ASSIGNMENT FINAL REPORT

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Unit number and title	**Unit 4: Database Design & Development**		
Submission date		**Date Received 1st submission**	
Re-submission Date		**Date Received 2nd submission**	
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specification. I certify I have clearly referenced any sources and any artificial intelligence (AI) tools used in the work. I understand that making a false declaration is a form of malpractice.

Student’s signature	HAI

Grading grid

P1	P2	P3	P4	P5	M1	M2	M3	M4	M5	D1	D2	D3

❐ Summative Feedback:		❐ Resubmission Feedback:
Grade:	Assessor Signature:	Date:
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I. Introduction

In the era of data-driven decision-making, the significance of effective data management cannot be overstated. At the forefront of this domain are Relational Database Management Systems (RDBMS), which provide a powerful framework for storing, retrieving, and managing data in a structured format. RDBMS is built on the relational model introduced by E.F. Codd in the 1970s, which organizes data into tables (or relations) that can be easily accessed and manipulated.

One of the key features of RDBMS is its ability to enforce data integrity through the use of primary and foreign keys, ensuring that relationships between data entities are maintained accurately. This structured approach allows users to perform complex queries using Structured Query Language (SQL), a standardized language for managing and manipulating relational databases. SQL provides a powerful means to filter, sort, and aggregate data, making it an essential tool for data analysts and developers alike.

Moreover, RDBMS supports transaction management, which ensures that all operations within a database are completed successfully and maintain consistency even in the face of failures. This is particularly important for applications that require high reliability, such as banking and e-commerce systems. The ACID (Atomicity, Consistency, Isolation, Durability) properties of transactions in RDBMS guarantee that data remains accurate and reliable.

As organizations continue to generate vast amounts of data, the demand for efficient and scalable database solutions has grown. RDBMS platforms such as MySQL, PostgreSQL, Oracle Database, and Microsoft SQL Server are widely used across various industries, offering robust performance, security features, and support for complex data structures.

In conclusion, RDBMS plays a crucial role in modern data management strategies, enabling organizations to harness the power of their data effectively. By understanding the principles and functionalities of relational databases, businesses can make informed decisions and drive innovation in their operations.

II. System requirements

1. Functional requirements

Functional requirements outline the specific actions and operations that a system is expected to perform. These requirements form the foundation of the system's capabilities, ensuring it aligns with the operational demands of the organization.

A key function is user management, which allows administrators to create, update, and oversee user accounts. This includes defining roles and permissions to ensure users access only the features pertinent to their responsibilities, thereby enhancing security and operational efficiency. The system should also enable the deactivation or deletion of accounts that are no longer required, ensuring that only current personnel can access the system.

Another essential function is order processing. The system must support the creation, modification, and management of customer orders. It should track the status of orders from initiation to fulfillment, handle payment processing, and provide options for order cancellations or returns as needed. This function should be integrated smoothly with inventory management to ensure real-time updates of stock during the ordering process, minimizing errors and delays.

Inventory management is crucial as well, requiring the system to monitor stock levels in real time. This involves updating quantities when products are sold or replenished, issuing alerts for low inventory levels, and supporting inventory audits. The system should also categorize products by attributes such as type, price, or supplier, facilitating efficient management of extensive inventories.

The system should feature reporting and analytics capabilities, allowing users to generate comprehensive reports on various business aspects, including sales trends, customer behavior, and inventory levels. These insights can aid managers in making informed decisions, optimizing operations, and predicting future demand. Reports should be customizable, enabling users to filter data based on specific criteria like time frames or product categories.

Lastly, product management is a vital function. The system should empower users to add new products, update existing product information, and remove discontinued items. This includes managing critical product details such as names, descriptions, pricing, images, and categorization. Additionally, the system should track product versions or updates, ensuring an accurate and current product catalog.

2. Nonfunctional requirements

Non-functional requirements focus on how the system operates rather than its specific functionalities. These requirements are essential for ensuring that the system is secure, reliable, and user-friendly, addressing the long-term needs of the business.

Security is a paramount non-functional requirement. The system must safeguard sensitive information, such as customer data, payment details, and business records, against unauthorized access or breaches. This can be achieved through various security measures, including data encryption, multi-factor authentication, and stringent access controls based on user roles. Additionally, the system should regularly log and monitor user activities to identify and respond to potential security threats promptly.

Performance is another critical aspect. The system should be designed to efficiently handle a high volume of transactions, ensuring quick response times even during peak usage. For instance, during busy periods, the system must process up to 1,000 transactions per minute without experiencing slowdowns or failures. Performance optimization is also necessary to ensure that page load times, database queries, and other interactions occur swiftly, delivering a seamless user experience.

In terms of reliability, the system must maintain a high availability level, targeting 99.9% uptime to ensure accessibility and minimize disruptions. Should system failures occur, there need to be backup and recovery procedures in place to restore operations quickly and prevent data loss. The system should also exhibit fault tolerance, allowing it to continue functioning amid partial failures or network issues.

Data integrity is crucial for maintaining the accuracy and consistency of all processed data. The system should validate all inputs to prevent erroneous or corrupt data from entering the system. Furthermore, any data modifications should be traceable, with version history available for auditing, particularly in systems that handle financial transactions or sensitive customer information, where even minor errors can have significant consequences.

Scalability is another important non-functional requirement. As the organization expands, the system must be capable of accommodating more users, transactions, and data. This may involve increasing server capacity, enhancing database performance, or adopting cloud-based solutions to allow for dynamic scaling. A scalable system ensures that future growth will not adversely affect performance or necessitate a complete overhaul of the existing infrastructure.

Lastly, usability is vital for the success of any system. The user interface should be intuitive, enabling users to perform their tasks efficiently without requiring extensive training. Features such as clear navigation, consistent design elements, and useful error messages can significantly enhance the user experience. Additionally, the system should cater to users with varying technical skills, providing help documentation, tooltips, and tutorials to assist users with common tasks.

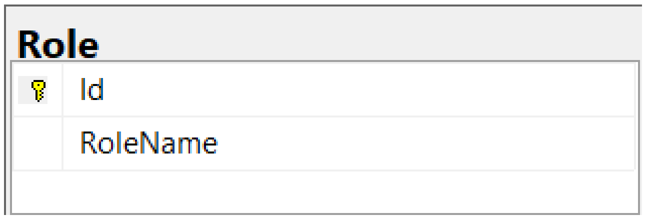
III. Design relational database system

3. Table of entities

Role Tablea:

Syntax:

```
CREATE TABLE Role (
    Id INT PRIMARY KEY,       -- ID vai trò (khóa chính, không tự động tăng)
    RoleName NVARCHAR(50) NOT NULL       -- Tên vai trò (bắt buộc)
);
```



Description: This table stores the roles that can be assigned to employees (e.g., Admin, Salesperson, Warehouse, etc.).

Columns:

- id (Primary Key - PK): A unique identifier for each role, typically an integer (INT).
- roleName: The name of the role, such as 'Admin' or 'Employee', stored as a string (VARCHAR or TEXT).

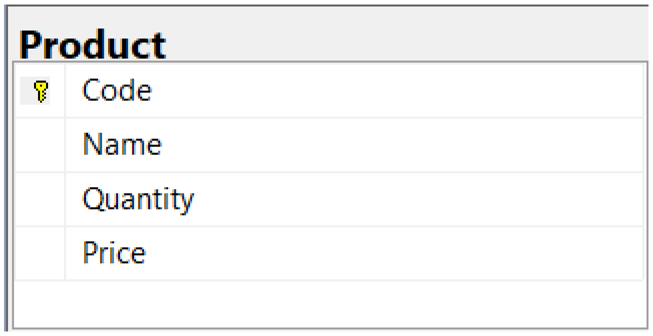
Relationships:

The Role table has a one-to-many relationship with the Employee table. Each role can be assigned to multiple employees.

Product Table:

Syntax:

```sql
CREATE TABLE Product (
    Code NVARCHAR(50) PRIMARY KEY,      -- Mã sản phẩm (khóa chính)
    Name NVARCHAR(100) NOT NULL,        -- Tên sản phẩm (bắt buộc)
    Quantity INT NOT NULL,              -- Số lượng trong kho (bắt buộc)
    Price DECIMAL(10, 2) NOT NULL       -- Giá sản phẩm (bắt buộc)
);
```



Description: This table holds information about the products available for sale in the store.

Columns:

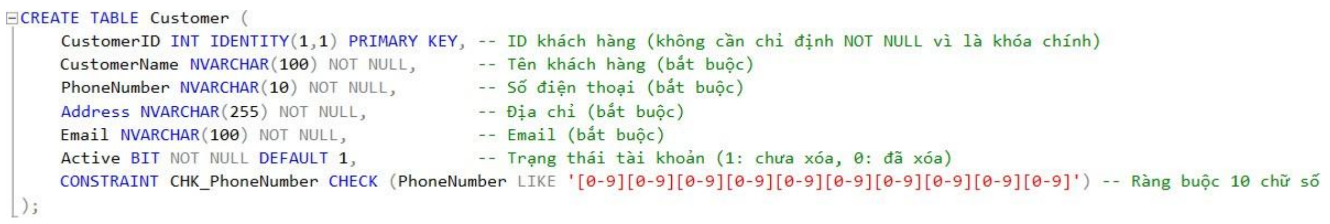
- code (Primary Key - PK): A unique identifier for each product, likely an integer (INT).
- name: The name or description of the product, stored as a string (VARCHAR).
- quantity: The current stock level or available quantity of the product, stored as an integer (INT).
- price: The price of the product, likely stored as a decimal or float (DECIMAL or FLOAT) to allow for fractional values.

Relationships:

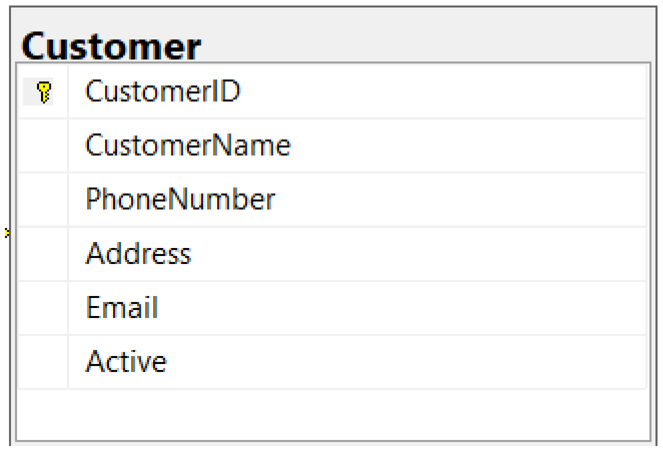
The code column is referenced in the PurchaseHistory table to track which products were bought in each transaction, establishing a one-to-many relationship between Product and PurchaseHistory (i.e., one product can appear in many purchase history records).

Customer Table:

Syntax:



```
CREATE TABLE Customer (
    CustomerID INT IDENTITY(1,1) PRIMARY KEY, -- ID khách hàng (không cần chỉ định NOT NULL vì là khóa chính)
    CustomerName NVARCHAR(100) NOT NULL,      -- Tên khách hàng (bắt buộc)
    PhoneNumber NVARCHAR(10) NOT NULL,        -- Số điện thoại (bắt buộc)
    Address NVARCHAR(255) NOT NULL,           -- Địa chỉ (bắt buộc)
    Email NVARCHAR(100) NOT NULL,             -- Email (bắt buộc)
    Active BIT NOT NULL DEFAULT 1,            -- Trạng thái tài khoản (1: chưa xóa, 0: đã xóa)
    CONSTRAINT CHK_PhoneNumber CHECK (PhoneNumber LIKE '[0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9]') -- Ràng buộc 10 chữ số
);
```



Description: This table, named Customer, stores detailed information about customers who engage in purchases within the system. The data is essential for tracking customer interactions and linking them to transactions recorded in the PurchaseHistory table.

Columns:

- **CustomerID (Primary Key - PK):**
  A unique identifier for each customer, stored as an integer (INT). It auto-increments with each new customer entry (IDENTITY(1,1)).

- **CustomerName:**
  The customer's full name, stored as a Unicode string (NVARCHAR(100)), to support names with special characters.

- **PhoneNumber:**
  The customer's 10-digit contact number, stored as a string (NVARCHAR(10)), validated by a constraint to ensure it contains exactly 10 numerical digits.

- **Address:**
  The customer's physical address, including details like street, city, and postal code, stored as a Unicode string (NVARCHAR(255)).

- **Email:**
  The customer's email address, stored as a Unicode string (NVARCHAR(100)), to accommodate multilingual email addresses.

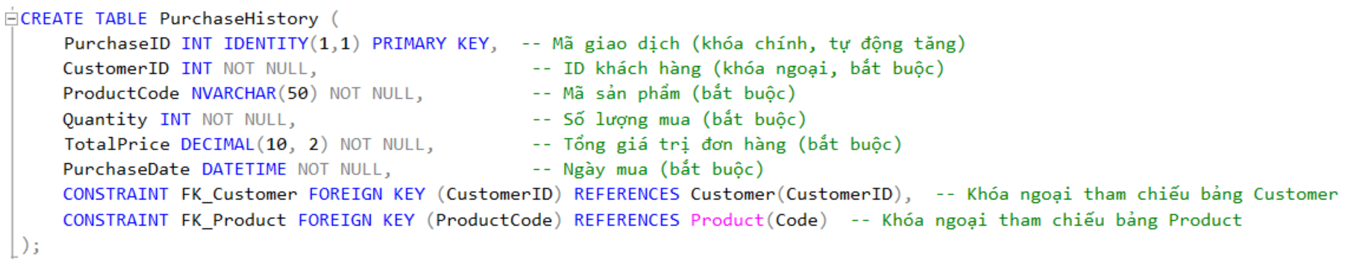
- **Active:**
  A boolean column (BIT) that indicates whether the customer's account is active. The default value is 1 (active). 0 signifies that the account is inactive or deleted.

Relationships:

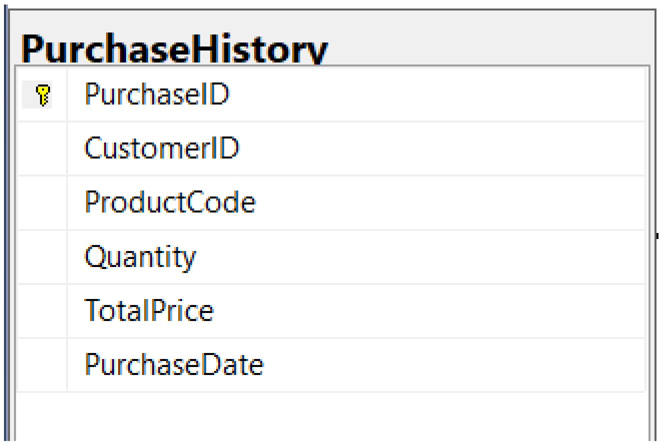
- The CustomerID is referenced as a foreign key in the PurchaseHistory table to record the association between customers and their purchases. This establishes a one-to-many relationship: one customer can have multiple purchase record

PurchaseHistory Table:

Syntax:



```sql
CREATE TABLE PurchaseHistory (
    PurchaseID INT IDENTITY(1,1) PRIMARY KEY,  -- Mã giao dịch (khóa chính, tự động tăng)
    CustomerID INT NOT NULL,                    -- ID khách hàng (khóa ngoại, bắt buộc)
    ProductCode NVARCHAR(50) NOT NULL,          -- Mã sản phẩm (bắt buộc)
    Quantity INT NOT NULL,                      -- Số lượng mua (bắt buộc)
    TotalPrice DECIMAL(10, 2) NOT NULL,         -- Tổng giá trị đơn hàng (bắt buộc)
    PurchaseDate DATETIME NOT NULL,             -- Ngày mua (bắt buộc)
    CONSTRAINT FK_Customer FOREIGN KEY (CustomerID) REFERENCES Customer(CustomerID),  -- Khóa ngoại tham chiếu bảng Customer
    CONSTRAINT FK_Product FOREIGN KEY (ProductCode) REFERENCES Product(Code)  -- Khóa ngoại tham chiếu bảng Product
);
```



Description:

This table, named PurchaseHistory, tracks all transactions made by customers. It acts as a bridge between the Customer and Product tables, maintaining a record of each purchase, including the customer who made the purchase, the product purchased, and relevant transaction details.

Columns:

- **PurchaseID (Primary Key - PK):**
  A unique identifier for each purchase, stored as an integer (INT). It auto-increments with each new entry (IDENTITY(1,1)).

- **CustomerID (Foreign Key - FK):**
  Links to the CustomerID in the Customer table, identifying the customer involved in the purchase.

- **ProductCode (Foreign Key - FK):**
  Links to the Code in the Product table, identifying the purchased product.

- **PurchaseDate:**
  The date and time of the transaction, stored as a datetime value (DATETIME).

- **Quantity:**
  The number of items purchased, stored as an integer (INT).

- **TotalPrice:**
  The total cost of the purchase, calculated as the product price multiplied by the quantity, stored as a decimal (DECIMAL(10, 2)).

Relationships:

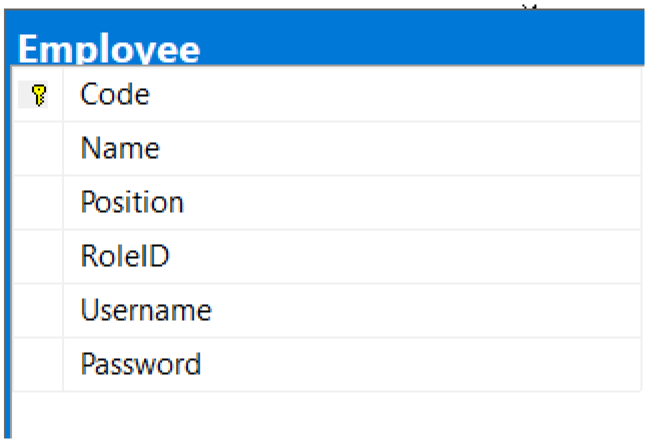
- **CustomerID:**
  Establishes a many-to-one relationship between PurchaseHistory and Customer, where many purchases can be associated with a single customer.

- **ProductCode:**
  Establishes a many-to-one relationship between PurchaseHistory and Product, where many purchase records can involve the same product.

Employee Table

Syntax:

```sql
CREATE TABLE Employee (
    Code NVARCHAR(50) PRIMARY KEY,          -- Mã nhân viên (khóa chính)
    Name NVARCHAR(100) NOT NULL,            -- Tên nhân viên (bắt buộc)
    Position NVARCHAR(50) NOT NULL,         -- Chức vụ (bắt buộc)
    RoleID INT NOT NULL,                    -- ID vai trò (khóa ngoại, bắt buộc)
    Username NVARCHAR(50) NOT NULL,         -- Tên đăng nhập (bắt buộc)
    Password NVARCHAR(255) NOT NULL,        -- Mật khẩu (bắt buộc)
    CONSTRAINT FK_Role FOREIGN KEY (RoleID) REFERENCES Role(Id)  -- Khóa ngoại tham chiếu bảng Role
);
```



Description:
The Employee table stores essential details about employees within the organization, including their assigned roles. This table links to the Role table to establish the relationship between employees and their respective roles.

Columns:

- Code (Primary Key - PK): A unique identifier for each employee, stored as a string (NVARCHAR(50)).
- Name: The employee's full name, stored as a string (NVARCHAR(100)).

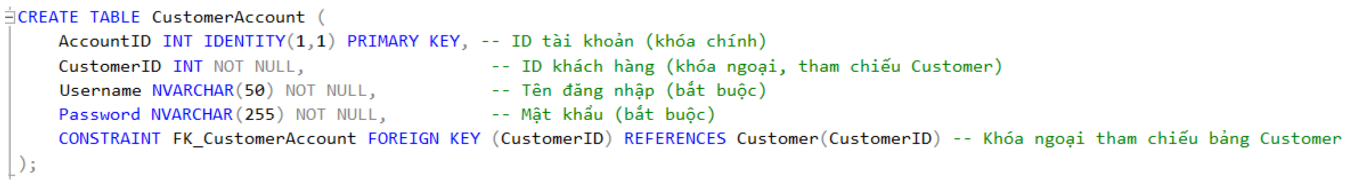
- Position: The job title or position of the employee (e.g., Salesperson, Manager), stored as a string (NVARCHAR(50)).
- RoleID (Foreign Key - FK): Links to the Id column in the Role table, representing the role assigned to the employee.
- Username: The employee’s login username, stored as a string (NVARCHAR(50)).
- Password: The employee’s login password, stored as a string (NVARCHAR(255)). This value should ideally be stored in hashed or encrypted format for security.

Relationships:

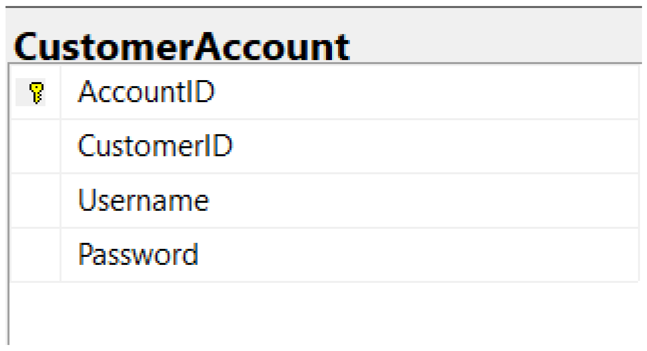
The RoleID column establishes a **many-to-one relationship** between the Employee and Role tables. A single role can be associated with multiple employees, but each employee is assigned only one role.

CustomerAccount Table

Syntax:



```
CREATE TABLE CustomerAccount (
    AccountID INT IDENTITY(1,1) PRIMARY KEY, -- ID tài khoản (khóa chính)
    CustomerID INT NOT NULL,                 -- ID khách hàng (khóa ngoại, tham chiếu Customer)
    Username NVARCHAR(50) NOT NULL,          -- Tên đăng nhập (bắt buộc)
    Password NVARCHAR(255) NOT NULL,         -- Mật khẩu (bắt buộc)
    CONSTRAINT FK_CustomerAccount FOREIGN KEY (CustomerID) REFERENCES Customer(CustomerID) -- Khóa ngoại tham chiếu bảng Customer
);
```



Description:

The CustomerAccount table stores login credentials for customers who access the system. This table links to the Customer table to ensure that each account is associated with a specific customer.

Columns:

- AccountID (Primary Key - PK):
  A unique identifier for each account, automatically generated as an integer (INT).

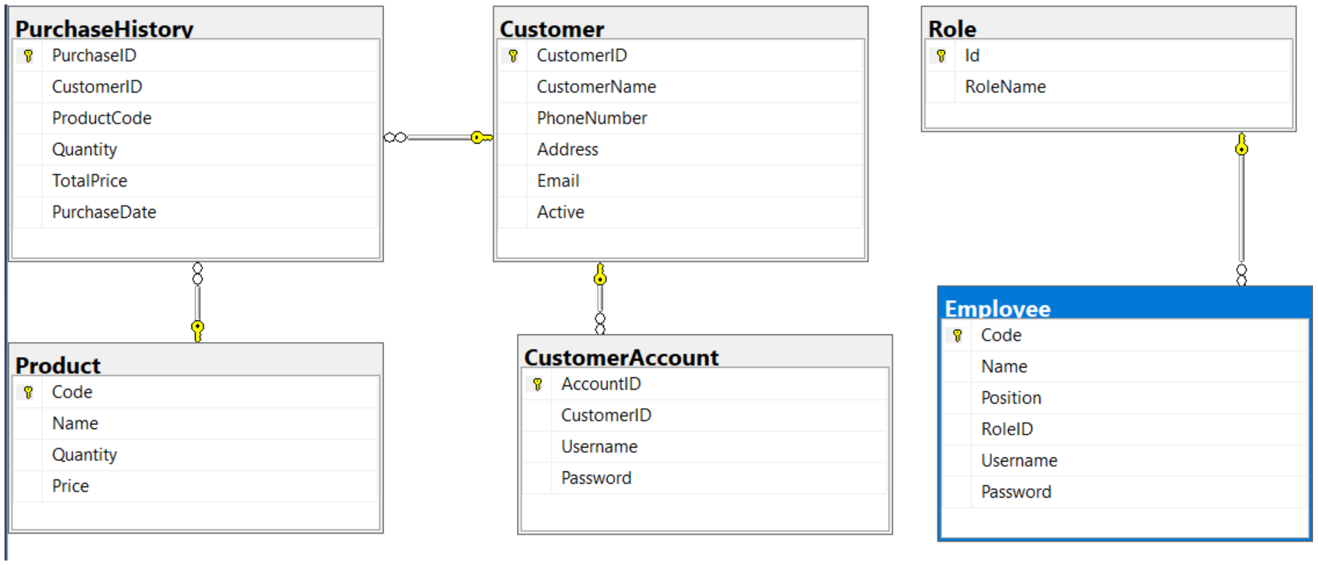
- CustomerID (Foreign Key - FK):
  References the CustomerID column in the Customer table, establishing a relationship between the account and the corresponding customer.

- Username:
  The customer's chosen username, stored as a string (NVARCHAR(50)).

- Password:
  The customer's password, stored as a string (NVARCHAR(255)). Passwords should be stored securely (hashed and salted) to protect customer data.

Relationships:
The CustomerID column creates a many-to-one relationship between the CustomerAccount and Customer tables. Each customer can have one account, while every account must be linked to an existing customer.

4. ERD (Entity Relational Diagram)



Key Relationships Summary

Role – Employee:

- One-to-Many relationship.
- One role (Role.id) can be assigned to many employees (Employee.roleId).

Customer – PurchaseHistory:

- One-to-Many relationship.
- One customer (Customer.CustomerID) can have multiple purchase records in the PurchaseHistory table (PurchaseHistory.CustomerID).

Product – PurchaseHistory:

- One-to-Many relationship.
- One product (Product.code) can appear in multiple purchase records in the PurchaseHistory table (PurchaseHistory.Code).

Data Types (Assumed):

- INT: For primary and foreign keys like id, code, CustomerID, PurchaseID, roleId.
- VARCHAR: For textual fields such as roleName, name, position, username, password, CustomerName, PhoneNumber, Address, status.
- DECIMAL/FLOAT: For fields that represent prices (price), to allow for decimal precision.
- DATETIME: For fields like PurchaseDate to store date and time information.

This schema represents a typical sales management system, where employees (assigned to specific roles) manage products, and customers purchase products. The system tracks each purchase in detail, including the customer, products purchased, and transaction status, creating a robust and relational structure that supports the business's operations

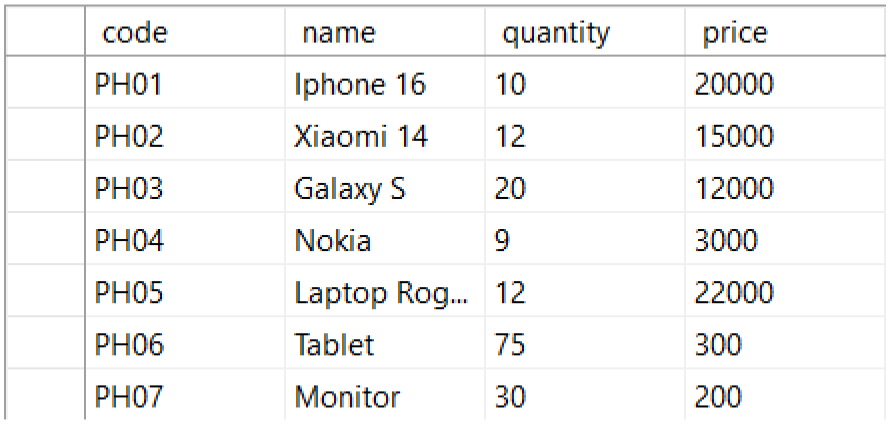
5. Normalise the database

1NF

First Normal Form (1NF) requires that all columns in a database table contain atomic values, meaning that each value is indivisible. Additionally, a table must not have any duplicate rows. To achieve 1NF, every column must hold values of the same data type, and each row must be unique. Moreover, no column should contain multi-valued attributes, such as lists or arrays. The goal of 1NF is to ensure that the data is structured in a way that eliminates redundancy at the level of individual values.

