

Digital Pharmacy Management System

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ABSTRACT: This project presents the design and development of a Digital Pharmacy Management System aimed at improving the efficiency, accuracy, and reliability of pharmacy operations. Traditional systems often rely on manual record-keeping, leading to errors in inventory management, billing delays, and difficulty in tracking medicine expiry. To address these challenges, the system automates key processes such as inventory control, sales management, customer handling, and prescription management using a structured database approach. The application is developed using Java Swing for the user interface, JDBC for database connectivity, and PostgreSQL as the backend database. It follows a DAO-based architecture to ensure modular design, separation of concerns, and maintainability. Key features include transaction management for data consistency, input validation for ensuring data integrity, and real-time monitoring capabilities such as low-stock alerts and expiry tracking. The system also incorporates secure database interactions using Prepared Statement to prevent SQL injection attacks. The final implementation results in a fully functional desktop application that demonstrates practical knowledge of software engineering principles, database management, and real-time system operations. Overall, the system provides a scalable and efficient solution for modern pharmacy management and enhances workflow efficiency in healthcare environments.

KEYWORDS: Digital Pharmacy Management System, Java Swing, PostgreSQL, JDBC, Data Access Object (DAO) Pattern, Inventory Management, Transaction Processing, Data Validation, Real-Time Monitoring, Healthcare Information Systems.

I. INTRODUCTION

Traditional pharmacy systems often rely on manual record-keeping or partially digitized solutions, which can lead to issues such as inaccurate inventory tracking, delayed billing, and difficulty in monitoring medicine expiry dates. These limitations reduce operational efficiency and increase the risk of human errors, which can directly impact patient safety and service quality. Additionally, the absence of centralized data management makes it difficult to maintain records, retrieve information quickly, and generate accurate reports for decision-making.

With the advancement of information technology, there is an increasing demand for automated and integrated systems in healthcare environments. Digital solutions enable efficient data storage, faster processing, and improved accuracy compared to traditional methods. By utilizing relational databases and structured software design, pharmacy operations can be streamlined, reducing redundancy and ensuring data consistency. Such systems also support real-time updates and monitoring, allowing pharmacists to manage inventory and transactions more effectively.

To address these challenges, this project proposes a Digital Pharmacy Management System that automates key

operations such as inventory management, customer handling, prescription processing, and sales management through a centralized platform. The system is developed using Java Swing for the graphical user interface, JDBC for database connectivity, and PostgreSQL as the backend database. It follows the DAO design pattern to ensure modularity and maintainability, while incorporating secure database interactions using Prepared Statement and real-time features like low-stock alerts and expiry tracking. This approach bridges the gap between traditional pharmacy workflows and modern software engineering practices, providing a reliable and efficient solution.

II. RELATED WORK

Several research efforts have focused on improving healthcare management systems through automation and digital solutions. Traditional pharmacy systems primarily rely on manual record-keeping or partially digitized tools, which often lead to inefficiencies in inventory tracking, billing delays, and difficulty in monitoring medicine expiry. These systems treat pharmacy operations as isolated tasks rather than an integrated workflow, resulting in poor coordination and increased risk of human error.

Modern healthcare applications have introduced database-driven solutions to address these limitations. Systems built using relational databases such as PostgreSQL ensure data consistency, integrity, and efficient query processing. Research highlights the importance of centralized data storage and ACID-compliant transactions for maintaining reliability in critical applications like pharmacy management. Unlike manual systems, these solutions provide real-time visibility into stock levels and sales operations.

In addition, software engineering practices such as the DAO (Data Access Object) pattern and layered architecture have been widely adopted to improve system maintainability and scalability. Studies emphasize that separating business logic from database operations reduces system complexity and enhances flexibility. Security mechanisms such as Prepared Statement and input validation are also essential to protect sensitive healthcare data from vulnerabilities like SQL injection attacks.

III. METHODOLOGY

The Digital Pharmacy Management System follows a structured and modular approach to ensure efficient handling of pharmacy operations. The system is designed using a layered architecture that separates different functionalities into independent modules, allowing better organization, maintainability, and scalability. System Architecture: The application is divided into multiple layers, including the GUI layer, utility layer, DAO layer, model layer, and the PostgreSQL database. The GUI layer, implemented using Java Swing, manages user interaction and system navigation. The utility layer handles validation and table operations to ensure proper data handling. The DAO layer, built using JDBC, acts as a bridge between the application and the database. The model layer represents data entities using POJO classes, while PostgreSQL serves as the backend for data storage and management.

