLO 3.1** describe how databases are applied in libraries for cataloguing, classification, circulation, and digital archives,
- **SLO 3.2** explain the role of databases in information systems, including bibliographic, full-text, and multimedia resources,
- **SLO 3.3** analyse case studies of microcomputer-based database packages such as Koha, Greenstone, DSpace, and EPrints, and
- **SLO 3.4** evaluate the practical relevance of database applications in supporting library and information services.

3.1 Database Applications in Libraries

Libraries are among the most prominent users of database systems. They rely on databases to organise, store, and retrieve information efficiently. In this Part, we will examine how databases support cataloguing, classification, circulation, and digital repositories.

3.1.1 Cataloguing and Classification

Databases are used to create and maintain catalogues that describe library materials. Each record contains bibliographic details such as author, title, subject, and publication date. Classification systems (e.g., Dewey Decimal Classification) are integrated into databases to organise materials systematically.

Fill in the blank:

- A library database record that contains bibliographic details such as author and title is called a __________.

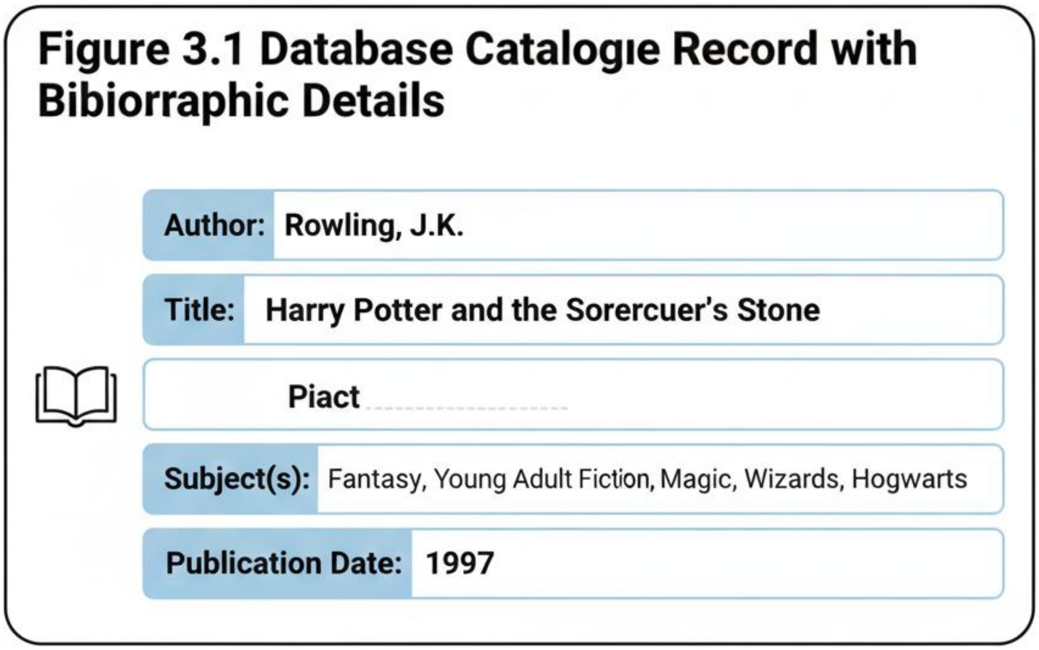


Figure 3.1 Database catalogue record with Bibiographic details

3.1.2 Circulation and User Services

Databases manage circulation activities such as borrowing, returning, and renewing items. They also track user accounts, fines, and reservations. This ensures that library services are efficient and transparent.

Fill in the blank:

- The library function that involves borrowing and returning items is called __________.

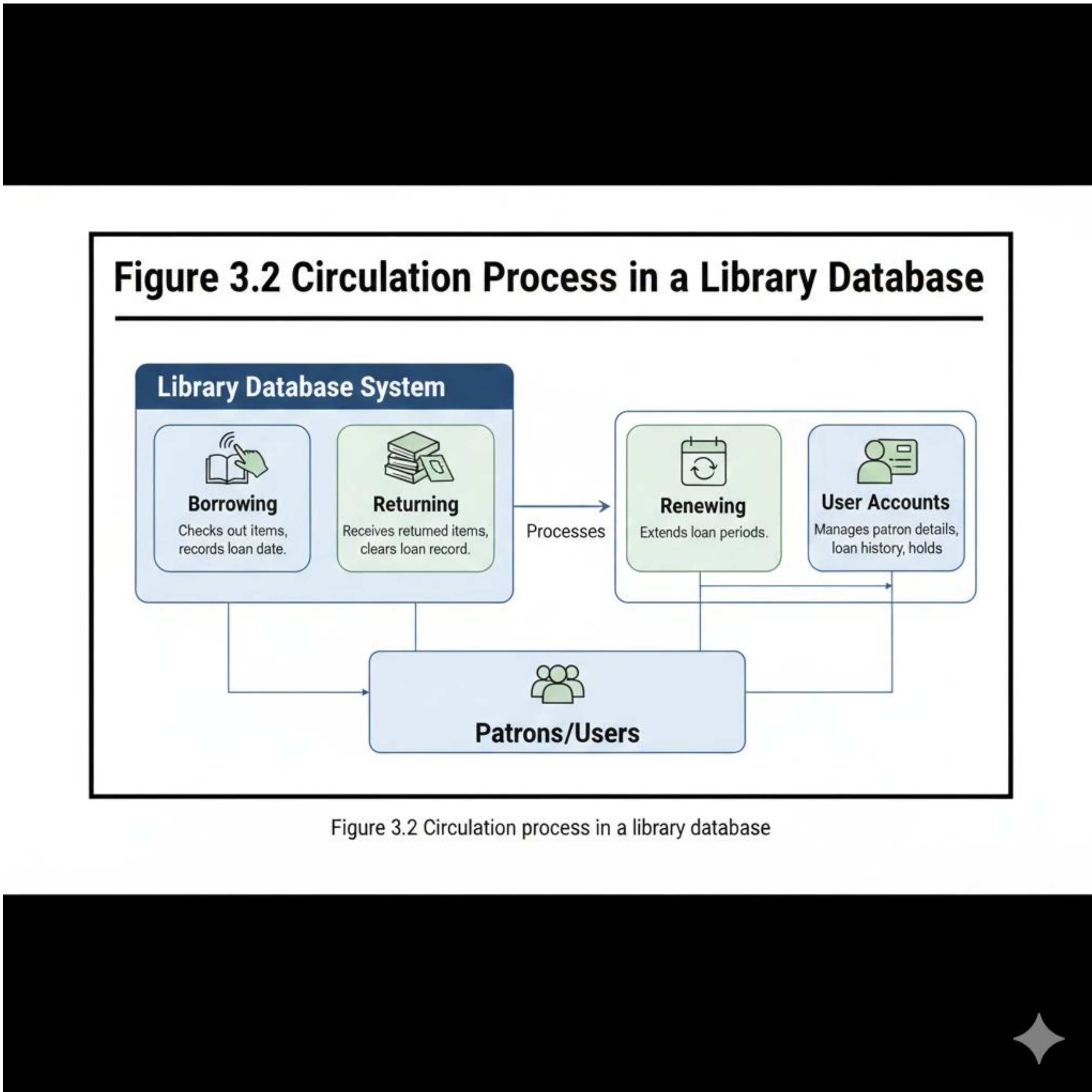


Figure 3.2 Circulation process in a library database

3.1.3 Digital Repositories and Archives

Modern libraries maintain digital repositories that store electronic resources such as e-books, journals, theses, and multimedia files. Databases ensure that these resources are searchable and accessible to users. Archives also rely on databases to preserve historical documents and records.

Fill in the blank:

- A collection of electronic resources such as e-books and journals stored in a database is called a digital __________.

Figure 3.3 Digital Repostory Structure in a Library Database

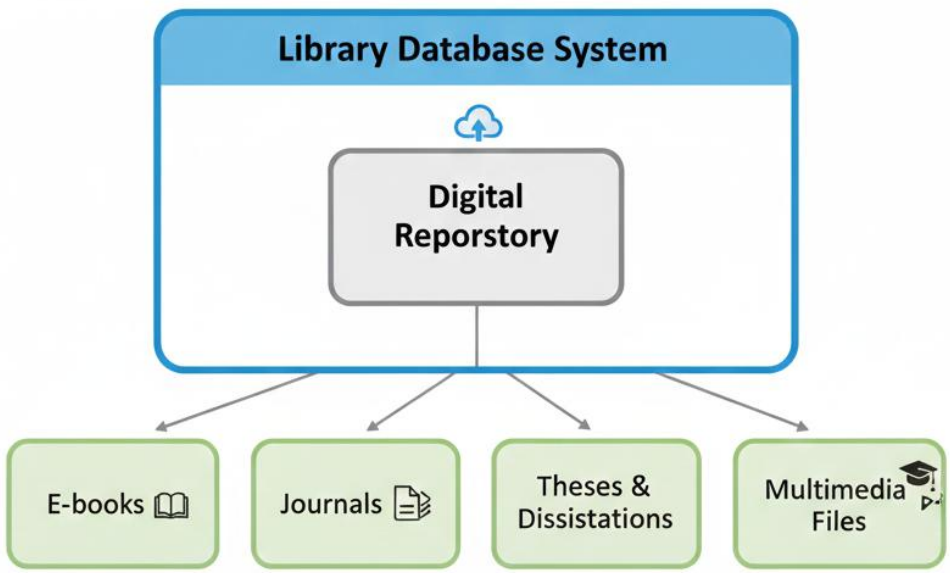


Figure 3.3 Digital Repostory structure in a Library database

Pilot Questions 3.1

1. What bibliographic details are typically included in a library catalogue record?
2. Fill in the blank: The library function that involves borrowing and returning items is called ___________.
3. Explain how databases support circulation services in libraries.
4. What types of resources are stored in digital repositories?
5. Why are databases important for preserving archives in libraries?

3.2 Database Applications in Information Systems

Beyond libraries, databases play a vital role in broader information systems. They support the organisation, retrieval, and dissemination of information across diverse fields such as research, publishing, and multimedia. In this Part, we will examine bibliographic databases, full-text databases, and multimedia databases.

3.2.1 Information Retrieval Systems

Information retrieval systems use databases to store and provide access to large collections of documents. They allow users to search by keywords, subjects, or authors, and retrieve relevant records quickly.

Fill in the blank:

- A system that allows users to search and retrieve documents from a database is called an information __________ system.

Figure 3.4 Information Retrrival System Workflow

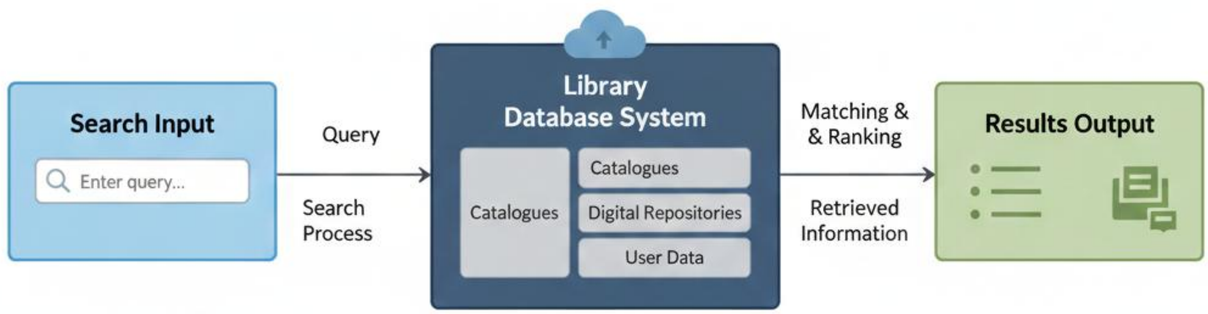


Figure 3.4 Information retirival system workflow

3.2.2 Bibliographic Databases

Bibliographic databases contain references to published works such as books, journal articles, and conference papers. They provide bibliographic details but may not include the full text. Examples include PubMed and Scopus.

Fill in the blank:

- A database that contains references to published works such as journal articles is called a __________ database.

Figure 3.5 Structure of a Bibligraphic Database Record

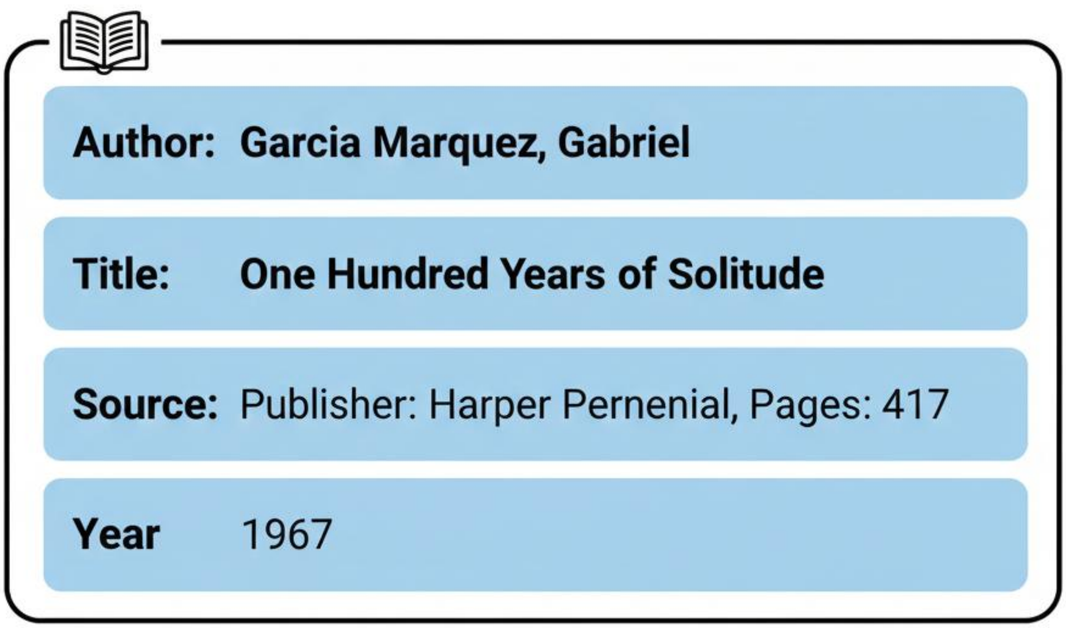


Figure 3.5 Structure of a bibliographic database record.

3.2.3 Full-Text and Multimedia Databases

Full-text databases provide access to the complete content of documents, such as journal articles or e-books. Multimedia databases store non-textual materials such as images, audio, and video files, making them essential for modern information systems.

Fill in the blank:

- A database that provides access to the complete content of documents is called a __________ database.