In my database, I've ensured that it satisfies First Normal Form (1NF) by making sure that every column contains atomic values. This means that each column holds a single, indivisible value, with no arrays or lists. For example, in the Product table, the name column contains only one product name per row, such as "Iphone 16" or "Xiaomi 14." Similarly, each row in the Product table has a unique identifier, which is the code field. This makes sure that there are no duplicate rows, as each product is identified by a unique code like "PH01" or "PH02." The same principle applies to other tables, like Customer and Employee, where each row is unique, and all columns hold single values.

In short, by ensuring that there are no repeating groups and that every piece of information is stored in a unique and atomic way, I've made sure that my database satisfies 1NF.



	code	name	quantity	price
	PH01	Iphone 16	10	20000
	PH02	Xiaomi 14	12	15000
	PH03	Galaxy S	20	12000
	PH04	Nokia	9	3000
	PH05	Laptop Rog...	12	22000
	PH06	Tablet	75	300
	PH07	Monitor	30	200

2NF

Second Normal Form (2NF) builds on the principles of 1NF by ensuring that all non-key attributes are fully functionally dependent on the primary key. This means that if a table has a composite primary key (composed of multiple columns), every non-key attribute must depend on the entire primary key, not just a part of it. To be in 2NF, a table must first satisfy the conditions of 1NF. The primary purpose of 2NF is to eliminate partial dependencies, which can lead to redundancy and inconsistency in data.

To satisfy Second Normal Form (2NF), I made sure that my database is not only in 1NF but also avoids any partial dependencies. This means that all non-key attributes in each table depend entirely on the primary key, and not just on part of it.

For example, in the Product table, the primary key is code, which uniquely identifies each product. All other columns, like name, quantity, and price, are fully dependent on the product code. So, the name "Iphone 16" only makes sense when associated with the code "PH01", and the price of 20,000 is tied specifically to that product code. There are no composite keys (where the primary key is made up of more than one column), so there's no risk of partial dependencies.

In tables like Employee, the primary key is code, and every attribute, like name, position, and username, is directly related to that employee code. I've avoided any columns that might be dependent on other non-primary key columns, which ensures that my database is in 2NF.

3NF

Third Normal Form (3NF) further refines the design of the database by ensuring that there are no transitive dependencies among non-key attributes. This means that all non-key attributes should depend only on the primary key and not on other non-key attributes. For a table to be in 3NF, it must first meet the criteria for 2NF. The primary goal of 3NF is to remove any indirect relationships between non-key attributes, thus enhancing data integrity and reducing redundancy.

I've ensured that my database also satisfies Third Normal Form (3NF) by eliminating any transitive dependencies. This means that no non-key column is dependent on another non-key column. All the columns are dependent solely on the primary key.

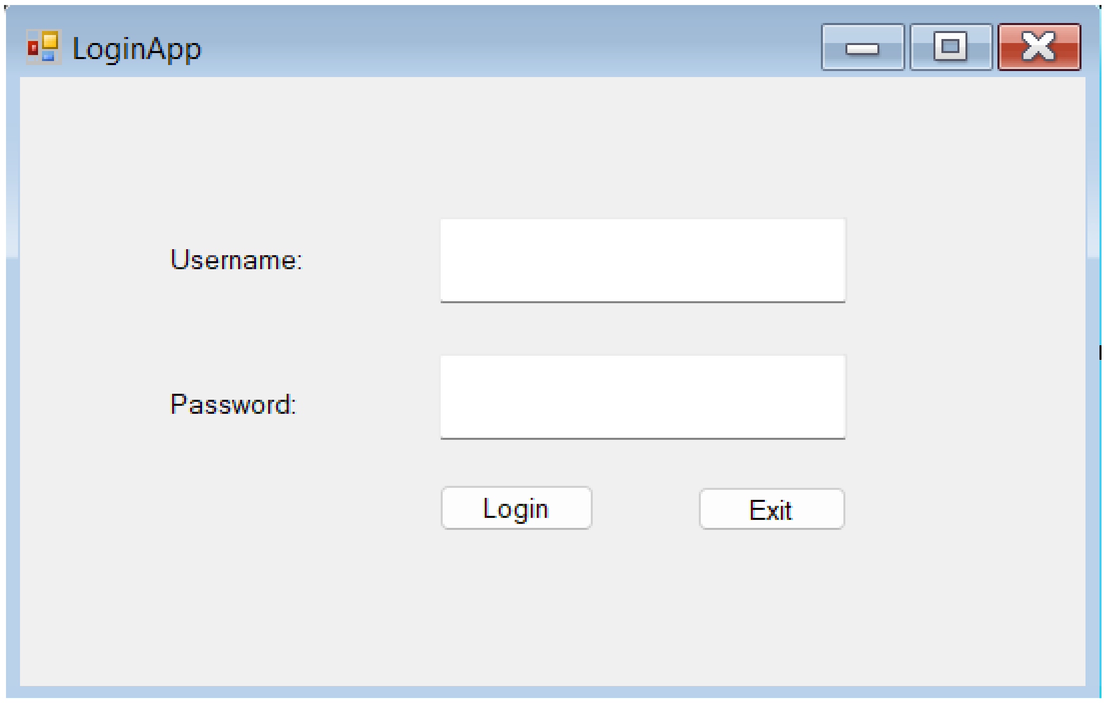
For example, in the Product table, the columns name, quantity, and price are all dependent on the code column, but they don't depend on each other. The price of a product doesn't depend on its name, and the quantity doesn't depend on the price—each of these values is directly tied to the unique product code. The same goes for other tables like Customer and Employee, where attributes like CustomerName and PhoneNumber are only dependent on the CustomerID, not on each other.

By ensuring that there are no indirect relationships between non-key attributes, I've designed my database to satisfy 3NF. This helps maintain data integrity and reduces redundancy, making it easier to manage in the long run.

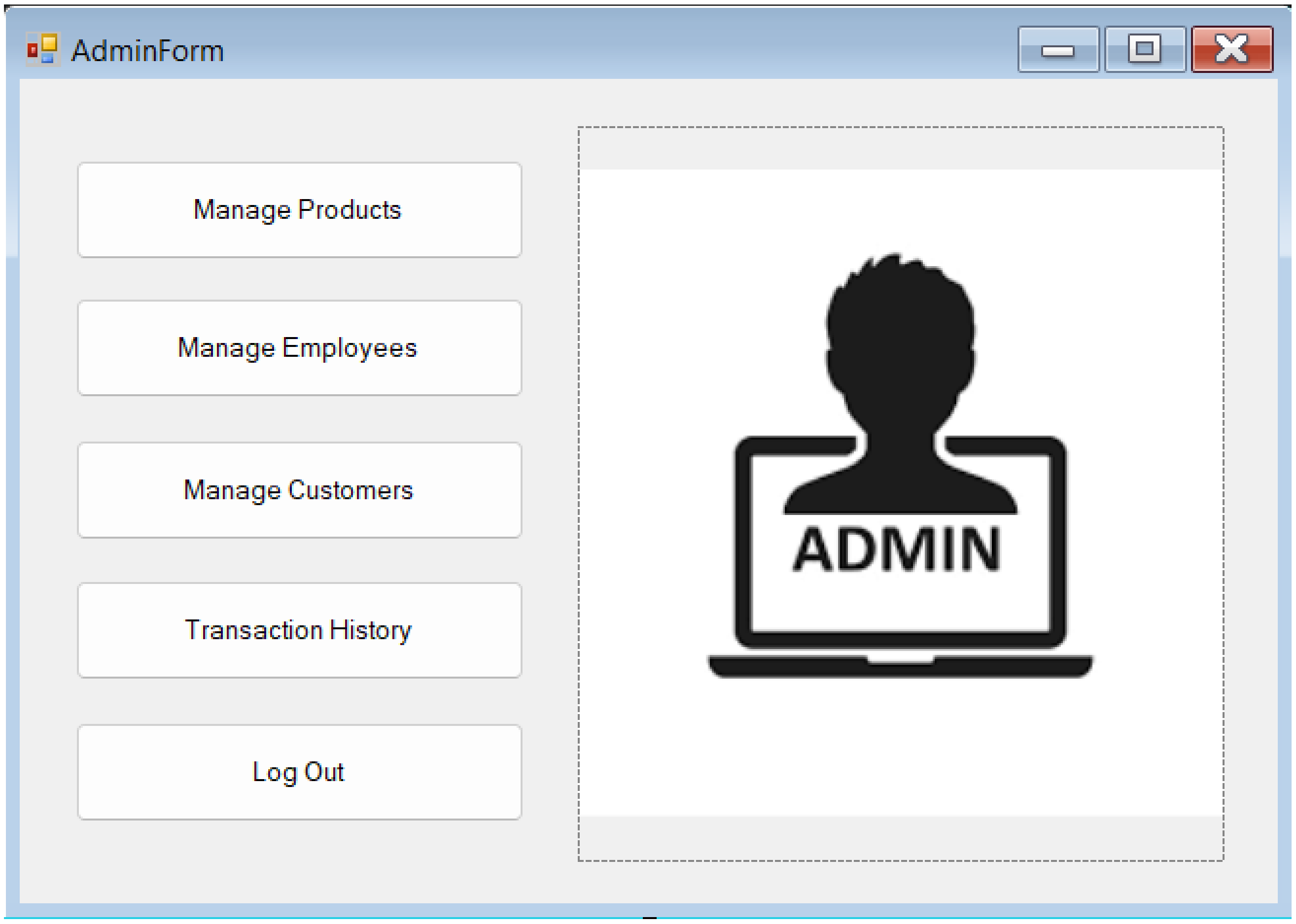
IV. Software Design

6. Mockup (wireframe)

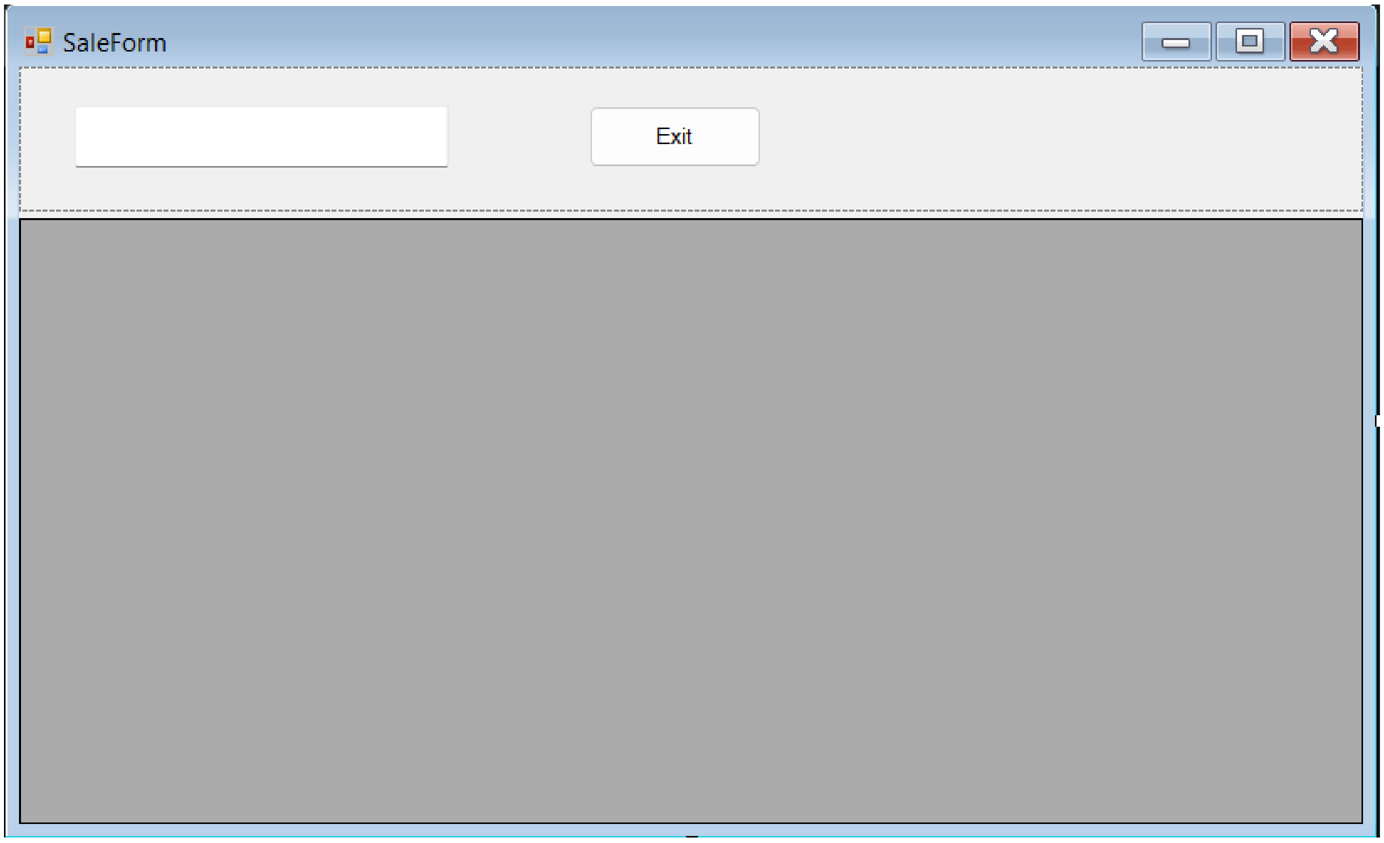
Login Form:

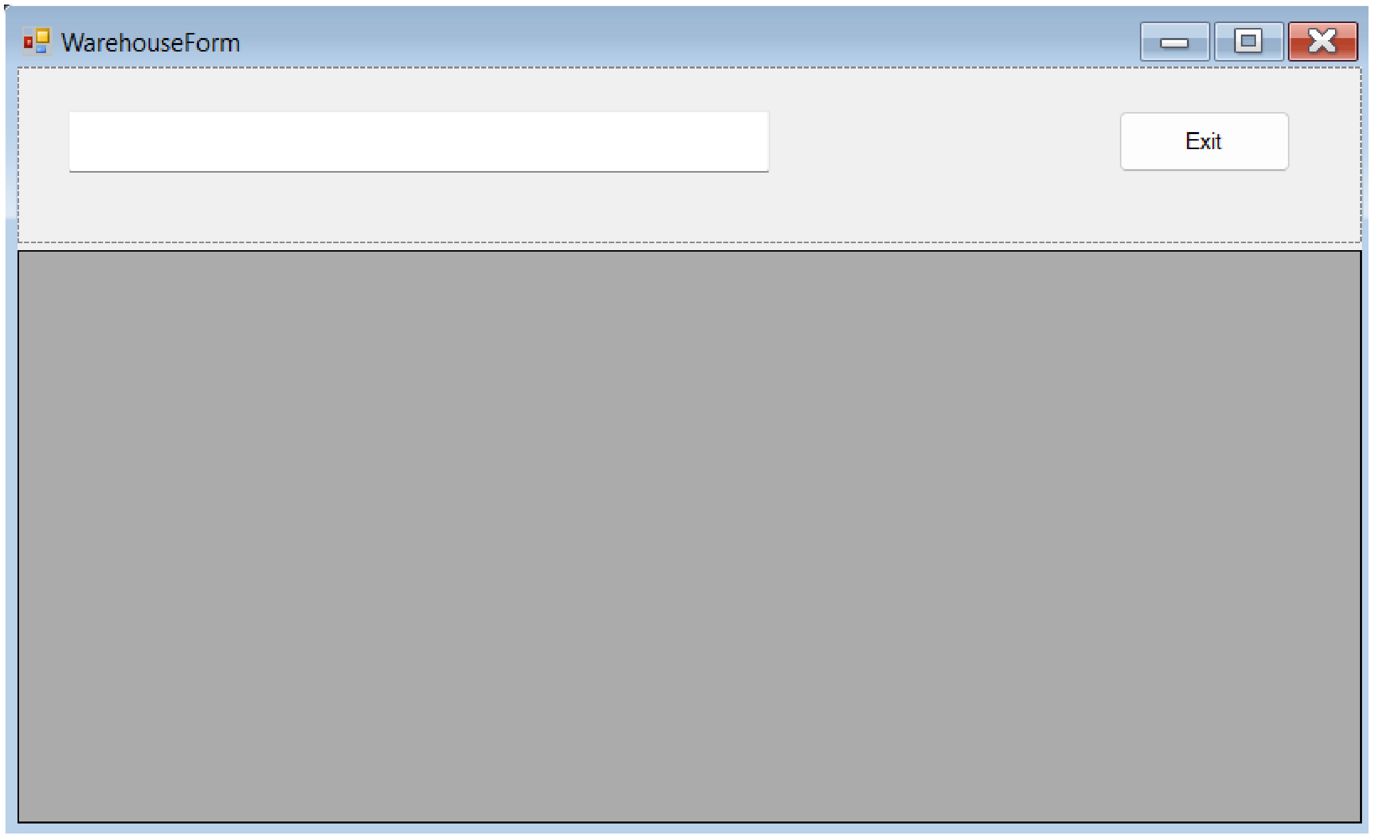


Admin Form:

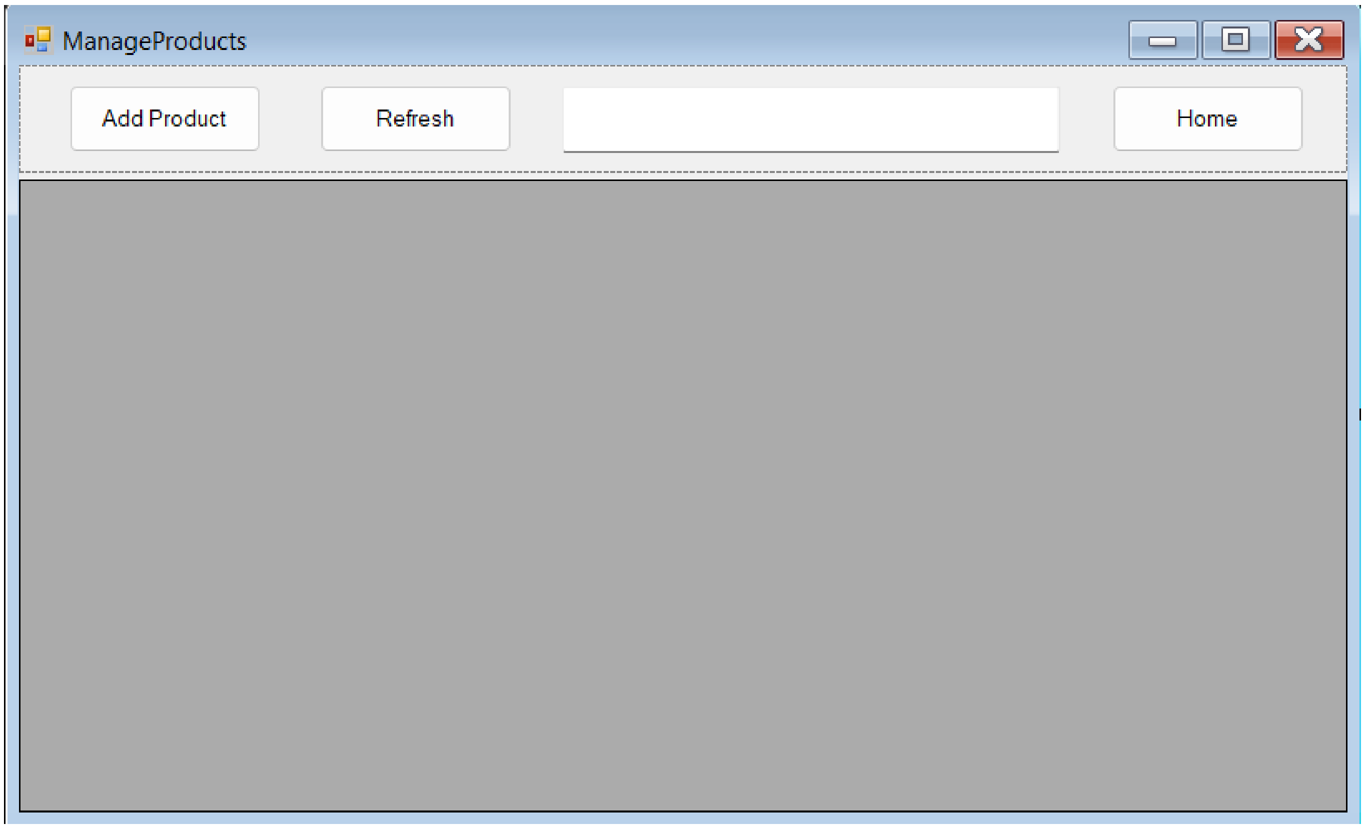


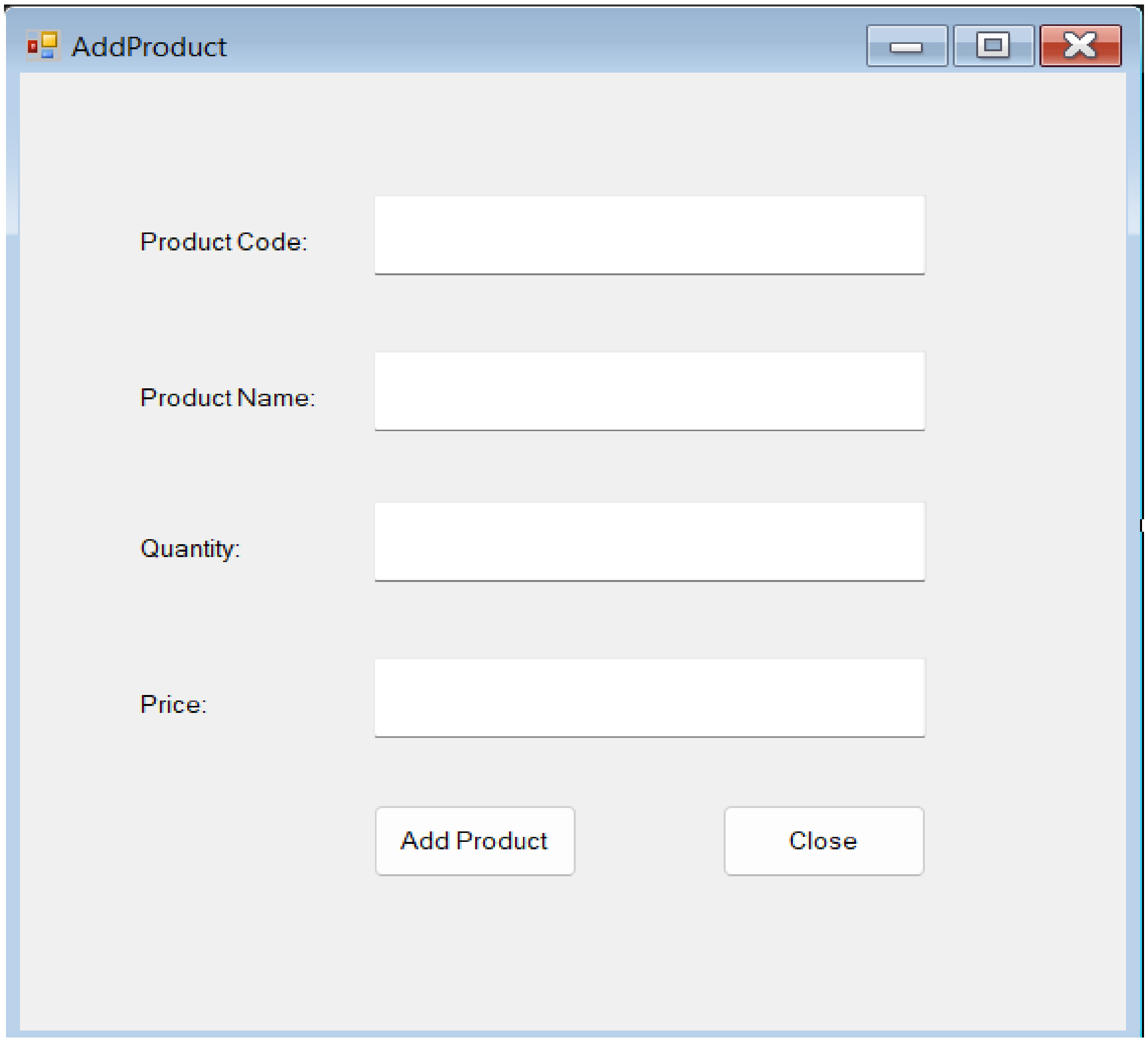
Sales Form and Warehouse Form:

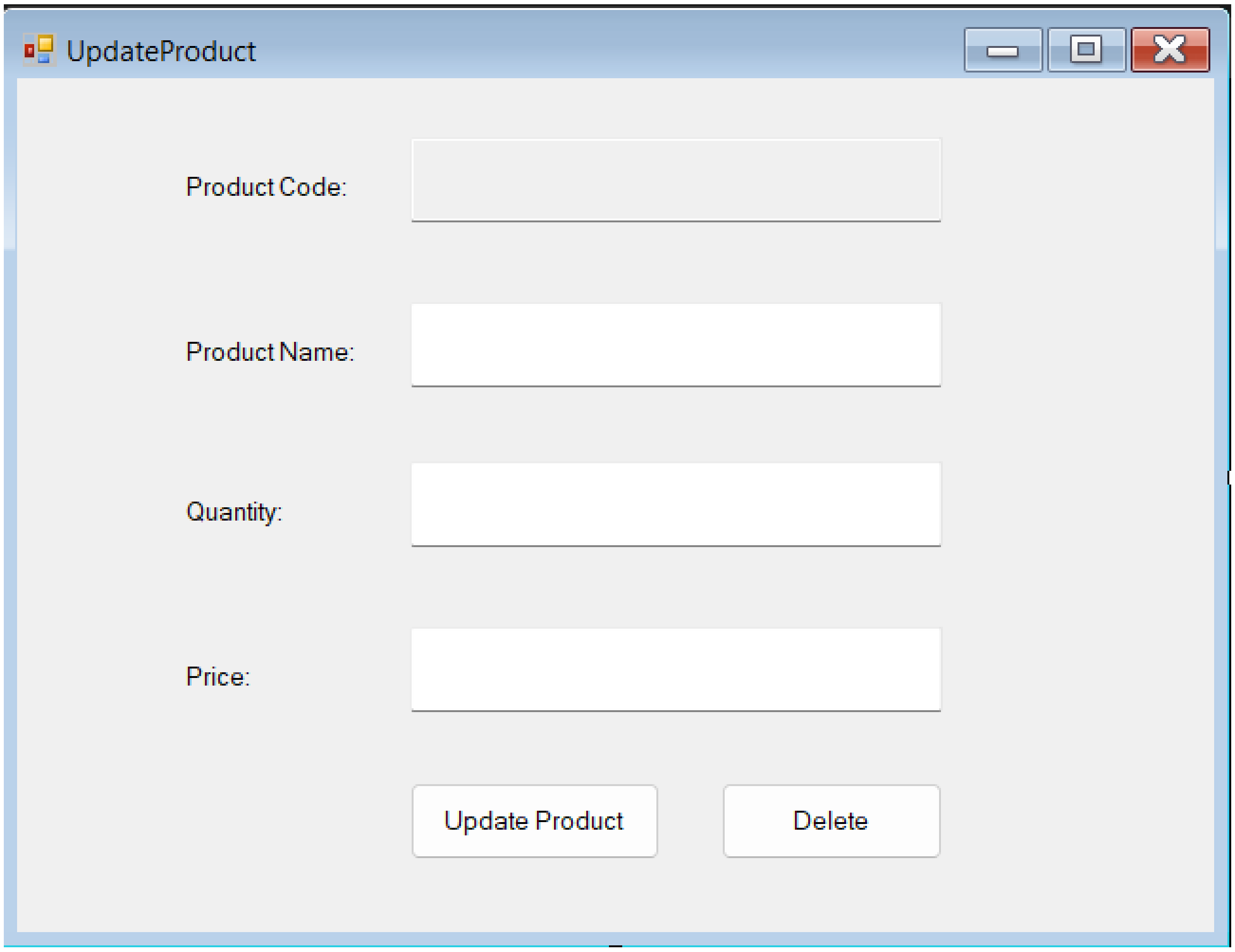

SaleForm
Exit


WarehouseForm
Exit

ManageProduct Form, Update Form, Add Form:




AddProduct
Product Code:
Product Name:
Quantity:
Price:
Add Product
Close



7. Data validation (code)

When designing data validation for the user interface, I need to ensure that the data users provide is accurate, complete, and follows specific formatting and content standards. This will help create smooth user experience and prevent errors or security issues. To do this, I must implement validation checks for each input field, both on the client side to give immediate feedback and on the server side to ensure data integrity. Let me walk through how I can apply these checks, especially focusing on account creation, such as when customers sign up.

