COMPREHENSIVE DATABASE MANAGEMENT SOLUTION FOR ABC ELECTRONICS:

EXECUTIVE SUMMARY

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Unit 11
Deciphering Big Data

University of Essex Online

11 July 2024

Contents

List of Abbreviations

DBMS - Database Management System

ERD - Entity-Relationship Diagram

GDPR - General Data Protection Regulation

IoT - Internet of Things

PCI DSS - Payment Card Industry Data Security Standard

UI - User Interface

UX - User Experience

DFD - Data Flow Diagram

ACID - Atomicity, Consistency, Isolation, Durability

SQL - Structured Query Language

Introduction

The vibrant mid-sized shop ABC Electronics, which specialises in electronics and home appliances, has started a major project to update its infrastructure for data management. The organisation functions via physical storefronts and an online platform, requiring a strong and integrated database system to improve client engagement (Ho et al., 2020), inventory management (Fernández et al., 2021), and operational efficiency (Bag et al., 2020). Our team of knowledgeable software developers and consultants was entrusted with creating a logical database system that would satisfy these complex specifications. The extensive work that was done, such as creating the database design, choosing the best database management system (DBMS), and adhering to all applicable legal and compliance requirements, is summarised in this executive summary.

The requirement for a unified data management system to meet the strategic objectives of ABC Electronics led to this project. In the retail industry, competitive advantage and operational effectiveness are contingent upon effective data management (Mondol, 2021 and Dekimpe, 2020). It makes data-driven decision-making, individualised customer interactions, and accurate inventory management possible (Hannila et al., 2022). The recently created database system offers real-time data synchronisation, sophisticated analytical capabilities, and seamless integration with the current sales channels. This review will cover the tools used to make sure ABC Electronics is well-positioned for future development and innovation, from the first requirements analysis to the system implementation. It will also provide light on decisions made on data protection compliance, database modelling, and DBMS selection.

The order of actions involved in the order processing system is outlined in a Data Flow Diagram (DFD) (**Figure 1**) that we created to give a visual depiction of ABC Electronics' operational workflow. DFD shows how data moves from the moment a consumer puts an order until the order tracking process's conclusion. This graphic makes it easier to grasp how various system components work together and exchange information, ensuring that every stage—from stock checking to payment and delivery—is methodically recorded and efficiently optimised.

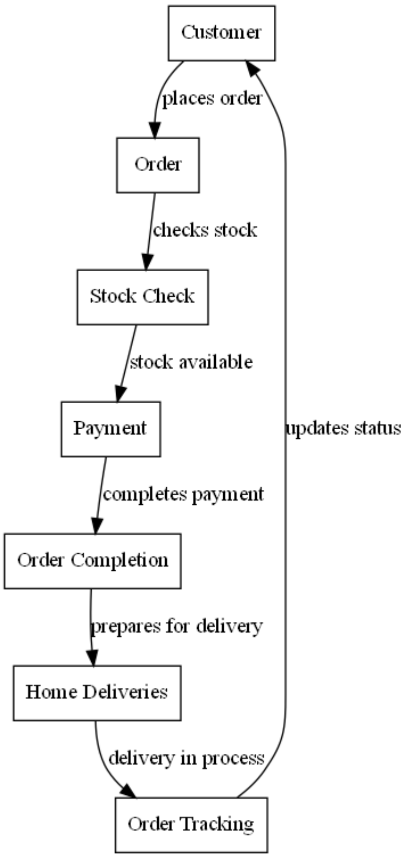


Figure 1 A DFD of ABC Electronics

Database Modelling for ABC Electronics

Figure 2 illustrates the methodical process of developing a strong and effective database system by following an organised series of steps in the extensive database modelling process for ABC Electronics. In describing each step, this section highlights how it was practically implemented to satisfy ABC Electronics' unique requirements.