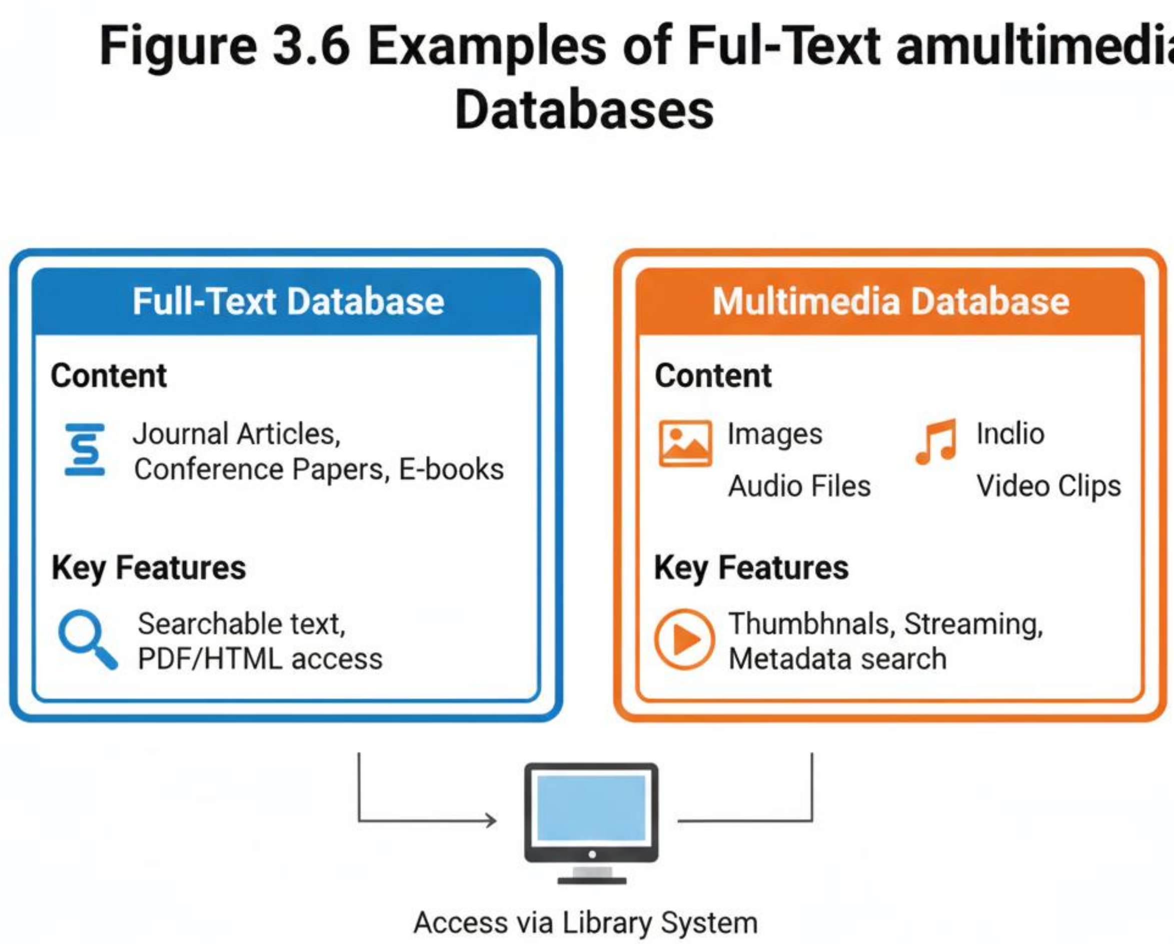


Figure 3.6 Examples of full-text and multimedia databases

”

Pilot Questions 3.2

1. What is the main function of an information retrieval system?
2. Fill in the blank: A database that contains references to published works is called a __________ database.
3. Give one example of a bibliographic database.
4. What is the difference between a bibliographic database and a full-text database?
5. Name two types of materials stored in multimedia databases.

3.3 Case Studies of Database Packages

To bring this Series into practical focus, we will now examine specific database packages that are widely used in libraries and information systems. These case studies illustrate how theoretical principles are applied in real-world contexts.

3.3.1 Koha (Integrated Library System)

Koha is an open-source integrated library system (ILS) that supports cataloguing, circulation, acquisitions, and user services. It is widely adopted by libraries around the world because of its flexibility and community support.

Fill in the blank:

Figure 3.7 Koha Interface for Library Management

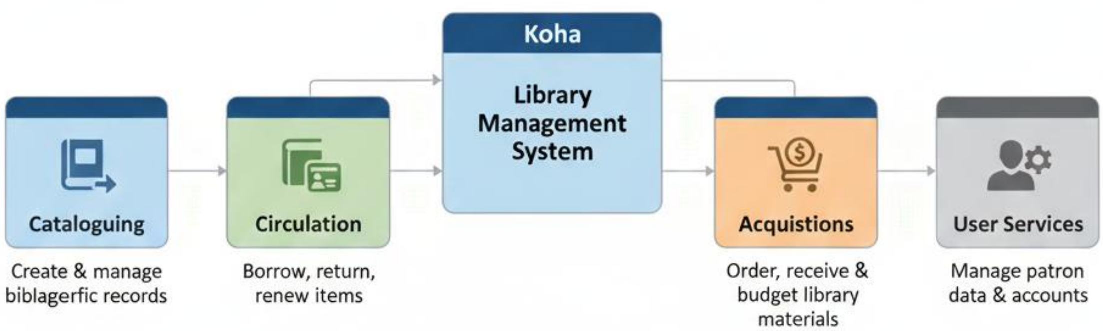


Figure 3.7 Koha interface for library management

3.3.2 Greenstone (Digital Library Software)

Greenstone is an open-source software package for building digital libraries. It enables libraries and organisations to create searchable collections of electronic documents, including text, images, audio, and video.

Fill in the blank:

- A digital library software package that allows creation of searchable collections is called __________.

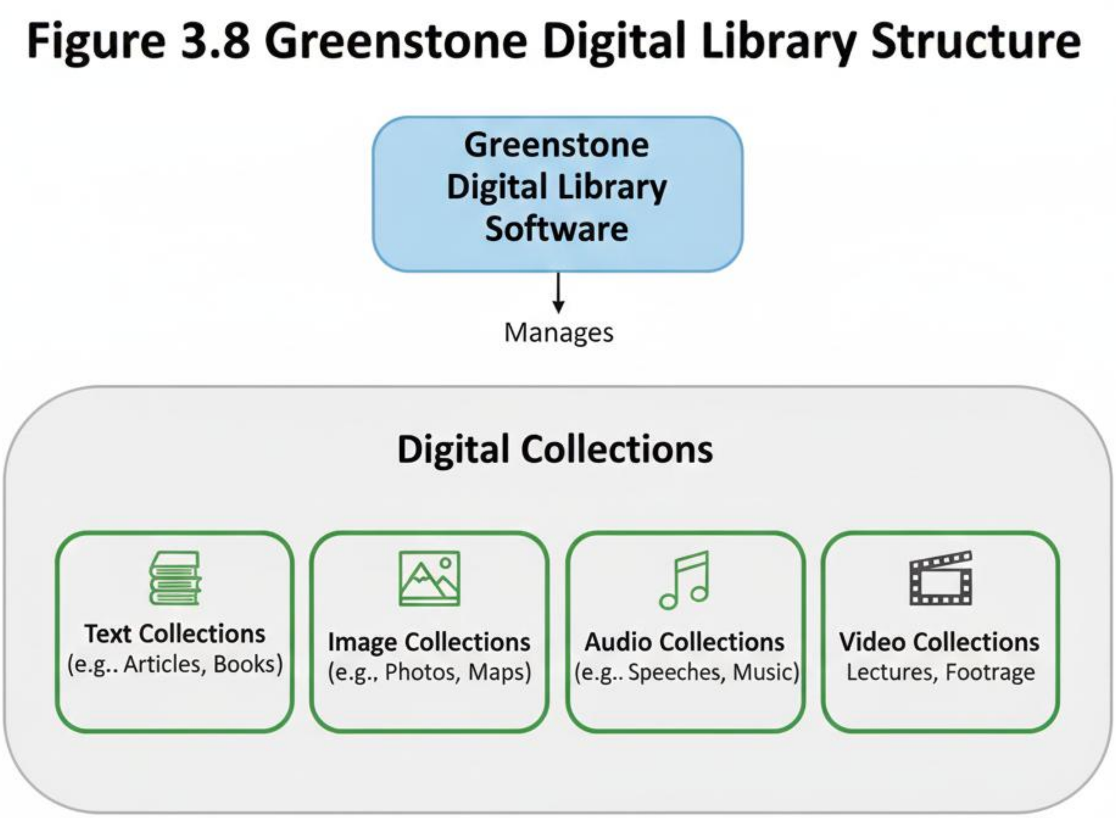


Figure 3.8 Greenstone digital library structure

3.3.3 DSpace and EPrints (Repository Software)

DSpace and **EPrints** are repository software packages used to manage and provide access to digital content such as theses, dissertations, and research articles. They are commonly used in academic institutions to support open access initiatives.

Fill in the blank:

- Repository software used to manage and provide access to digital content includes __________ and __________.

Figure 3.9 Repository Structure in DSpace and EPrints

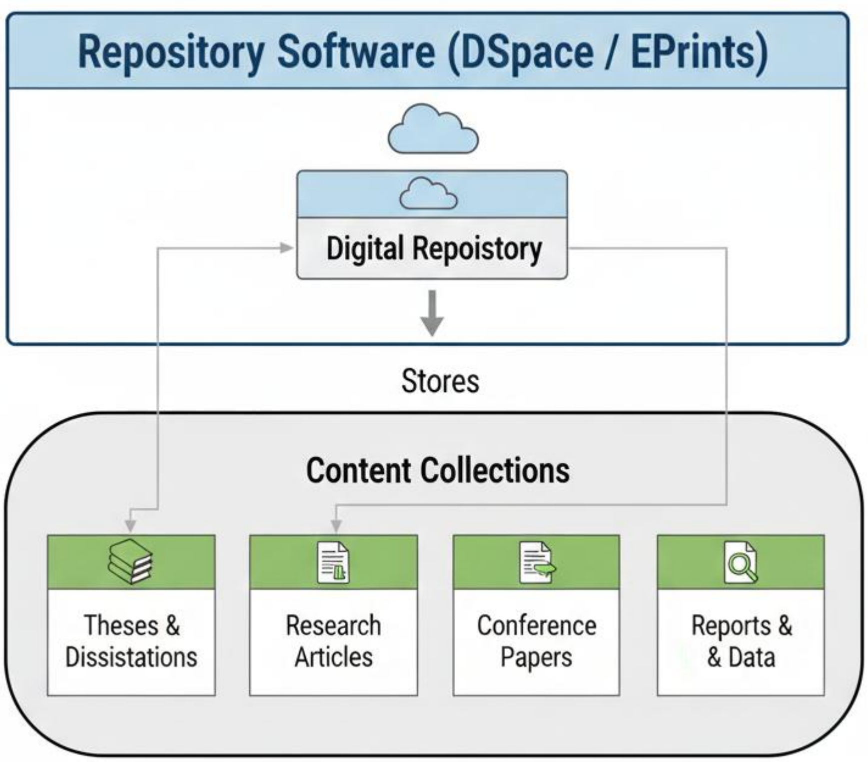


Figure 3.9 Repository structure in DSpace and EPrints

Pilot Questions 3.3

1. What library functions does Koha support?
2. Fill in the blank: A digital library software package that allows creation of searchable collections is called __________.
3. What types of materials can be stored in Greenstone?
4. Name two repository software packages used in academic institutions.

5. Why are DSpace and EPrints important for open access initiatives?

Series Summary

In **Series 3: Database Applications in Libraries and Information Systems**, we examined how databases are applied in practical contexts to support information organisation, retrieval, and management.

- We began with **library applications**, focusing on cataloguing, classification, circulation, and digital repositories. These functions demonstrate how databases underpin the daily operations of libraries.
- We then explored **information systems applications**, including bibliographic databases, full-text databases, and multimedia databases, showing how databases extend beyond libraries to support research and publishing.
- Finally, we studied **case examples of database packages** such as Koha, Greenstone, DSpace, and EPrints, which illustrate how theoretical principles are implemented in real-world systems.

By completing this Series, you should now be able to:

- **Describe** how databases are applied in libraries for cataloguing, circulation, and digital archives.
- **Explain** the role of databases in bibliographic, full-text, and multimedia information systems.
- **Analyse** case studies of microcomputer-based database packages.
- **Evaluate** the practical relevance of database applications in supporting library and information services.

This Series has shown you how database principles translate into practice, preparing you to connect theory with the tools and systems used in professional information environments.

Glossary of Terms

Archive A collection of historical documents or records preserved in a library database for long-term use.

Bibliographic Database A database that contains references to published works such as books, journal articles, and conference papers, usually without the full text.

Circulation The library function that manages borrowing, returning, and renewing of items, as well as tracking user accounts.

Classification The systematic arrangement of library materials into categories or subjects, often using schemes like the Dewey Decimal Classification.

Digital Repository A database that stores and provides access to electronic resources such as e-books, journals, theses, and multimedia files.

DSpace An open-source repository software used to manage and provide access to digital content, commonly in academic institutions.

EPrints Software for building open access repositories, often used to store and share research outputs.

Greenstone An open-source software package for creating digital libraries, enabling searchable collections of text, images, audio, and video.

Information Retrieval System A system that allows users to search and retrieve documents from a database using keywords, subjects, or authors.

Koha An open-source integrated library system (ILS) that supports cataloguing, circulation, acquisitions, and user services.

Multimedia Database A database that stores non-textual materials such as images, audio, and video files.

Repository Software Software designed to store, manage, and provide access to digital content such as theses, dissertations, and research articles.

User Services Library services managed through databases that include user accounts, reservations, and fines.

Concept Check Questions 3

Objective Questions

1. A library database record that contains bibliographic details such as author and title is called a __________. *(Linked to SLO 3.1)*
2. The library function that manages borrowing and returning items is called __________. *(Linked to SLO 3.1)*
3. A database that contains references to published works such as journal articles is called a __________ database. *(Linked to SLO 3.2)*
4. Repository software used to manage and provide access to digital content includes __________ and __________. *(Linked to SLO 3.3)*
5. An open-source integrated library system widely used in libraries is called __________. *(Linked to SLO 3.3)*

Short-Answer Questions

6. Describe how classification systems are integrated into library databases. *(Linked to SLO 3.1)*

7. Explain the difference between a bibliographic database and a full-text database. *(Linked to SLO 3.2)*

8. Give one example of how multimedia databases support modern information systems. *(Linked to SLO 3.2)*

9. Identify two functions supported by Koha as an integrated library system. *(Linked to SLO 3.3)*

10. Why are DSpace and EPrints important for academic institutions? *(Linked to SLO 3.4)*

Long-Answer Questions

11. Analyse the role of databases in cataloguing, circulation, and digital repositories within libraries. *(Linked to SLO 3.1)*

12. Evaluate the practical relevance of bibliographic, full-text, and multimedia databases in supporting information systems. *(Linked to SLO 3.2)*

13. Discuss case studies of Koha, Greenstone, DSpace, and EPrints, highlighting their contributions to library and information services. *(Linked to SLO 3.3 & SLO 3.4)*

Answers to Concept Check Questions 3

Objective Questions

1. Catalogue record.
2. Circulation.
3. Bibliographic database.
4. DSpace and EPrints.
5. Koha.

Short-Answer Questions

6. Classification systems such as Dewey Decimal are integrated into databases to organise materials systematically, making retrieval easier.

7. A bibliographic database provides references only, while a full-text database gives access to the complete content of documents.

8. Multimedia databases store images, audio, and video, supporting modern systems such as digital libraries and e-learning platforms.

9. Koha supports cataloguing and circulation (also acquisitions and user services).

10. DSpace and EPrints are important because they manage digital repositories and support open access to academic research outputs.

Long-Answer Questions

11. **Basic response:** Databases support cataloguing by storing bibliographic details, circulation by tracking borrowing and returning, and digital repositories by preserving electronic resources. **Value-added response:** Beyond these functions, databases also integrate classification schemes, automate fines and reservations, and ensure long-term preservation of archives, enhancing efficiency and user satisfaction.

12. **Basic response:** Bibliographic databases provide references, full-text databases give complete documents, and multimedia databases store non-textual materials, all supporting information retrieval. **Value-added response:** Together, these databases expand access to scholarly communication, enable interdisciplinary research, and support diverse learning formats such as text, audio, and video.

13. **Basic response:** Koha supports library management, Greenstone builds digital libraries, and DSpace and EPrints manage repositories. **Value-added response:** These packages collectively advance open access, foster collaboration across institutions, and demonstrate how open-source solutions empower libraries and information centres to serve global communities effectively.

Answers to Pilot Questions 3

Pilot Questions 3.1 (Database Applications in Libraries)

1. Bibliographic details typically included in a library catalogue record are **author, title, subject, and publication date**.
2. The library function that involves borrowing and returning items is called **circulation**.
3. Databases support circulation services by **tracking borrowed items, managing due dates, calculating fines, and handling reservations**.
4. Digital repositories store resources such as **e-books, journals, theses, dissertations, and multimedia files**.
5. Databases are important for preserving archives because they **ensure long-term storage, organisation, and retrieval of historical documents and records**.

Pilot Questions 3.2 (Database Applications in Information Systems)

1. The main function of an information retrieval system is to **allow users to search and retrieve documents quickly using keywords or subjects**.
2. A database that contains references to published works is called a **bibliographic database**.
3. One example of a bibliographic database is **PubMed** (others include Scopus and Web of Science).
4. A bibliographic database provides **references only**, while a full-text database provides **complete access to the content of documents**.
5. Two types of materials stored in multimedia databases are **images and audio files** (also video).