Mandatory Fields and Length Limits

First, I need to make certain fields required, like Username, Password, and Email. These fields should be non-optional, meaning users must fill them out before they can submit the form. Additionally, I'll put length constraints on these fields. For instance, usernames should be between 3 and 20 characters long. This prevents users from entering names that are too short to be useful or too long to manage efficiently. Similarly, passwords should be at least 8 characters to ensure they meet basic security requirements. By setting these limits, I can help standardize the data that goes into the system and avoid problems caused by overly long or short inputs.

Email Validation

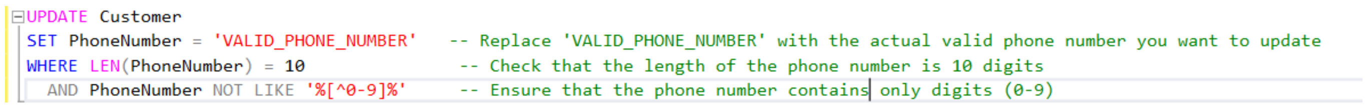
When it comes to email validation, I'll make sure the email entered follows the standard format, like example@domain.com. The email must have exactly one "@" symbol, and a valid domain (such as gmail.com). I'll also prevent users from entering invalid characters like spaces or symbols such as ! or #. If the email doesn't match these rules, I can display an error message like "Please enter a valid email address". By giving real-time feedback, I can guide users toward entering correct information before they attempt to submit the form.

Username Validation

For the Username, I'll check two main things: uniqueness and allowed characters. The username should consist of letters and numbers, with optional characters like underscores (_) or periods (.), but I won't allow special symbols like @,!, or spaces. I'll also make sure the username isn't already taken by querying the database. If there's an issue, such as an invalid character or if the username is already in use, I'll guide the user with an error message like "Username can only contain letters, numbers, and underscores." By validating usernames this way, I can prevent duplicate accounts and ensure they all follow a consistent format.

Phone Number Validation

For phone numbers, I'll ensure that the number follows the correct format for the user's location. The input should contain only numbers, with the possible inclusion of a leading + for international numbers. I'll block letters and special characters to prevent invalid inputs. If the phone number doesn't follow these rules, I'll notify the user with a message like "Please enter a valid phone number." This will ensure that contact information is valid and can be used later without issues when reaching out to customers.


```sql
UPDATE Customer
SET PhoneNumber = 'VALID_PHONE_NUMBER'    -- Replace 'VALID_PHONE_NUMBER' with the actual valid phone number you want to update
WHERE LEN(PhoneNumber) = 10                -- Check that the length of the phone number is 10 digits
  AND PhoneNumber NOT LIKE '%[^0-9]%'      -- Ensure that the phone number contains only digits (0-9)
```

Address Validation

For fields like Address, I'll apply more flexible validation, but there are still key rules to follow. For example, the city field shouldn't contain numbers, and the Postal Code should only contain valid alphanumeric characters, depending on the format for that country. Some fields, like Apartment Number or Address Line 2, might be optional, but if they're filled out, they should still adhere to the correct format. This way, I can ensure that addresses entered into the system are usable for shipping or communication.

V. Evalue of the effectivenesses database design

8. Compare the design to user and system requirements (Verification)

When evaluating the database design, the first step is to verify whether the design aligns with both the user and system requirements. I need to make sure that all essential data entities and relationships are represented accurately. For example, the Customer, Employee, Product, and Purchase History tables must meet the business needs, ensuring that users can retrieve and store data efficiently. The Employee table, for instance, should allow only valid roles and positions to be assigned, while the Purchase History should accurately capture transactions for both customers and products.

Verification also includes ensuring the system supports scalability, security, and usability as outlined in the initial requirements. If user requirements change, the design must remain flexible enough to accommodate future modifications, such as adding new entities or expanding existing ones without significant rework.

9. Check the accuracy, integrity, and consistency of the data (Validation)

Data validation plays a critical role in maintaining the quality and reliability of the database. During the CREATE TABLE process, I need to define constraints and validation rules to ensure that data entries are accurate and consistent. For example, when creating a table that includes an Email field, I can apply a CHECK constraint or use VARCHAR with validation to ensure that the entered value follows a valid email format. Similarly, when designing the Password field, I can impose a rule that passwords must meet minimum length and complexity requirements (e.g., a mix of letters, numbers, and symbols).

In addition, other fields such as Phone Number can be validated to ensure they contain only numeric values and follow the correct format for the given locale. These validation rules are applied at the table creation stage using constraints like NOT NULL, UNIQUE, and CHECK, ensuring that data inserted into the database is reliable from the outset. By defining these conditions in the CREATE TABLE statement, I ensure that the data remains accurate, consistent, and secure.

10. Evaluate the performance of the system (Performance Testing)

Performance testing evaluates how efficiently the system processes and retrieves data under various loads. I will assess how well the database design supports queries for common tasks like product searches, customer management, and purchase history retrieval. Indexing critical columns like Product Code, CustomerID, and PurchaseID will improve the speed of these operations, especially when dealing with large datasets.

Another key aspect of performance testing involves measuring the response time of complex queries that join multiple tables. I'll need to check whether the database performs well under typical and peak usage conditions. If any slowdowns are detected, I may need to optimize the design by adding indexes, partitioning tables, or restructuring certain relationships. For example, evaluating the need for additional indexes on frequently queried columns will be crucial in maintaining performance standards.

11. Analyse the weaknesses and suggest improvements to the design (Evaluation)

Through a detailed analysis, I can identify any weaknesses or limitations in the current database design. For example, if there are potential redundancy issues—such as storing the same data across multiple tables—this could lead to data inconsistency. I can suggest improvements like normalizing the design to reduce redundancy, ensuring that each piece of information is stored only once and referenced through relationships.

Another possible weakness could be insufficient validation rules, which could lead to invalid data being stored in the database. To improve, I could suggest adding more constraints and refining the table structures to better meet business logic and system performance needs. For instance, if phone numbers are being entered incorrectly, adding a validation check to ensure they follow the correct format would be a practical improvement.

12. Perform testing to ensure the system works correctly as required (Testing)

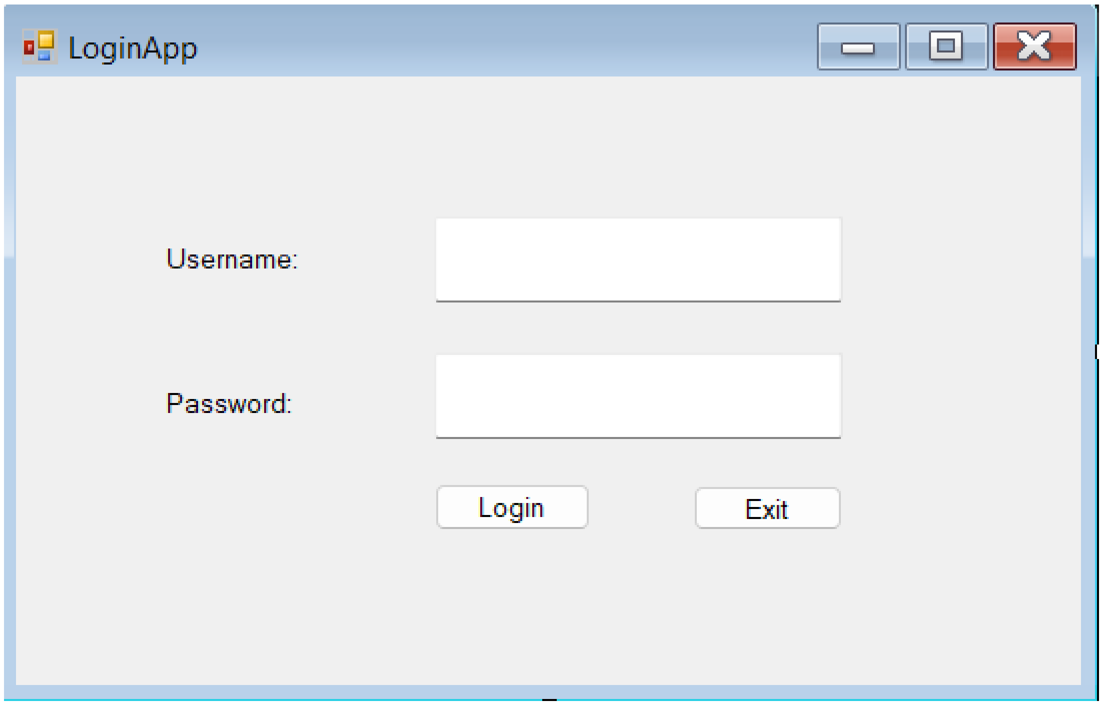
Finally, testing is crucial to confirm that the system works according to the requirements. I would perform various types of testing, including unit testing, integration testing, and acceptance testing, to validate that the database functions as expected. Unit tests could involve inserting and retrieving data from individual tables to ensure basic functionality, while integration tests would check how well the tables work together (e.g., ensuring that when a customer makes a purchase, the purchase is recorded in both the Purchase History and Customer tables).

Moreover, I'll perform load testing to see how well the system performs under different levels of traffic, ensuring that the database can handle peak usage without crashes or slowdowns. After conducting these tests, I can further refine the design based on test results, making sure that the system meets both functional and non-functional requirements effectively.

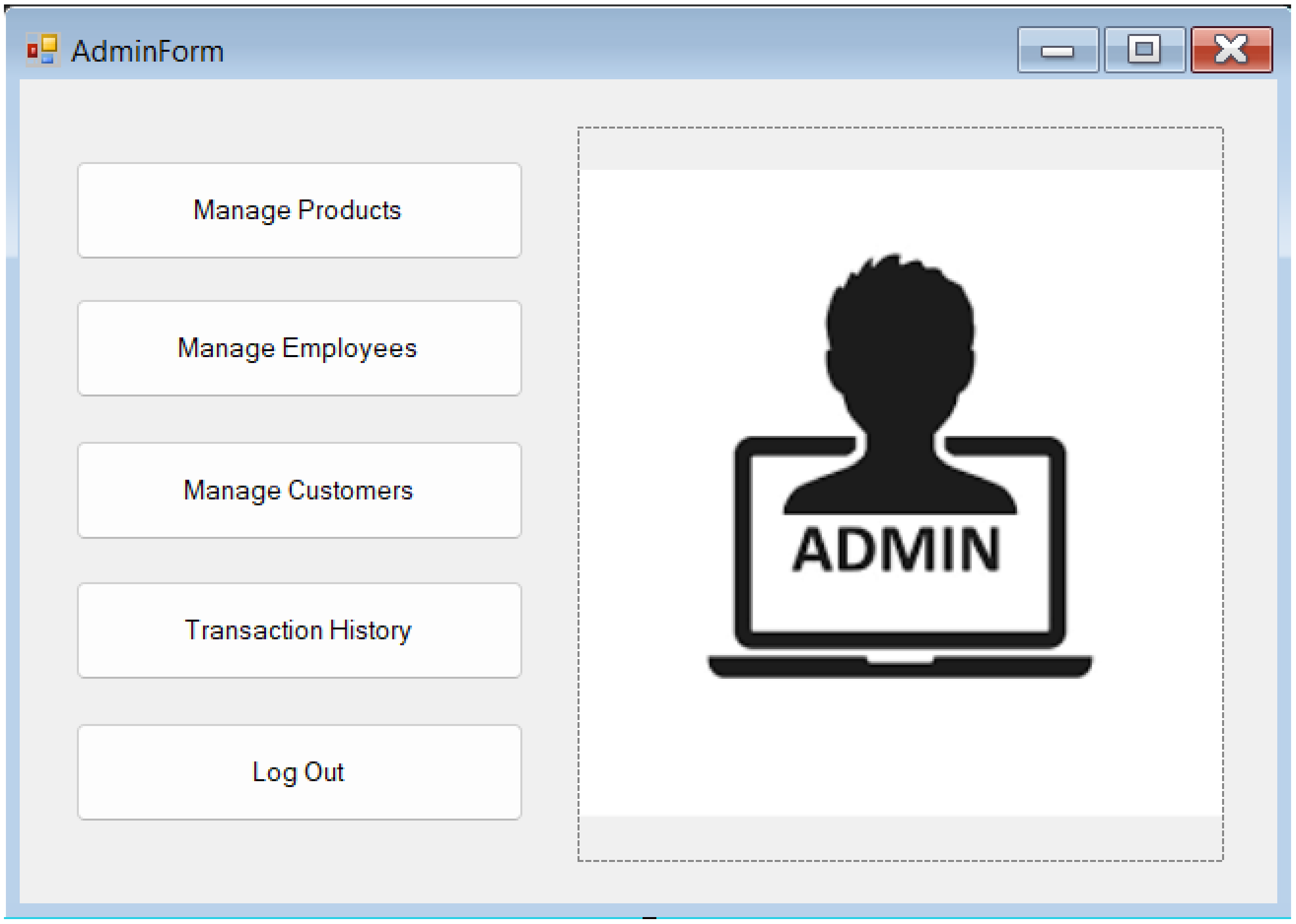
In conclusion, by evaluating and improving the database design based on user needs, data validation, performance, and testing, I can ensure that the database is not only effective but also scalable, secure, and reliable.

VI. Develop the database system with evidence of user interface, output and data validations, and querying across multiple tables.

13. Develop a user interface (UI) for users to interact with the database (e.g., forms, menus).



The **Login Form** is a simple and user-friendly interface designed to authenticate users before granting access to the application. It features two essential input fields: **Username** and **Password**, where users can securely enter their credentials. Below these fields, there are two buttons: **Login**, which initiates the authentication process, and **Exit**, which allows users to close the application. The layout is clean and intuitive, ensuring ease of use and quick navigation. This form serves as the primary entry point to the system, emphasizing both functionality and security.

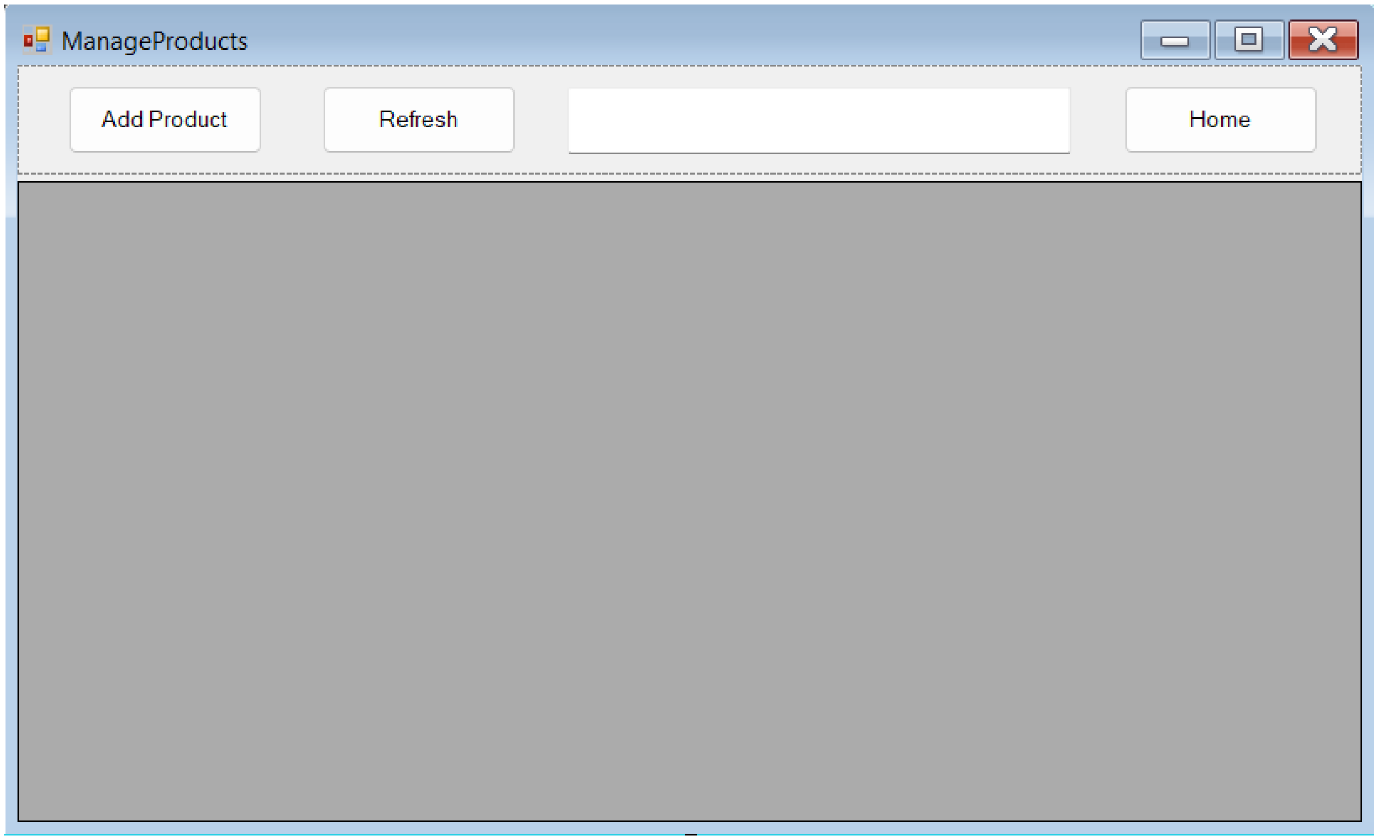


The **Admin Form** serves as the central hub for administrators to efficiently manage various aspects of the store management system. It features five key functionalities accessible through intuitive buttons: **Manage Products**, which allows administrators to oversee product details and inventory; **Manage Employees**, enabling the management of staff accounts and roles; **Manage Customers**, for handling customer information and accounts; **Transaction History**, providing access to past sales records; and **Log Out**, ensuring secure session termination. Additionally, a dedicated image section enhances the interface, offering a professional and visually appealing design for the admin dashboard.

14. Design outputs (*reports, visualizations*) to present data to users in a meaningful way.

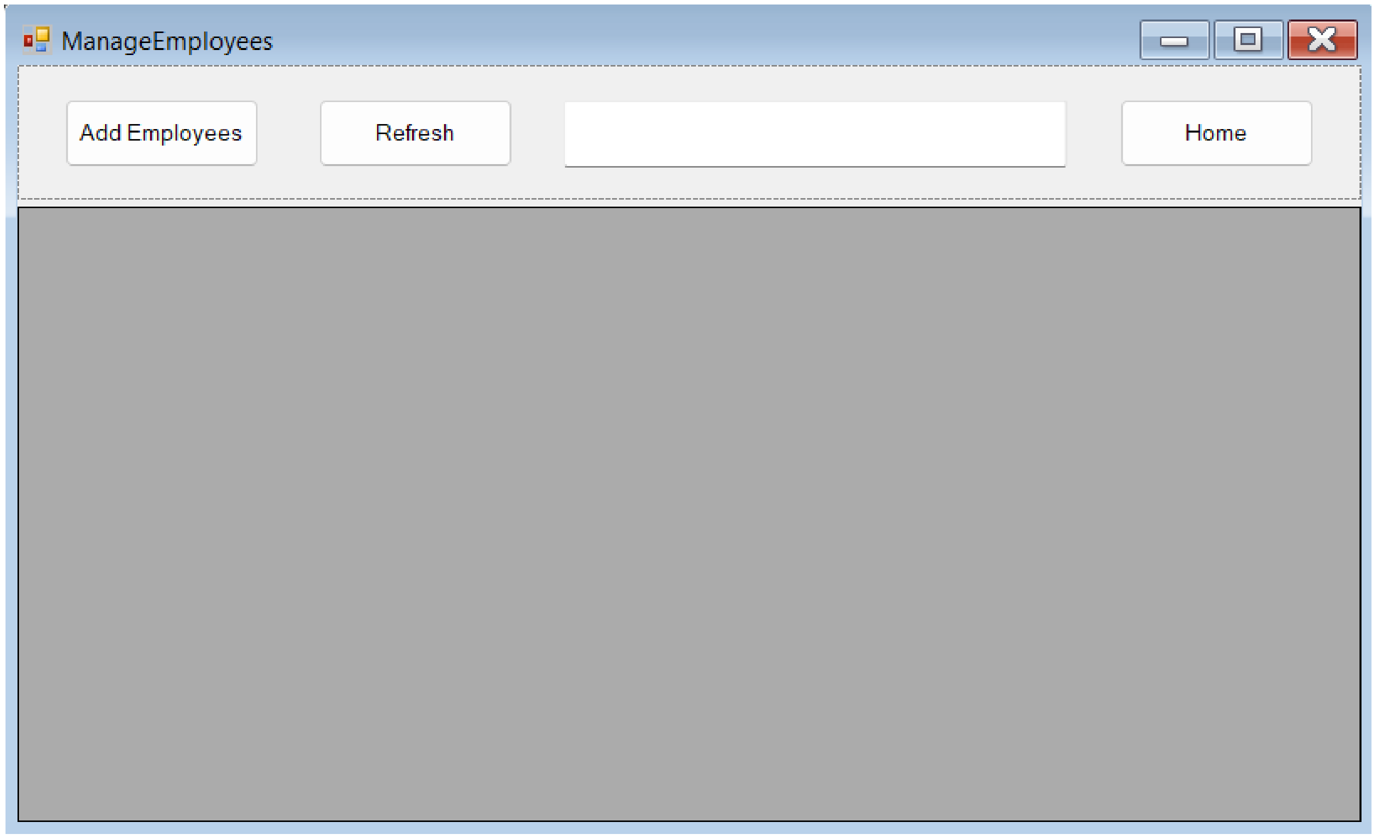
ManageProducts Form

The **ManageProducts Form** is a crucial part of the Store Management System, designed to provide an easy interface for administrators to manage product information efficiently. The form is divided into two main sections using a **split container**. The top section contains controls for interacting with the system, including a search bar for quickly finding products based on their name or code. There are also buttons for refreshing the product list, returning to the home screen, and adding new products to the inventory. The bottom section features a **DataGridView** that displays the products in the inventory, with details like the product name, quantity, price, and product code. This grid allows users to view and interact with all the available products. The form enables administrators to add new products, update existing ones, or delete obsolete products. By providing an organized and easy-to-use interface, the **ManageProducts Form** helps ensure that the store's inventory is always up-to-date and accurate.



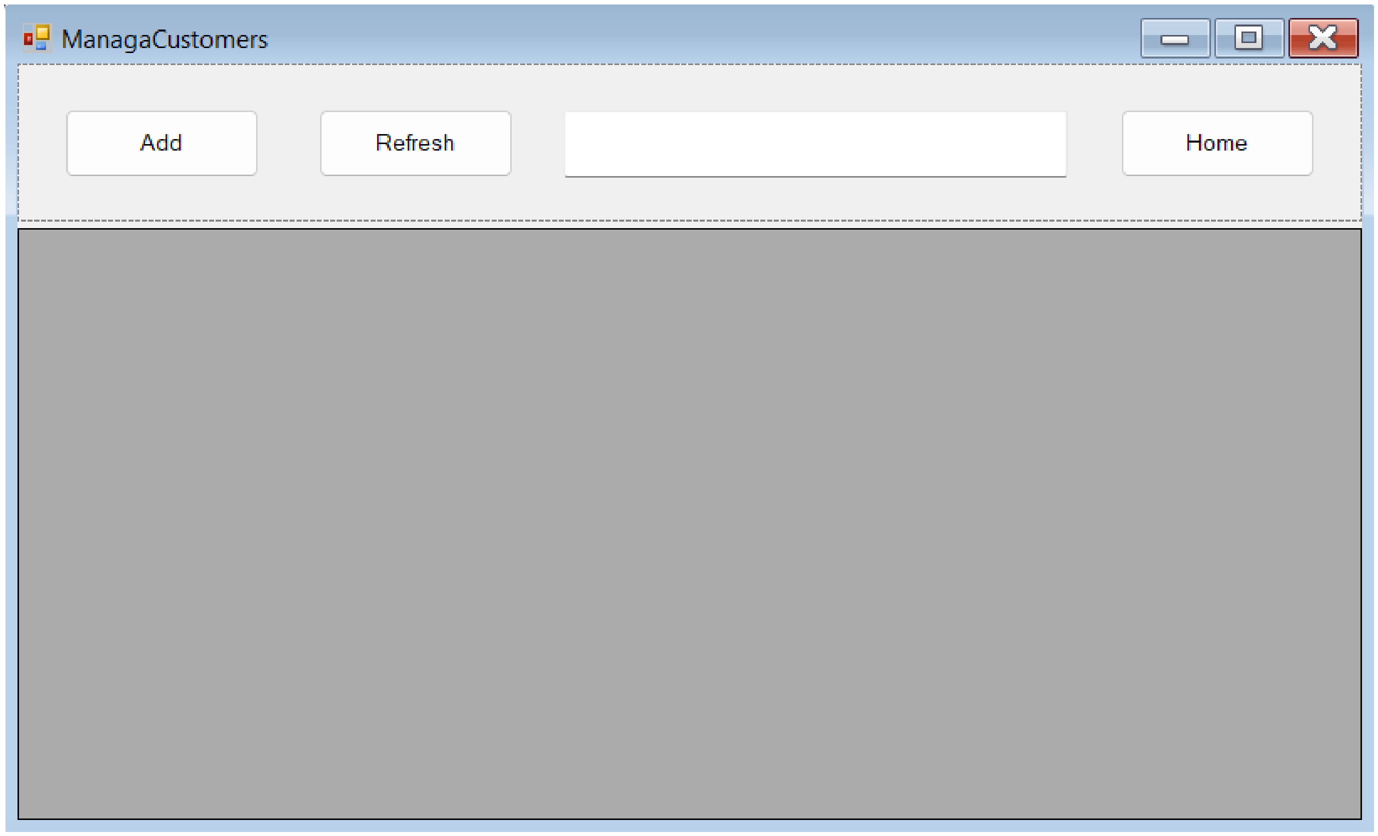
ManageEmployees Form

The **ManageEmployees Form** is designed to facilitate the management of employee information within the store. It provides administrators with an organized layout to view and manage all employees, including their roles and personal details. The form also uses a **split container**, with the top section containing controls for searching through employees, refreshing the list, navigating back to the home screen, and adding new employees. The search functionality allows quick access to specific employee records based on their name, employee ID, or other criteria. The bottom section is dedicated to the **DataGridView**, where the employee details are displayed, including the employee's name, position, role, and other relevant information. Administrators can add new employees, edit existing records, and remove employees who are no longer part of the team. This form serves as a central hub for HR-related tasks, helping store managers and administrators maintain an up-to-date employee roster.