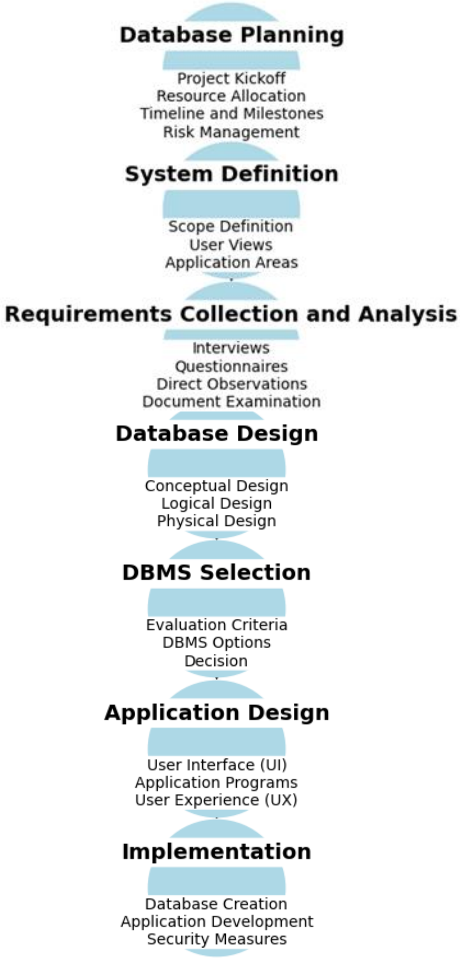


Figure 2 Database Project Stages for ABC Electronics

Database Planning

We started the project with a kick-off meeting comprising key stakeholders such store managers, IT personnel, and department heads, to establish the scope, objectives, and deliverables, in order to guarantee the database lifecycle stages for ABC Electronics were implemented smoothly. Important resources were carefully distributed, including knowledgeable database designers, seasoned project managers, and IT staff. We created a thorough schedule that included significant checkpoints at every level of development to make tracking progress easier. Prospective hazards were proactively recognised, and mitigation techniques, such as staggered deployment and thorough testing, were devised (Adkins et al., 2020 and Lund et al., 2024). Potential risks included data migration issues and system outages. To ensure that the project was in line with ABC Electronics' strategic goals for operational efficiency and competitive advantage, real-time stock updates, for instance, were given priority.

IoT sensors were integrated for automatic stock tracking and smooth e-commerce platform updates.

System Definition

In system theory, clearly defining the boundaries and interactions of system components is essential for understanding the dependencies and ensuring operational efficiency (Wiig et al., 2024). The database system's essential elements and their interactions are depicted in **Figure 3** below, which offers a clear visual summary of how different departments communicate with one another inside the company.

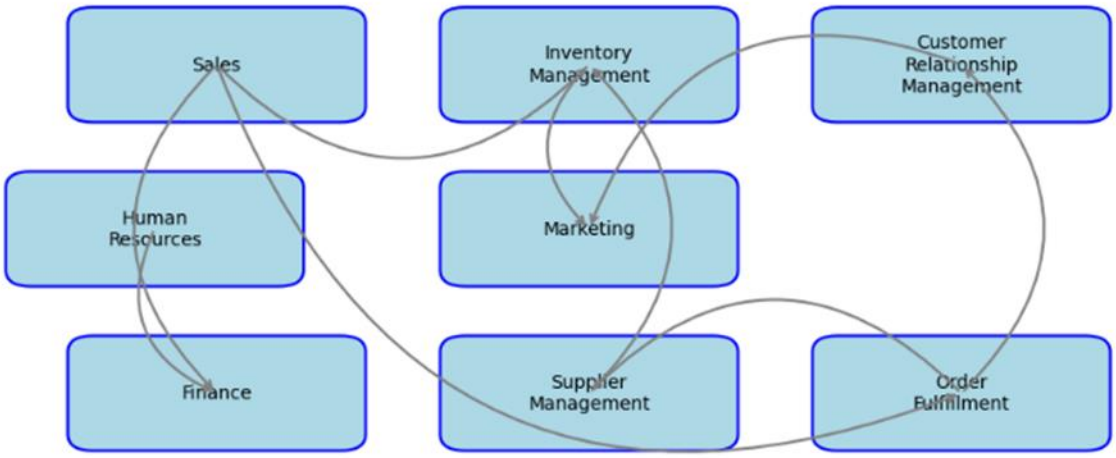


Figure 3 Systems Boundary for ABC Electronics

For ABC Electronics, defining the boundaries between components like Sales, Inventory Management, and Customer Relationship Management ensures seamless data flow and effective interaction across these functions, which enhances overall operational efficiency. Each component is strategically placed to highlight its role and interactions with other components.

Requirements Collection and Analysis

During this stage, we collected a thorough grasp of ABC Electronics' data management requirements using a combination of direct observations, interviews, and document reviews (**Table 1**). This multifaceted strategy yielded insightful information that directed the development process.

Table 1 Fact-Finding Techniques and Outcomes

Techniques	Description	Outcomes
Interviews	Conducted detailed one-on-one sessions with store managers and IT staff to understand their specific data management needs and expectations from the new system	Gained critical insights into the necessity for real-time inventory updates, seamless integration with the online store, and enhanced data accessibility for better customer service
Direct Observations	Performed systematic observations of daily operations in physical stores and during online order processing to witness firsthand the interaction with existing systems and identify inefficiencies	Identified specific workflow inefficiencies such as redundant data entry in inventory systems, delays in stock updates affecting customer orders, and insufficient data visibility across departments, highlighting the need for better data synchronization
Document Examination	Analysed existing technical documents, user manuals, system logs, and historical sales data to understand the current system architecture, data flow, and historical issues logged by users	Provided a clear picture of the current system's limitations, such as poor integration between sales and inventory systems, inconsistent data formats, and inadequate reporting tools

One particular need that was noted was the use of IoT sensors for automatic monitoring of stock levels. Real-time updates to the e-commerce platform and physical stores were made possible by this solution, which made sure that customers were constantly informed about the availability of products.