Pilot Questions 3.3 (Case Studies of Database Packages)

1. Koha supports library functions such as **cataloguing, circulation, acquisitions, and user services**.
2. A digital library software package that allows creation of searchable collections is called **Greenstone**.
3. Materials stored in Greenstone include **text documents, images, audio, and video files**.
4. Two repository software packages used in academic institutions are **DSpace and EPrints**.

5. DSpace and EPrints are important for open access initiatives because they **enable institutions to share research outputs freely and manage digital repositories effectively**.

References and Attributions 3

General References

- Connolly, T., & Begg, C. (2015). *Database systems: A practical approach to design, implementation, and management*. Pearson Education.
- Elmasri, R., & Navathe, S. B. (2016). *Fundamentals of database systems*. Pearson.
- Borgman, C. L. (2000). *From Gutenberg to the global information infrastructure: Access to information in the networked world*. MIT Press.
- Lynch, C. A. (2003). *Institutional repositories: Essential infrastructure for scholarship in the digital age*. ARL.

Illustrations

- *Figure 3.1 Database catalogue record with bibliographic details*
    - AI-generated using prompt: "Generate a diagram showing a library catalogue record with fields for author, title, subject, and publication date."
- *Figure 3.2 Circulation process in a library database*
    - AI-generated using prompt: "Generate a diagram showing circulation activities: borrowing, returning, renewing, and user accounts."
- *Figure 3.3 Digital repository structure in a library database*
    - AI-generated using prompt: "Generate a diagram showing a digital repository with e-books, journals, theses, and multimedia files."
- *Figure 3.4 Information retrieval system workflow*
    - AI-generated using prompt: "Generate a diagram showing an information retrieval system with search input, database, and results output."
- *Figure 3.5 Structure of a bibliographic database record*
    - AI-generated using prompt: "Generate a diagram showing a bibliographic database record with fields for author, title, source, and year."
- *Figure 3.6 Examples of full-text and multimedia databases*
    - AI-generated using prompt: "Generate a diagram showing a full-text database with journal articles and a multimedia database with images, audio, and video."
- *Figure 3.7 Koha interface for library management*
    - AI-generated using prompt: "Generate a diagram showing Koha modules for cataloguing, circulation, acquisitions, and user services."

- *Figure 3.8 Greenstone digital library structure*
    - AI-generated using prompt: "Generate a diagram showing Greenstone digital library with text, images, audio, and video collections."
- *Figure 3.9 Repository structure in DSpace and EPrints*
    - AI-generated using prompt: "Generate a diagram showing repository software storing theses, dissertations, and research articles."

Notes on Attribution

- All illustrations were created using Microsoft Copilot Image Gen, with prompts provided in the instructional content.
- References listed above provide scholarly support for the concepts and examples presented in Series 3.
- Learners are encouraged to consult these sources for deeper study and reinforcement of the material.

Course code: LIS 421

- **Course title**: Database Design and Management
- **Credit load**: 2 Units (Lecture Hours 15; Practical Hours 45)
- **Series list**:

1. Concepts and Foundations of Database Design and Management
2. Types of Databases and Principles for Microcomputers
3. Applications of Databases in Library and Information Fields
4. Processes of Database Design, Creation, and Maintenance
5. Advanced Database Systems and Practical Management

Series 4:Processes of Database Design, Creation, and Maintenance

Proposed Outline for Series 4

- **Part 4.1 Principles of Database Design**
    - 4.1.1 Importance of design in database systems
    - 4.1.2 Data modelling concepts
    - 4.1.3 Normalisation and its role
- **Part 4.2 Database Development Process**
    - 4.2.1 Requirements analysis
    - 4.2.2 Logical and physical design
    - 4.2.3 Implementation and testing
- **Part 4.3 Tools and Techniques for Database Development**

- 4.3.1 Database management systems (DBMS)
- 4.3.2 Query languages (SQL basics)
- 4.3.3 Development environments and utilities

3. Review Against Guidelines

- The outline contains **3 main Parts**, which fits perfectly within the guideline for a **2-credit course (2 to 4 Parts per Series)**.
- The sub-Parts are logically grouped:
  - **Part 4.1** introduces design principles.
  - **Part 4.2** covers the development process step by step.
  - **Part 4.3** highlights practical tools and techniques.
- No merging or splitting is required, as the structure is balanced and comprehensive.

Introduction

In the previous Series, we explored how databases are applied in libraries and information systems, focusing on cataloguing, circulation, repositories, and case studies of packages such as Koha and DSpace. Having understood these applications, we now move to the crucial stage of **designing and developing databases**. This stage is where theory meets practice, as effective design ensures that databases are efficient, reliable, and scalable.

The aim of this Series is to introduce you to the principles of database design and guide you through the development process, equipping you with the knowledge of tools and techniques needed to build functional database systems.

We shall commence this Series by examining the principles of database design, including data modelling and normalisation. Next, we will explore the database development process, covering requirements analysis, logical and physical design, and implementation. Finally, we will wrap up by considering the tools and techniques used in database development, such as DBMS, SQL, and development environments.

Series Learning Outcomes

Upon completing **Series 4: Designing and Developing Databases**, you should be able to:

- **SLO 4.1** describe the principles of database design, including data modelling and normalisation,

- **SLO 4.2** explain the stages of the database development process, from requirements analysis to implementation,

- **SLO 4.3** demonstrate the use of database management systems (DBMS) and query languages such as SQL, and

- **SLO 4.4** evaluate tools and techniques used in database development environments.

4.1 Principles Of Database Design

Designing a database is one of the most critical stages in database development. A well-designed database ensures that data is stored efficiently, relationships are clear, and retrieval is accurate. In this Part, we will explore the importance of design, the concept of data modelling, and the role of normalisation.

4.1.1 Importance of design in database systems

A **database design** is the structured plan that determines how data will be organised, stored, and accessed. Good design prevents redundancy, supports scalability, and ensures data integrity. Without proper design, databases may become inefficient, difficult to maintain, and prone to errors.

Fill in the blank:

- A structured plan that determines how data will be organised, stored, and accessed is called __________.

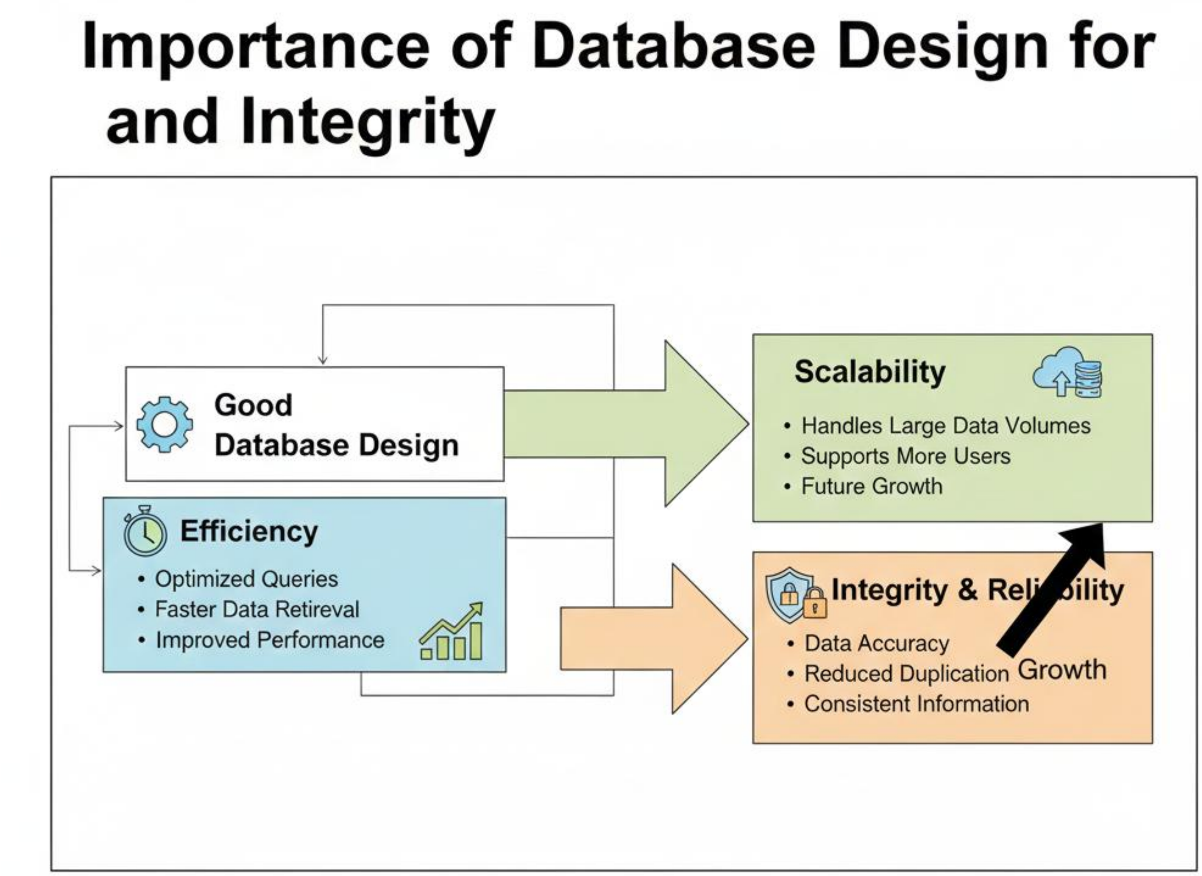


Figure 4.1 Importance of database design for efficiency and integrity

4.1.2 Data modelling concepts

Data modelling is the process of creating a visual representation of data structures and their relationships. It helps designers understand how data flows and interacts within a system. Common models include the **entity-relationship (ER) model**, which uses entities, attributes, and relationships to represent data.

Fill in the blank:

- The process of creating a visual representation of data structures and their relationships is called __________.

Figure 4.2 Example of an Entity-Relationship Model

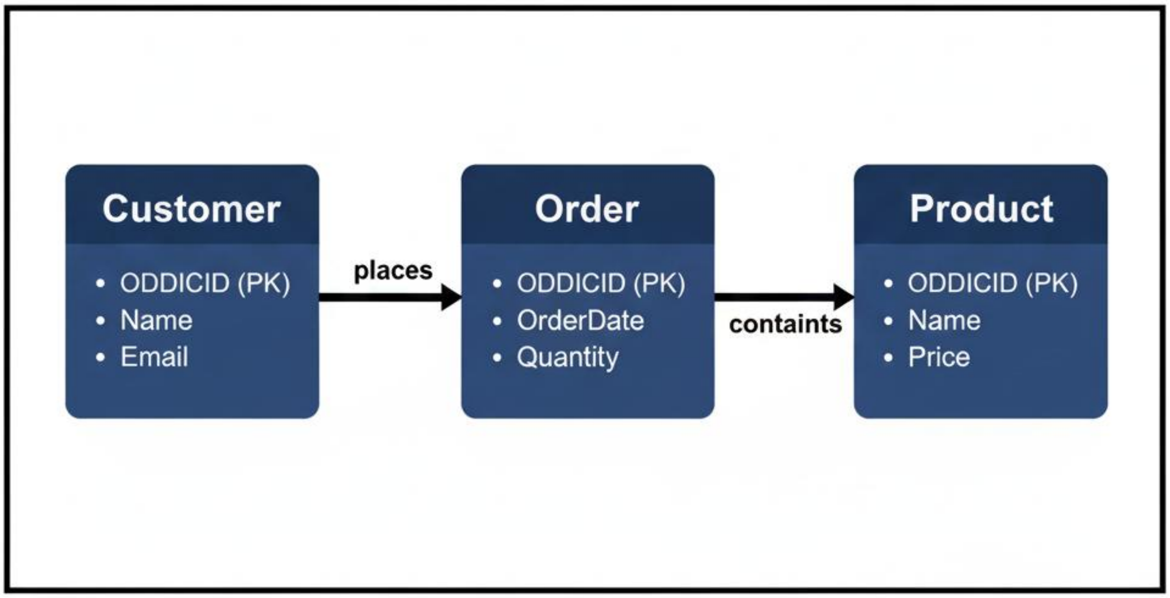


Figure 4.2 Example of an entity-relationship model

4.1.3 Normalisation and its role

Normalisation is the process of organising data into tables to reduce redundancy and improve consistency. It involves dividing large tables into smaller ones and defining relationships between them. The most common levels are **First Normal Form (1NF)**, **Second Normal Form (2NF)**, and **Third Normal Form (3NF)**. Each level addresses specific issues such as duplicate data, partial dependencies, and transitive dependencies.

Fill in the blank:

- The process of organising data into tables to reduce redundancy and improve consistency is called __________.

Normalisation Form	Key Features
1NF (First Normal Form)	• Atomic values (no repeating groups • Unique rows •Each column contains values of the same type
2NF (Second Normal Form)	
Is in 2NF	• Is in 1NF • All non-key attributes are fully dependent on the primary key
3Third	• No transitive dependency (non-key attributes depend not other of thery attributes)

Table 4.1 Summary of normalisation forms

”

Case study: Why normalisation matters

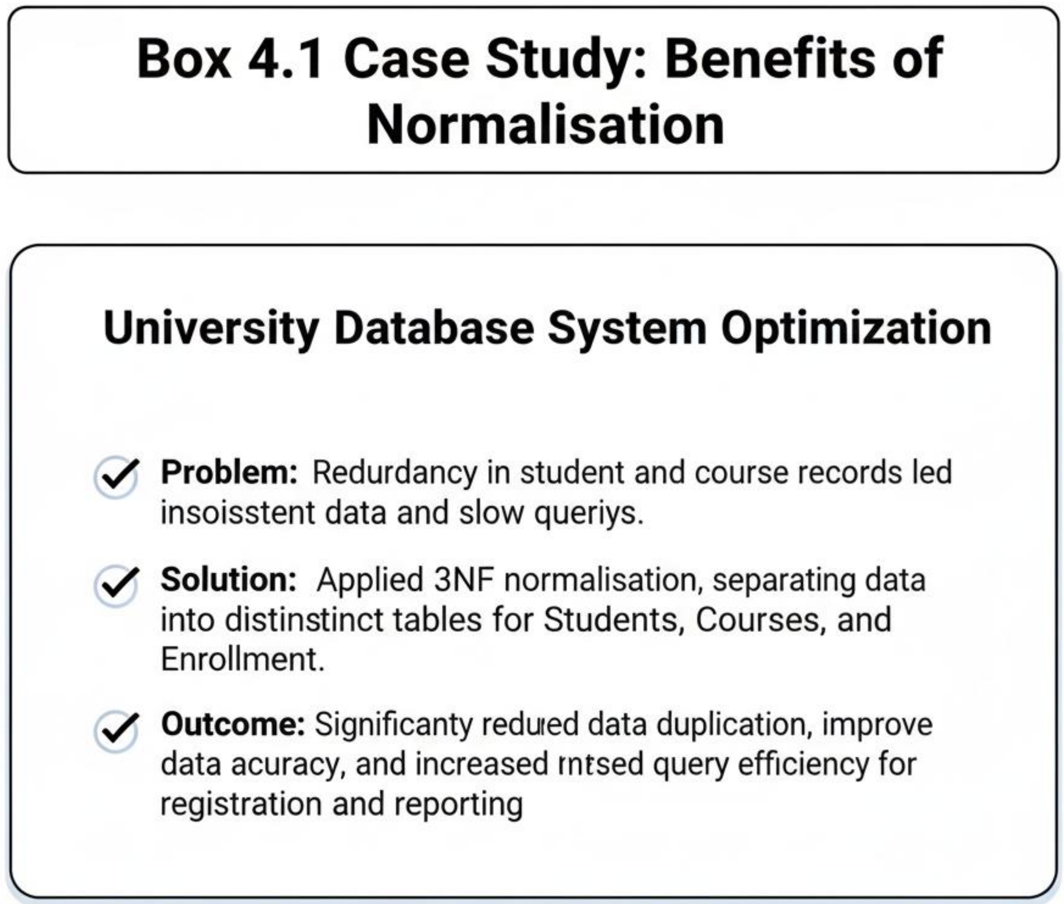


Figure 4.1 Case study: Benefits of roformation systems

4.2 Database Development Process

Designing a database is only the beginning. To make it functional, we must follow a structured **development process** that ensures the system meets user needs, operates efficiently, and can be maintained over time. In this Part, we will explore requirements analysis, logical and physical design, and the stages of implementation and testing.