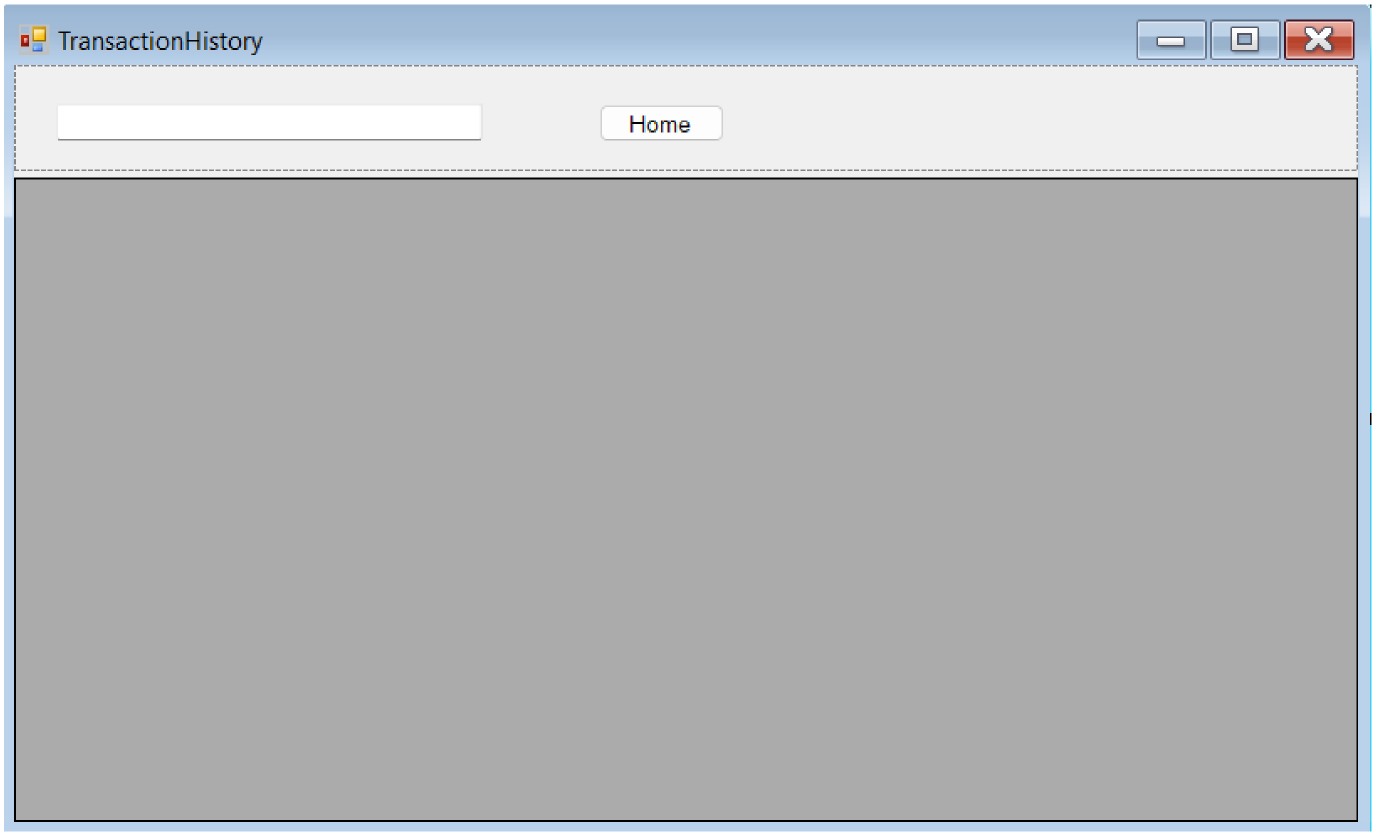
Customer Management Form

The **Customer Management Form** serves as the central interface for managing customer data. It allows store managers and administrators to view and update customer information easily. The form is divided into two main sections: the top section contains search and action buttons, while the bottom section displays the list of customers in a **DataGridView**. The search functionality allows administrators to filter customer records based on customer ID, name, or other criteria, helping them quickly find the specific customer they are looking for. The form also includes buttons for adding new customers, refreshing the customer list, and navigating back to the home screen. Customers' information displayed in the grid includes details such as their name, contact information, purchase history, and account status. By utilizing this form, administrators can efficiently manage customer accounts, resolve customer inquiries, and maintain an organized customer database.



TransactionHistory Form

The **TransactionHistory Form** provides administrators and store managers with an overview of all past transactions. This form is essential for tracking purchases, analyzing sales trends, and managing customer purchase histories. Similar to the other forms, it uses a **split container** layout, with the top section containing search filters and action buttons, and the bottom section displaying the transaction data in a **DataGridView**. Administrators can filter transactions based on various criteria, such as transaction date, customer name, or product purchased. The grid displays key details of each transaction, including the transaction ID, customer information, product code, quantity purchased, total price, and the date of purchase. This form helps store managers monitor the flow of goods, check customer purchase patterns, and generate reports for auditing purposes. By offering an easy way to track and manage transactions, the **TransactionHistory Form** supports the store in maintaining accurate records and efficient operations.



15. Implement data validation rules to ensure data accuracy and consistency during input.

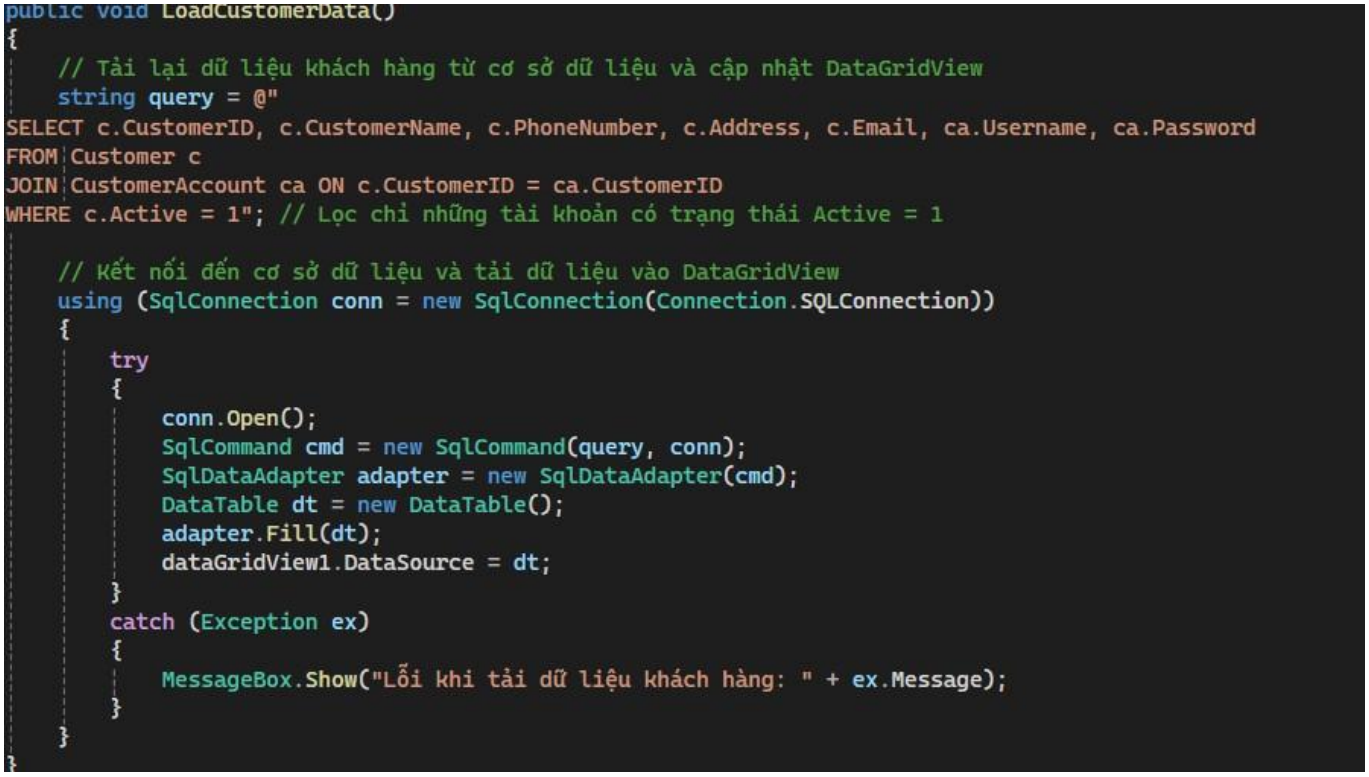
To ensure data accuracy and consistency, **data validation rules** will be implemented at both the user interface and database levels. On the interface side, fields such as **username** and **password** will include validations to enforce minimum and maximum character limits. For example, passwords may require a minimum of 8 characters. At the database level, additional validations will be applied, such as ensuring email addresses conform to a valid format, phone numbers consist of exactly 10 digits, and passwords are securely hashed before storage. These combined measures guarantee data integrity and prevent the entry of invalid or incomplete information into the system.

```
CONSTRAINT CHK_PhoneNumber CHECK (PhoneNumber LIKE '[0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9][0-9]') -- Kiểm tra 10 chữ số
```

16. Develop queries that can retrieve and manipulate data across multiple tables.

The LoadCustomerData method retrieves active customer information along with their associated account details and displays it in a DataGridView. The SQL query used begins by selecting key details from two tables: Customer and CustomerAccount. Specifically, it retrieves CustomerID, CustomerName, PhoneNumber, Address, and Email from the Customer table and Username and Password from the CustomerAccount table. These tables are joined using an INNER JOIN on the CustomerID column, ensuring that each record includes data from both tables. The WHERE clause filters the results to only include customers whose accounts are active (c.Active = 1). This ensures that only relevant and valid customer data is displayed.

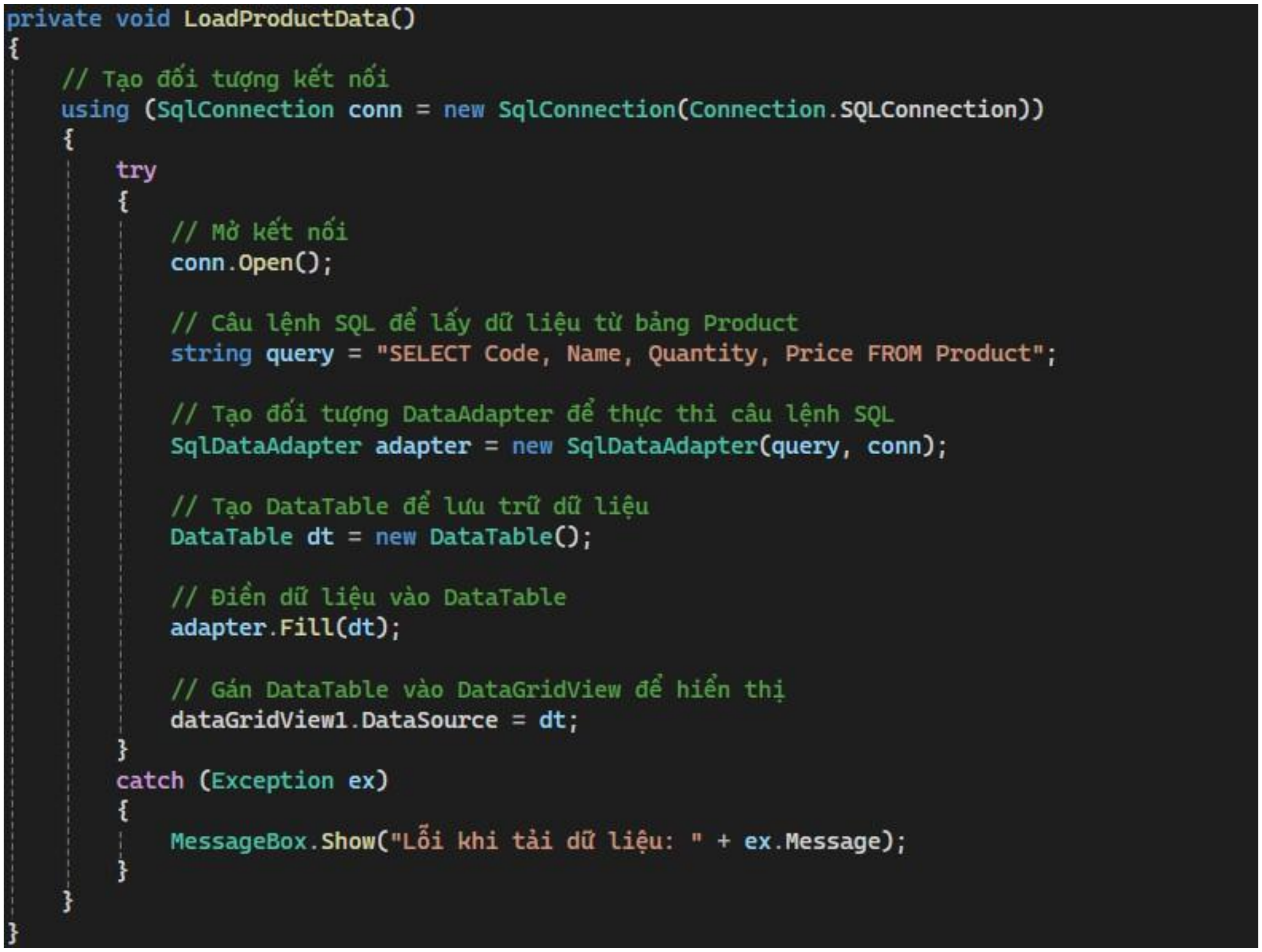
Within the method, a SqlConnection object connects to the database, and a SqlCommand executes the query. The SqlDataAdapter fills a DataTable with the retrieved data, which is then bound to dataGridView1 to display the results. Error handling is implemented to catch and report any exceptions during this process. This approach efficiently synchronizes the database with the user interface.



```
public void LoadCustomerData()
{
    // Tải lại dữ liệu khách hàng từ cơ sở dữ liệu và cập nhật DataGridView
    string query = @"
SELECT c.CustomerID, c.CustomerName, c.PhoneNumber, c.Address, c.Email, ca.Username, ca.Password
FROM Customer c
JOIN CustomerAccount ca ON c.CustomerID = ca.CustomerID
WHERE c.Active = 1"; // Lọc chỉ những tài khoản có trạng thái Active = 1

    // Kết nối đến cơ sở dữ liệu và tải dữ liệu vào DataGridView
    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection))
    {
        try
        {
            conn.Open();
            SqlCommand cmd = new SqlCommand(query, conn);
            SqlDataAdapter adapter = new SqlDataAdapter(cmd);
            DataTable dt = new DataTable();
            adapter.Fill(dt);
            dataGridView1.DataSource = dt;
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi khi tải dữ liệu khách hàng: " + ex.Message);
        }
    }
}
```

The LoadProductData method retrieves and displays product information from the Product table in a DataGridView. The method starts by establishing a connection to the database using a SqlConnection object. Once the connection is successfully opened, a SQL query is executed to select specific columns (Code, Name, Quantity, Price) from the Product table.

A SqlDataAdapter is then used to execute the query and fetch the data, storing the results in a DataTable object. This data is subsequently bound to dataGridView1 to present the product information in a tabular format. Error handling is incorporated to manage potential exceptions, such as database connectivity issues, by displaying an appropriate error message to the user. This method provides an efficient way to synchronize the database content with the user interface.

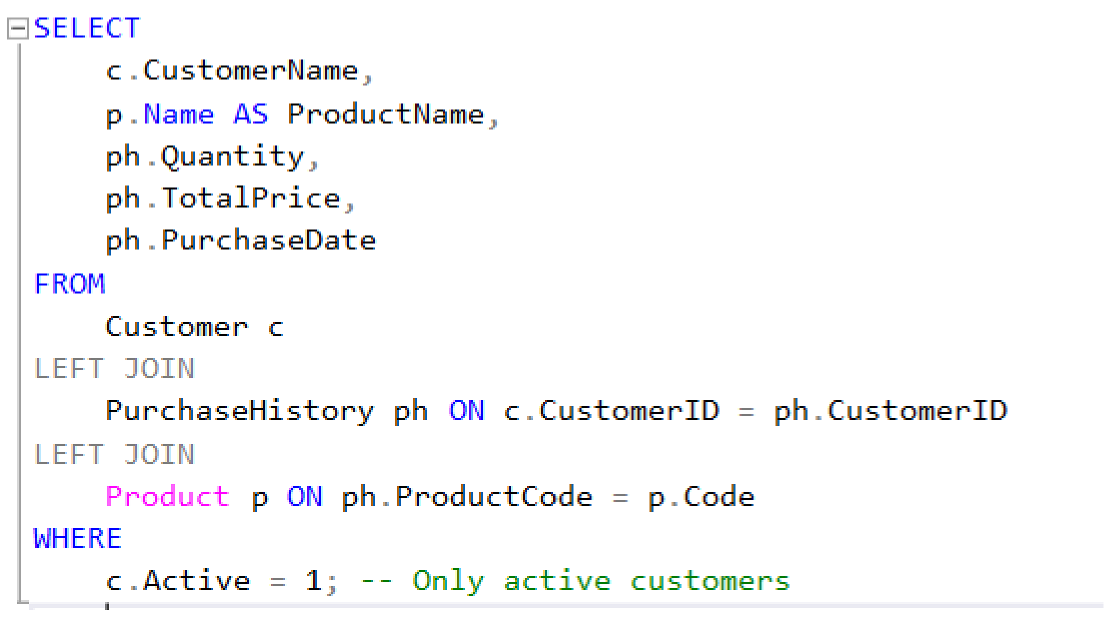

```
private void LoadProductData()
{
    // Tạo đối tượng kết nối
    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection))
    {
        try
        {
            // Mở kết nối
            conn.Open();

            // Câu lệnh SQL để lấy dữ liệu từ bảng Product
            string query = "SELECT Code, Name, Quantity, Price FROM Product";

            // Tạo đối tượng DataAdapter để thực thi câu lệnh SQL
            SqlDataAdapter adapter = new SqlDataAdapter(query, conn);

            // Tạo DataTable để lưu trữ dữ liệu
            DataTable dt = new DataTable();

            // Điền dữ liệu vào DataTable
            adapter.Fill(dt);

            // Gán DataTable vào DataGridView để hiển thị
            dataGridView1.DataSource = dt;
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi khi tải dữ liệu: " + ex.Message);
        }
    }
}
```

VII. Implement a query language into the relational database system

17. Assess the suitability of the T-SQL query language for sales software applications.

T-SQL (Transact-SQL) is an ideal query language for implementing a relational database system in a sales software application. Its extended capabilities over standard SQL, such as procedural programming, error handling, and built-in functions, make it highly suitable for managing complex sales operations. The ability to define stored procedures, triggers, and views ensures that T-SQL can efficiently handle the needs of real-time sales data processing, customer management, and inventory control. Additionally, T-SQL's compatibility with Microsoft SQL Server aligns with the robust, scalable, and secure requirements of enterprise-grade sales applications.

For example, the following query uses JOIN to retrieve customer purchase details:

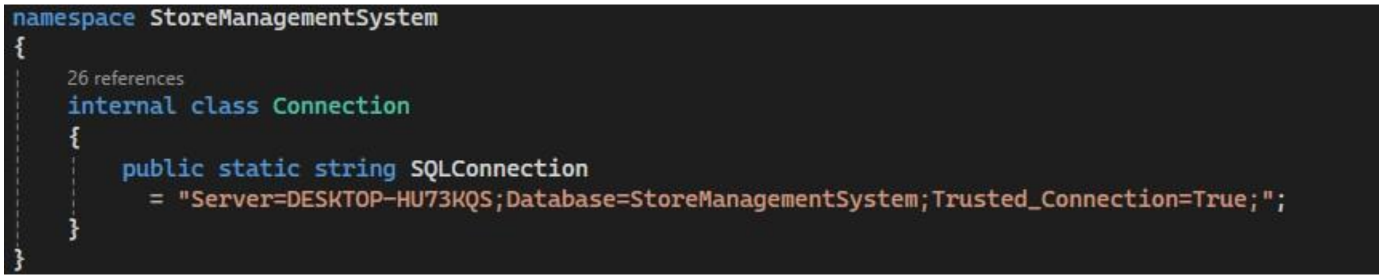

```sql
SELECT
    c.CustomerName,
    p.Name AS ProductName,
    ph.Quantity,
    ph.TotalPrice,
    ph.PurchaseDate
FROM
    Customer c
LEFT JOIN
    PurchaseHistory ph ON c.CustomerID = ph.CustomerID
LEFT JOIN
    Product p ON ph.ProductCode = p.Code
WHERE
    c.Active = 1; -- Only active customers
```

This query demonstrates T-SQL's strength in handling relational data effectively, making it a valuable choice for sales applications.

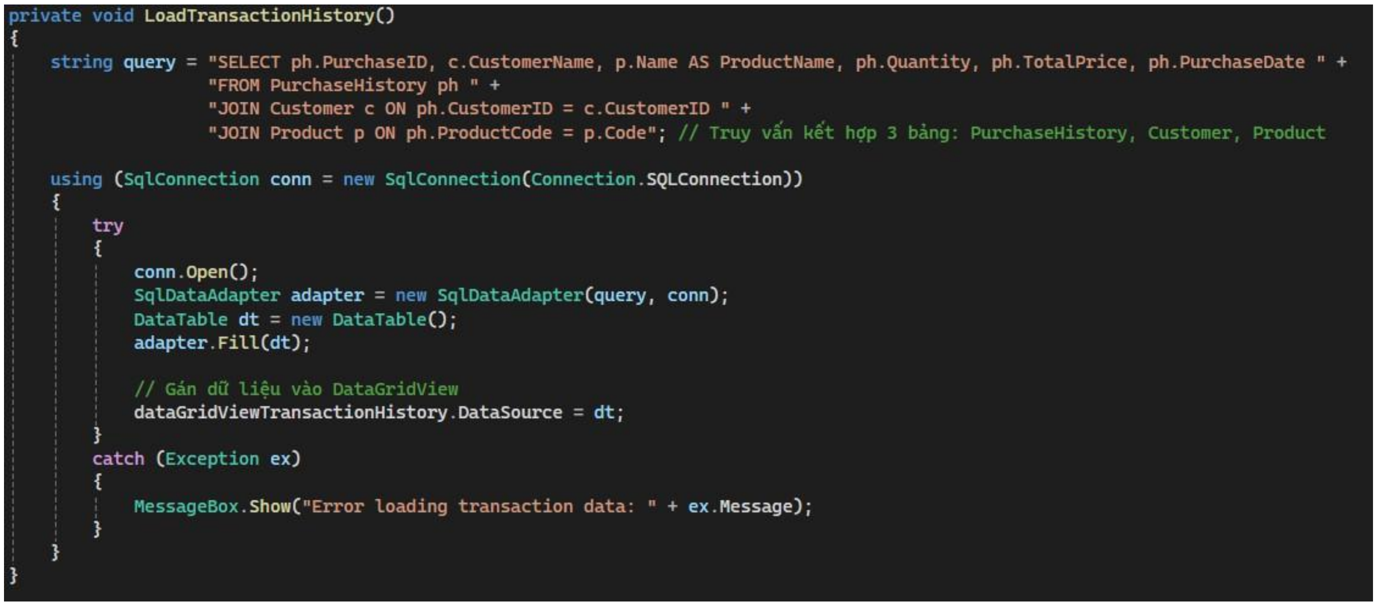
18. Implement data connection and execute queries to fulfill software functionalities.

To fulfill the functionalities of the sales software application, T-SQL queries were integrated into the system through a .NET framework. Below are examples of implemented queries and their purposes

The Connection class in the StoreManagementSystem namespace provides a centralized way to manage the database connection string used throughout the application. It contains a static property named SQLConnection, which holds the necessary details for connecting to a SQL Server database. The connection string specifies the server (DESKTOP-HU73KQS), the target database (StoreManagementSystem), and uses Windows Authentication (Trusted_Connection=True). By encapsulating the connection string in a static property, this class ensures consistency and reusability, allowing other parts of the system to easily access the database without duplicating connection details. This approach simplifies maintenance and enhances the security of connection management.


```csharp
namespace StoreManagementSystem
{
    26 references
    internal class Connection
    {
        public static string SQLConnection
          = "Server=DESKTOP-HU73KQS;Database=StoreManagementSystem;Trusted_Connection=True;";
    }
}
```

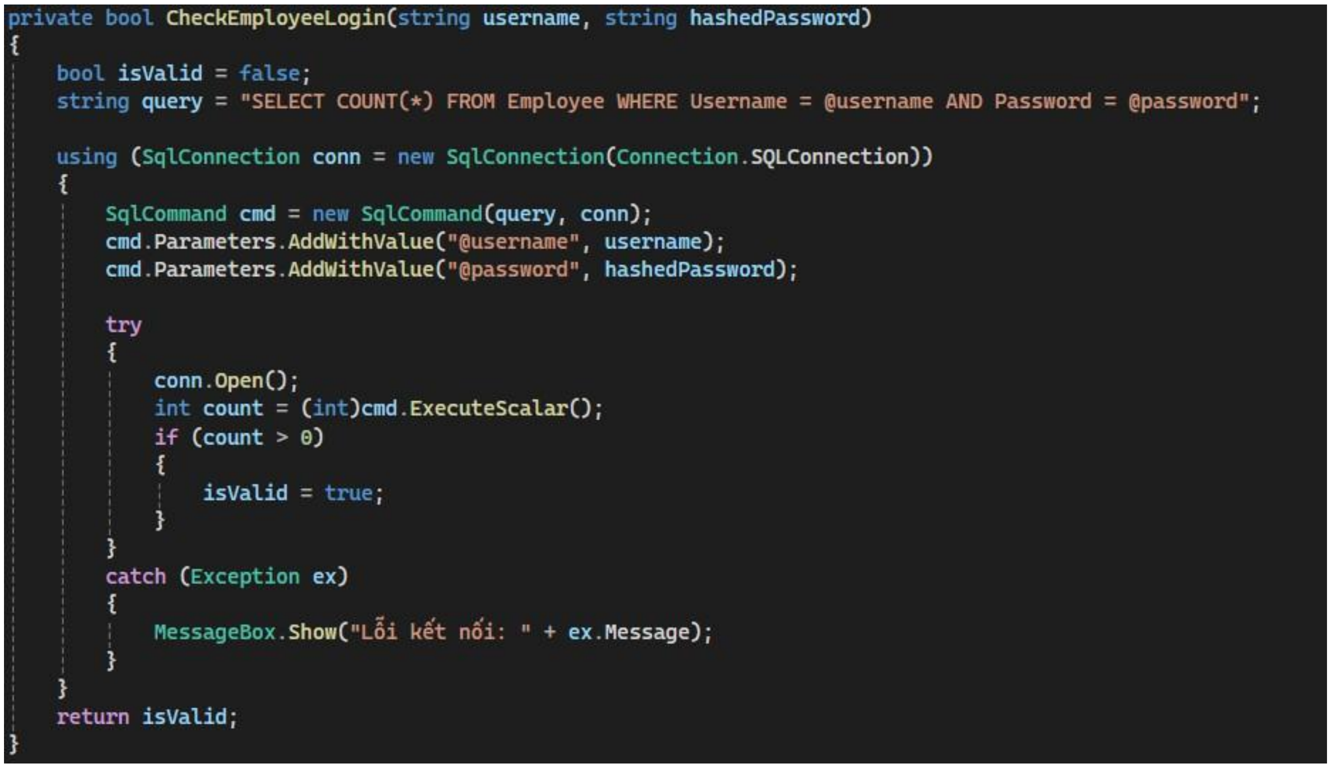
The LoadTransactionHistory method is used to retrieve and display transaction history data in a user interface, by executing a SQL query that joins three database tables: PurchaseHistory, Customer, and Product. The method constructs a query to select key data points such as PurchaseID, customer names, product names, quantities purchased, total price, and purchase dates. It then establishes a connection to the database using a connection string and a SqlConnection object. Once connected, the query is executed using a SqlDataAdapter, and the results are loaded into a DataTable. This data is then bound to a DataGridView control to display the transaction information to the user. The method also includes error handling to catch any issues that may arise during data retrieval, ensuring that users are notified of any problems that occur. Overall, this method plays an essential role in presenting transaction history in a clear and organized manner within the application.