Database Design

We carefully created conceptual and logical database designs as part of the process of building a solid database system for ABC Electronics to guarantee structural integrity and effectively handle all required business processes.

The logical design, which builds on the conceptual design, converts this abstract model into a precise structure that outlines the data storage methods in the database (Date, 2019). The first, second, and third normal forms are among the normalisation principles that are essential for minimising data duplication and enhancing data integrity (Rajendran & Priya, 2023). These guidelines were carefully followed throughout the database design process at ABC Electronics. The Entity-Relationship Diagram (ERD), for instance, shows how data was organised into tables like Customers, Products, and Orders, each with specified primary and foreign keys to maintain relational integrity, in order to accomplish normalisation.

The items and their connections are highlighted in this thorough ERD, which offers a clear visual depiction of the database design. The ERD for ABC Electronics is shown in **Figure 4** below.

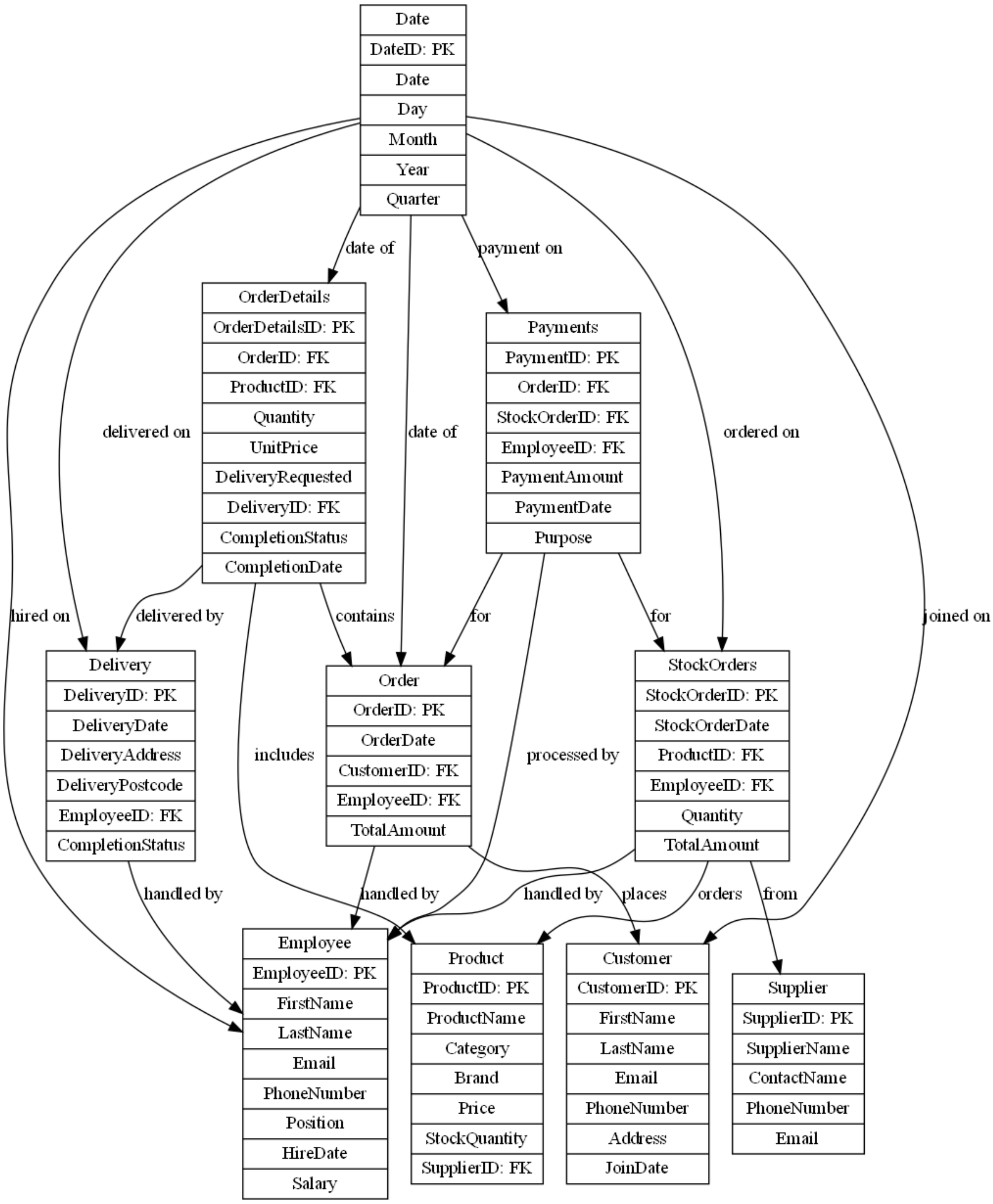


Figure 4 An ERD for ABC Electronics

To efficiently store data, the logical data model is transformed into a physical structure during the physical database design step. The database structure must be defined, storage settings must be configured, and indexing techniques must be established in order to maximise the effectiveness of data retrieval (Petrov, 2019 and Khan et al., 2019). An example of the Customer table's physical design from ABC Electronics' database is shown in **Table 2.**