4.2.1 Requirements analysis

Requirements analysis is the stage where the needs of users and the organisation are gathered and documented. It involves identifying what data must be stored, how it will be used, and what outputs are expected. This step ensures that the database is built to solve real problems rather than imagined ones.

Fill in the blank:

- The stage where user and organisational needs are gathered and documented is called __________.

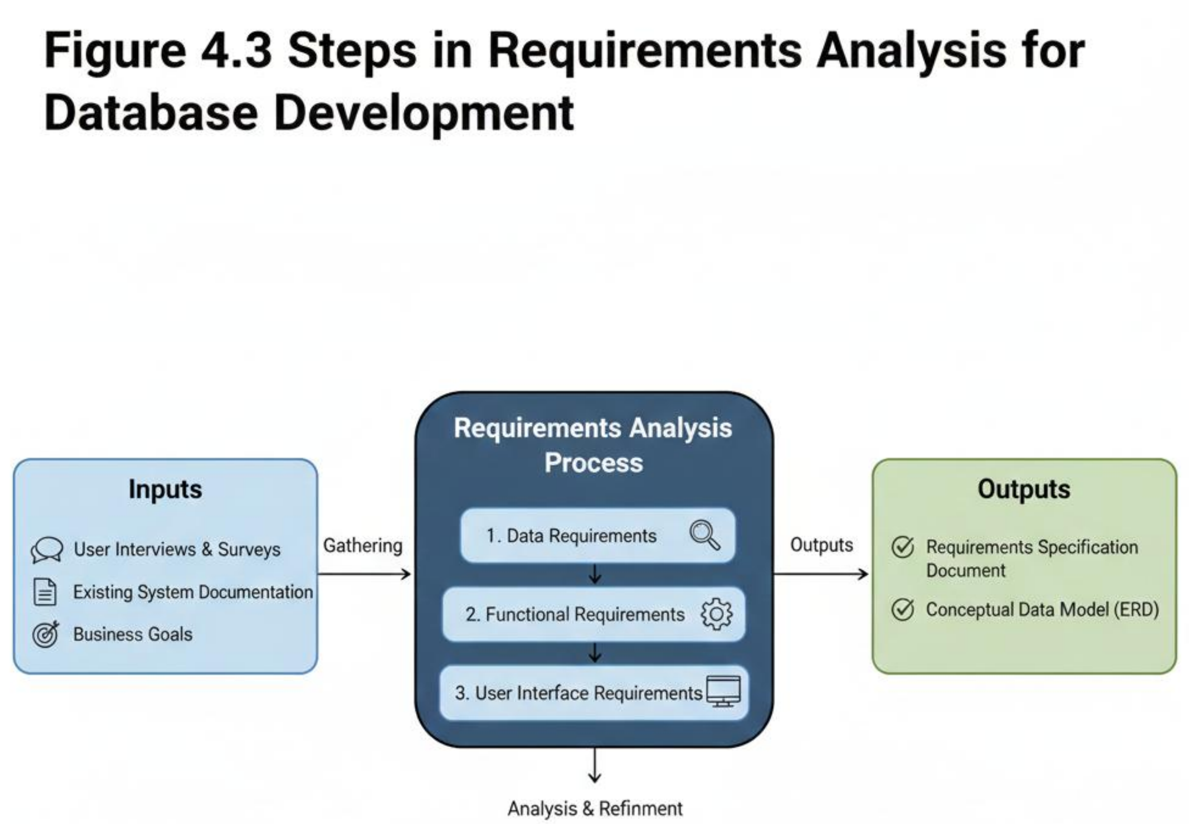


Figure 4.3 Steps in requirements analysis for database development

4.2.2 Logical and physical design

Logical design refers to the abstract representation of the database, including tables, relationships, and constraints. It focuses on how data is structured conceptually. **Physical design**, on the other hand, deals with how the database will be implemented on hardware and software, considering storage, indexing, and performance.

Fill in the blank:

- The abstract representation of tables, relationships, and constraints is called __________ design.

Figure 4.2 Comparison of Logical and Physical Design

Logical Design	Physical Design
Conceptual schema of the database	Internal schema & file structures
Focuses on data relationships & constraints	Focuss on storage, indexing & access methods
Independent of specific DDMS software	Dependent on specific DMS DIMS (e.g, MySQL, Oracle)
Example: ER diagrams, UML class diagrams	Example: Table schemas, indexes, partioning

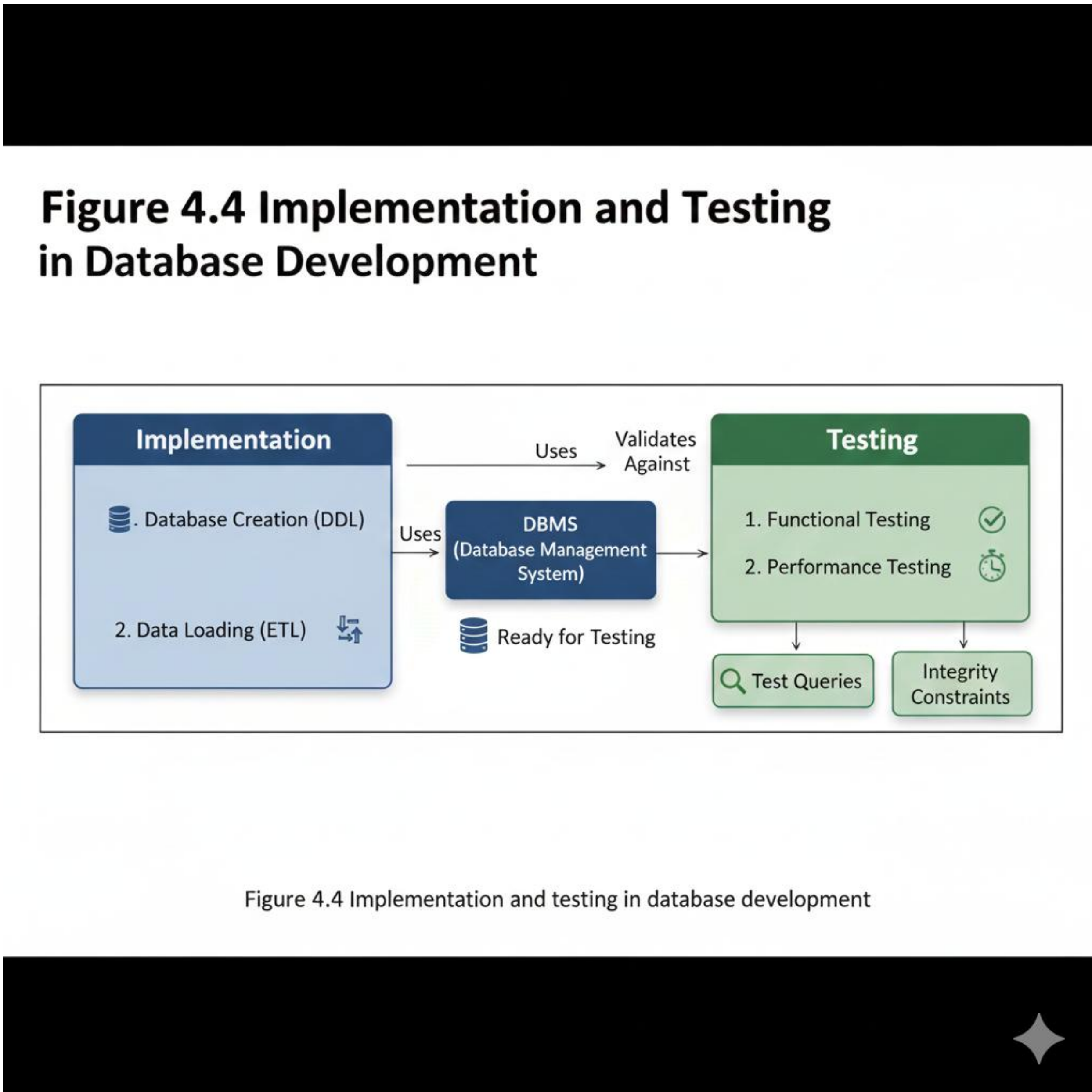
Table 4.2 Comparison of logical and physical design

4.2.3 Implementation and testing

Implementation is the stage where the database is created using a database management system (DBMS). This involves writing SQL commands, creating tables, and loading data. **Testing** follows implementation to ensure that the database works as intended, meets requirements, and performs efficiently. Testing may include checking queries, validating constraints, and simulating user operations.

Fill in the blank:

- The stage where the database is created using a DBMS is called __________.



Case study: Testing a student records database

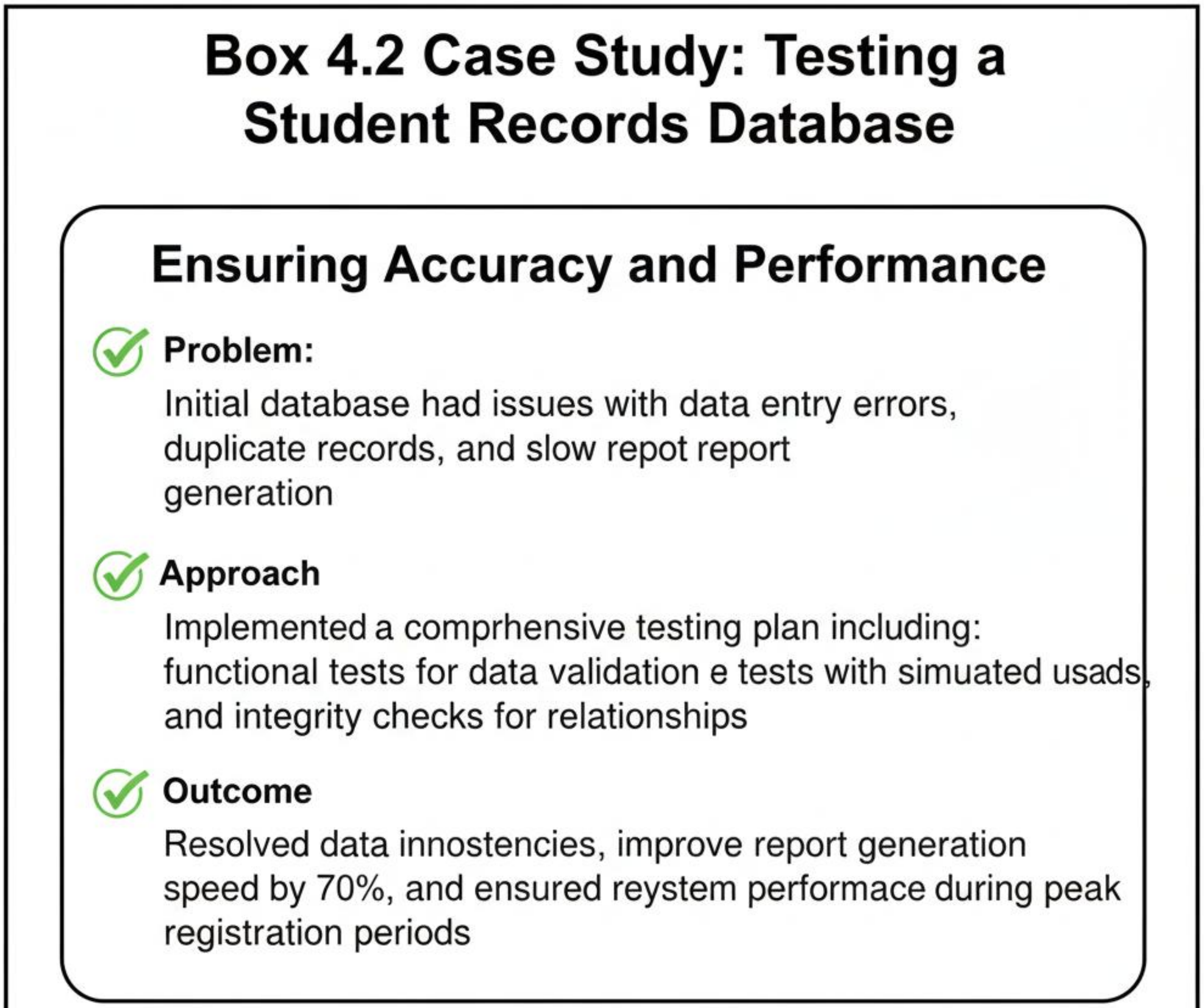


Figure 4.2 Case study: Testing a student records database

4.3 Tools And Techniques For Database Development

Developing a database requires not only sound design principles but also the right **tools and techniques**. These tools help implement, manage, and optimise databases, while techniques ensure that the system is efficient and user-friendly. In this Part, we will explore database management systems, query languages, and development environments.

4.3.1 Database management systems (DBMS)

A **database management system (DBMS)** is software that allows users to create, manage, and interact with databases. It provides functions such as data storage, retrieval, security, and backup. Examples include MySQL, Oracle, and Microsoft SQL Server.

Fill in the blank:

- Software that allows users to create, manage, and interact with databases is called a __________.

[

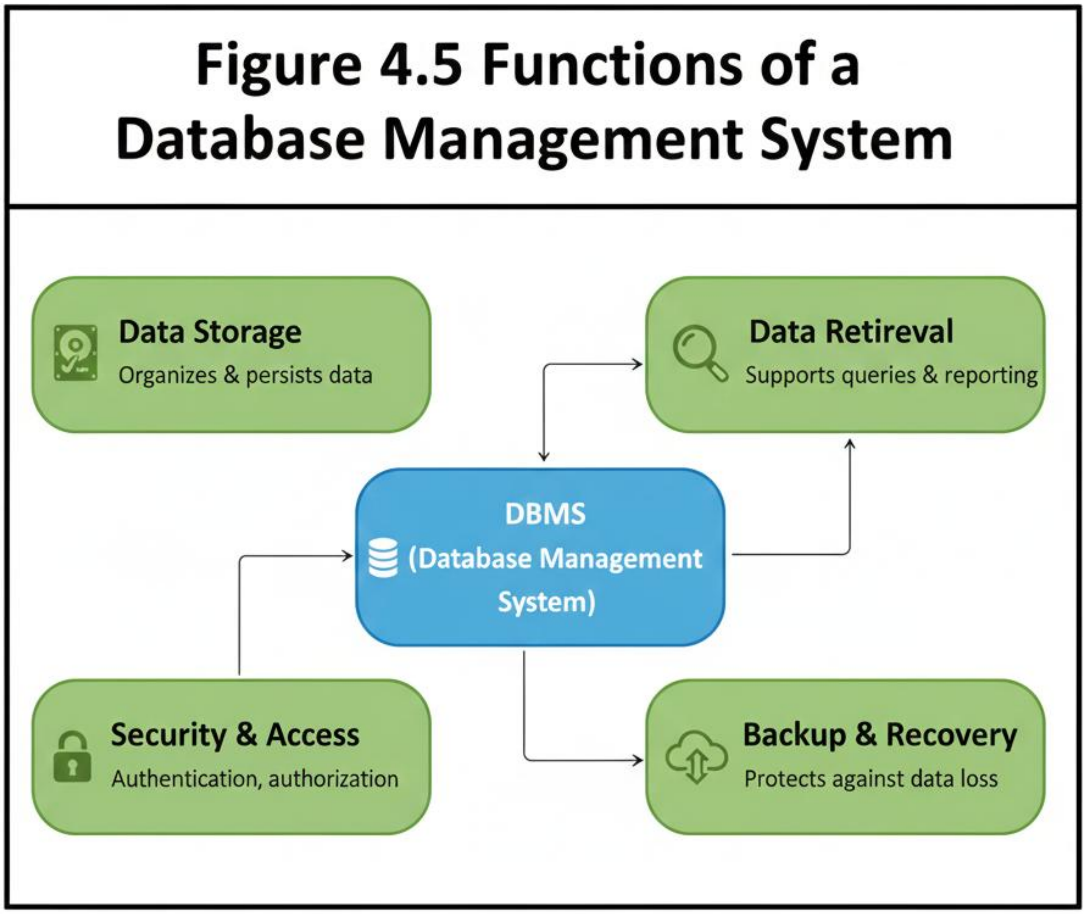


Figure 4.5 Functions of a database management system

4.3.2 Query languages (SQL basics)

A **query language** is a language used to communicate with a database. The most widely used is **Structured Query Language (SQL)**, which allows users to create tables, insert data, and retrieve information. SQL commands are divided into categories such as Data Definition Language (DDL), Data Manipulation Language (DML), and Data Control Language (DCL).