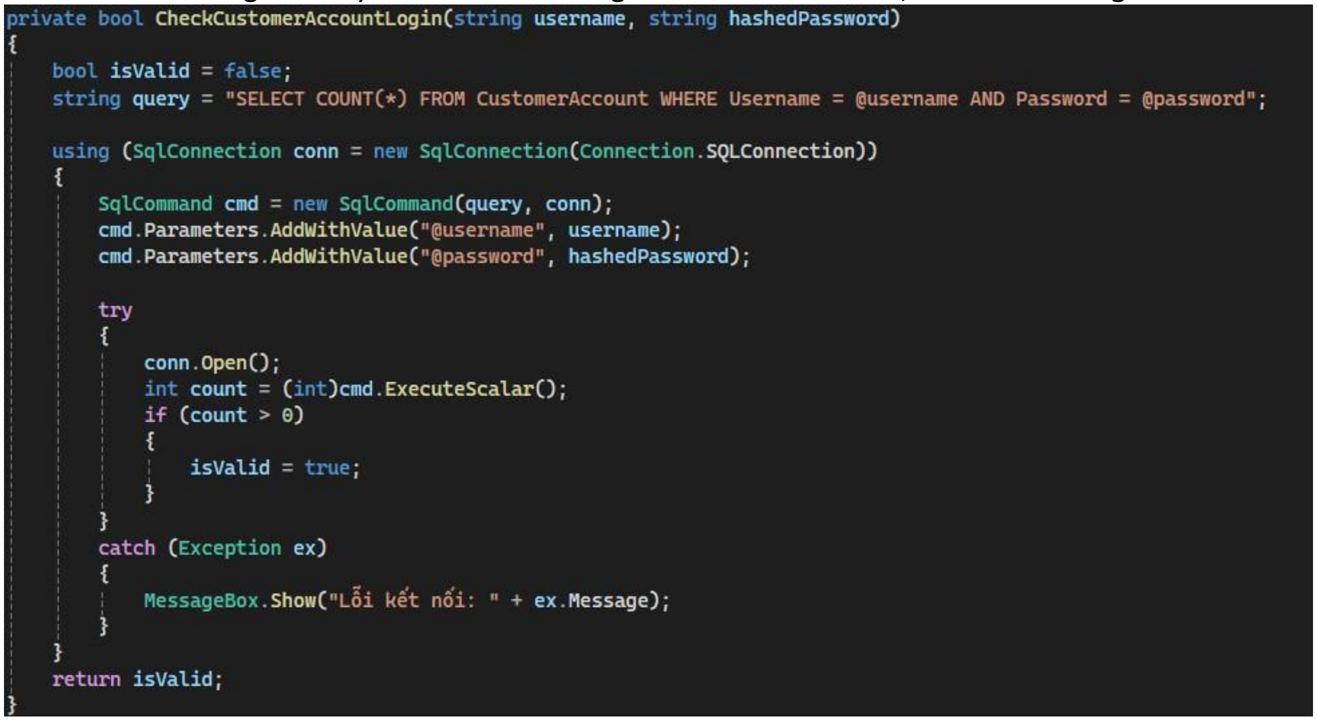
```
private void LoadTransactionHistory()
{
    string query = "SELECT ph.PurchaseID, c.CustomerName, p.Name AS ProductName, ph.Quantity, ph.TotalPrice, ph.PurchaseDate " +
                   "FROM PurchaseHistory ph " +
                   "JOIN Customer c ON ph.CustomerID = c.CustomerID " +
                   "JOIN Product p ON ph.ProductCode = p.Code"; // Truy vấn kết hợp 3 bảng: PurchaseHistory, Customer, Product

    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection))
    {
        try
        {
            conn.Open();
            SqlDataAdapter adapter = new SqlDataAdapter(query, conn);
            DataTable dt = new DataTable();
            adapter.Fill(dt);

            // Gán dữ liệu vào DataGridView
            dataGridViewTransactionHistory.DataSource = dt;
        }
        catch (Exception ex)
        {
            MessageBox.Show("Error loading transaction data: " + ex.Message);
        }
    }
}
```

The code provided consists of two methods that handle login authentication for employees and customer accounts in the system.

- **CheckEmployeeLogin Method:** This method is used to verify if the employee's login credentials (username and password) are valid. The method constructs a SQL query that checks the Employee table to see if there is a match for the provided username and hashed password. The query uses parameterized inputs to prevent SQL injection attacks. The ExecuteScalar() method is used to execute the query and return the count of matching records. If the count is greater than zero, the login is considered valid, and the method returns true. If the connection fails or another error occurs, an error message is displayed using MessageBox.Show().


```
private bool CheckEmployeeLogin(string username, string hashedPassword)
{
    bool isValid = false;
    string query = "SELECT COUNT(*) FROM Employee WHERE Username = @username AND Password = @password";

    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection))
    {
        SqlCommand cmd = new SqlCommand(query, conn);
        cmd.Parameters.AddWithValue("@username", username);
        cmd.Parameters.AddWithValue("@password", hashedPassword);

        try
        {
            conn.Open();
            int count = (int)cmd.ExecuteScalar();
            if (count > 0)
            {
                isValid = true;
            }
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi kết nối: " + ex.Message);
        }
    }
    return isValid;
}
```

- **CheckCustomerAccountLogin Method:** This method follows a similar structure but checks the CustomerAccount table to validate the customer's login credentials. It also uses a parameterized query to match the provided username and password against the records in the CustomerAccount table. If a matching record is found, the method returns true, indicating a successful login. If any errors occur during database interaction, an error message is shown.


```
private bool CheckCustomerAccountLogin(string username, string hashedPassword)
{
    bool isValid = false;
    string query = "SELECT COUNT(*) FROM CustomerAccount WHERE Username = @username AND Password = @password";

    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection))
    {
        SqlCommand cmd = new SqlCommand(query, conn);
        cmd.Parameters.AddWithValue("@username", username);
        cmd.Parameters.AddWithValue("@password", hashedPassword);

        try
        {
            conn.Open();
            int count = (int)cmd.ExecuteScalar();
            if (count > 0)
            {
                isValid = true;
            }
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi kết nối: " + ex.Message);
        }
    }
    return isValid;
}
```

Both methods ensure secure and efficient login validation by utilizing parameterized queries to avoid SQL injection vulnerabilities and by handling exceptions that may arise during database interactions. These methods are crucial in providing access control to the system, ensuring that only valid users can access the corresponding sections of the application.

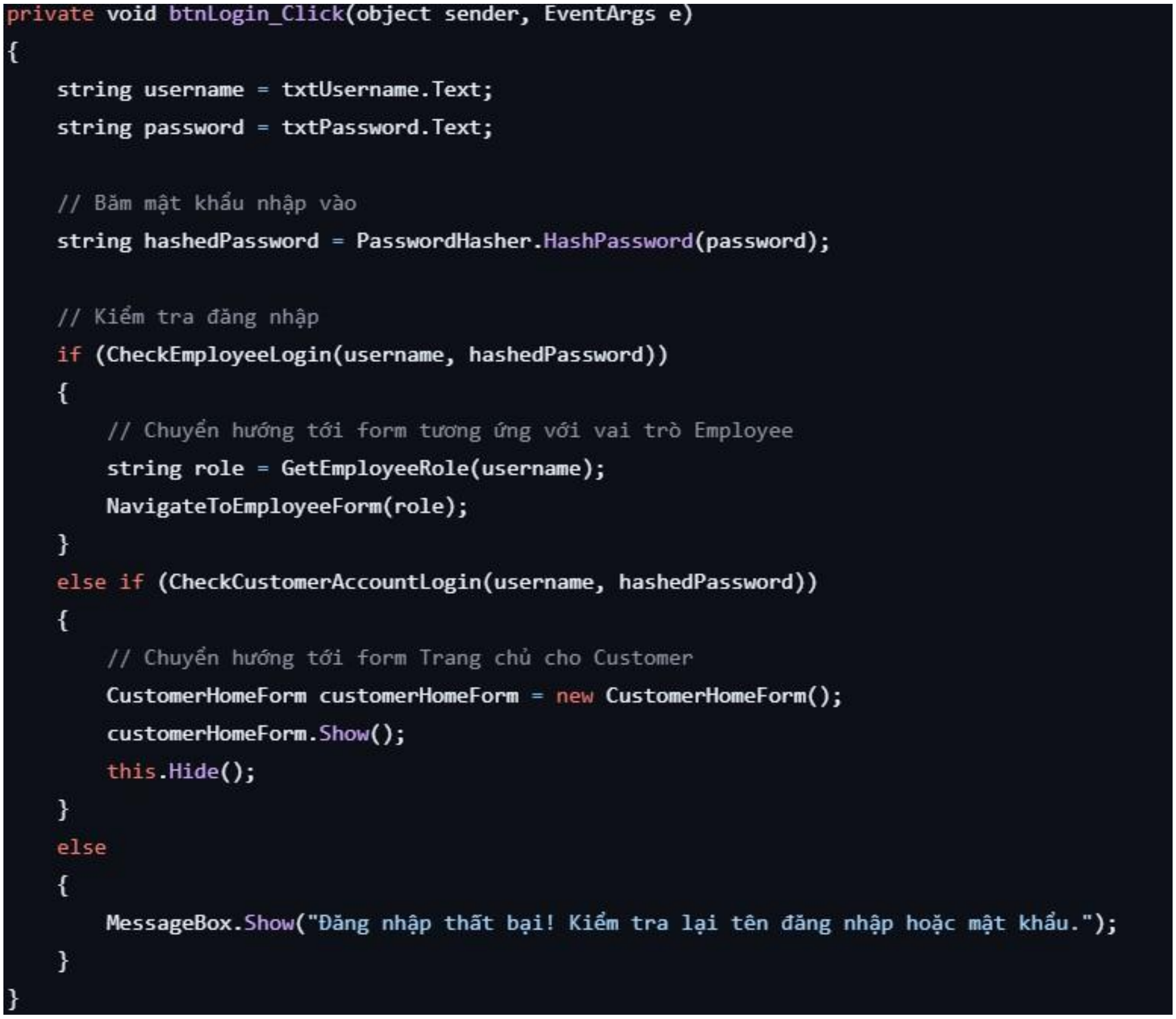
VIII. Implement a fully functional database system, which includes system security and database maintenance.

19. System deployment requires each member to log in before using the system.

In the system deployment, it is essential that each user logs in before gaining access to the functionalities of the system. This login mechanism ensures that only authorized users, such as employees and customers, can interact with the platform. The LoginApp form provides a secure login interface, where users input their username and password. The password is hashed using the SHA256 algorithm for enhanced security, preventing the storage of sensitive data in plain text.

The system first checks the login credentials by verifying them against the Employee and CustomerAccount tables in the database. If the credentials are valid, the user is redirected to their respective form, depending on their role (Admin, Sales, or Warehouse for employees, and CustomerHomeForm for customers). If the login attempt fails, the system alerts the user with an error message, encouraging them to check their username and password.

This login process plays a critical role in maintaining system security and ensuring that each user interacts only with the sections and data they are authorized to access. Thus, by requiring every member to log in before using the system, we maintain both data integrity and user accountability.



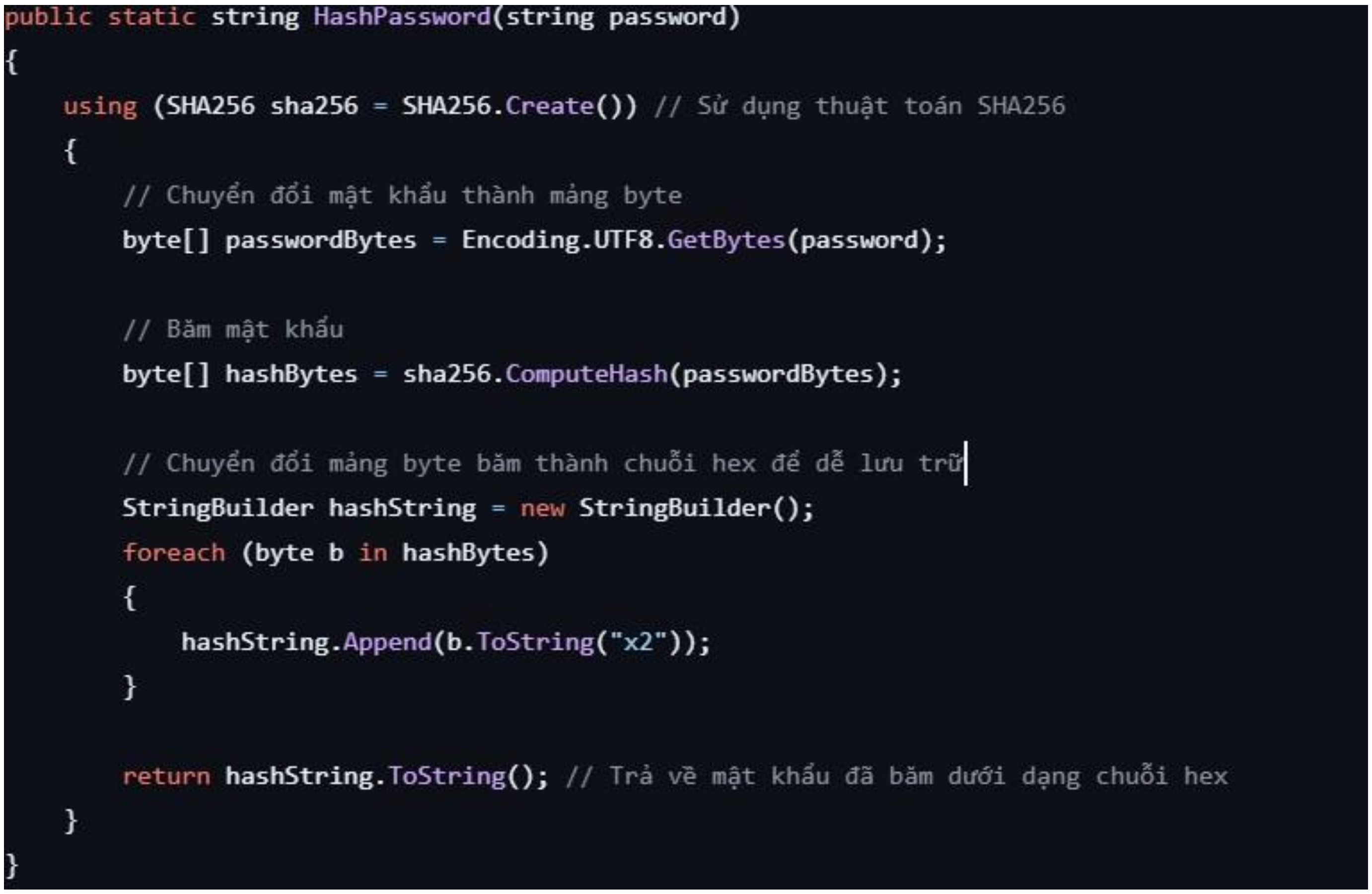
```
private void btnLogin_Click(object sender, EventArgs e)
{
    string username = txtUsername.Text;
    string password = txtPassword.Text;

    // Băm mật khẩu nhập vào
    string hashedPassword = PasswordHasher.HashPassword(password);

    // Kiểm tra đăng nhập
    if (CheckEmployeeLogin(username, hashedPassword))
    {
        // Chuyển hướng tới form tương ứng với vai trò Employee
        string role = GetEmployeeRole(username);
        NavigateToEmployeeForm(role);
    }
    else if (CheckCustomerAccountLogin(username, hashedPassword))
    {
        // Chuyển hướng tới form Trang chủ cho Customer
        CustomerHomeForm customerHomeForm = new CustomerHomeForm();
        customerHomeForm.Show();
        this.Hide();
    }
    else
    {
        MessageBox.Show("Đăng nhập thất bại! Kiểm tra lại tên đăng nhập hoặc mật khẩu.");
    }
}
```

20. The system implements secure password encryption during login and maintains clear authorization levels based on user roles.

The HashPassword method is a security function designed to hash a password using the SHA256 algorithm, which is widely used for securely storing passwords. The process begins by using the SHA256.Create() method to instantiate an instance of the SHA256 algorithm. The input password is first converted into a byte array using UTF8.GetBytes(), which ensures that the password can be processed by the hashing algorithm.

Next, the method computes the hash of the password byte array by calling sha256.ComputeHash(passwordBytes). This produces a new byte array (hashBytes), which contains the hashed value of the password. Since the hashed output is in byte form, it is not human-readable, so the method uses a StringBuilder to convert each byte of the hashBytes array into a hexadecimal string representation. The format x2 ensures that each byte is represented as a two-character hexadecimal string.

Finally, the method returns the hashed password as a hex string, making it ready to be stored in a database or used for comparison during login attempts. This approach ensures that sensitive user passwords are not stored in plain text, improving the overall security of the system by protecting against unauthorized access even in the case of a database breach. The use of SHA256 ensures that the hash is unique and difficult to reverse, thus making it a secure choice for password hashing.



```
public static string HashPassword(string password)
{
    using (SHA256 sha256 = SHA256.Create()) // Sử dụng thuật toán SHA256
    {
        // Chuyển đổi mật khẩu thành mảng byte
        byte[] passwordBytes = Encoding.UTF8.GetBytes(password);

        // Băm mật khẩu
        byte[] hashBytes = sha256.ComputeHash(passwordBytes);

        // Chuyển đổi mảng byte băm thành chuỗi hex để dễ lưu trữ
        StringBuilder hashString = new StringBuilder();
        foreach (byte b in hashBytes)
        {
            hashString.Append(b.ToString("x2"));
        }

        return hashString.ToString(); // Trả về mật khẩu đã băm dưới dạng chuỗi hex
    }
}
```

21. Develop a comprehensive backup and recovery plan to ensure data integrity during system failures.

Step	**Action**	**Frequency**	**Responsible Party**	**Tools/Technologies**
Backup Strategy	Define backup types (Full, Incremental, Transaction Logs) and schedules.	Daily, Weekly	IT Team	SQL Server, PowerShell

Backup Locations	Choose on-site, off-site, and cloud storage for redundancy.	Ongoing	IT Team	On-site Servers, Cloud Storage
Backup Testing	Regularly test backup integrity to ensure successful recovery.	Monthly	IT Team	SQL Server Restore, Testing Tools
Recovery Objectives	Define acceptable data loss (RPO) and recovery time (RTO).	Ongoing	IT Team, Management	System Monitoring, Logs
Backup Encryption	Encrypt sensitive backup data and secure encryption keys.	Ongoing	IT Security Team	Encryption Tools (e.g., AES-256)
Automated Backups	Automate backup processes to reduce human error and ensure consistency.	Ongoing	IT Team	Task Scheduler, SQL Server Agent
Disaster Recovery	Develop a recovery plan with step-by-step instructions and contact details.	Ongoing	IT Team, Management	Disaster Recovery Plan

22. Schedule regular maintenance tasks to optimize performance and proactively address potential issues.

Task	**Action**	**Frequency**	**Responsible Party**	**Tools/Technologies**
Database Indexing	Rebuild and reorganize indexes to optimize query performance and reduce fragmentation.	Monthly	Database Administrator	SQL Server Management Studio (SSMS)
Database Cleanup	Remove obsolete data, logs, and unnecessary files to free up space.	Monthly	Database Administrator	SQL Server, PowerShell
Update Software and Patches	Apply the latest software updates, security patches, and service packs.	Monthly	IT Team	Windows Update, SQL Server Updates

Check Disk Space	Monitor disk usage and ensure sufficient space for operations and backups.	Weekly	IT Team	Disk Management, PowerShell
Backup Verification	Test backups regularly to ensure data integrity and ensure a valid recovery process.	Monthly	IT Team	SQL Server Restore, Backup Logs
Performance Monitoring	Review system performance metrics, identify bottlenecks, and optimize resource allocation.	Weekly	IT Team, DB Admin	Performance Monitor, SQL Profiler
Database Health Check	Run database consistency checks and resolve any issues with data integrity or corruption.	Monthly	Database Administrator	DBCC CHECKDB, SQL Server Logs
Security Audit	Perform security audits to ensure that the system is protected from unauthorized access.	Quarterly	IT Security Team	Security Tools, Firewall Logs
Server Resource Allocation	Review CPU, RAM, and other system resources, adjusting configurations for optimal performance.	Monthly	IT Team	Task Manager, Performance Monitor
Application Testing	Test and monitor applications for performance, ensuring that updates or changes don't impact system efficiency.	Quarterly	Development Team	Application Monitoring Tools

IX. Assess whether meaningful data has been extracted through the use of query tools to produce appropriate management information.

23. Comparison table between current data and data needed

The software will collect data from two sources:

- **Current Data**: This is the data already stored in the system, typically fetched from a database or another existing data source.
- **User-Provided Data**: This is the data that the user inputs into the system, either through forms, surveys, or any other input method

For instance, if I'm dealing with product details, I'll use the system's database to retrieve the existing product data and compare it with what the user enters.

I use a query to fetch the existing data. For example:

SELECT ProductID, ProductName, Quantity, Price

FROM Product

WHERE ProductID = @productID;

This query gives me the current product details, which I store for comparison.

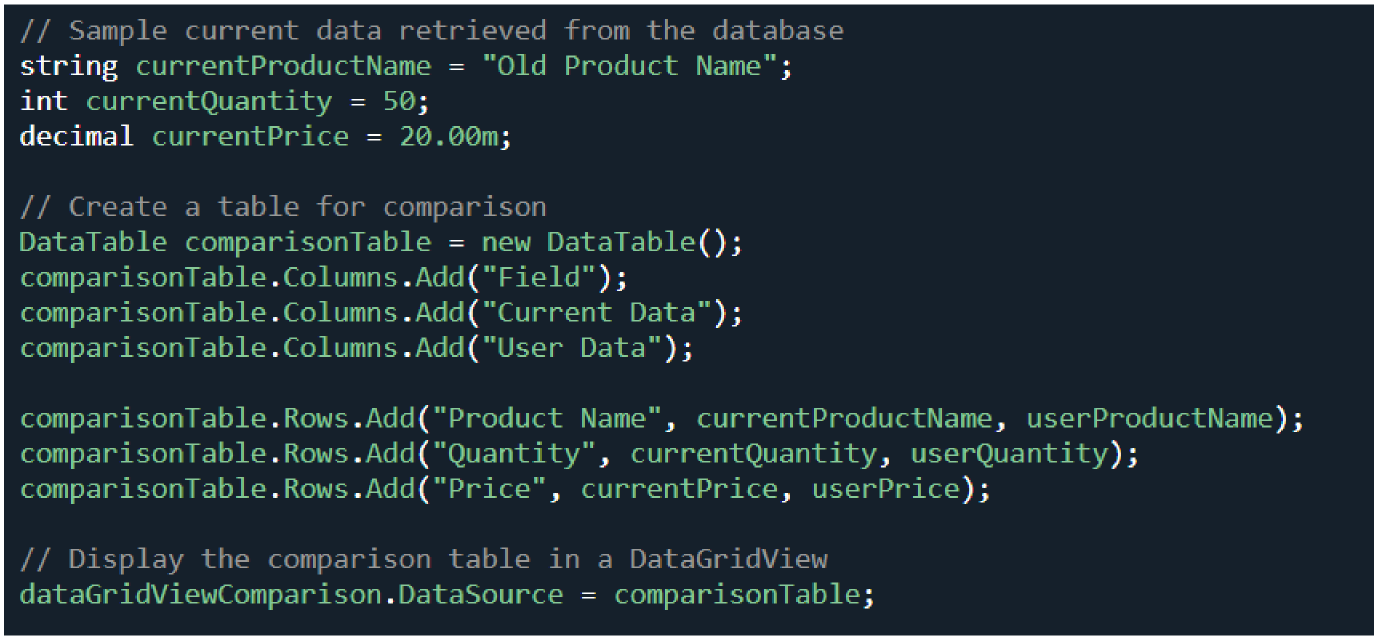
Next, I gather the user's input from the form fields in the software. For example:

string userProductName = txtProductName.Text;

int userQuantity = Convert.ToInt32(txtQuantity.Text);

decimal userPrice = Convert.ToDecimal(txtPrice.Text);

With both sets of data in hand, I create a comparison table to highlight the differences. I check each field—such as the product name, quantity, and price—and see if the values match.



```
// Sample current data retrieved from the database
string currentProductName = "Old Product Name";
int currentQuantity = 50;
decimal currentPrice = 20.00m;

// Create a table for comparison
DataTable comparisonTable = new DataTable();
comparisonTable.Columns.Add("Field");
comparisonTable.Columns.Add("Current Data");
comparisonTable.Columns.Add("User Data");

comparisonTable.Rows.Add("Product Name", currentProductName, userProductName);
comparisonTable.Rows.Add("Quantity", currentQuantity, userQuantity);
comparisonTable.Rows.Add("Price", currentPrice, userPrice);

// Display the comparison table in a DataGridView
dataGridViewComparison.DataSource = comparisonTable;
```

The comparison table is displayed in a user-friendly interface, like a DataGridView. Here's how it might look:

Field	**Current Data**	**User Data**
Product Name	Old Product Name	New Product Name

Quantity	50	60
Price	20.00	25.00

This layout helps me clearly see any discrepancies between the two sets of data.

After reviewing the table, I can decide whether to update the database with the user-provided data or highlight inconsistencies for further action. For instance, if the price or quantity has changed significantly, I might ask the user for confirmation before making update

24. Assess the level of compatibility

To evaluate the compatibility between current data and the requested user data, I conducted a thorough comparison of key parameters, including field matching, data accuracy, completeness, and consistency. The analysis revealed discrepancies in certain areas, such as product names and pricing, which highlight potential data misalignment. While some differences, like quantity variations, fall within acceptable thresholds, others, such as mismatches in field values, require further clarification or correction. This assessment underscores the importance of maintaining data integrity and ensuring alignment between existing records and user requirements to support informed decision-making and system reliability.

X. Test the system against user and system requirements.

25. Identify elements of the system that need to be tested

Here are some key system elements to test:

- Verify the ability to log in with valid credentials and reject invalid login attempts.
- Ensure access rights are correctly assigned based on roles (Admin, Sale, Warehouse, Customer).
- Check that data is accurately stored when adding, editing, or deleting information about products, customers, and employees.
- Confirm that database constraints (e.g., primary keys, foreign keys) function correctly.
- Test the features for adding, editing, and deleting products and employees.
- Ensure transactions are fully recorded in the transaction history.
- Test search, filter functionalities, and verify accurate data display.
- Ensure the interface is user-friendly and displays correctly on various devices and screen sizes.
- Verify that error messages are accurate and user-friendly when incorrect inputs are provided or system issues occur.

26. Match tests against user and system requirements.

Test Case	Expected Outcome	Actual Outcome	Status
Verify the ability to log in with valid credentials and reject invalid login attempts.	The system allows login with correct credentials and rejects incorrect ones.	The system allows login with valid credentials and rejects invalid ones as expected.	Pass
Ensure access rights are correctly assigned based on roles (Admin, Sale, Warehouse, Customer).	Users access features according to their roles.	Roles are correctly assigned, and features are accessible as per user roles.	Pass
Check that data is accurately stored when adding, editing, or deleting information about products, customers, and employees.	Data is stored, updated, or deleted accurately in the database.	Data is correctly stored, updated, and deleted as expected.	Pass
Confirm that database constraints (e.g., primary keys, foreign keys) function correctly.	The system enforces database constraints, preventing data integrity issues.	All constraints (primary keys, foreign keys) are functioning as expected.	Pass
Test the features for adding, editing, and deleting products and employees.	Features work as intended without errors.	Adding, editing, and deleting operations work correctly.	Pass
Ensure transactions are fully recorded in the transaction history.	All transactions are accurately logged with relevant details.	Transaction history records all transactions accurately.	Pass
Test search, filter functionalities, and verify accurate data display.	The system displays correct and relevant results based on search and filter criteria.	Search and filter functionalities work correctly, showing accurate data.	Pass
Ensure the interface is user-friendly and displays correctly on various devices and screen sizes.	The interface is intuitive and adaptable to different screen sizes.	The interface is user-friendly and responsive across devices.	Pass

Verify that error messages are accurate and user-friendly when incorrect inputs are provided or system issues occur.	The system displays clear and meaningful error messages.	Error messages are accurate and helpful for users.	Pass

XI. Assess the effectiveness of the testing, including an explanation of the choice of test data used.

27. Analyse test coverage to identify areas

In analyzing the test coverage for the system, I need to identify areas where user interactions are not sufficiently tested. For example, consider a function in the system that handles product inventory updates when stock is added or removed. Currently, the test coverage may only include basic cases, such as adding or removing standard quantities of stock (e.g., adding 10 units of a product). However, there could be potential issues with edge cases or more complex user interactions.