Table 2 Physical Design of Customer Table in ABC Electronics' Database

CustomerID	FirstName	LastName	Email	PhoneNumber	Address	JoinDate
25255	John	Muller	john.m@gmail.com	+49151121216	X Street 15	13.07.2020
25256	Frank	Schmidt	fr.fdd@gmail.com	+17985622266	Y Street 12	14.07.2020
25257	Thomas	Connard	connard58@gmx.de	+3678941245	Z Street 12	15.07.2020

DBMS Selection

ABC Electronics, a mid-sized shop, required a database management system (DBMS) that could effectively manage a wide variety of data, facilitate transaction consistency, and guarantee data integrity. The relational model was chosen for its robustness in managing structured data (Sarstedt et al., 2020), and MySQL was selected due to its numerous benefits (Palanisamy & SuvithaVani, 2020 and Šušter & Ranisavljević, 2023), as illustrated in **Figure 5**.

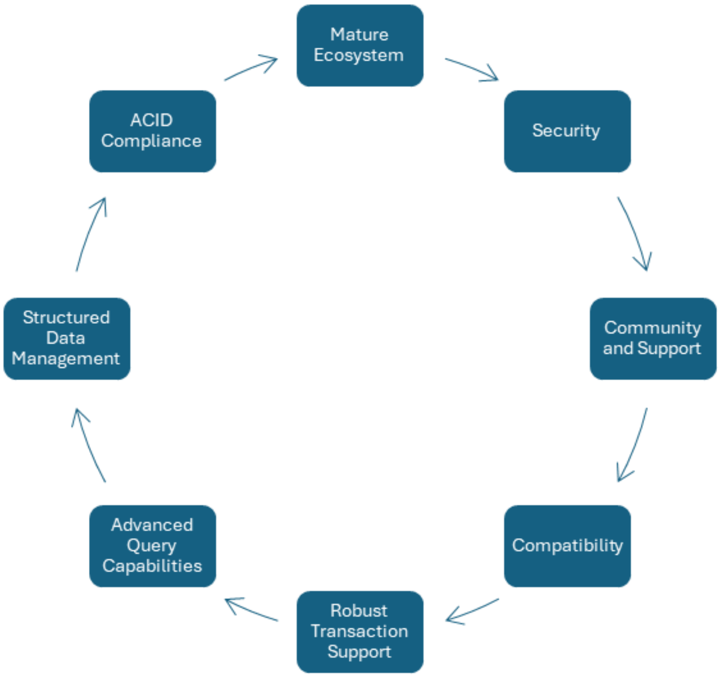


Figure 5 Benefits of MySQL for ABC Electronics' Database Management System

Although MySQL offers several advantages, there are certain drawbacks that need to be taken into account given the way ABC Electronics does business. A noteworthy constraint is the capacity to scale. MySQL could have trouble handling very big datasets or high transaction volumes (ElDahshan et al., 2022) as ABC Electronics grows, which might have an effect on overall performance. Compared to many NoSQL alternatives (such as like MongoDB and Cassandra) MySQL is more efficient at managing structured data than unstructured data, which may restrict the company's capacity to utilise a variety of data sources (Győrödi et al., 2022 and Filip & Čegan, 2020). In order to maximise speed and guarantee strong security settings, the initial setup and configuration of MySQL can be complicated and need a high level of skill. Furthermore, even while MySQL provides a free version, corporate functionality and expert support might come at a significant cost (Widenius & Axmark, 2002). The long-term cost-benefit balance must be carefully considered because these additional costs might be financially burdensome for a mid-sized company like ABC Electronics.

However, despite NoSQL databases' exceptional scalability and flexibility in managing massive amounts of unstructured data, ABC Electronics has a number of significant issues with them. NoSQL databases frequently provide eventual consistency rather than instantaneous consistency, which might result in data inconsistencies (Diogo et al., 2019). These databases lack ACID features, which are crucial for preserving data integrity and transactional dependability in a retail scenario (Dzhakishev, 2014). Furthermore, the sophisticated queries required for comprehensive reporting and analytics at ABC Electronics require more sophisticated querying capabilities than NoSQL platforms can provide. NoSQL's schema-less

Table 3 Strengths and Weaknesses of NoSQL Databases

Strengths	Weaknesses
Scalability • Horizontal Scalability	Consistency • Eventual Consistency
Flexibility • Schema-less	Complexity • Lack of Standardization
Performance • Speed and Efficiency	Maturity • Less Mature Ecosystem
Variety of Data Models • Support for Different Data Models	Transaction Support • Limited ACID Transactions
Handling Big Data • Large Data Volume Management	Data Integrity • Constraints and Joins

design might eventually cause problems with data modelling and inconsistencies, and its high learning curve necessitates specialised expertise that may not be easily available within the existing team. These elements highlight the reasons why SQL databases such as MySQL are better appropriate for ABC Electronics because they provide data integrity, transactional dependability, and strong query capability. **Table 3** presents the advantages and disadvantages of NoSQL databases, emphasising their inadequacies in catering to ABC Electronics' particular requirements.