Fill in the blank:

- The most widely used query language for interacting with databases is __________.

Table 4.3 Categories of SQL Commands

SQL Category	Key Features & Examples
DDL (Data Definition Language)	• Defines database structure Example TABLE, DROP TABLE
Focuses on data relationships & constraints	• Mample: CREATE TABLE, ALTER DROP TABLE
DML (Mata Manulation DDDS software	• Example: INSERT INTO, SELECT, UPDATE, DELETE
DCL (Control Language)	• Example: GRANT, REVOVE

Table 4.3 Comparison of logical and physical design

4.3.3 Development environments and utilities

Development environments provide platforms for building and testing databases. They often include graphical interfaces, debugging tools, and utilities for performance monitoring. Examples include phpMyAdmin for MySQL and SQL Server Management Studio (SSMS) for Microsoft SQL Server. These environments simplify the development process and make it easier for users to interact with databases.

Fill in the blank:

- A platform that provides tools for building and testing databases is called a development __________.

Plate 4.1 Example of a Database Enveropment (SQL Server Management Studio)

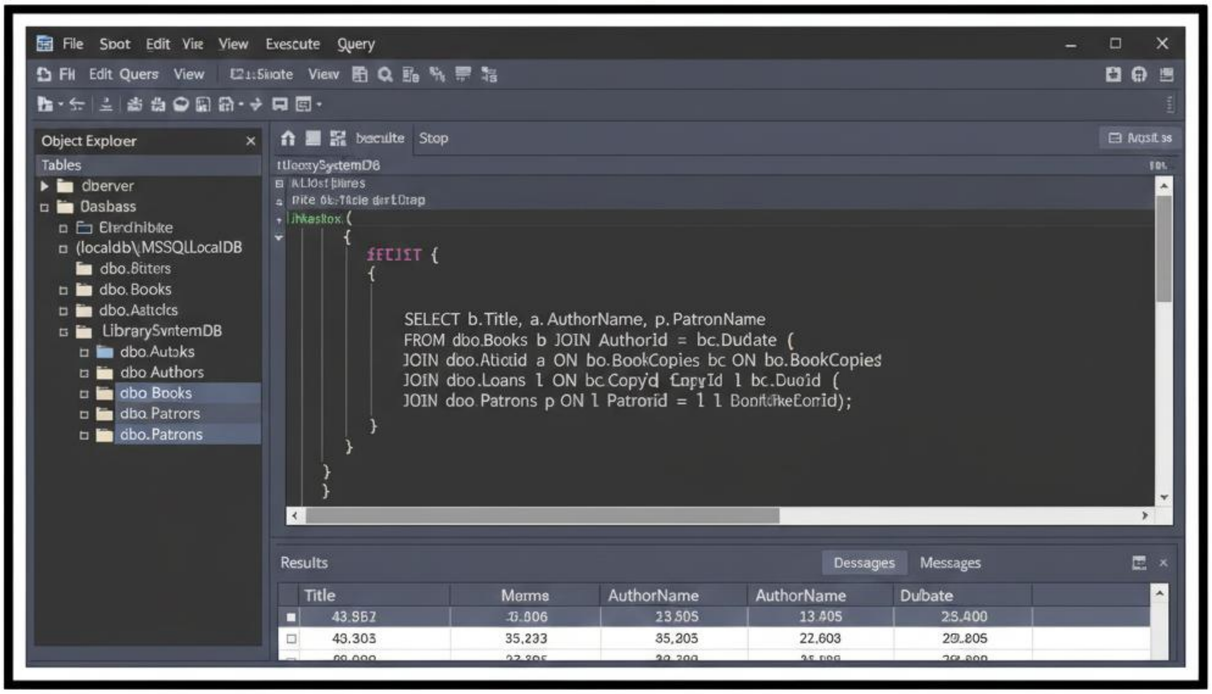


Plate 4.1 Example of a database develoιment environment (SQ Server Management Studio)

Pilot Questions 4.3

1. What functions are provided by a DBMS?
2. Fill in the blank: The most widely used query language for interacting with databases is __________.
3. Name the three categories of SQL commands.
4. Give one example of a database development environment.
5. Why are development environments important for database developers?

Series Summary

In **Series 4: Designing and Developing Databases**, we explored the essential principles and processes involved in creating effective database systems.

- We began with **principles of database design**, focusing on the importance of design, data modelling, and normalisation. These concepts ensure that databases are efficient, consistent, and scalable.
- We then examined the **database development process**, covering requirements analysis, logical and physical design, and the stages of implementation and testing. This provided a step-by-step framework for building reliable systems.
- Finally, we studied **tools and techniques for database development**, including DBMS, SQL, and development environments, which equip learners with practical skills to implement and manage databases.

By completing this Series, you should now be able to:

- **Describe** the principles of database design, including modelling and normalisation.
- **Explain** the stages of database development from requirements analysis to testing.
- **Demonstrate** the use of DBMS and SQL in database creation and management.
- **Evaluate** tools and techniques used in development environments.

This Series has shown you how to move from theoretical design to practical implementation, preparing you to build and manage databases that meet real-world needs.

Glossary of Terms

Data modelling The process of creating a visual representation of data structures and their relationships, often using diagrams such as the entity-relationship (ER) model.

Database design A structured plan that determines how data will be organised, stored, and accessed within a database system.

Database management system (DBMS) Software that allows users to create, manage, and interact with databases, providing functions such as storage, retrieval, security, and backup.

Development environment A platform that provides tools for building and testing databases, often including graphical interfaces, debugging tools, and performance monitoring utilities.

Implementation The stage of database development where the database is created using a DBMS, involving tasks such as creating tables and loading data.

Logical design An abstract representation of the database structure, including tables, relationships, and constraints, focusing on how data is conceptually organised.

Normalisation The process of organising data into tables to reduce redundancy and improve consistency, typically through stages such as 1NF, 2NF, and 3NF.

Physical design The stage of database design that deals with how the database will be implemented on hardware and software, considering storage, indexing, and performance.

Query language A language used to communicate with a database. The most widely used is SQL, which allows users to define, manipulate, and control data.

Requirements analysis The stage of database development where user and organisational needs are gathered and documented to ensure the database meets real requirements.

SQL (Structured Query Language) The most widely used query language for interacting with databases, divided into categories such as DDL, DML, and DCL.

Testing The stage of database development where the system is checked to ensure it meets requirements, performs efficiently, and produces accurate results.

Concept Check Questions 4

Objective Questions

1. A structured plan that determines how data will be organised, stored, and accessed is called __________. *(Linked to SLO 4.1)*
2. The process of creating a visual representation of data structures and their relationships is called __________. *(Linked to SLO 4.1)*
3. The stage where user and organisational needs are gathered and documented is called __________. *(Linked to SLO 4.2)*
4. The most widely used query language for interacting with databases is __________. *(Linked to SLO 4.3)*
5. Software that allows users to create, manage, and interact with databases is called a __________. *(Linked to SLO 4.3)*

Short-Answer Questions

6. Explain why normalisation is important in database design. *(Linked to SLO 4.1)*

7. Differentiate between logical design and physical design in database development. *(Linked to SLO 4.2)*

8. Give one example of a DBMS and describe one of its functions. *(Linked to SLO 4.3)*

9. Identify the three categories of SQL commands and give one example for each. *(Linked to SLO 4.3)*

10. Why are development environments important for database developers? *(Linked to SLO 4.4)*

Long-Answer Questions

11. Analyse the role of requirements analysis in ensuring successful database development. *(Linked to SLO 4.2)*

12. Evaluate the contribution of normalisation to efficiency and consistency in database systems. *(Linked to SLO 4.1)*

13. Discuss the practical relevance of DBMS, SQL, and development environments in modern database development. *(Linked to SLO 4.3 & SLO 4.4)*

Answers to Concept Check Questions 4

Objective Questions

1. Database design.
2. Data modelling.
3. Requirements analysis.
4. SQL (Structured Query Language).
5. Database management system (DBMS).

Short-Answer Questions

6. Normalisation reduces redundancy and improves consistency by organising data into well-structured tables.

7. Logical design is the abstract representation of tables and relationships, while physical design focuses on implementation details such as storage and indexing.

8. Example: MySQL. One function is managing data storage and retrieval.

9. DDL (e.g., CREATE TABLE), DML (e.g., INSERT), DCL (e.g., GRANT).

10. Development environments provide tools for building, testing, and monitoring databases, making development easier and more efficient.

Long-Answer Questions

11. **Basic response:** Requirements analysis ensures that the database meets user and organisational needs by documenting what data is required and how it will be used. **Value-added response:** Beyond documentation, requirements analysis aligns database design with business goals, prevents costly redesigns, and ensures stakeholder satisfaction by involving users early in the process.

12. **Basic response:** Normalisation improves efficiency by reducing duplicate data and ensures consistency by enforcing clear relationships. **Value-added response:** It also enhances scalability, supports complex queries, and reduces anomalies in data manipulation, making databases more reliable in large-scale systems.

13. **Basic response:** DBMS manage data, SQL provides a language for interaction, and development environments offer tools for building and testing. **Value-added response:** Together, they form the backbone of modern database development, enabling automation, performance optimisation, and collaborative work across diverse platforms and industries.

Answers to Pilot Questions 4

Pilot Questions 4.1 (Principles of Database Design)

1. A structured plan that determines how data will be organised, stored, and accessed is called **database design**.
2. The process of creating a visual representation of data structures and their relationships is called **data modelling**.
3. Normalisation is important because it **reduces redundancy and improves consistency** in database tables.
4. The most common normalisation forms are **1NF, 2NF, and 3NF**.
5. An entity-relationship (ER) model represents **entities, attributes, and relationships** in a database.

Pilot Questions 4.2 (Database Development Process)

1. The stage where user and organisational needs are gathered and documented is called **requirements analysis**.
2. Logical design is the **abstract representation of tables, relationships, and constraints**, while physical design is the **implementation on hardware and software**.
3. Implementation is the stage where the database is **created using a DBMS**.
4. Testing ensures that the database **works as intended, meets requirements, and performs efficiently**.
5. One benefit of requirements analysis is that it **aligns database design with real user needs**.

Pilot Questions 4.3 (Tools and Techniques for Database Development)

1. A DBMS provides functions such as **data storage, retrieval, security, and backup**.
2. The most widely used query language for interacting with databases is **SQL**.
3. The three categories of SQL commands are **DDL, DML, and DCL**.
4. One example of a database development environment is **SQL Server Management Studio (SSMS)**.
5. Development environments are important because they **simplify building, testing, and monitoring databases**.

References and Attributions 4

General References

- Connolly, T., & Begg, C. (2015). *Database systems: A practical approach to design, implementation, and management*. Pearson Education.
- Elmasri, R., & Navathe, S. B. (2016). *Fundamentals of database systems*. Pearson.
- Coronel, C., & Morris, S. (2019). *Database systems: Design, implementation, and management*. Cengage Learning.

- Date, C. J. (2004). *An introduction to database systems*. Addison-Wesley.

Illustrations

- *Figure 4.1 Importance of database design for efficiency and integrity*
    - AI-generated using prompt: "Generate a diagram showing database design benefits: efficiency, scalability, and integrity."
- *Figure 4.2 Example of an entity-relationship model*
    - AI-generated using prompt: "Generate a diagram showing an ER model with entities, attributes, and relationships."
- *Table 4.1 Summary of normalisation forms*
    - AI-generated using prompt: "Generate a table summarising normalisation forms: 1NF, 2NF, 3NF with features."
- *Box 4.1 Case study: Benefits of normalisation*
    - AI-generated using prompt: "Generate a text box explaining a case study where normalisation improved a university database."
- *Figure 4.3 Steps in requirements analysis for database development*
    - AI-generated using prompt: "Generate a diagram showing requirements analysis with inputs, processes, and outputs."
- *Table 4.2 Comparison of logical and physical design*
    - AI-generated using prompt: "Generate a table comparing logical design and physical design in database development."
- *Figure 4.4 Implementation and testing in database development*
    - AI-generated using prompt: "Generate a diagram showing database implementation with DBMS and testing with queries and constraints."
- *Box 4.2 Case study: Testing a student records database*
    - AI-generated using prompt: "Generate a text box explaining a case study of testing a student records database."
- *Figure 4.5 Functions of a database management system*
    - AI-generated using prompt: "Generate a diagram showing DBMS functions: storage, retrieval, security, and backup."
- *Table 4.3 Categories of SQL commands*
    - AI-generated using prompt: "Generate a table listing SQL categories: DDL, DML, DCL with examples."
- *Plate 4.1 Example of a database development environment (SQL Server Management Studio)*

- AI-generated using prompt: “Generate an image showing a database development environment interface with tables and queries.”

Notes on Attribution

- All illustrations were created using Microsoft Copilot Image Gen, with prompts provided in the instructional content.
- References listed above provide scholarly support for the concepts and examples presented in Series 4.
- Learners are encouraged to consult these sources for deeper study and reinforcement of the material.

Course code: LIS 421

- **Course title**: Database Design and Management
- **Credit load**: 2 Units (Lecture Hours 15; Practical Hours 45)
- **Series list**:
  1. Concepts and Foundations of Database Design and Management
  2. Types of Databases and Principles for Microcomputers
  3. Applications of Databases in Library and Information Fields
  4. Processes of Database Design, Creation, and Maintenance
  5. Advanced Database Systems and Practical Management

SERIES5

2. Suggested Outline of Main Parts and Sub-Parts

Since the course is **2 credits**, each Series should have **2 to 4 main Parts**.

Proposed Outline for Series 5

- **Part 5.1 Introduction to Database Management Systems**
  - 5.1.1 Definition and purpose of DBMS
  - 5.1.2 Components of a DBMS
  - 5.1.3 Advantages and limitations of DBMS
- **Part 5.2 Types of Database Management Systems**
  - 5.2.1 Hierarchical DBMS
  - 5.2.2 Network DBMS
  - 5.2.3 Relational DBMS
  - 5.2.4 Object-oriented DBMS
- **Part 5.3 Functions of a DBMS**

    - 5.3.1 Data storage and retrieval
    - 5.3.2 Security and integrity management
    - 5.3.3 Backup and recovery
    - 5.3.4 Multi-user support and concurrency control
- **Part 5.4 Applications of DBMS**
    - 5.4.1 DBMS in libraries and information centres
    - 5.4.2 DBMS in business and industry
    - 5.4.3 DBMS in research and education

Introduction

In the previous Series, we explored how databases are designed and developed, moving from principles such as data modelling and normalisation to practical tools like SQL and DBMS environments. Having laid that foundation, we now turn to **Series 5: Understanding Database Management Systems (DBMS)**.

A **Database Management System (DBMS)** is software that enables the creation, organisation, and control of databases. It is the backbone of modern information systems, ensuring that data is stored securely, retrieved efficiently, and managed consistently. Without DBMS, the complexity of handling large volumes of data would overwhelm organisations and institutions.

The aim of this Series is to help you understand what DBMS are, the different types available, their core functions, and how they are applied in real-world contexts.

We shall commence this Series by introducing DBMS, defining their purpose, components, and advantages. Next, we will examine the various types of DBMS, including hierarchical, network, relational, and object-oriented systems. We will then explore the functions of DBMS, such as storage, security, backup, and concurrency control. Finally, we will consider applications of DBMS in libraries, businesses, and research environments.