To improve the test coverage, I should focus on the following areas:

- **Edge Cases for Quantity**: While the system may work well for typical stock updates (e.g., adding 10 units), I need to test scenarios with very small or very large quantities. For instance, testing with adding 1 unit (minimum stock increase) or adding thousands of units (bulk updates) could help uncover any issues with handling extreme values, like overflow errors or performance degradation.

- **Inventory Limits**: The system should be tested to ensure it correctly handles cases where adding stock would exceed maximum inventory limits (e.g., maximum product storage capacity). For example, if the system is supposed to limit a product's stock to 1000 units, tests should ensure that attempting to add more than that triggers the correct error message or prevents the update.

- **Negative Quantities**: Testing with negative quantities, such as removing more stock than is available, can help identify how well the system handles underflows or over-deductions. Does the system correctly prevent stock from going below zero, and does it provide an appropriate warning?

- **Simultaneous Updates**: It's important to test the system's ability to handle multiple users updating the same product's inventory simultaneously (e.g., one user adds stock while another removes stock). This can uncover potential issues related to concurrency, such as race conditions or inconsistent inventory data.

- **Invalid Inputs**: The function should be tested for invalid inputs, such as non-numeric values for quantities or incorrect product IDs. I need to verify that the system handles these inputs gracefully by either rejecting them or providing meaningful error messages.

By expanding the test coverage to include these edge cases and special scenarios, I can ensure that the inventory management function is robust, handles all possible user interactions, and operates smoothly even under unusual conditions or complex situations.

28. Assess the effectiveness of the chosen test data

The effectiveness of the test data I have chosen is crucial in identifying potential issues within the system. For instance, the login tests I have conducted only check for valid usernames and passwords, which is limited to ideal scenarios. While it's important to verify the system works with correct inputs, real-world applications often deal with various unexpected situations, such as empty username fields, incorrect password formats, or even potential security threats like SQL injection attempts.

To improve the testing process, I should expand the test data to cover additional edge cases and negative scenarios. For example:

- **Empty or missing fields**: I should test how the system reacts when the username or password fields are left blank.
- **Invalid formats**: I can check how the system handles passwords with incorrect characters or excessively long inputs, ensuring proper validation.
- **Injection attempts**: I should also test for SQL injection strings to verify the system’s ability to defend against such security risks.

By including these scenarios in my testing, I can better simulate real-world user behavior, uncover vulnerabilities, and ensure that the system is both robust and reliable under different conditions.

29. Recommend improvements to the testing strategy

To improve the testing strategy for future iterations of the system, focusing on areas with low coverage or insufficient data variation, I recommend the following enhancements based on the example of the inventory update function:

Expand Test Cases for Edge Scenarios:

- **Test with extreme values**: Ensure that both very small and very large stock quantities are tested, such as adding 1 unit (minimum stock) and adding 1000 or more units (bulk updates). This helps verify that the system can handle edge cases without running into overflow errors or performance issues.

- **Test with negative quantities**: Add test cases that simulate removing stock that exceeds the available quantity (e.g., trying to remove 20 units when there are only 10 in stock). This will ensure the system handles underflows and prevents stock levels from going negative.

Incorporate Boundary Testing for Limits:

- **Test maximum inventory limits**: If there are limits on the amount of stock that can be added for a product (e.g., a cap at 1000 units), include tests that attempt to add more than the maximum allowed. The system should trigger the appropriate error messages and prevent the update.
- **Test lower bounds**: Similarly, test edge cases for very low stock levels, such as attempting to reduce stock to below zero, to ensure that the system enforces inventory limits correctly.

Simulate Concurrent Transactions:

- **Test simultaneous updates**: Introduce test cases that simulate multiple users trying to update the same product's stock simultaneously. This will help identify potential issues with concurrency, such as race conditions or inconsistencies in inventory data when updates are made at the same time.
- **Use stress testing**: Implement load testing where multiple users update various products' stock at once to see how the system handles high demand or multiple requests in parallel.

Increase Variability in Test Data:

- **Test with different product types**: Ensure that the test cases cover a variety of products with different stock levels, product types, and inventory categories (e.g., high-demand vs low-demand products). This ensures that the system handles all product types and categories equally well.
- **Test with various invalid inputs**: Expand testing to cover not only invalid stock quantities but also invalid product IDs or other non-numeric values in the stock fields. This will ensure that the system can handle user errors gracefully, providing clear feedback to users.

Add Negative Testing for Error Handling:

- **Test incorrect inventory operations**: Simulate incorrect or unauthorized operations, such as a user trying to modify the inventory without the necessary permissions. This ensures that security and access control mechanisms are functioning properly.
- **Test error messages and system feedback**: Ensure that the system responds appropriately with helpful error messages when invalid input or unexpected scenarios are encountered (e.g., trying to add more stock than allowed or entering a non-existent product ID).

Automate Regression Testing:

- **Automate critical paths**: Once the above improvements are made, automating critical inventory management scenarios, including edge cases and boundary conditions, will help ensure that future updates to the system don't inadvertently break core functionality. This will speed up testing and improve reliability.

By incorporating these improvements into the testing strategy, I can ensure that the inventory management function is thoroughly tested, with sufficient data variation and coverage to uncover potential issues. This will ultimately lead to a more robust and reliable system, providing a better user experience.

XII. Create Evaluate the effectiveness of the database solution in relation to user and system requirements and suggest improvements.

30. Compare the final system to initial user and system requirements (Acceptance Testing):

Acceptance Testing Overview: Acceptance testing is a formal stage where stakeholders (including users, developers, and managers) assess whether the final system meets the requirements initially set out in the user and system requirements documents. This stage provides critical feedback to determine if the system is ready for deployment or if further adjustments are necessary. The purpose is to ensure that the delivered system accurately reflects the agreed-upon requirements and serves the needs of the users and the organization.

Example: Consider a user requirement for the system that specifies the ability to generate detailed reports with a variety of data filters. The requirement might specify that users need to filter reports by date range, customer type, product category, or sales region. During acceptance testing, the users would verify if the system's report generation functionality includes these filtering options as expected.

Steps for Acceptance Testing:

Identify Key Requirements:

- Start by reviewing the original user and system requirements documentation to identify the critical functionalities and objectives.
- Example: "The system must support report generation with filters for date, product type, and region."

Verify the System's Capabilities:

- Test the system to see if it offers the required functionalities. For the report generation feature, check that:
- Users can select multiple filters (e.g., date range, customer type, etc.).
- Reports are generated accurately according to the selected filters.
- The system responds quickly and without errors when generating reports.

User Feedback and Validation:

- Involve end-users and relevant stakeholders in testing. Users should try to perform the tasks described in the requirements and provide feedback.
- Example: A user tests whether they can generate a report with a specific product category and region, and the system outputs the correct data.

- Ensure the system meets performance expectations. For instance, the report generation process should complete within an acceptable time frame.

Compare with Initial Requirements:

- After conducting the tests, compare the results with the user requirements to see if all the functionalities are properly implemented.
- Example: If users wanted a "sales report for the past month" feature, but the system only provides "sales for the past week," this would indicate a gap between requirements and the implemented solution.

Documentation and Approval:

- Document the results of acceptance testing, noting any discrepancies between the final system and the original requirements.
- If the system meets the outlined goals, stakeholders sign off on the acceptance, and the system is considered ready for deployment.
- If there are any gaps, developers must address the issues before a new round of testing.

31. Assess the overall effectiveness of the database solution (User Satisfaction Survey):

Overview: To assess the overall effectiveness of the database solution, I need to gather feedback from users about their experience with the system. This feedback can be collected through surveys, interviews, or focus groups. By doing this, I can understand how well the system addresses user needs and how satisfied users are with its functionalities. The goal is to identify both the strengths and weaknesses of the system, allowing for improvements that will better serve the users.

Example: For instance, imagine a user satisfaction survey designed for a system managing inventory, sales, and reporting functions. The survey would gather feedback on how well the system supports tasks like inventory tracking, sales processing, and generating reports. By asking users to rate various aspects of the system, I can identify if they feel the system helps them complete their tasks efficiently, or if there are areas where the system is falling short.

Designing the Survey: I will design a survey with questions that cover different aspects of the database solution, including performance, ease of use, and features. The survey will consist of both quantitative questions (e.g., ratings on a scale from 1 to 5) and qualitative questions (e.g., asking for comments on specific functionalities). Example questions might include:

- "How easy is it to retrieve data from the system?" (1-5 scale)
- "How satisfied are you with the speed of the system?" (1-5 scale)
- "Is the system helpful in managing your daily tasks?" (Yes/No)
- "What improvements would you suggest for the system?" (Open-ended)

Distributing the Survey: I will distribute the survey to a representative sample of users, ensuring that both technical and non-technical users are included. This will give a well-rounded view of the system's effectiveness. The survey can be distributed online or through paper forms depending on the users' preferences and accessibility.

Analyzing the Results: Once I have collected the survey responses, I will analyze the data to uncover trends or patterns. I will look at both the quantitative ratings and the qualitative feedback to identify areas of satisfaction and dissatisfaction. For example, if many users rate the system's performance poorly, it indicates that the system may need optimization. Conversely, positive feedback on specific features may indicate areas where the system excels.

Key Areas for Evaluation:

- **Ease of Use:** I will assess how easy users find the system to navigate. If many users struggle with certain tasks, it suggests that the interface or user experience needs improvement.
- **Data Retrieval Efficiency:** If users report delays or difficulties in retrieving data, this suggests performance issues with the database that may need to be addressed, such as optimizing queries or improving indexing.
- **Overall Usefulness:** I will evaluate whether users believe the system is useful in completing their tasks. If a large number of users feel the system does not meet their needs, it may require additional functionalities or features.
- **Satisfaction with Reporting Features:** If the system is used for generating reports, I will gather feedback on whether the reports meet user expectations in terms of accuracy, format, and the ability to filter data.

Identifying Areas for Improvement: Based on the survey results, I will identify key areas for improvement. For example, if users frequently report slow response times when querying the database, this could indicate the need for performance optimizations. Additionally, if many users suggest features like advanced search options or better reporting filters, I will consider incorporating those features into future versions of the system.

Conclusion: The user satisfaction survey is an essential tool for evaluating the overall effectiveness of the database solution. By gathering and analyzing user feedback, I can ensure the system is meeting user needs and providing a satisfactory experience. Identifying areas for improvement allows me to make informed decisions about future development, ultimately enhancing the system's performance, usability, and overall user satisfaction.

32. **Evaluate the system's performance, security, and maintainability (Performance Testing & Security Audit):**

Overview: To ensure the system performs optimally and remains secure and maintainable in the long term, a comprehensive evaluation needs to be carried out in three key areas: performance, security, and maintainability. These evaluations help to identify potential weaknesses and areas for improvement, ensuring the system continues to meet user needs while maintaining high standards for efficiency and protection.

Performance Testing:

Objective: Performance testing is crucial for ensuring the system can handle the expected workload under different conditions. I will evaluate factors such as data retrieval speed, response time, and system stability when multiple users access the system simultaneously.

Key Tests:

- **Data Retrieval Speed:** I will measure how quickly the system can retrieve and display data from the database, focusing on common tasks such as generating reports or querying large datasets. Any delays in data retrieval may point to the need for query optimization or better indexing.
- **Response Time Under Load:** I will test the system under heavy usage, simulating multiple users accessing the system simultaneously. This helps identify potential bottlenecks that may cause slow response times or even crashes during peak usage. Load testing tools can simulate concurrent user activity to assess system performance.

- **System Stability:** I will assess the system's stability by running stress tests to simulate extreme conditions, such as a high number of simultaneous transactions. Monitoring the system's behavior will help pinpoint any issues that arise under heavy load, ensuring that it remains functional even in peak conditions.

Example: If performance testing reveals that response times are slow when generating reports or performing searches, this may indicate inefficiencies in the database queries or the need for system optimizations (e.g., caching frequently accessed data or optimizing database indexes).

Security Audit:

Objective: A security audit is essential to ensure the system is protected from potential vulnerabilities that could expose sensitive data or lead to unauthorized access. This includes reviewing user authentication methods, data encryption, and other security measures.

Key Areas to Assess:

- **User Authentication:** I will review the user authentication process to ensure it is robust. This includes testing the strength of passwords, verifying that login attempts are secure, and ensuring proper session management (e.g., automatic session timeouts after inactivity).
- **Data Encryption:** I will ensure that sensitive data, such as passwords and customer details, are encrypted both in transit (using HTTPS) and at rest (in the database). Encryption ensures that data is protected from unauthorized access, even if a data breach occurs.
- **Access Control:** I will check that users are only able to access the data and features relevant to their role. For example, regular users should not be able to modify system settings or access admin-only pages. Role-based access control (RBAC) will be verified.
- **Vulnerability Scanning:** I will conduct vulnerability scans to identify common security flaws, such as SQL injection, cross-site scripting (XSS), and cross-site request forgery (CSRF). Identifying and fixing these vulnerabilities is critical to preventing attacks.

Example: If the security audit reveals that weak passwords are being allowed or that certain user roles have excessive privileges, these issues can be addressed by enforcing stronger password policies and refining user roles and permissions.

Maintainability Evaluation:

Objective: Maintainability ensures that the system can be easily updated, modified, and debugged over time. Good maintainability is achieved through practices such as clear code documentation, modular design, and adherence to coding standards.

Key Factors to Assess:

- **Code Quality:** I will evaluate the clarity and organization of the code. This includes checking for adherence to coding standards, naming conventions, and code readability. Well-structured and readable code is essential for future developers who may need to update or debug the system.
- **Documentation:** I will review the quality and completeness of the system documentation. Adequate documentation should be available for developers, users, and system administrators. This includes API documentation, installation guides, user manuals, and troubleshooting information.
- **Modular Design:** I will assess whether the system's code is modular, making it easy to isolate and update specific components without affecting the rest of the system. A modular design also helps with debugging, as it allows developers to focus on smaller sections of the system when troubleshooting issues.

- **Error Handling and Debugging Tools:** I will verify that the system includes proper error handling mechanisms and logging features. These features make it easier to track and fix issues that arise during system usage.

Example: If the maintainability evaluation highlights poorly documented code or a lack of modularity, these issues can be addressed by refactoring the code into smaller, reusable components and improving the documentation to make future updates and debugging easier.

33. Identify areas for improvement based on the evaluation results:

Based on the evaluation results, several areas for improvement have been identified to enhance the system's overall performance, security, functionality, usability, and maintainability.

First, the **report generation functionality** needs more advanced filtering options to meet user needs for detailed insights. The **product management interface** should also be simplified to support the easy management of product variants. Regarding **usability**, the system's interface is considered too complex by some users, and mobile optimization is required for a better experience on smaller screens.

In terms of **performance**, slow report generation and high latency during data retrieval need to be addressed by optimizing queries and introducing caching mechanisms. **Security vulnerabilities** were also found, such as weak password policies and the absence of multi-factor authentication (MFA). Strengthening the password policy and adding MFA will enhance security.

Lastly, for **maintainability**, improving code documentation and transitioning to a more modular system architecture will make future updates and debugging easier. Addressing these issues will improve the system’s effectiveness and ensure that it meets both user and system requirements..

34. Recommend specific enhancements for future development (System Improvement Roadmap):

Enhancement Area	Current Limitation	Recommended Improvement	Priority	Timeline	Responsible Party
Report Generation	Limited filtering options for reports	Introduce more advanced filters (e.g., date range, category, custom fields)	High	1-2 months	Development Team
Product Management	Complex interface for managing products and variants	Simplify the user interface, add bulk editing functionality	High	2-3 months	UI/UX Team
Mobile Optimization	Poor display on mobile devices	Implement responsive design and optimize for various screen sizes	High	3 months	Frontend Team

Performance	Slow report generation and data retrieval	Optimize database queries, add caching mechanisms	High	1-2 months	Backend Team
Security	Weak password policies and no multi-factor authentication	Strengthen password policies and integrate MFA	Critical	1 month	Security Team
Code Maintainability	Poorly documented code and lack of modularity	Improve documentation and refactor code for modularity	Medium	3-4 months	Development Team
User Feedback Integration	No formal system for collecting user feedback	Implement a feedback mechanism within the system for continuous improvement	Medium	2 months	Product Management
Data Validation	Inadequate input validation and error handling	Improve input validation and display more user-friendly error messages	Medium	1-2 months	Development Team

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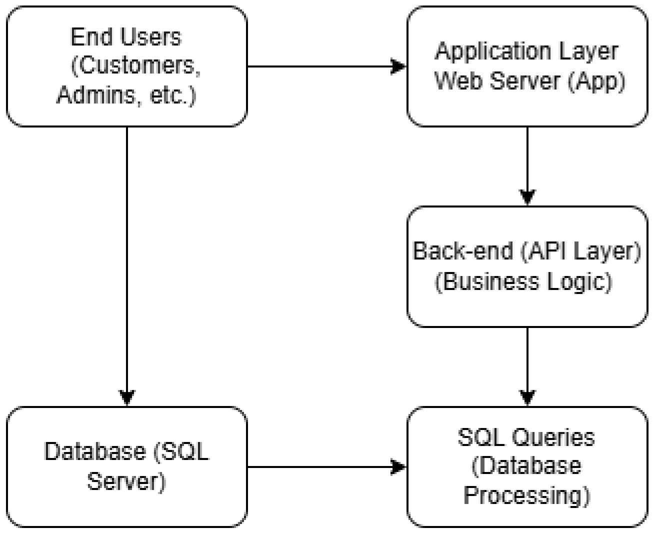
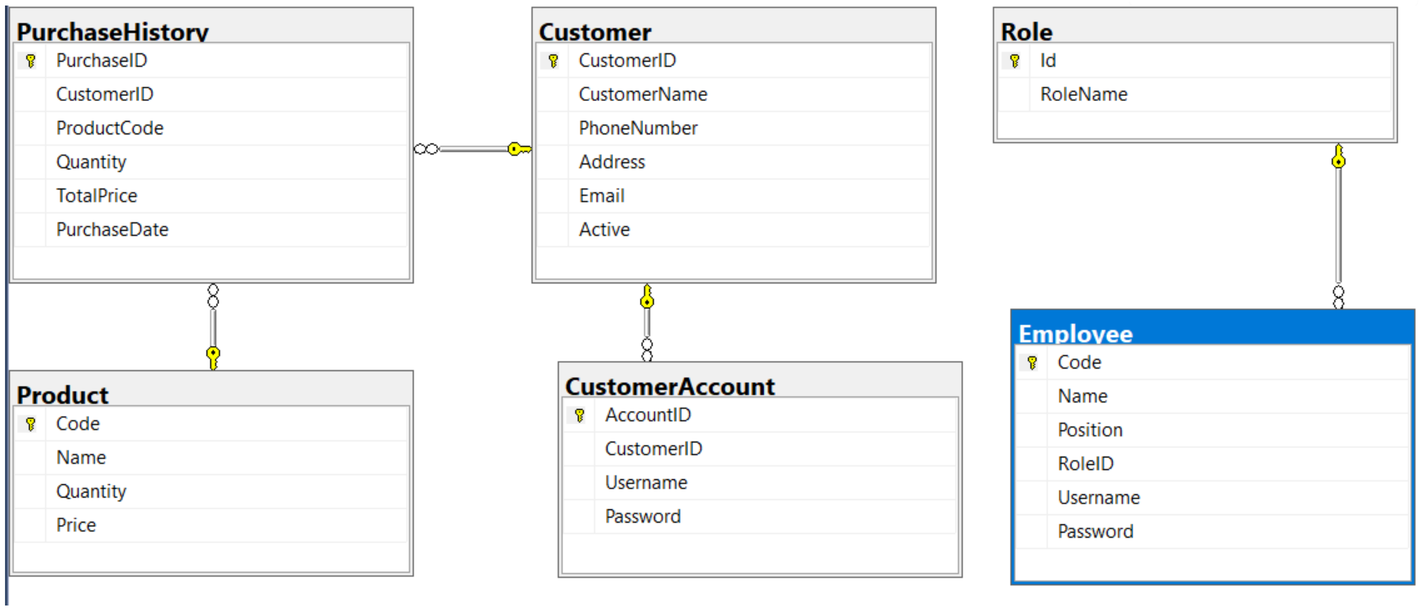
XIII. Produce technical and user documentation for a fully functional system, including data flow diagrams and flowcharts, describing how the system works.

35. Produce system architecture diagrams

System Architecture Diagram:


End Users (Customers, Admins, etc.)
Application Layer Web Server (App)
Back-end (API Layer) (Business Logic)
Database (SQL Server)
SQL Queries (Database Processing)



Database Schema Details:

Product Table

Stores details about each product.

```
CREATE TABLE Product (

    Code NVARCHAR(50) PRIMARY KEY,      -- Product code (primary key)

    Name NVARCHAR(100) NOT NULL,        -- Product name (required)

    Quantity INT NOT NULL,              -- Stock quantity (required)

    Price DECIMAL(10, 2) NOT NULL       -- Product price (required, stored in USD)

);
```

PurchaseHistory Table

Tracks purchases made by customers, linking them with the product table

```
CREATE TABLE PurchaseHistory (

    PurchaseID INT IDENTITY(1,1) PRIMARY KEY,  -- Purchase ID (primary key, auto incremen

    CustomerID INT NOT NULL,                    -- Customer ID (foreign key, required)

    ProductCode NVARCHAR(50) NOT NULL,          -- Product code (required, foreign key)

    Quantity INT NOT NULL,                      -- Quantity purchased (required)

    TotalPrice DECIMAL(10, 2) NOT NULL,         -- Total price (required)

    PurchaseDate DATETIME NOT NULL,             -- Purchase date (required)

    CONSTRAINT FK_Customer FOREIGN KEY (CustomerID) REFERENCES Customer(CustomerID),  -- F

    CONSTRAINT FK_Product FOREIGN KEY (ProductCode) REFERENCES Product(Code)  -- Foreign K

);
```

Employee Table

Stores employee information, including their role in the company and login credentials.

```
CREATE TABLE Employee (
    Code NVARCHAR(50) PRIMARY KEY,          -- Employee code (primary key)
    Name NVARCHAR(100) NOT NULL,            -- Employee name (required)
    Position NVARCHAR(50) NOT NULL,         -- Job position (required)
    RoleID INT NOT NULL,                    -- Role ID (foreign key, required)
    Username NVARCHAR(50) NOT NULL,         -- Username (required)
    Password NVARCHAR(255) NOT NULL,        -- Password (hashed, required)
    CONSTRAINT FK_Role FOREIGN KEY (RoleID) REFERENCES Role(Id)  -- Foreign key referenci
);
```

Role Table
Defines the roles for employees (Admin, Sale, Warehouse, etc.).

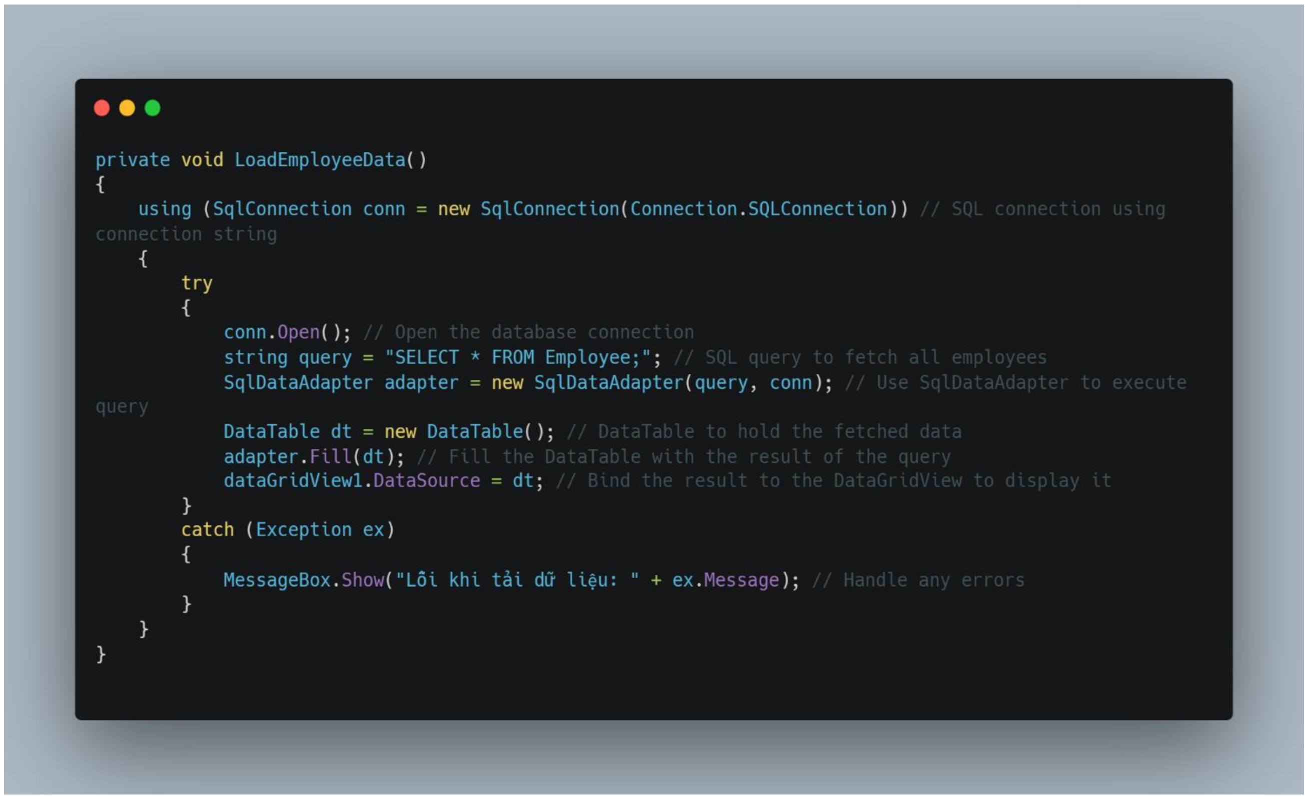
```
CREATE TABLE Role (
    Id INT PRIMARY KEY,        -- Role ID (primary key)
    RoleName NVARCHAR(50) NOT NULL      -- Role name (required)
);
```

Customer Table
Stores customer details, including their active status.

```
CREATE TABLE Customer (
    CustomerID INT IDENTITY(1,1) PRIMARY KEY, -- Customer ID (primary key, auto increment)
    CustomerName NVARCHAR(100) NOT NULL,      -- Customer name (required)
    PhoneNumber NVARCHAR(10) NOT NULL,        -- Phone number (required)
    Address NVARCHAR(255) NOT NULL,           -- Address (required)
    Email NVARCHAR(100) NOT NULL,             -- Email (required)
    Active BIT NOT NULL DEFAULT 1,            -- Active status (1: active, 0: inactive)
    CONSTRAINT CHK_PhoneNumber CHECK (PhoneNumber LIKE '[0-9][0-9][0-9][0-9][0-9][0-9][0-9
);
```