Application Design

A critical step in creating ABC Electronics' database system is application design, which guarantees that the user interface and application programmes are suited to effectively fulfil the business's operational requirements. Creating the required application programmes, optimising the user experience (UX), and creating the user interface (UI) are all included in this step (Sharma & Tiwari, 2021). An overview of the application design process is given in **Figure 6**, with a focus on important elements such interface design, application functionality, and user experience improvements. This methodical approach guarantees that the system fulfils functional requirements and offers a user experience that is both efficient and intuitive. By putting these components in place, ABC Electronics will ensure that the system is user-friendly and in accordance with company standards, which will simplify operations, improve customer relations, and increase overall productivity.

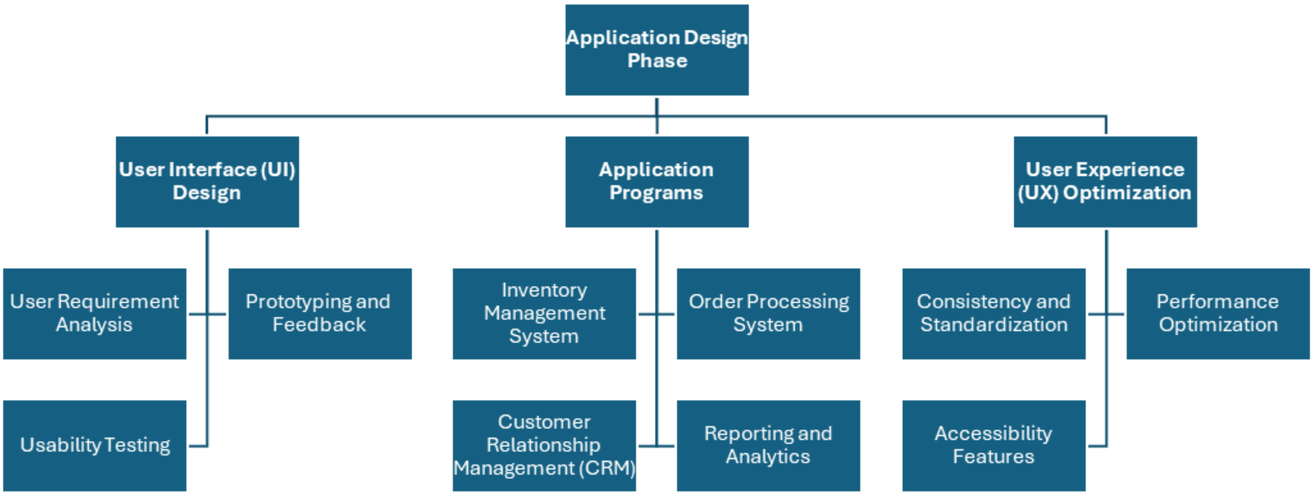


Figure 6 Components of ABC Electronics' Application Design Phase

Implementation

Using MySQL Workbench, the database system had to be carefully created and configured for ABC Electronics throughout the installation phase. This phase was essential in converting the theoretical database architecture into a workable system that satisfies the business's operational requirements. Using the powerful database administration tool MySQL Workbench, we made sure that all required tables, characteristics, and relationships were precisely specified and organised. ABC Electronics' database schemas, tables, and attributes are displayed in **Appendix 1**, which depicts the MySQL Workbench interface. The implementation process began with the development of detailed SQL scripts, which are provided in the **Appendix 2**. These scripts were meticulously crafted to create the various tables necessary for storing data related to customers, products, orders, employees, and other key entities.

Compliance and Legal Requirements

Maintaining data integrity and trust requires making sure ABC Electronics' database system complies with all applicable laws and regulations. The system conforms to GDPR (Shastri, 2020) by limiting the amount of data collected, obtaining express consent, providing customers the ability to view, amend, and remove their data, and guaranteeing data portability (Zarsky, 2016, Siegert et al., 2020 and Kutyłowski, 2020). The extensive compliance structure that ABC Electronics has put in place is shown in **Figure 7**. It includes data retention regulations, consumer protection legislation, GDPR (**a**) and PCI DSS compliance (**b**), as well as frequent compliance audits.