Series Learning Outcomes

Series 5: Understanding Database Management Systems

Upon completing this Series, you should be able to:

- **SLO 5.1** define the purpose and components of a database management system (DBMS),
- **SLO 5.2** explain the advantages and limitations of using DBMS in data management,
- **SLO 5.3** classify the different types of DBMS, including hierarchical, network, relational, and object-oriented systems,
- **SLO 5.4** describe the core functions of a DBMS such as storage, security, backup, and concurrency control, and
- **SLO 5.5** analyse real-world applications of DBMS in libraries, businesses, and research environments.

5.1 Introduction To Database Management Systems

In this Part, we will explore what a **Database Management System (DBMS)** is, why it is important, and how it works. A DBMS is the software that enables us to create, organise, and control databases. It ensures that data is stored securely, retrieved efficiently, and managed consistently.

5.1.1 Definition and purpose of DBMS

A **Database Management System (DBMS)** is software that allows users to define, create, maintain, and control access to databases. Its purpose is to simplify data handling by providing a structured way to store and retrieve information. Without DBMS, managing large volumes of data would be complex and error-prone.

Fill in the blank:

- Software that allows users to define, create, maintain, and control access to databases is called __________.

Figure 5.1 DDMS as an Interface Between Users and Databases

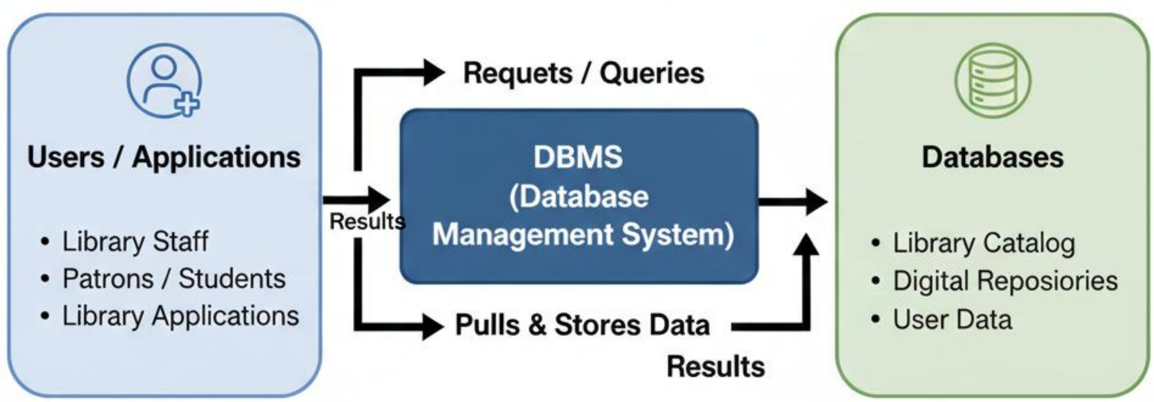


Figure 5.1 DDMS as an interface between users and databases

5.1.2 Components of a DBMS

A DBMS is made up of several **components**, each serving a specific function:

- **Database engine**: The core service that stores, processes, and secures data.
- **Data definition subsystem**: Provides tools to define the structure of the database, such as tables and relationships.
- **Data manipulation subsystem**: Allows users to add, update, and retrieve data.
- **Application generation subsystem**: Helps create user interfaces and applications that interact with the database.
- **Data administration subsystem**: Ensures security, backup, and performance monitoring.

Fill in the blank:

- The core service of a DBMS that stores, processes, and secures data is called the __________.

Table 5.1 Components of a DDMS and their Functions

DMS Component	Function / Role
Database Engine	• Stores, retrieves, and updates data data
Database Engine	• Manages data access
Data Definition Subsystem (DDL)	• Defines database structure (schams) Manages metadato
Data Manipulation Subsystem DML)	• Adds, deletes, modifies data Supports query languages (eeg., SQL)
Data Manipulation Subsystem (DMŁ	Connects with external programs
Application Interfaces	• User management & security Backup & recovery
Database Administration Tools	• Performance monitoring

Table 5.1 Components of a DDMS and their functions

5.1.3 Advantages and limitations of DBMS

A DBMS offers several **advantages**:

- Reduces data redundancy by storing information in a structured way.
- Improves data consistency and integrity.
- Provides security features to protect sensitive information.

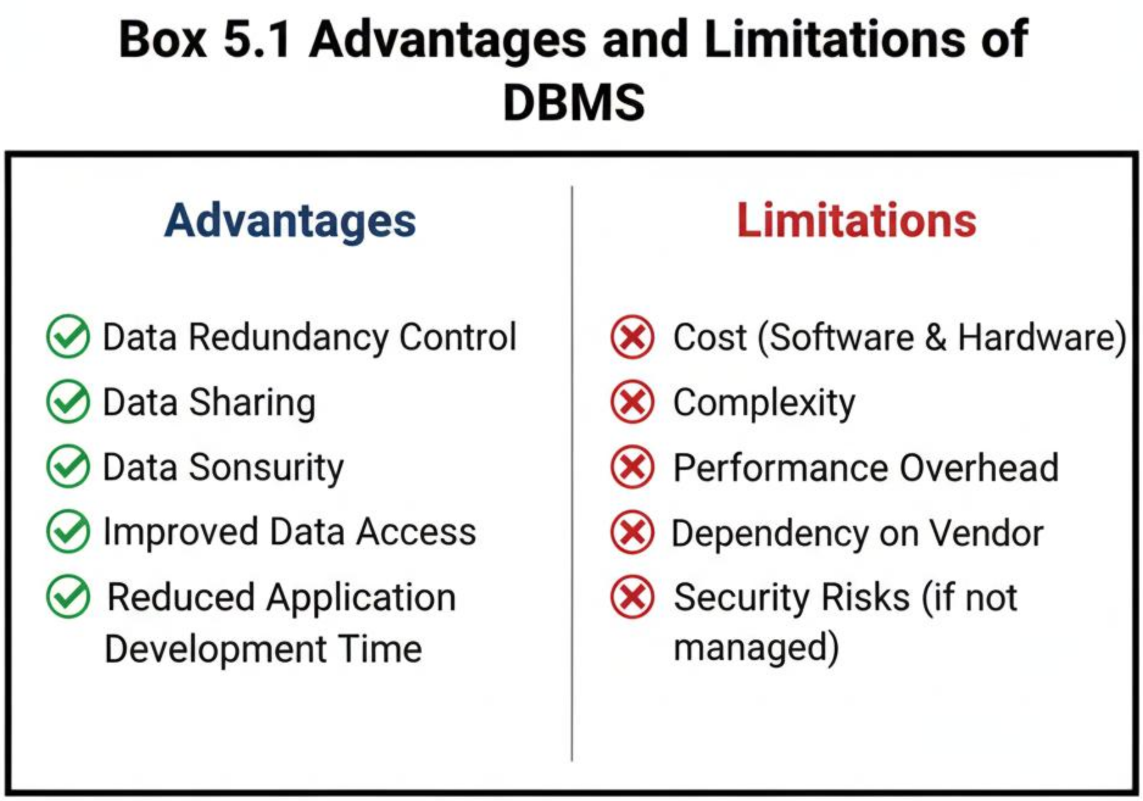
- Supports multi-user access and concurrency control.
- Facilitates backup and recovery.

However, DBMS also has **limitations**:

- It can be expensive to purchase and maintain.
- Requires technical expertise to operate effectively.
- May demand significant hardware resources.

Fill in the blank:

- One advantage of a DBMS is that it reduces __________ by storing information in a structured way.



Box 5.1 Advantages and limitations of DDMS

This Part has introduced you to the definition, components, and advantages of DBMS. You should now appreciate why DBMS is considered the backbone of modern information systems.

5.2 Types Of Database Management Systems

Database management systems are not all the same. Over time, different types have been developed to meet varying needs. In this Part, we will look at hierarchical, network, relational, and object-oriented DBMS. Each type has unique features, strengths, and limitations.

5.2.1 Hierarchical DBMS

A **hierarchical DBMS** organises data in a tree-like structure, where records are linked in parent-child relationships. Each child record has only one parent, but a parent can have multiple children. This model is efficient for applications where data is naturally hierarchical, such as organisational charts.

Fill in the blank:

- A DBMS that organises data in a tree-like structure with parent-child relationships is called __________.

Figure 5.2 Hierorahical DDMS Structure

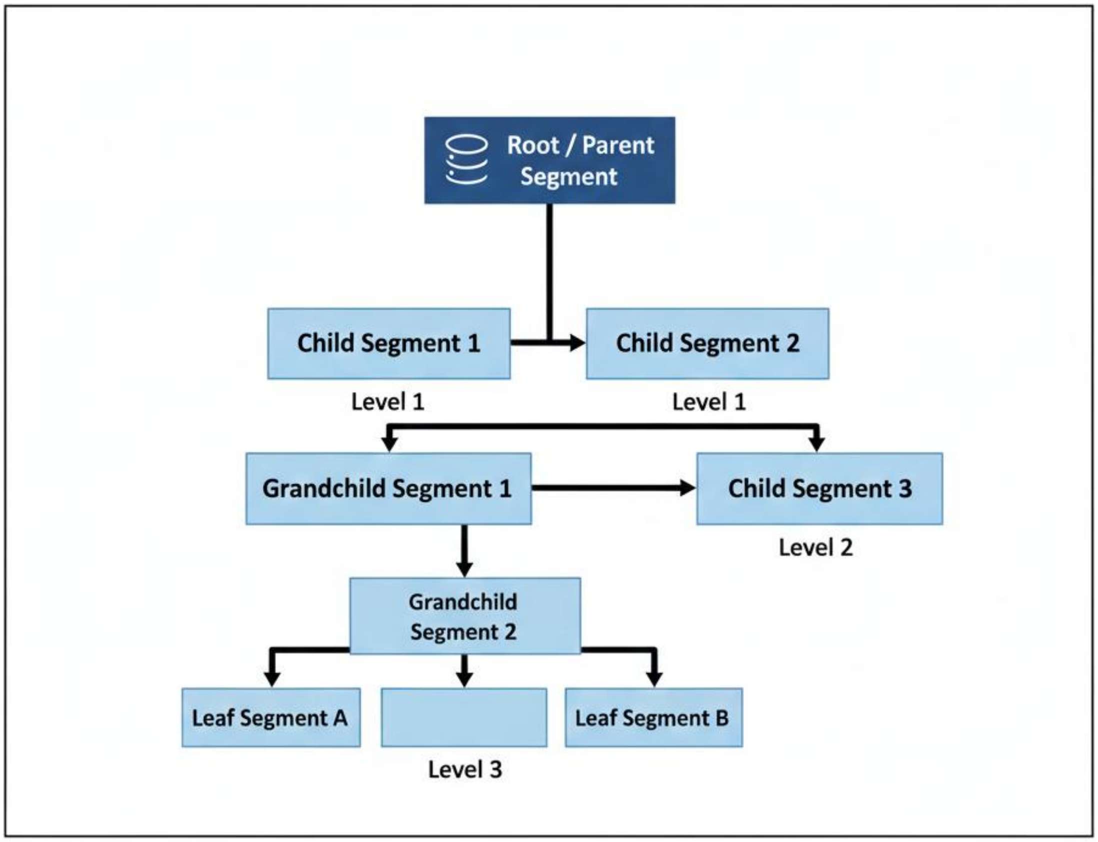


Figure 5.2 Hierorahical DDMS structure

5.2.2 Network DBMS

A **network DBMS** uses a graph structure, allowing records to have multiple parent and child relationships. This model is more flexible than the hierarchical model and is useful for complex applications such as supply chain management.

Fill in the blank:

- A DBMS that uses a graph structure with multiple parent and child relationships is called __________.

Figure 5.3 Network DDMS Structure

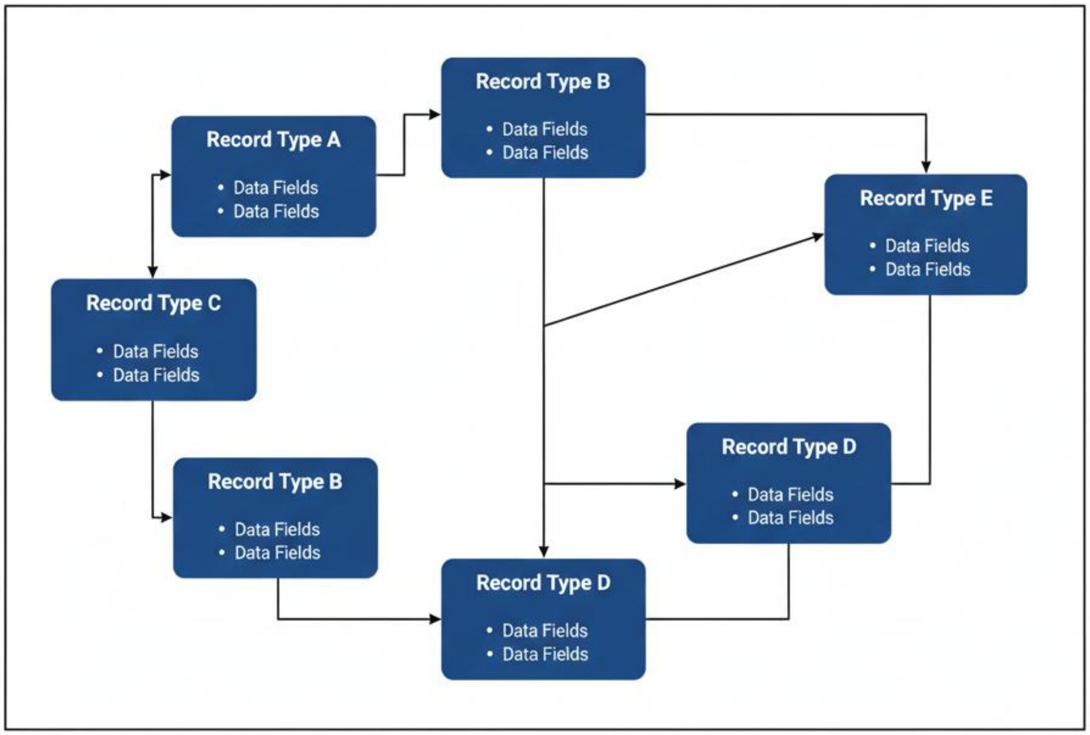


Figure 5.3 Network DDMS structure

5.2.3 Relational DBMS

A **relational DBMS (RDBMS)** stores data in tables, with rows representing records and columns representing attributes. Relationships between tables are established using keys. This is the most widely used type of DBMS today, with examples such as MySQL, Oracle, and Microsoft SQL Server.

Fill in the blank:

- The most widely used type of DBMS that stores data in tables is called __________.

[Insert table here] Caption: *Table 5.2 Example of relational DBMS table structure* Short description: Table showing rows and columns with primary and foreign keys. Sample AI prompt:

"Generate a table showing relational DBMS with rows, columns, primary key, and foreign key."
Search string: "relational DBMS table example OER"

5.2.4 Object-oriented DBMS

An **object-oriented DBMS (OODBMS)** integrates database capabilities with object-oriented programming concepts. Data is stored as objects, which include both attributes and methods. This type is suitable for applications requiring complex data such as multimedia, engineering, and scientific research.

Fill in the blank:

- A DBMS that stores data as objects with attributes and methods is called __________.