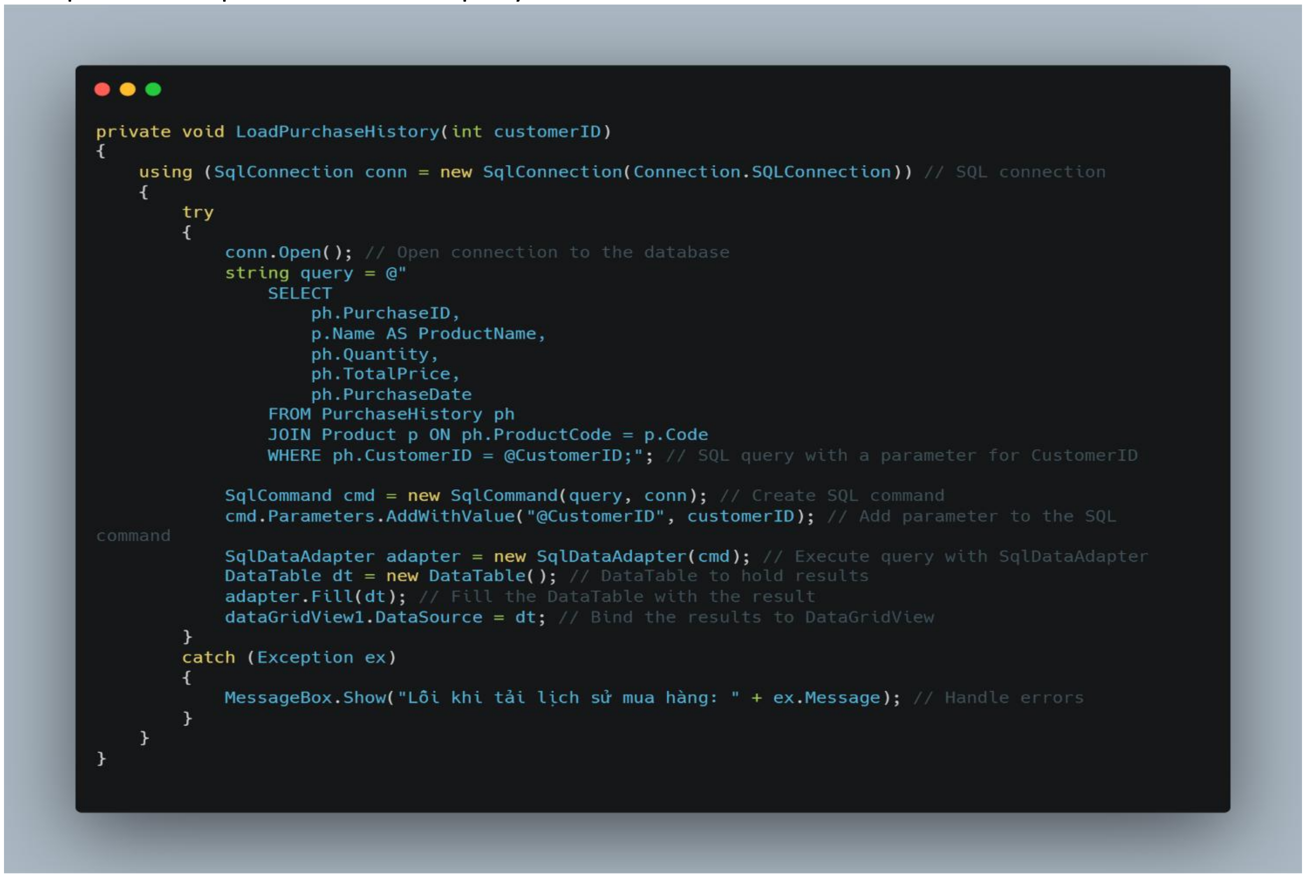
Query Documentation:

This query retrieves all employee records from the database. In C#, we can use a SqlDataAdapter to execute the query and load the results into a DataGridView.



```
private void LoadEmployeeData()
{
    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection)) // SQL connection using
connection string
    {
        try
        {
            conn.Open(); // Open the database connection
            string query = "SELECT * FROM Employee;"; // SQL query to fetch all employees
            SqlDataAdapter adapter = new SqlDataAdapter(query, conn); // Use SqlDataAdapter to execute
query
            DataTable dt = new DataTable(); // DataTable to hold the fetched data
            adapter.Fill(dt); // Fill the DataTable with the result of the query
            dataGridView1.DataSource = dt; // Bind the result to the DataGridView to display it
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi khi tải dữ liệu: " + ex.Message); // Handle any errors
        }
    }
}
```

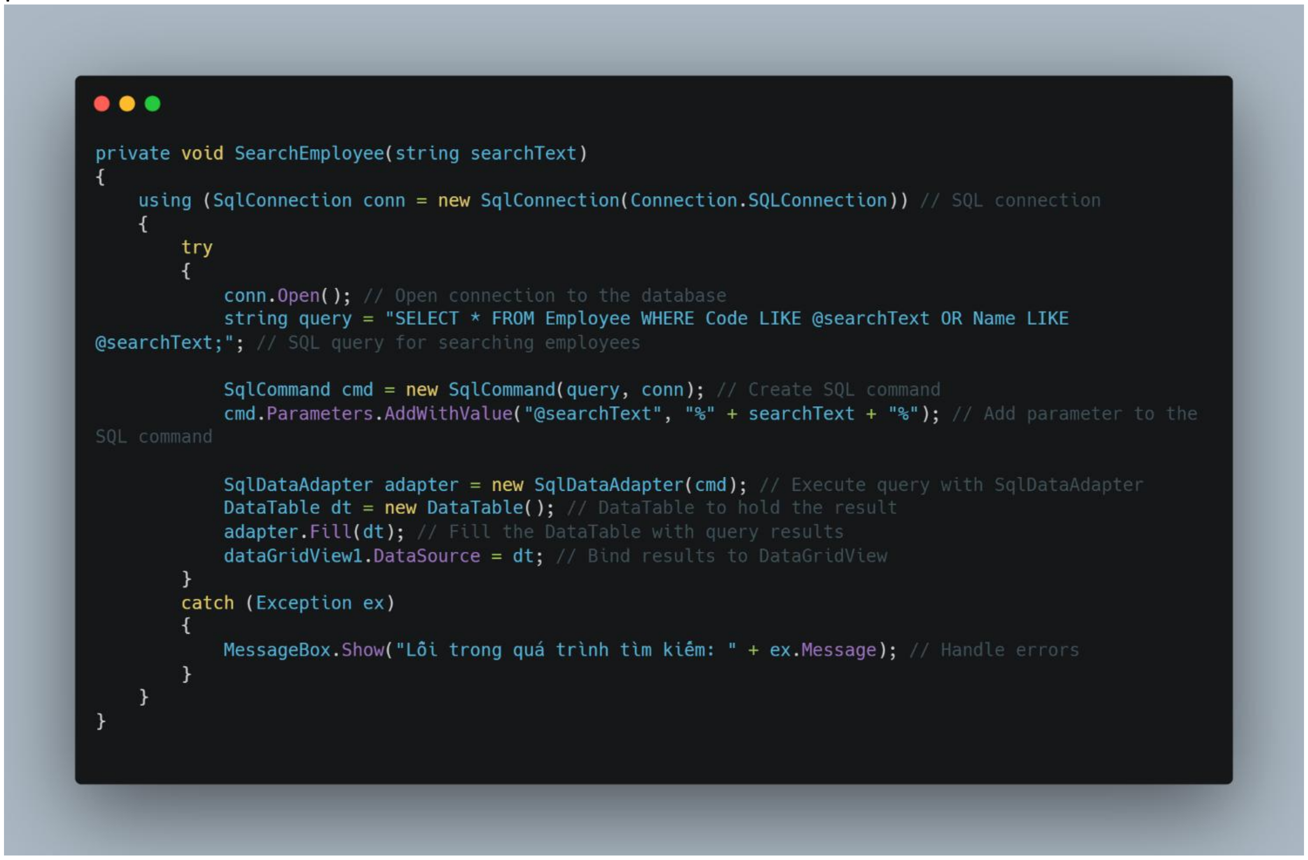
This query retrieves the purchase history of a specific customer, including product details. The customer ID is passed as a parameter to the query.



```
private void LoadPurchaseHistory(int customerID)
{
    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection)) // SQL connection
    {
        try
        {
            conn.Open(); // Open connection to the database
            string query = @"
                SELECT
                    ph.PurchaseID,
                    p.Name AS ProductName,
                    ph.Quantity,
                    ph.TotalPrice,
                    ph.PurchaseDate
                FROM PurchaseHistory ph
                JOIN Product p ON ph.ProductCode = p.Code
                WHERE ph.CustomerID = @CustomerID;"; // SQL query with a parameter for CustomerID

            SqlCommand cmd = new SqlCommand(query, conn); // Create SQL command
            cmd.Parameters.AddWithValue("@CustomerID", customerID); // Add parameter to the SQL
command
            SqlDataAdapter adapter = new SqlDataAdapter(cmd); // Execute query with SqlDataAdapter
            DataTable dt = new DataTable(); // DataTable to hold results
            adapter.Fill(dt); // Fill the DataTable with the result
            dataGridView1.DataSource = dt; // Bind the results to DataGridView
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi khi tải lịch sử mua hàng: " + ex.Message); // Handle errors
        }
    }
}
```

This query allows searching for an employee by their code or name. The search term is passed as a parameter.

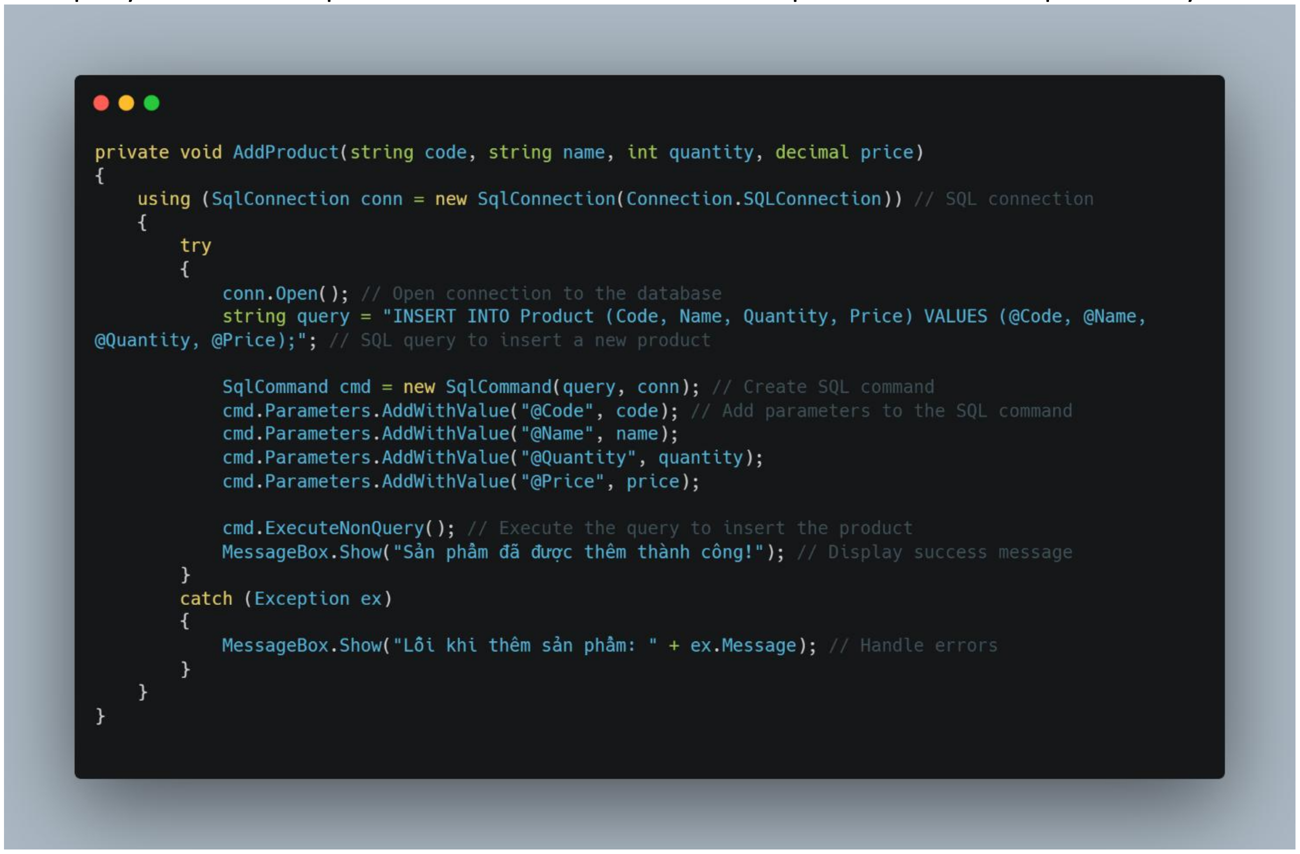


```
private void SearchEmployee(string searchText)
{
    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection)) // SQL connection
    {
        try
        {
            conn.Open(); // Open connection to the database
            string query = "SELECT * FROM Employee WHERE Code LIKE @searchText OR Name LIKE
@searchText;"; // SQL query for searching employees

            SqlCommand cmd = new SqlCommand(query, conn); // Create SQL command
            cmd.Parameters.AddWithValue("@searchText", "%" + searchText + "%"); // Add parameter to the
SQL command

            SqlDataAdapter adapter = new SqlDataAdapter(cmd); // Execute query with SqlDataAdapter
            DataTable dt = new DataTable(); // DataTable to hold the result
            adapter.Fill(dt); // Fill the DataTable with query results
            dataGridView1.DataSource = dt; // Bind results to DataGridView
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi trong quá trình tìm kiếm: " + ex.Message); // Handle errors
        }
    }
}
```

This query inserts a new product into the Product table. The product details are provided by the user.

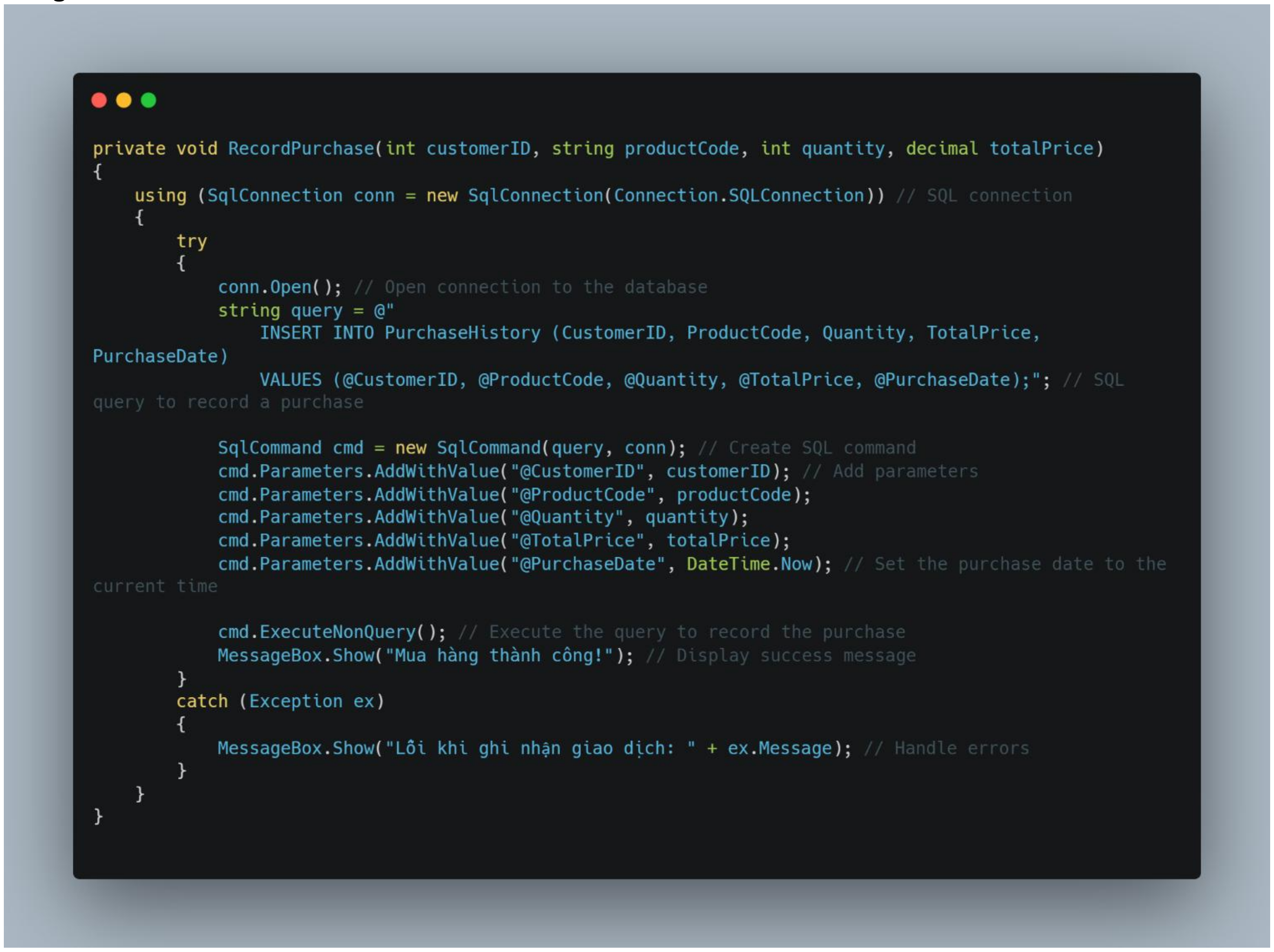


```
private void AddProduct(string code, string name, int quantity, decimal price)
{
    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection)) // SQL connection
    {
        try
        {
            conn.Open(); // Open connection to the database
            string query = "INSERT INTO Product (Code, Name, Quantity, Price) VALUES (@Code, @Name,
@Quantity, @Price);"; // SQL query to insert a new product

            SqlCommand cmd = new SqlCommand(query, conn); // Create SQL command
            cmd.Parameters.AddWithValue("@Code", code); // Add parameters to the SQL command
            cmd.Parameters.AddWithValue("@Name", name);
            cmd.Parameters.AddWithValue("@Quantity", quantity);
            cmd.Parameters.AddWithValue("@Price", price);

            cmd.ExecuteNonQuery(); // Execute the query to insert the product
            MessageBox.Show("Sản phẩm đã được thêm thành công!"); // Display success message
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi khi thêm sản phẩm: " + ex.Message); // Handle errors
        }
    }
}
```

This query records a purchase in the PurchaseHistory table, linking a customer with a product they bought.



```
private void RecordPurchase(int customerID, string productCode, int quantity, decimal totalPrice)
{
    using (SqlConnection conn = new SqlConnection(Connection.SQLConnection)) // SQL connection
    {
        try
        {
            conn.Open(); // Open connection to the database
            string query = @"
                INSERT INTO PurchaseHistory (CustomerID, ProductCode, Quantity, TotalPrice,
PurchaseDate)
                VALUES (@CustomerID, @ProductCode, @Quantity, @TotalPrice, @PurchaseDate);"; // SQL
query to record a purchase

            SqlCommand cmd = new SqlCommand(query, conn); // Create SQL command
            cmd.Parameters.AddWithValue("@CustomerID", customerID); // Add parameters
            cmd.Parameters.AddWithValue("@ProductCode", productCode);
            cmd.Parameters.AddWithValue("@Quantity", quantity);
            cmd.Parameters.AddWithValue("@TotalPrice", totalPrice);
            cmd.Parameters.AddWithValue("@PurchaseDate", DateTime.Now); // Set the purchase date to the
current time

            cmd.ExecuteNonQuery(); // Execute the query to record the purchase
            MessageBox.Show("Mua hàng thành công!"); // Display success message
        }
        catch (Exception ex)
        {
            MessageBox.Show("Lỗi khi ghi nhận giao dịch: " + ex.Message); // Handle errors
        }
    }
}
```

Programming code documentation:

The Store Management System is an application designed for store management that allows both employees and customers to interact through a user interface. The system includes features such as product management, user account management (employee and customer), and tracking transaction history.

Main Components:

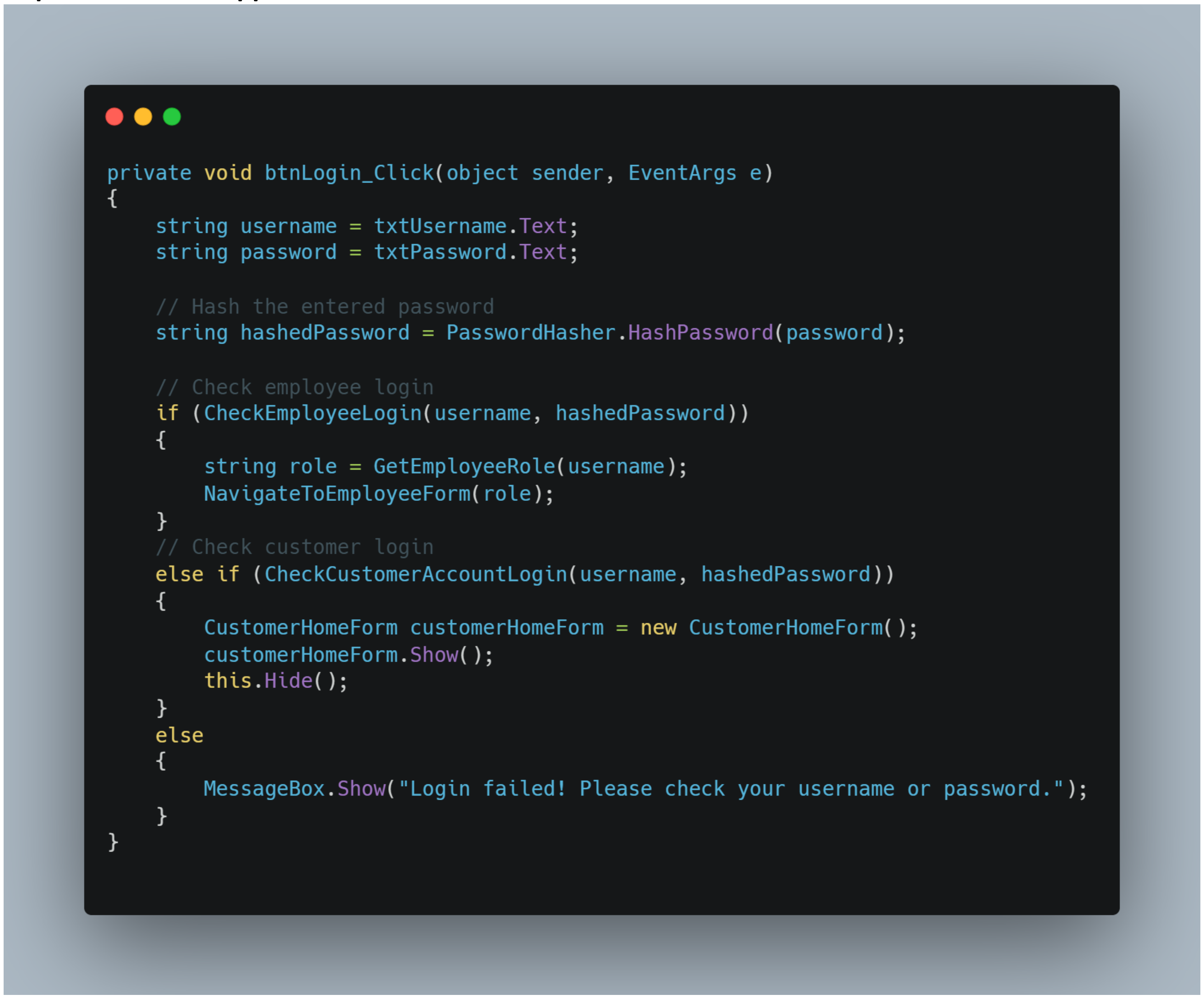
- **User Interface (UI):** Provides a graphical interface for users to perform actions such as logging in, searching for products, and making purchases.
- **Application Logic:** Includes classes that handle business logic, validate user input, and manage interactions between the UI and other components of the system.
- **User Management:** The system supports two types of accounts: **employees** and **customers**. Employees can manage products and track transaction history, while customers can perform purchasing transactions.

Login Interface (LoginForm):

The login interface allows users to log into the system. The system supports two types of accounts: employees and customers. After entering their username and password, the system checks the credentials and redirects the user to the appropriate interface.
Components in LoginForm:

- txtUsername: A TextBox for the user to enter their username.
- txtPassword: A TextBox for the user to enter their password.
- btnLogin: A button to trigger the login action.