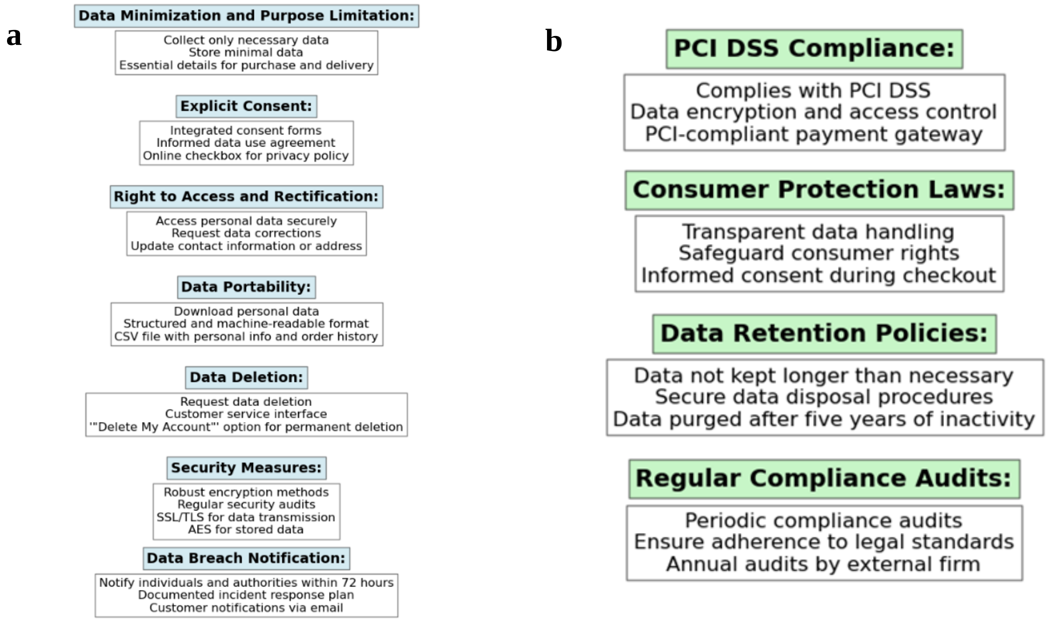


Figure 7 Data Protection Standards (a) and Compliance Measures (b) for ABC Electronics

These compliance measures are integrated into the daily operations of ABC Electronics. For example, during the development of the database system, explicit consent mechanisms were incorporated into the customer registration and transaction processes. Regular security audits and updates are performed to maintain the integrity of the system, and data retention policies are strictly enforced to ensure compliance with GDPR and other legal frameworks.

Conclusion

ABC Electronics was able to effectively handle the pressing need for better data management through the implementation of a comprehensive database system, which ensured increased operational effectiveness, better customer interaction, and solid data-driven decision-making. Real-time updates and smooth synchronisation between offline and online platforms are offered by the system thanks to the integration of Internet of Things sensors and MySQL for structured data administration. The project successfully traversed the challenges of system definition, database planning, and thorough requirements gathering and analysis, resulting in an organised ERD that serves as the foundation for both the logical and physical database architectures. Using MySQL Workbench, the implementation step turned these concepts into a working system that supports ABC Electronics' strategic goals. Strict adherence to GDPR and other regulatory requirements was made to protect client information and uphold confidence.