Figure 5.4

Object-Oriented DDMS Structure

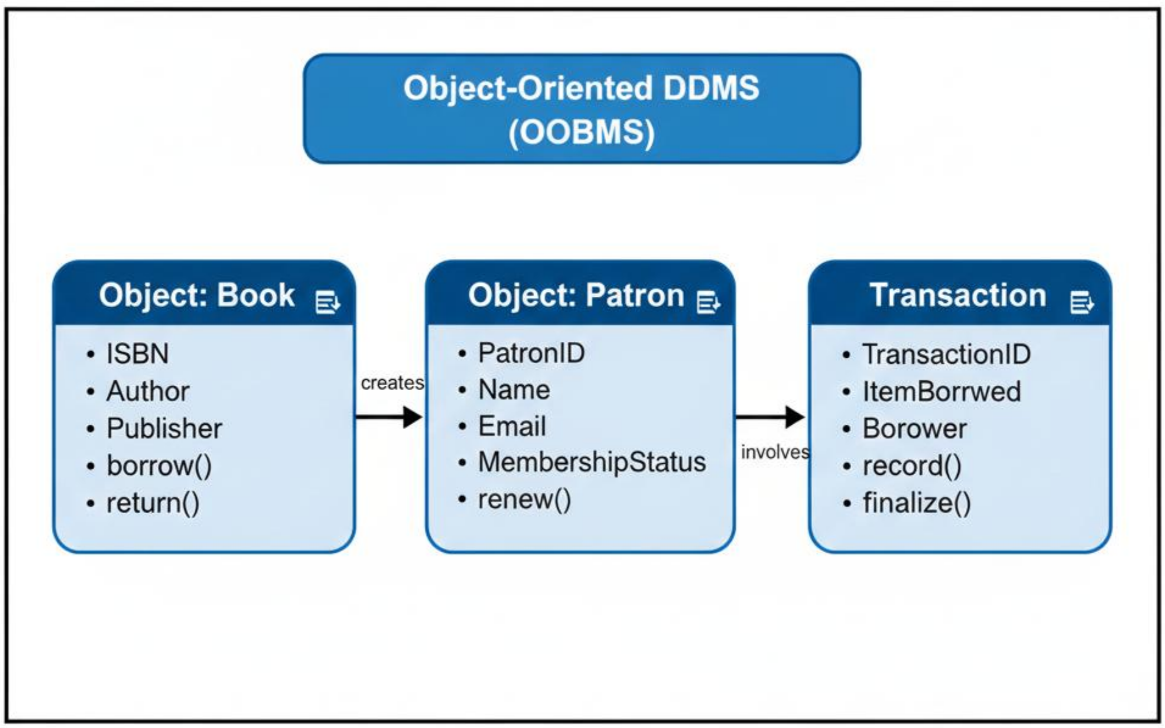


Figure 5.4 Object-oriented DDMS structure

[Insert box here] Caption: *Box 5.2 Case study: Selecting a DBMS for an organisation* Short description: Box explaining how a company chose between hierarchical, network, relational, and object-oriented DBMS. Sample AI prompt: "Generate a text box explaining a case study of selecting the right DBMS type for an organisation." Search string: "case study choosing DBMS type OER"

5.3 Functions Of A Database Management System

A **Database Management System (DBMS)** is not just about storing data. It provides a wide range of functions that make data reliable, secure, and accessible to multiple users. In this Part, we will explore the core functions of a DBMS: data storage and retrieval, security and integrity management, backup and recovery, and multi-user support with concurrency control.

5.3.1 Data storage and retrieval

Data storage and retrieval is the fundamental function of a DBMS. It ensures that data is stored in a structured format and can be retrieved quickly when needed. Retrieval is often achieved through queries, which allow users to specify exactly what information they want.

Fill in the blank:

- The fundamental function of a DBMS that ensures data is stored and accessed quickly is __________.

Figure 5.5 Data storage and retrieval in DDMS

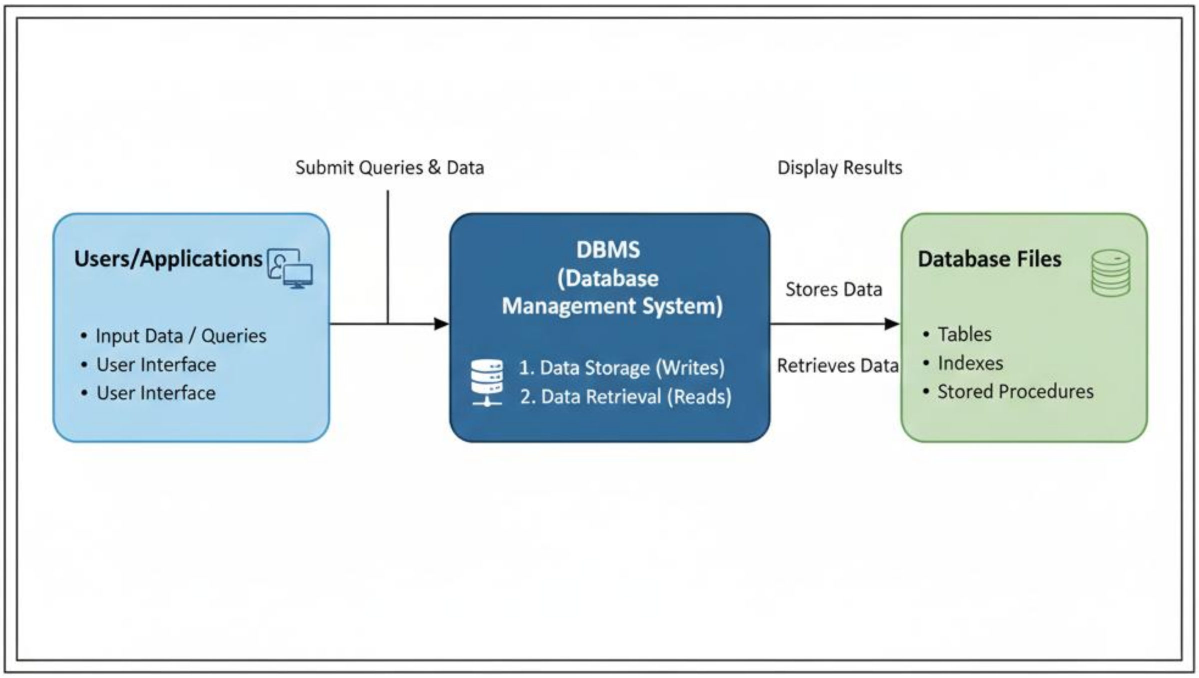


Figure 5.5 Data storage and retrieval in DDMS

5.3.2 Security and integrity management

Security management ensures that only authorised users can access or modify data. This is achieved through authentication, access controls, and encryption. **Integrity management** ensures that data remains accurate and consistent, often enforced through constraints such as primary keys and foreign keys.

Fill in the blank:

- The DBMS function that ensures only authorised users can access or modify data is called __________.

Table 5.3 Security and Integrity Functions in DDMS

Category	Functions & Examples
Authentation	Verifies user identity (e., Username/Password
Access Control (Auhorization)	Restricts data access (e., User Roles, Permisions
Encryption	Protects data confidebility (e., Data at Rest/In Transit Encryption
Integrity Functions	Enforces data rules (e., Primary Key, Foregn Key, CHECK)
Validation	Checks data corrctess (e., e. Data Type, Format Checks

Table 5.3 Security and integrity functions in DMS

5.3.3 Backup and recovery

Backup and recovery functions protect data against loss due to hardware failure, software errors, or human mistakes. Backup involves creating copies of data at regular intervals, while recovery restores data from backups when needed. This ensures continuity and reliability of operations.

Fill in the blank:

- The DBMS function that protects data against loss by creating copies is called __________.

Figure 5.6 Backup and Recovery in DDMS

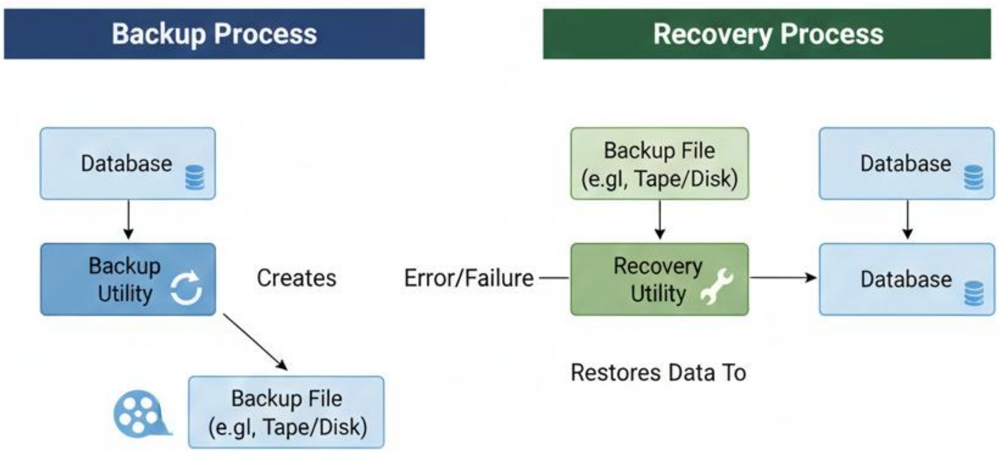


Figure 5.6 Backup and recovery in DDMS

5.3.4 Multi-user support and concurrency control

Multi-user support allows several users to access the database simultaneously. **Concurrency control** ensures that transactions are processed reliably without conflicts, even when multiple users are working at the same time. Techniques such as locking and transaction management are used to maintain consistency.

Fill in the blank:

- The DBMS function that ensures reliable processing when multiple users access the database simultaneously is called __________.

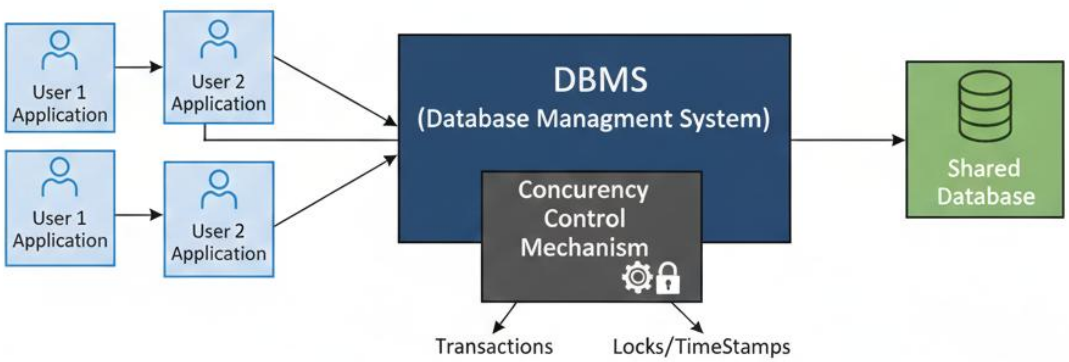
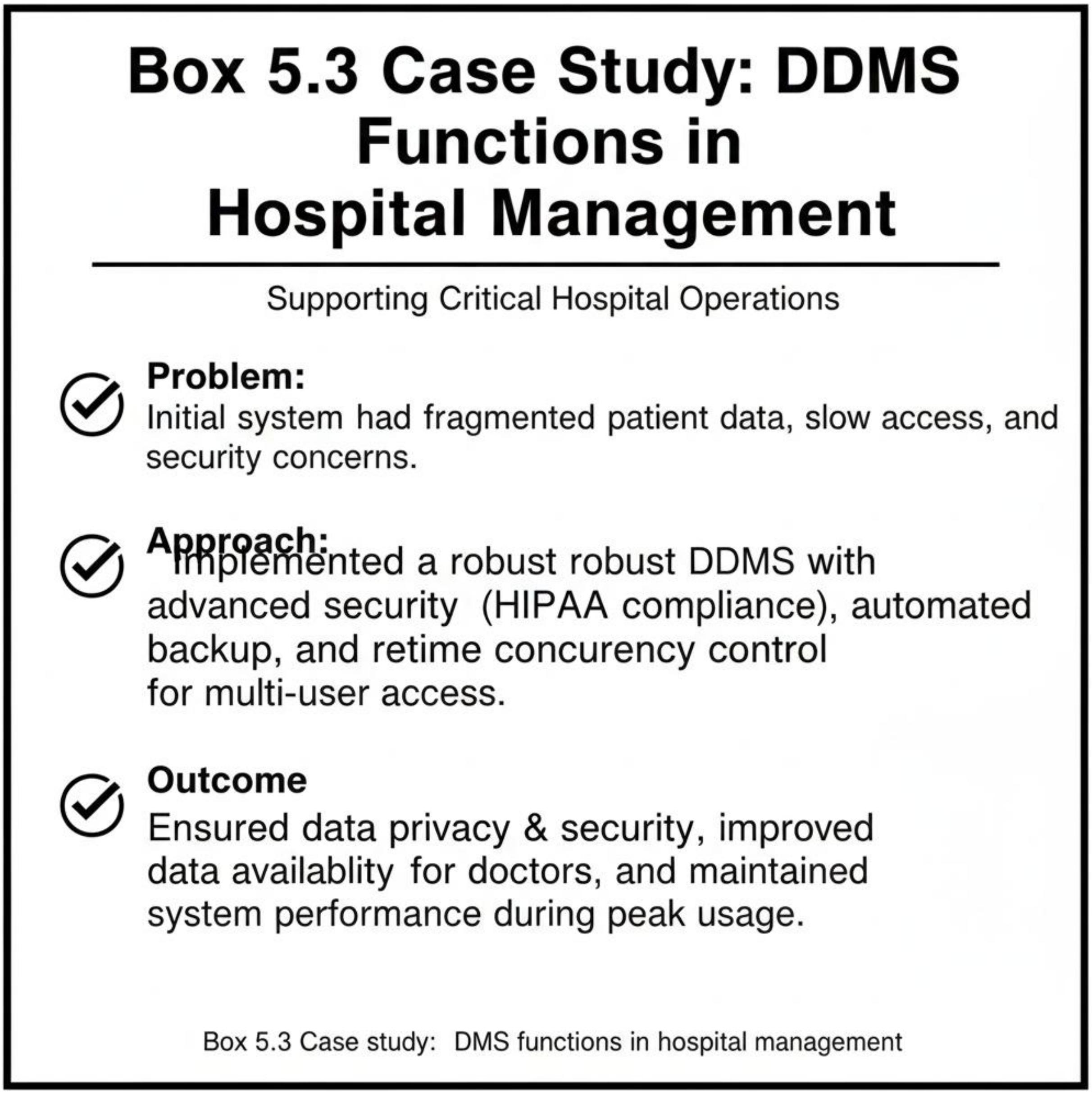


Figure 5.7 Multi-user support and Concuency Control in DDMS

”

Case study: DBMS in a hospital system



Box 5.3 Case study: DMS functions in hospital management

5.4 Applications Of Database Management Systems

Database management systems are widely applied across different sectors. Their ability to organise, secure, and retrieve data makes them indispensable in modern society. In this Part, we will explore how DBMS are used in libraries and information centres, business and industry, and research and education.

5.4.1 DBMS in libraries and information centres

Libraries use DBMS to manage catalogues, circulation, acquisitions, and digital repositories. A DBMS ensures that bibliographic records are stored systematically, borrowing and returning are tracked, and digital resources such as e-books and journals are accessible.

Fill in the blank:

- Libraries use DBMS to manage catalogues, __________, acquisitions, and digital repositories.

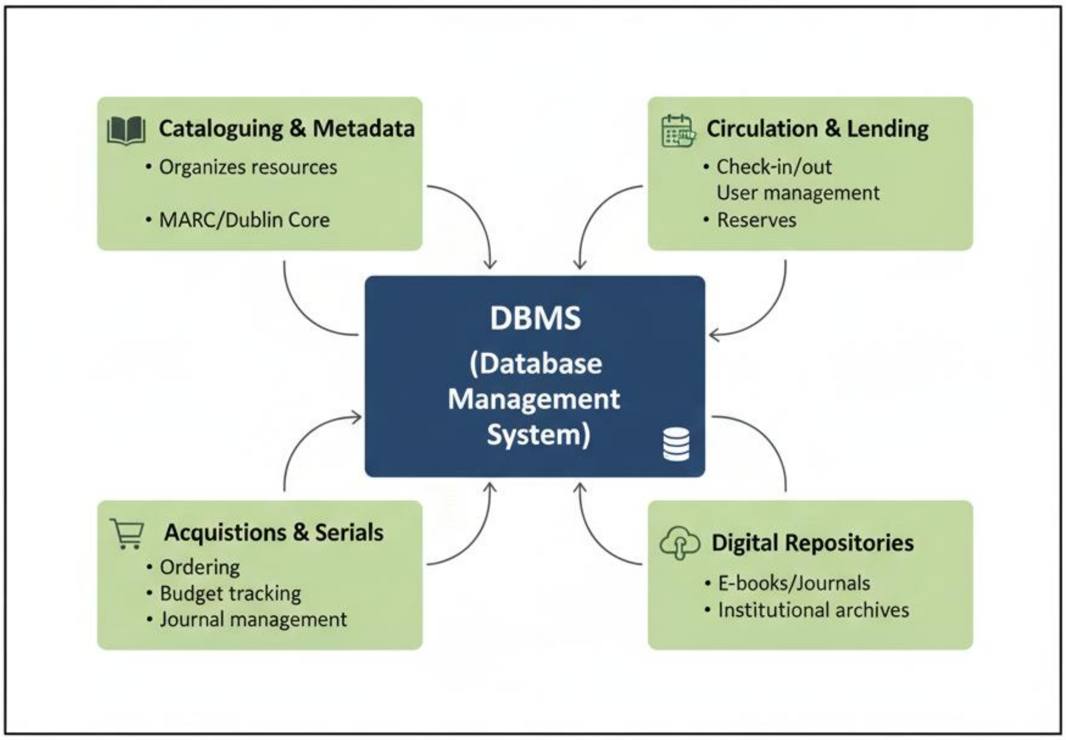


Figure 5.8 DDMS applications in libraries

5.4.2 DBMS in business and industry

Businesses rely on DBMS to manage customer records, inventory, sales, and financial data. A DBMS supports decision-making by providing accurate reports and enables secure handling of sensitive information such as transactions and employee records.