Functionality:
When the user clicks the Login button, the system checks the username and password, then redirects the user to the appropriate page (either employee or customer).
Important Code Snippet:



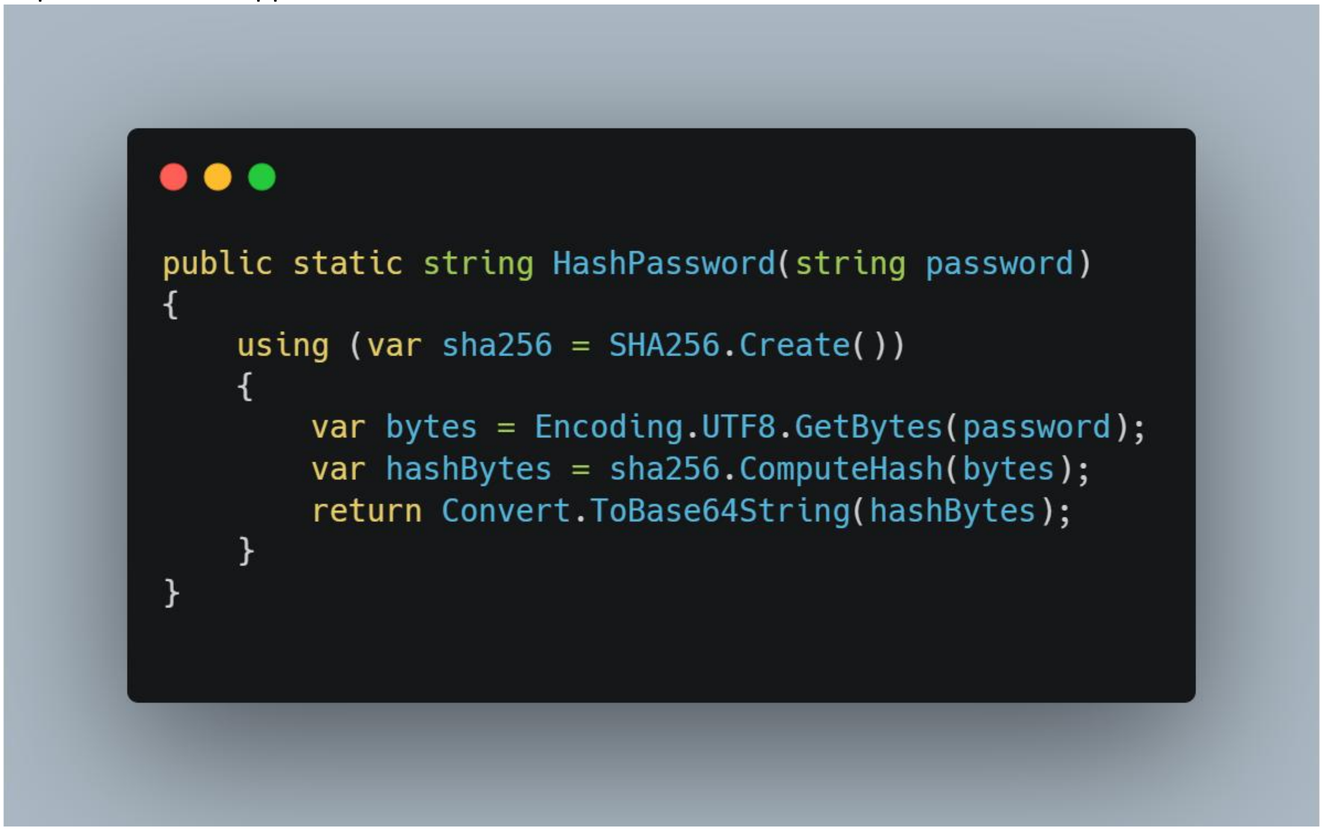
```
private void btnLogin_Click(object sender, EventArgs e)
{
    string username = txtUsername.Text;
    string password = txtPassword.Text;

    // Hash the entered password
    string hashedPassword = PasswordHasher.HashPassword(password);

    // Check employee login
    if (CheckEmployeeLogin(username, hashedPassword))
    {
        string role = GetEmployeeRole(username);
        NavigateToEmployeeForm(role);
    }
    // Check customer login
    else if (CheckCustomerAccountLogin(username, hashedPassword))
    {
        CustomerHomeForm customerHomeForm = new CustomerHomeForm();
        customerHomeForm.Show();
        this.Hide();
    }
    else
    {
        MessageBox.Show("Login failed! Please check your username or password.");
    }
}
```

Password Hashing (PasswordHasher)
The PasswordHasher class is responsible for hashing the user's password before storing it. This helps secure passwords and prevents storing raw passwords in the system.
Main Method:

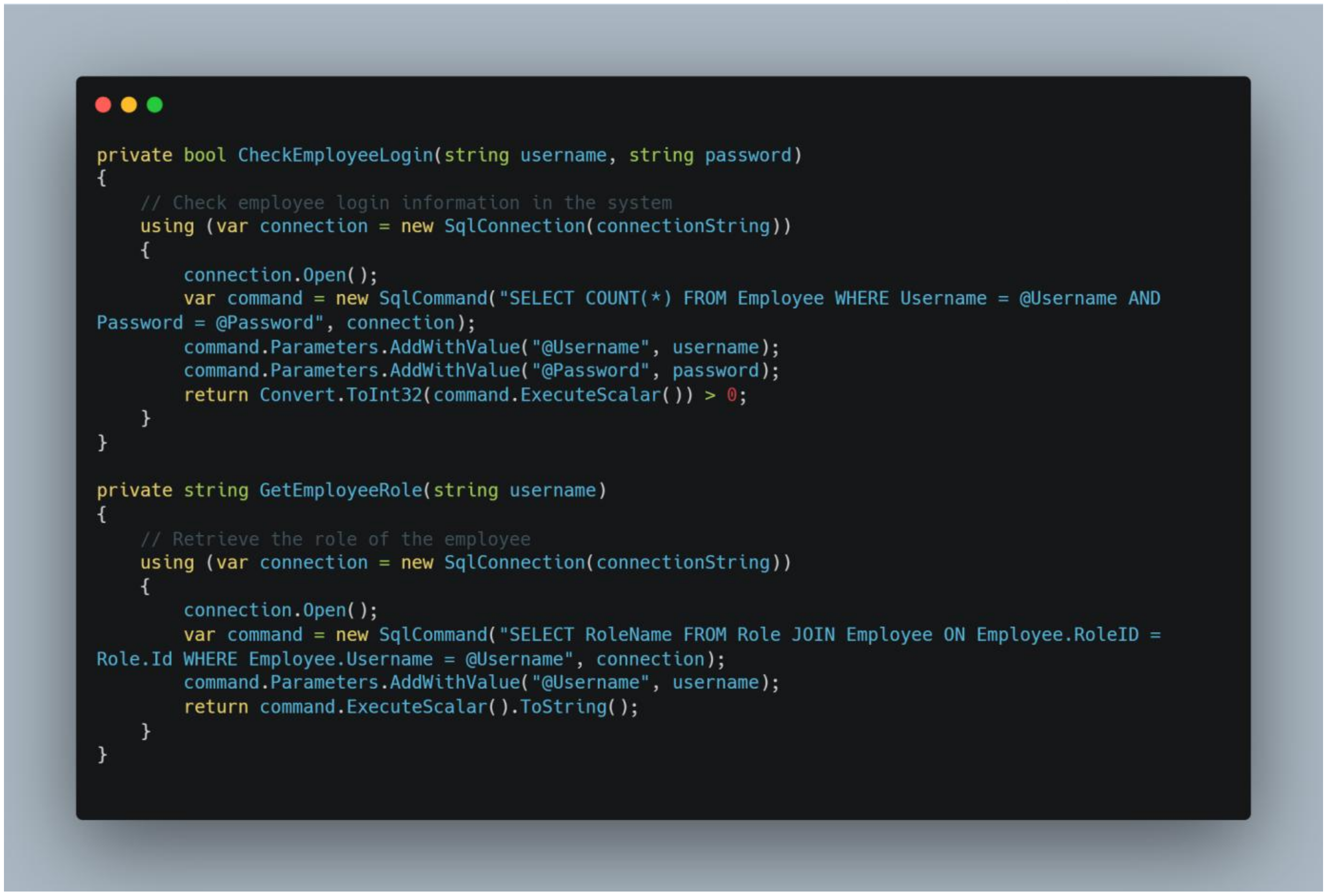
HashPassword: Accepts a raw password and returns the hashed password.
Important Code Snippet:



```
public static string HashPassword(string password)
{
    using (var sha256 = SHA256.Create())
    {
        var bytes = Encoding.UTF8.GetBytes(password);
        var hashBytes = sha256.ComputeHash(bytes);
        return Convert.ToBase64String(hashBytes);
    }
}
```

Employee Management (Employee Management)
This class handles managing employee information, checking employee login, and processing actions related to employee roles.
Main Methods in EmployeeManagement:
- CheckEmployeeLogin: Verifies if the username and password match the employee's credentials in the system.
- GetEmployeeRole: Retrieves the role of the employee from the system (e.g., manager, sales staff, etc.).
- NavigateToEmployeeForm: Based on the employee's role, it redirects the user to the appropriate form.

Important Code Snippet:



```
private bool CheckEmployeeLogin(string username, string password)
{
    // Check employee login information in the system
    using (var connection = new SqlConnection(connectionString))
    {
        connection.Open();
        var command = new SqlCommand("SELECT COUNT(*) FROM Employee WHERE Username = @Username AND
Password = @Password", connection);
        command.Parameters.AddWithValue("@Username", username);
        command.Parameters.AddWithValue("@Password", password);
        return Convert.ToInt32(command.ExecuteScalar()) > 0;
    }
}

private string GetEmployeeRole(string username)
{
    // Retrieve the role of the employee
    using (var connection = new SqlConnection(connectionString))
    {
        connection.Open();
        var command = new SqlCommand("SELECT RoleName FROM Role JOIN Employee ON Employee.RoleID =
Role.Id WHERE Employee.Username = @Username", connection);
        command.Parameters.AddWithValue("@Username", username);
        return command.ExecuteScalar().ToString();
    }
}
```

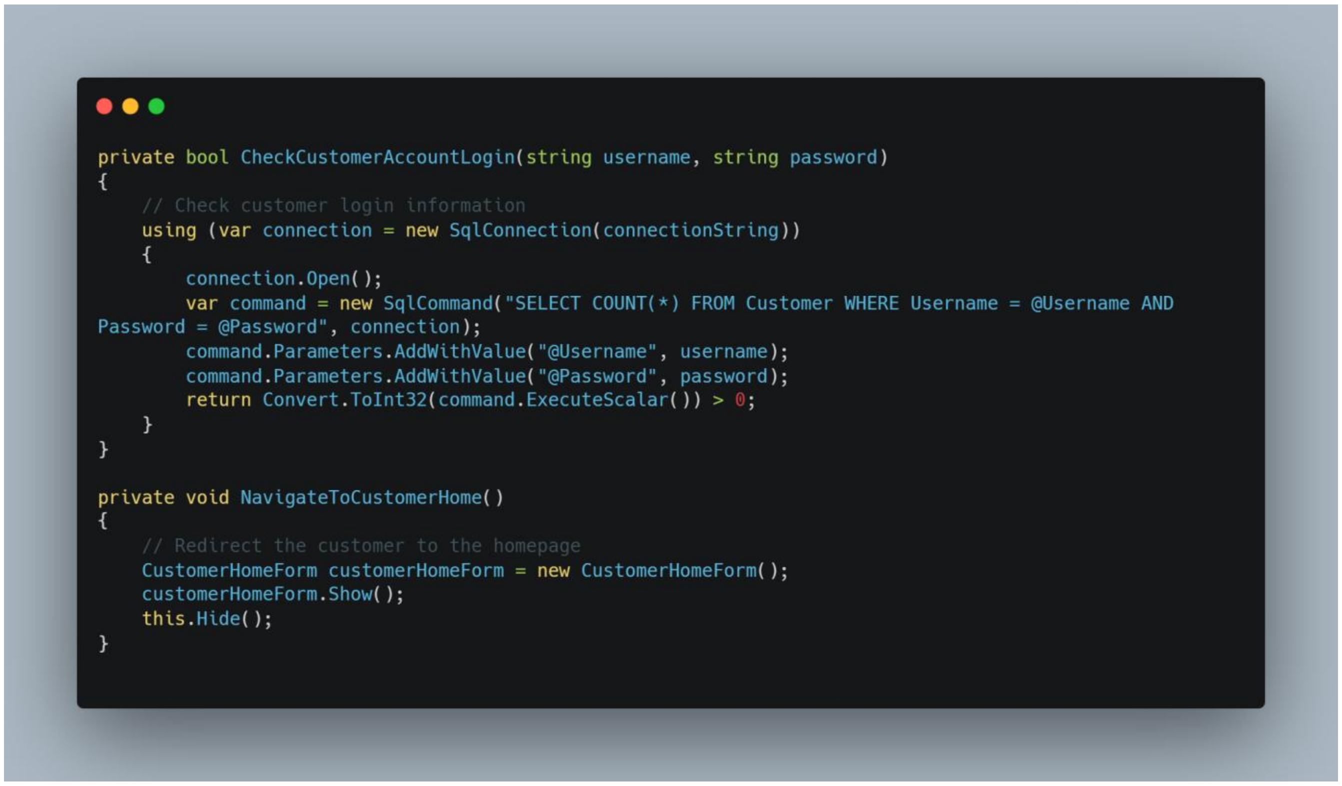
Customer Management (Customer Management)

The CustomerManagement class handles customer accounts and actions related to customers in the system.

Main Methods in CustomerManagement:

- CheckCustomerAccountLogin: Checks the customer's login using the username and hashed password.
- NavigateToCustomerHome: Redirects the customer to the customer homepage.

Important Code Snippet:



```
private bool CheckCustomerAccountLogin(string username, string password)
{
    // Check customer login information
    using (var connection = new SqlConnection(connectionString))
    {
        connection.Open();
        var command = new SqlCommand("SELECT COUNT(*) FROM Customer WHERE Username = @Username AND
Password = @Password", connection);
        command.Parameters.AddWithValue("@Username", username);
        command.Parameters.AddWithValue("@Password", password);
        return Convert.ToInt32(command.ExecuteScalar()) > 0;
    }
}

private void NavigateToCustomerHome()
{
    // Redirect the customer to the homepage
    CustomerHomeForm customerHomeForm = new CustomerHomeForm();
    customerHomeForm.Show();
    this.Hide();
}
```

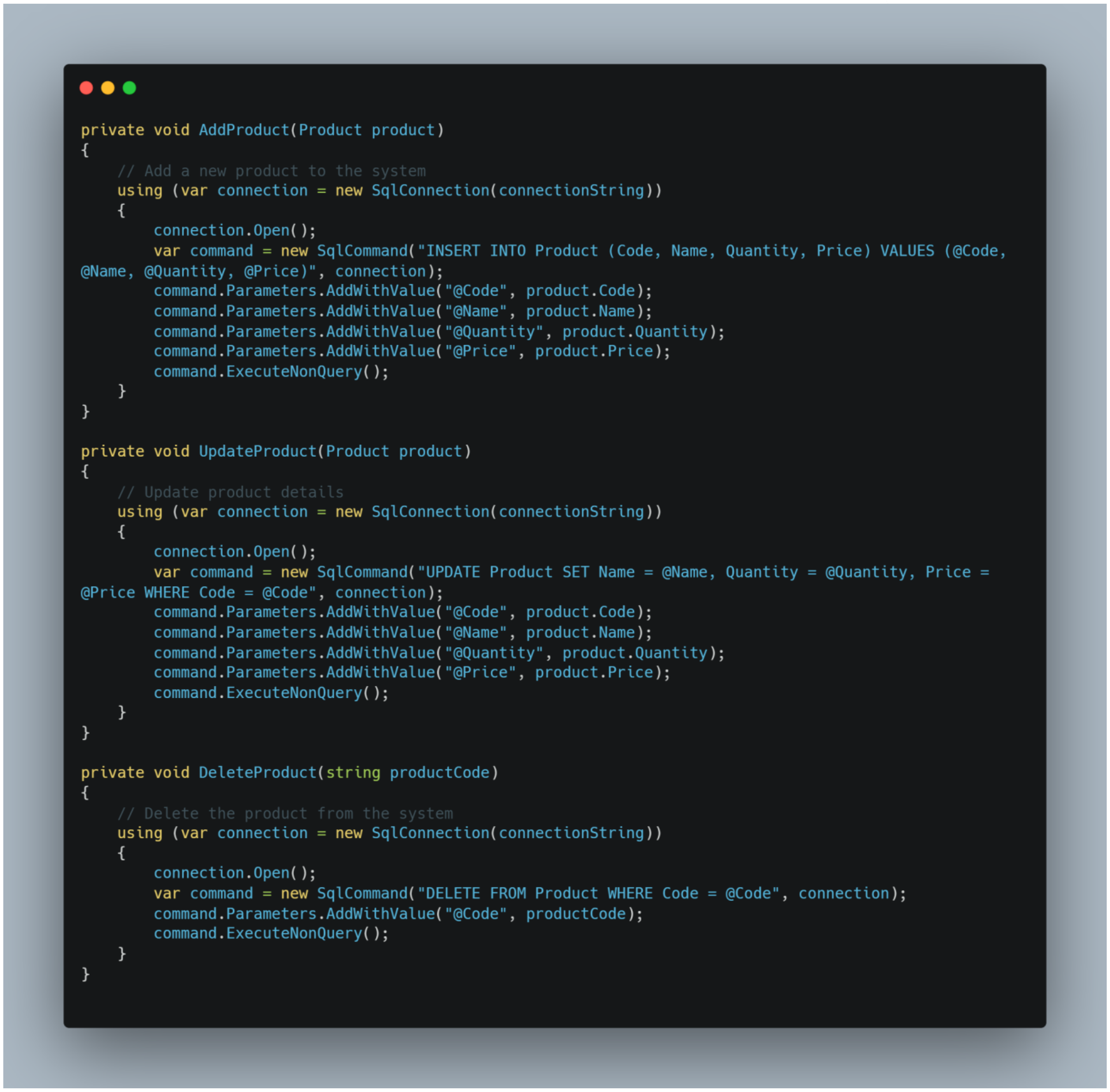
Product Management (Product Management)

This class is responsible for handling operations related to product management in the system, including adding, updating, and deleting products.

Main Methods in ProductManagement:

- AddProduct: Adds a new product to the system.
- UpdateProduct: Updates the product details in the system.
- DeleteProduct: Deletes a product from the system.

Important Code Snippet:



```
private void AddProduct(Product product)
{
    // Add a new product to the system
    using (var connection = new SqlConnection(connectionString))
    {
        connection.Open();
        var command = new SqlCommand("INSERT INTO Product (Code, Name, Quantity, Price) VALUES (@Code,
@Name, @Quantity, @Price)", connection);
        command.Parameters.AddWithValue("@Code", product.Code);
        command.Parameters.AddWithValue("@Name", product.Name);
        command.Parameters.AddWithValue("@Quantity", product.Quantity);
        command.Parameters.AddWithValue("@Price", product.Price);
        command.ExecuteNonQuery();
    }
}

private void UpdateProduct(Product product)
{
    // Update product details
    using (var connection = new SqlConnection(connectionString))
    {
        connection.Open();
        var command = new SqlCommand("UPDATE Product SET Name = @Name, Quantity = @Quantity, Price =
@Price WHERE Code = @Code", connection);
        command.Parameters.AddWithValue("@Code", product.Code);
        command.Parameters.AddWithValue("@Name", product.Name);
        command.Parameters.AddWithValue("@Quantity", product.Quantity);
        command.Parameters.AddWithValue("@Price", product.Price);
        command.ExecuteNonQuery();
    }
}

private void DeleteProduct(string productCode)
{
    // Delete the product from the system
    using (var connection = new SqlConnection(connectionString))
    {
        connection.Open();
        var command = new SqlCommand("DELETE FROM Product WHERE Code = @Code", connection);
        command.Parameters.AddWithValue("@Code", productCode);
        command.ExecuteNonQuery();
    }
}
```

Main Features of the System:

- User Login: Allows both employees and customers to log in and navigate to different sections of the system.
- Product Management: Employees can add, update, or delete products in the system.
- User Account Management: The system supports account creation and login verification for both employees and customers.
- Customer Transactions: Customers can view products and make purchases through the system.

36. Produce user documentation for end-users:

Tutorials and guides for specific functionalities:

Logging In to the System

Logging in is the first step to access the Store Management System. The login page consists of two fields: Username and Password. Follow these steps to log in:

- Enter Your Username: Type your unique username into the "Username" field. This is the identifier provided to you by the administrator. Make sure there are no extra spaces or typos.
- Enter Your Password: In the "Password" field, input your assigned password. For security, the password is case-sensitive. If your password includes special characters, ensure you enter them correctly.
- Click the Login Button: After entering your credentials, click the Login button to submit. If the credentials are correct, you will be redirected to the dashboard.
- Error Handling: If you see an error message, verify the username and password and try again. If the issue persists:

Click on the Forgot Password option (if available) to recover or reset your password.

Contact the system administrator to ensure your account is active and the credentials are accurate.

Using the Employee Dashboard

The Employee Dashboard is a central hub where employees can perform critical tasks like managing products, handling customer accounts, and reviewing transaction history. Each feature is accessible from the navigation menu, categorized for ease of use.

Managing Products

Product management is essential for maintaining accurate inventory records. In this section, you can add, update, or delete products.

Adding a New Product:

- Navigate to the Product Management menu.
- Click on Add Product.
- Fill in the required fields:
- Product Code: A unique identifier for the product.
- Name: The product's name.
- Quantity: The number of units available in stock.
- Price: The price per unit of the product.
- Click Save to store the product in the system.

Updating Product Details:

- Locate the product in the inventory list. Use the search bar to find products quickly.
- Click Edit next to the product you want to modify.
- Update the relevant fields (e.g., price, quantity).
- Save the changes by clicking Update.

Deleting a Product:

- Select the product you wish to remove from the list.
- Click the Delete button and confirm the action in the popup dialog. *Note: Deleted products cannot be restored, so proceed carefully.*

Viewing Transaction History

The transaction history section provides an overview of all sales activities. Employees can use this feature to track sales and assist customers with queries about past purchases.

Viewing Transactions:

- Go to the Transaction History menu.
- A list of transactions will appear, including:
- Transaction ID: A unique identifier for the sale.
- Customer Name: The buyer's name.
- Product Details: Items purchased and their quantities.
- Total Price: The total cost of the transaction.
- Purchase Date: When the transaction occurred.

Filtering Transactions:

Use the search filters to find specific transactions:

- Filter by Customer Name to see purchases by a particular individual.
- Filter by Date Range to view transactions from a specific period.
- Filter by Product Code to track the sale of a specific product.

Managing Customers

Employees can add new customers or update details for existing ones. This ensures accurate and up-to-date records in the system.

Adding a Customer:

- Go to the Customer Management menu.
- Click Add New Customer.
- Fill in the following fields:
- Name: The customer's full name.
- Phone Number: A valid 10-digit contact number.
- Address: The customer's residential or business address.
- Email: A valid email address for communication.
- Click Save to create the customer profile.

Updating Customer Information:

- Locate the customer in the list using the search function.
- Click Edit next to the customer's name.
- Modify the necessary fields and click Update.

Deactivating a Customer:

- Select the customer profile.
- Click Deactivate. Confirm the action to mark the account as inactive. *Note: Inactive accounts are not deleted but are hidden from active lists.*

FAQs (Frequently Asked Questions) to address common user iss:

1. What Should I Do If I Forget My Password?

If you forget your password, you can reset it using the Forgot Password feature on the login page. Click the Forgot Password link, and you'll be prompted to enter your registered email address. A password reset link will be sent to your email. Follow the instructions in the email to create a new password. If you do not receive the email or encounter issues, contact your system administrator for assistance.

2. How Can I Add a New Product to the System?
To add a new product, navigate to the Product Management menu and select the Add Product option. Fill in all the required fields, such as product code, name, quantity, and price. Once the information is complete, click Save to add the product to the inventory. Ensure that the product code is unique to avoid duplication errors.

3. Why Am I Unable to Log In?
If you cannot log in, check the following:

- Ensure you are entering the correct username and password. Passwords are case-sensitive, so verify capitalization and special characters.
- Confirm that your account is active. Deactivated accounts cannot log in. Contact the administrator if you suspect your account has been deactivated.
- If you continue to experience issues, reset your password using the Forgot Password option or contact technical support for assistance.

4. How Do I Update Product Information?
To update a product's details, go to the Product Management menu and locate the product in the inventory list. Use the search bar to find it quickly. Click the Edit button next to the product, modify the required fields, and click Update to save the changes. Only authorized employees can update product details.

5. What Happens If I Delete a Product?
When you delete a product, it is permanently removed from the system and cannot be restored. Ensure you no longer need the product in the inventory before confirming deletion. If the product has related transactions, those records will remain in the system but will reference the deleted product.

6. Can Customers View Their Purchase History?
Yes, customers can view their purchase history by logging into their accounts and navigating to the Purchase History section. This page displays all past transactions, including the purchase date, items purchased, quantities, and the total price. Customers can use this feature to track their orders or review previous purchases for reordering.

7. How Do I Deactivate a Customer Account?
To deactivate a customer account, go to the Customer Management section, locate the customer, and click Deactivate. This will mark the account as inactive, making it invisible in the active customer list. Deactivated accounts can be reactivated if needed, but they are not deleted unless explicitly removed by an administrator.

8. What Should I Do If the System Freezes or Crashes?

If the system freezes or crashes:

- Try refreshing the page or restarting the application.
- Check your internet connection, as a weak connection can disrupt system performance.
- Clear your browser cache if using a web-based system.
- If the issue persists, report the problem to your technical support team, providing details about the error and any recent actions that may have caused the crash.

9. How Can I Filter Transactions in the Transaction History?

To filter transactions, go to the Transaction History menu and use the available filters, such as date range, customer name, or product code. Enter the desired criteria, and the system will display the relevant transactions. This feature is particularly useful for generating reports or resolving customer queries.

10. Is It Possible to Reactivate a Deleted Customer or Product?

No, deleted customers or products cannot be reactivated. However, deactivated accounts or products can be reactivated from the management sections. If an account or product was mistakenly deleted, you will need to re-add it manually.

11. How Do I Contact Support?

If you encounter an issue you cannot resolve, contact your system administrator or technical support team. Most systems have a Help or Support section with contact details, such as email addresses or phone numbers. Be prepared to provide details about the issue, including screenshots if possible, to help the support team resolve your problem quickly.

12. Can I Export Reports from the System?

Yes, most systems allow employees to export transaction histories, inventory data, or customer lists as reports. Navigate to the relevant section, such as Transaction History, and look for an Export or Download button. Choose the desired file format (e.g., Excel, PDF) and save the report to your device.

13. What If My Customer’s Phone Number Doesn’t Meet the Format Requirements?

The system enforces a strict 10-digit format for phone numbers. If the number you’re trying to enter doesn’t meet this requirement, ensure that it doesn’t include spaces, symbols, or country codes. Enter only the digits. For international customers, store additional details in the Address or Notes fields.

14. How Can I Change My Password?

To change your password, log in and navigate to the Account Settings or Profile section. Select the Change Password option, enter your current password, and then input your new password twice for confirmation. Ensure your new password meets security requirements, such as a minimum length and the inclusion of special characters.

15. What Should I Do If My Customer Reports an Incorrect Transaction?
If a customer reports an incorrect transaction, review the transaction details in the Transaction History section. Use the customer's name or transaction ID to locate the record. If the issue is confirmed, update the relevant fields if allowed or issue a manual adjustment (e.g., refund or product exchange) following your company's policies.

XIV. Evaluate the database in terms of improvements needed to ensure the continued effectiveness of the system.

1. Monitor system usage and user feedback

To ensure that the Store Management System is functioning as expected and meeting user needs, it is essential to continuously monitor both system usage and user feedback. Usage data can be collected by analyzing metrics such as login frequency, transaction volumes, and the number of active users. User feedback can be obtained through surveys, interviews, or support tickets, helping to identify any issues users may face, such as difficulties in navigating the interface or system errors. Regular monitoring allows us to detect problems early and make timely adjustments to enhance system performance and user satisfaction..

2. Analyze database performance metrics

A key aspect of maintaining a Store Management System is analyzing the database's performance metrics. This includes monitoring query execution times, ensuring that complex queries do not take too long to process, and checking storage utilization to avoid issues such as database bloat or slow response times. For instance, frequent queries should be optimized, and indexing strategies must be reviewed to ensure that data retrieval is as efficient as possible. Monitoring these metrics helps ensure the database can handle growing data volumes and user activity without compromising performance

3. Evaluate the effectiveness of data security measures

To protect sensitive information such as customer data, payment details, and inventory records, it is vital to evaluate the effectiveness of the data security measures implemented in the system. This includes assessing the strength of user authentication protocols (e.g., password policies, two-factor authentication) and the encryption methods used for data at rest and in transit. Regular security audits should be conducted to identify potential vulnerabilities, such as weak password policies or unauthorized access risks, ensuring that the system remains secure and compliant with data protection regulations.

4. Assess the overall maintainability of the system

The maintainability of the Store Management System is a critical factor for long-term success. Assessing this involves reviewing both the system's documentation and the clarity of the programming code. Clear, well-documented code allows developers to quickly identify issues and implement changes or update without introducing new errors. Additionally, maintaining comprehensive documentation ensures that new team members can easily understand the system's structure and functionality, reducing the learning curve and improving overall development efficiency. Periodic code reviews and updates are essential to maintain the system's ability to adapt to evolving business needs.

5. Identify areas for improvement

Based on the evaluation results from monitoring system usage, analyzing database performance, assessing data security measures, and evaluating maintainability, it is important to identify areas for improvement. For example, if system usage data reveals a bottleneck during peak hours, improvements could be made to optimize system performance. If security audits uncover vulnerabilities, further enhancements to user authentication methods or encryption could be recommended. Similarly, if users report difficulties navigating the system, the user interface may need to be simplified. Identifying these areas ensures that the system continues to evolve and better meet the needs of its users.

6. Recommend changes to the database system

Based on the evaluation results, recommending changes to the database system or its documentation is necessary to maintain the system's effectiveness. This might include optimizing slow-performing queries, revising database schema for better organization, or improving indexing strategies to speed up data retrieval. Additionally, updating the documentation to reflect any changes in the database design or architecture ensures that future developers and system administrators can work efficiently.
Recommendations for changes should be based on a thorough analysis of current system performance and feedback to guarantee they address the most pressing needs for continued success.

Link my code: https://github.com/buihai041203/Database-BuiMinhHai.git

XV. Conclusion

In conclusion, the development of a relational database system for calculating water bills has been meticulously designed to meet both functional and nonfunctional requirements. Through a comprehensive approach that included the identification of system requirements, the design of an effective relational database, and the implementation of rigorous software design principles, we have ensured a robust and user-friendly solution.

The design process involved creating a detailed table of entities and an Entity-Relationship Diagram (ERD), followed by normalization to enhance data integrity and reduce redundancy. The mockup wireframes provided a visual representation of the user interface, ensuring that user experience considerations were integrated into the design.

Moreover, we conducted a thorough evaluation of the database design's effectiveness against user and system requirements, verifying that all specified functionalities are addressed. Validation processes confirmed the accuracy, integrity, and consistency of the data, while performance testing evaluated the system's efficiency under expected workloads. Despite the strengths of the current design, we also identified potential weaknesses, suggesting improvements to optimize performance and enhance user experience further. Finally, comprehensive testing was performed to ensure that the system functions correctly, adheres to all requirements, and is ready for deployment. This project has not only demonstrated the feasibility of creating a secure and efficient software solution for calculating water bills but also laid the groundwork for future enhancements and scalability. The ongoing commitment to evaluation and improvement will ensure that the system continues to meet the evolving needs of users and stakeholders

XVI. References

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