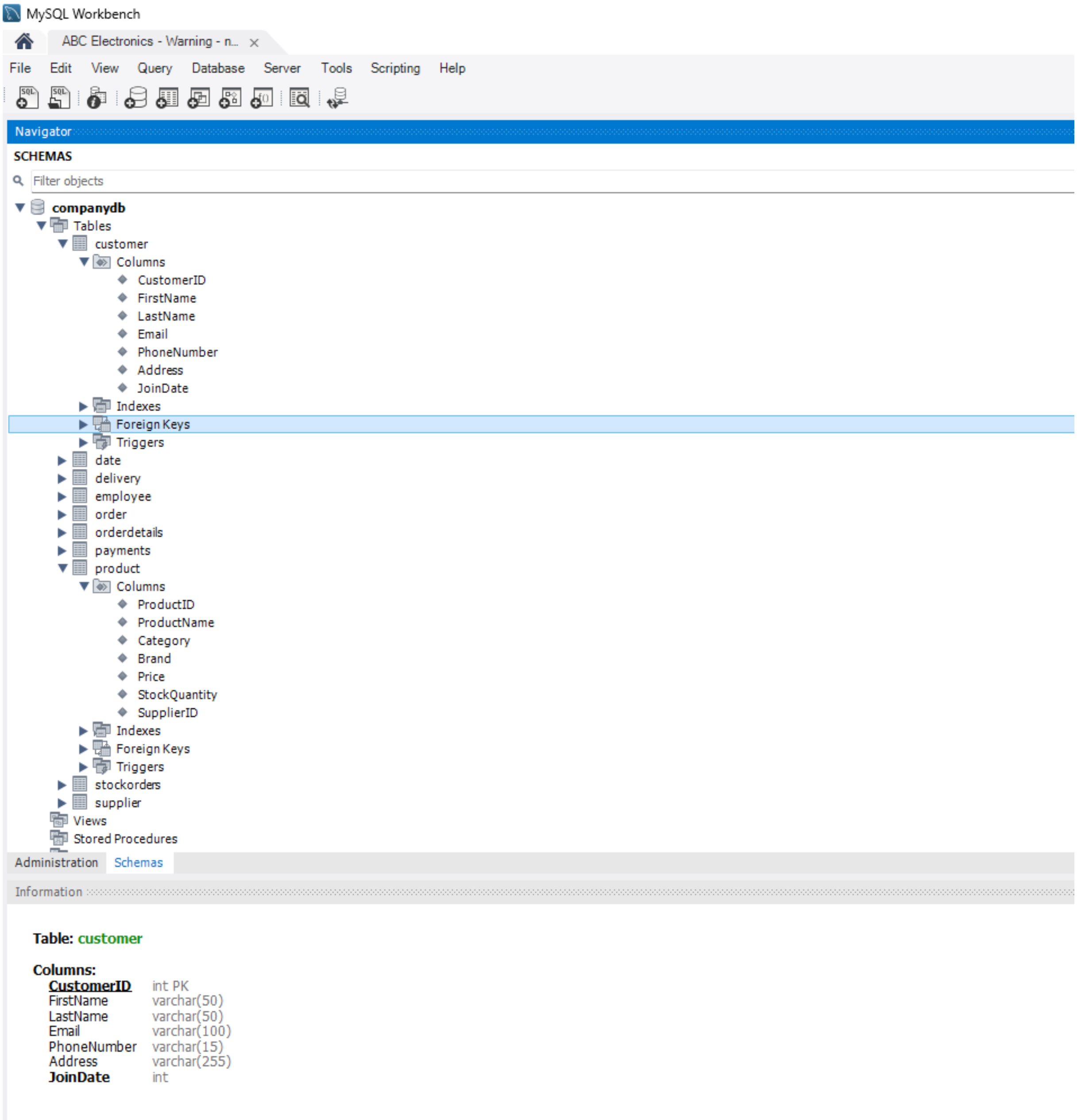
Recommendations

Several important recommendations are made in order to guarantee the database system of ABC Electronics' continuous efficacy and scalability. To manage growing data quantities effectively, first improve scalability by thinking about partitioning, indexing techniques, or switching to a more scalable DBMS like PostgreSQL (Pirozzi, 2018). To support in-depth analysis and strategic decision-making, incorporate cutting-edge analytics technologies like Tableau or Power BI (Pala, 2017 and Gonçalves et al., 2023). To ensure data privacy and regulatory compliance, regularly carry out compliance audits to ensure conformity to GDPR, PCI DSS, and other legal frameworks (Elluri et al., 2018). To optimise system utilisation and efficiency, give staff members thorough training (Elnaga & Imran, 2013). To ensure optimal functioning and promptly detect possible problems, use powerful performance monitoring tools such as Nagios or New Relic (Cardoso, 2018). To increase usability and user happiness, make constant improvements to the user interface based on input from users. To prevent data loss and guarantee business continuity, create and maintain a thorough data backup and recovery plan (Cerullo & Cerullo, 2004). Prioritising these suggestions will help ABC Electronics meet its current and future requirements while maintaining the database system's sturdiness, scalability, and compliance. **Figure 8** presents a summary of these suggestions together with their explanations and order of importance.

Figure 8 Recommendations for Enhancing ABC Electronics' Database System

Additionally, implementing machine learning algorithms for predictive analytics is recommended to forecast trends and optimize inventory management (Li et al., 2022). Establishing a dedicated data governance team to oversee data quality, security, and compliance is essential, ensuring the system remains aligned with industry best practices and regulatory standards (Abraham et al., 2019). Lastly, fostering a culture of continuous improvement by regularly reviewing system performance and incorporating technological advancements will ensure the database system remains at the forefront of innovation.