Fill in the blank:

- Businesses rely on DBMS to manage customer records, inventory, __________, and financial data.

Table 5.4 DDMS Applications in Business and Industry

Application Area	Functions & Benefits
Authentation	•Stores customer data, interactions Persasinarketing, improves service
Customer Relationship Management (CRM)	• Stores customer data, interactions Pectolates ceraizers
Inventory & Supply Chain Management	• Tracks stock levels, orders, shipments • Optimizes logistics, reduces costs
Sales & Marketing	• Manages sales pinpelines, Analyzis trends, targets targets customers
Finance & Accounting	• Automates billing, generate, generates reports

Table 5.4 Security applications in business and industry

5.4.3 DBMS in research and education

In research and education, DBMS are used to store and manage large datasets, theses, dissertations, and experimental results. They support collaboration by allowing multiple users to access and update information simultaneously. DBMS also ensure that academic repositories are searchable and well-organised.

Fill in the blank:

- In research and education, DBMS are used to store and manage large __________, theses, and dissertations.

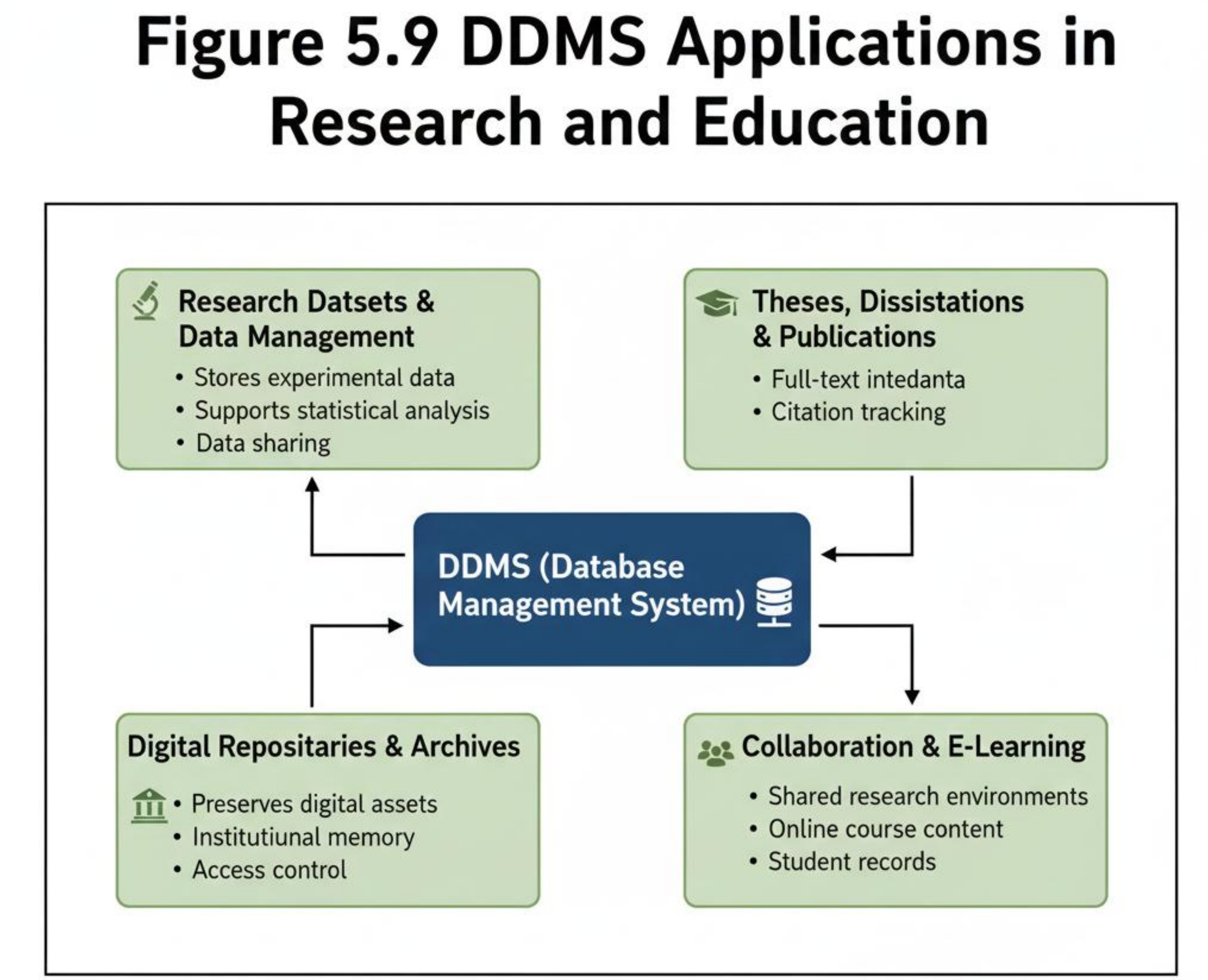


Figure 5.9 DDMS applications in research and education

Case study: DBMS in a university repository

[Insert box here] Caption: *Box 5.4 Case study: DBMS in a university repository* Short description: Box explaining how a university uses DBMS to manage theses, dissertations, and research outputs. Sample AI prompt: “Generate a text box explaining a case study of DBMS in a university repository.” Search string: “university repository DBMS case study OER”

This Part has shown you how DBMS are applied in libraries, businesses, and research institutions. You should now appreciate the versatility of DBMS in supporting information management across different sectors.

Series Summary

In **Series 5: Understanding Database Management Systems**, we examined the essential role of DBMS in modern information management.

- We began with **Part 5.1 Introduction to Database Management Systems**, where we defined DBMS, explored its components, and considered its advantages and limitations.
- In **Part 5.2 Types of Database Management Systems**, we classified DBMS into hierarchical, network, relational, and object-oriented models, highlighting their unique structures and applications.
- **Part 5.3 Functions of a DBMS** focused on the core services provided by DBMS, including data storage and retrieval, security and integrity management, backup and recovery, and multi-user support with concurrency control.
- Finally, **Part 5.4 Applications of DBMS** demonstrated how DBMS are applied in libraries, businesses, and research institutions, showing their versatility across different sectors.

By completing this Series, you should now be able to:

- **Define** the purpose and components of DBMS.
- **Explain** the advantages and limitations of DBMS.
- **Classify** the different types of DBMS.
- **Describe** the core functions of DBMS.
- **Analyse** real-world applications of DBMS in various contexts.

This Series has provided you with both conceptual knowledge and practical insights into DBMS, preparing you to evaluate and apply these systems in diverse environments.

Glossary of Terms

Application generation subsystem A component of a DBMS that helps create user interfaces and applications which interact with the database.

Backup and recovery Functions of a DBMS that protect data against loss by creating copies and restoring them when needed.

Concurrency control A DBMS mechanism that ensures reliable transaction processing when multiple users access the database simultaneously.

Data administration subsystem The DBMS component responsible for managing security, backup, and performance monitoring.

Data definition subsystem The part of a DBMS that provides tools to define the structure of the database, such as tables and relationships.

Data manipulation subsystem The DBMS component that allows users to add, update, and retrieve data.

Database engine The core service of a DBMS that stores, processes, and secures data.

Database management system (DBMS) Software that enables users to define, create, maintain, and control access to databases.

Hierarchical DBMS A type of DBMS that organises data in a tree-like structure with parent-child relationships.

Integrity management A DBMS function that ensures data remains accurate and consistent, often enforced through constraints.

Network DBMS A type of DBMS that uses a graph structure, allowing records to have multiple parent and child relationships.

Object-oriented DBMS (OODBMS) A DBMS that stores data as objects, integrating attributes and methods, suitable for complex applications.

Relational DBMS (RDBMS) The most widely used type of DBMS, storing data in tables with rows and columns, and establishing relationships using keys.

Requirements analysis The stage of database development where user and organisational needs are gathered and documented.

Security management A DBMS function that ensures only authorised users can access or modify data, often through authentication and encryption.

SQL (Structured Query Language) The most widely used query language for interacting with databases, enabling definition, manipulation, and control of data.

Transaction management A DBMS process that ensures all operations within a transaction are completed successfully, maintaining consistency.

Concept Check Questions 5

Objective Questions

1. Software that enables users to define, create, maintain, and control access to databases is called __________. *(Linked to SLO 5.1)*
2. The DBMS component that stores, processes, and secures data is called the __________. *(Linked to SLO 5.1)*
3. A DBMS that organises data in a tree-like structure with parent-child relationships is called __________. *(Linked to SLO 5.3)*
4. The most widely used type of DBMS that stores data in tables is called __________. *(Linked to SLO 5.3)*
5. The DBMS function that protects data against loss by creating copies is called __________. *(Linked to SLO 5.4)*

Short-Answer Questions

6. Explain one advantage and one limitation of DBMS. *(Linked to SLO 5.2)*
7. Differentiate between hierarchical DBMS and network DBMS. *(Linked to SLO 5.3)*
8. Give one example of a relational DBMS and describe its key feature. *(Linked to SLO 5.3)*
9. Identify two security measures provided by DBMS. *(Linked to SLO 5.4)*

10. Why is concurrency control important in multi-user environments? *(Linked to SLO 5.4)*

Long-Answer Questions

11. Analyse the role of DBMS components in ensuring efficient data management. *(Linked to SLO 5.1)*

12. Evaluate the contribution of relational DBMS to modern business operations. *(Linked to SLO 5.3)*

13. Discuss the practical applications of DBMS in libraries, businesses, and research institutions. *(Linked to SLO 5.5)*

Answers to Pilot Questions 5

Pilot Questions 5.1 (Introduction to Database Management Systems)

1. Software that enables users to define, create, maintain, and control access to databases is called a **Database Management System (DBMS)**.
2. The DBMS component that stores, processes, and secures data is the **database engine**.
3. One advantage of a DBMS is that it reduces **data redundancy**.
4. One limitation of a DBMS is that it can be **expensive to purchase and maintain**.
5. The subsystem that ensures security, backup, and performance monitoring is the **data administration subsystem**.

Pilot Questions 5.2 (Types of Database Management Systems)

1. A DBMS that organises data in a tree-like structure with parent-child relationships is a **hierarchical DBMS**.
2. A DBMS that uses a graph structure with multiple parent and child relationships is a **network DBMS**.
3. The most widely used type of DBMS that stores data in tables is a **relational DBMS (RDBMS)**.
4. A DBMS that stores data as objects with attributes and methods is an **object-oriented DBMS (OODBMS)**.
5. Choosing the right DBMS depends on **the complexity of data and organisational needs**.

Pilot Questions 5.3 (Functions of a DBMS)

1. The fundamental function of a DBMS that ensures data is stored and accessed quickly is **data storage and retrieval**.
2. The DBMS function that ensures only authorised users can access or modify data is **security management**.
3. The DBMS function that protects data against loss by creating copies is **backup**.

4. The DBMS function that restores data from copies when needed is **recovery**.
5. The DBMS function that ensures reliable processing when multiple users access the database simultaneously is **concurrency control**.

Pilot Questions 5.4 (Applications of DBMS)

1. Libraries use DBMS to manage catalogues, **circulation**, acquisitions, and digital repositories.
2. Businesses rely on DBMS to manage customer records, inventory, **sales**, and financial data.
3. In research and education, DBMS are used to store and manage large **datasets**, theses, and dissertations.
4. DBMS support collaboration by allowing **multiple users to access and update information simultaneously**.
5. A university repository uses DBMS to manage **theses, dissertations, and research outputs**.

References and Attributions 5

General References

- Connolly, T., & Begg, C. (2015). *Database systems: A practical approach to design, implementation, and management*. Pearson Education.
- Elmasri, R., & Navathe, S. B. (2016). *Fundamentals of database systems*. Pearson.
- Coronel, C., & Morris, S. (2019). *Database systems: Design, implementation, and management*. Cengage Learning.
- Date, C. J. (2004). *An introduction to database systems*. Addison-Wesley.

Illustrations

- *Figure 5.1 DBMS as an interface between users and databases*
  - AI-generated using prompt: “Generate a diagram showing DBMS connecting users, applications, and databases.”
- *Table 5.1 Components of a DBMS and their functions*
  - AI-generated using prompt: “Generate a table listing DBMS components: engine, definition, manipulation, application, administration with functions.”
- *Box 5.1 Advantages and limitations of DBMS*
  - AI-generated using prompt: “Generate a text box summarising advantages and limitations of DBMS.”
- *Figure 5.2 Hierarchical DBMS structure*

- AI-generated using prompt: "Generate a diagram showing hierarchical DBMS with parent and child nodes in a tree structure."

- *Figure 5.3 Network DBMS structure*
  - AI-generated using prompt: "Generate a diagram showing network DBMS with interconnected nodes and multiple relationships."
- *Table 5.2 Example of relational DBMS table structure*
  - AI-generated using prompt: "Generate a table showing relational DBMS with rows, columns, primary key, and foreign key."
- *Figure 5.4 Object-oriented DBMS structure*
  - AI-generated using prompt: "Generate a diagram showing object-oriented DBMS with objects containing attributes and methods."
- *Box 5.2 Case study: Selecting a DBMS for an organisation*
  - AI-generated using prompt: "Generate a text box explaining a case study of selecting the right DBMS type for an organisation."
- *Figure 5.5 Data storage and retrieval in DBMS*
  - AI-generated using prompt: "Generate a diagram showing DBMS storing data in tables and retrieving data using queries."
- *Table 5.3 Security and integrity functions in DBMS*
  - AI-generated using prompt: "Generate a table listing DBMS security and integrity functions with examples."
- *Figure 5.6 Backup and recovery in DBMS*
  - AI-generated using prompt: "Generate a diagram showing DBMS backup process and recovery process with arrows."
- *Figure 5.7 Multi-user support and concurrency control in DBMS*
  - AI-generated using prompt: "Generate a diagram showing multiple users accessing DBMS with concurrency control mechanisms."
- *Box 5.3 Case study: DBMS functions in hospital management*
  - AI-generated using prompt: "Generate a text box explaining a case study of DBMS functions in hospital management."
- *Figure 5.8 DBMS applications in libraries*
  - AI-generated using prompt: "Generate a diagram showing DBMS functions in a library: cataloguing, circulation, acquisitions, repositories."
- *Table 5.4 DBMS applications in business and industry*

    - AI-generated using prompt: "Generate a table listing DBMS applications in business: customer records, inventory, sales, finance."
- *Figure 5.9 DBMS applications in research and education*
    - AI-generated using prompt: "Generate a diagram showing DBMS applications in research: datasets, theses, repositories, collaboration."
- *Box 5.4 Case study: DBMS in a university repository*
    - AI-generated using prompt: "Generate a text box explaining a case study of DBMS in a university repository."

Notes on Attribution

- All illustrations were created using Microsoft Copilot Image Gen, with prompts provided in the instructional content.
- References listed above provide scholarly support for the concepts and examples presented in Series 5.
- Learners are encouraged to consult these sources for deeper study and reinforcement of the material.