Appendices



Appendix 1 MySQL Workbench Interface Displaying Database

```sql
CREATE DATABASE CompanyDB;
USE CompanyDB;

-- Create the Date table
CREATE TABLE Date (
    DateID INT PRIMARY KEY,
    Date DATE,
    Day INT,
    Month INT,
    Year INT,
    Quarter INT
);

-- Create the Employee table
CREATE TABLE Employee (
    EmployeeID INT PRIMARY KEY,
    FirstName VARCHAR(50),
    LastName VARCHAR(50),
    Email VARCHAR(100),
    PhoneNumber VARCHAR(15),
    Position VARCHAR(50),
    HireDate INT,
    Salary DECIMAL(10, 2),
    FOREIGN KEY (HireDate) REFERENCES Date(DateID)
);

-- Create the Customer table
CREATE TABLE Customer (
    CustomerID INT PRIMARY KEY,
    FirstName VARCHAR(50),
    LastName VARCHAR(50),
    Email VARCHAR(100),
    PhoneNumber VARCHAR(15),
    Address VARCHAR(255),
    JoinDate INT,
    FOREIGN KEY (JoinDate) REFERENCES Date(DateID)
);

-- Create the Supplier table
CREATE TABLE Supplier (
    SupplierID INT PRIMARY KEY,
    SupplierName VARCHAR(100),
    ContactName VARCHAR(50),
    PhoneNumber VARCHAR(15),
    Email VARCHAR(100)
);

-- Create the Product table
CREATE TABLE Product (
    ProductID INT PRIMARY KEY,
    ProductName VARCHAR(100),
    Category VARCHAR(50),
    Brand VARCHAR(50),
    Price DECIMAL(10, 2),
    StockQuantity INT,
    SupplierID INT,
    FOREIGN KEY (SupplierID) REFERENCES Supplier(SupplierID)
);

-- Create the Delivery table
CREATE TABLE Delivery (
    DeliveryID INT PRIMARY KEY,
    DeliveryDate INT,
    DeliveryAddress VARCHAR(255),
    DeliveryPostcode VARCHAR(10),
    EmployeeID INT,
    CompletionStatus VARCHAR(50),
    FOREIGN KEY (DeliveryDate) REFERENCES Date(DateID),
    FOREIGN KEY (EmployeeID) REFERENCES Employee(EmployeeID)
);

-- Create the Order table
CREATE TABLE `Order` (
    OrderID INT PRIMARY KEY,
    OrderDate INT,
    CustomerID INT,
    EmployeeID INT,
    TotalAmount DECIMAL(10, 2),
    FOREIGN KEY (OrderDate) REFERENCES Date(DateID),
    FOREIGN KEY (CustomerID) REFERENCES Customer(CustomerID),
    FOREIGN KEY (EmployeeID) REFERENCES Employee(EmployeeID)
);

-- Create the StockOrders table
CREATE TABLE StockOrders (
    StockOrderID INT PRIMARY KEY,
    StockOrderDate INT,
    ProductID INT,
    EmployeeID INT,
    Quantity INT,
    TotalAmount DECIMAL(10, 2),
    FOREIGN KEY (StockOrderDate) REFERENCES Date(DateID),
    FOREIGN KEY (ProductID) REFERENCES Product(ProductID),
    FOREIGN KEY (EmployeeID) REFERENCES Employee(EmployeeID)
);

-- Create the Payments table
CREATE TABLE Payments (
    PaymentID INT PRIMARY KEY,
    OrderID INT,
    StockOrderID INT,
    EmployeeID INT,
    PaymentAmount DECIMAL(10, 2),
    PaymentDate INT,
    Purpose VARCHAR(255),
    FOREIGN KEY (OrderID) REFERENCES `Order`(OrderID),
    FOREIGN KEY (StockOrderID) REFERENCES StockOrders(StockOrderID),
    FOREIGN KEY (PaymentDate) REFERENCES Date(DateID),
    FOREIGN KEY (EmployeeID) REFERENCES Employee(EmployeeID)
);
-- Create the OrderDetails table
CREATE TABLE OrderDetails (
    OrderDetailsID INT PRIMARY KEY,
    OrderID INT,
    ProductID INT,
    Quantity INT,
    UnitPrice DECIMAL(10, 2),
    DeliveryRequested BOOLEAN,
    DeliveryID INT,
    CompletionStatus VARCHAR(50),
    CompletionDate INT,
    FOREIGN KEY (OrderID) REFERENCES `Order`(OrderID),
    FOREIGN KEY (ProductID) REFERENCES Product(ProductID),
    FOREIGN KEY (DeliveryID) REFERENCES Delivery(DeliveryID),
    FOREIGN KEY (CompletionDate) REFERENCES Date(DateID)
);

-- Add the foreign keys related to the Date table
ALTER TABLE Employee ADD CONSTRAINT fk_employee_hiredate FOREIGN KEY (HireDate) REFERENCES Date(DateID);
ALTER TABLE Customer ADD CONSTRAINT fk_customer_joindate FOREIGN KEY (JoinDate) REFERENCES Date(DateID);
ALTER TABLE `Order` ADD CONSTRAINT fk_order_orderdate FOREIGN KEY (OrderDate) REFERENCES Date(DateID);
ALTER TABLE OrderDetails ADD CONSTRAINT fk_orderdetails_completiondate FOREIGN KEY (CompletionDate) REFERENCES Date(DateID);
ALTER TABLE Delivery ADD CONSTRAINT fk_delivery_deliverydate FOREIGN KEY (DeliveryDate) REFERENCES Date(DateID);
ALTER TABLE Payments ADD CONSTRAINT fk_payments_paymentdate FOREIGN KEY (PaymentDate) REFERENCES Date(DateID);
ALTER TABLE StockOrders ADD CONSTRAINT fk_stockorders_stockorderdate FOREIGN KEY (StockOrderDate) REFERENCES Date(DateID);
```

Appendix 2 SQL Code for Creating Database Tables for ABC Electronics.

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