1. Data Management and Transactions:

The system uses PostgreSQL to manage data related to medicines, customers, sales, and prescriptions. All entities are interconnected using foreign key relationships to maintain data integrity. Transaction management is implemented to ensure consistency during multi-step operations such as sales processing. In this approach, multiple operations are executed as a single unit, ensuring that either all operations succeed or none are applied.

2. Inventory Monitoring Mechanism:

To improve efficiency, the system includes automated monitoring features for stock management. SQL-based queries are used to detect low stock levels, identify expired medicines, and track medicines nearing expiry. This proactive approach helps prevent stock shortages and ensures that expired medicines are not dispensed.

3. Validation and Security Mechanism:

The system implements input validation to ensure accurate data entry for fields such as numbers, dates, and required values, reducing errors in the database. For security, Prepared Statement in JDBC is used to prevent SQL injection attacks by separating SQL queries from user input. Additionally, controlled access ensures that only authorized actions are performed, maintaining data integrity and system reliability.

IV. IMPLEMENTATION DETAILS

The Digital Pharmacy Management System is implemented using a modular and layered architecture, ensuring scalability, maintainability, and efficient performance. The system follows a structured design approach where the user interface, business logic, and database operations are clearly separated. This separation enables easier debugging, code reusability, and future enhancements. It also allows independent development and testing of each module, improving overall system reliability.

A. Graphical User Interface Layer (Java Swing): The application uses Java Swing to provide an interactive desktop interface with modules such as Login, Dashboard, Medicine Management, Customer Management, and Sales. Components like JTable display real-time data, allowing users to efficiently manage records. The interface is designed for easy navigation and user-friendly interaction. Additionally, event-driven actions such as button clicks and form inputs ensure smooth communication between the user and the system.

B. Application Logic and DAO Layer (JDBC Integration): The system follows the DAO pattern to separate database operations from the user interface. DAO classes handle CRUD operations, while JDBC enables communication with the PostgreSQL database. Prepared Statement is used to execute queries securely and efficiently, preventing SQL injection and ensuring safe data handling. This modular approach simplifies maintenance and allows future enhancements without affecting other system components.

C. Transaction Management: Transaction management is implemented for operations such as sales processing, where multiple steps are executed as a single unit. If any step fails, a rollback is performed to maintain data consistency and prevent partial updates. This ensures that the system maintains reliable and accurate records during critical operations.

D. Data Validation and Security: The system performs input validation to ensure correct data entry and prevent errors. Security is enhanced using Prepared Statement and controlled access mechanisms, ensuring data integrity and protection against unauthorized operations. These measures help maintain the confidentiality and reliability of sensitive pharmacy data.

E. Database Layer (PostgreSQL): PostgreSQL is used as the backend database to store and manage data efficiently. Tables are designed with proper relationships using foreign keys to maintain integrity. Optimized SQL queries ensure fast data retrieval and support real-time system performance. The database structure is designed to handle large volumes of data while maintaining consistency and reliability.

V. EXPERIMENTAL RESULTS

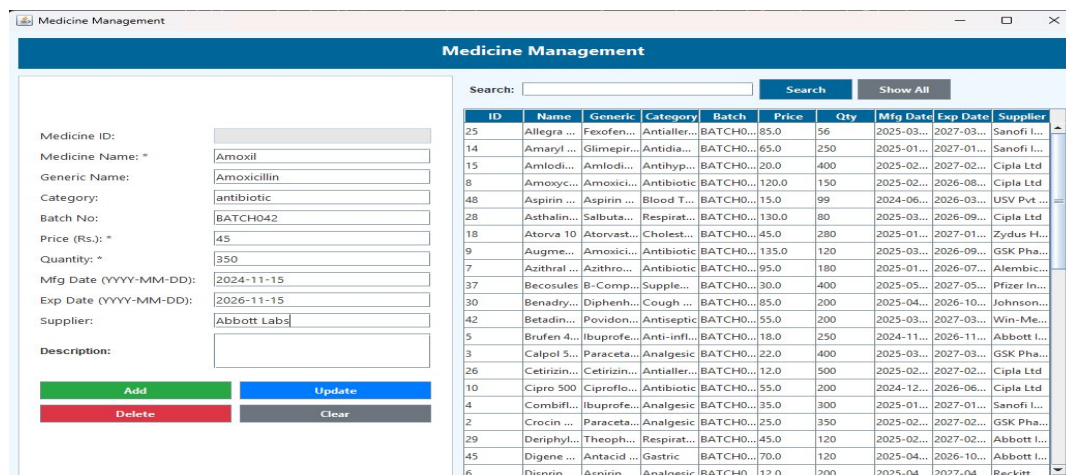
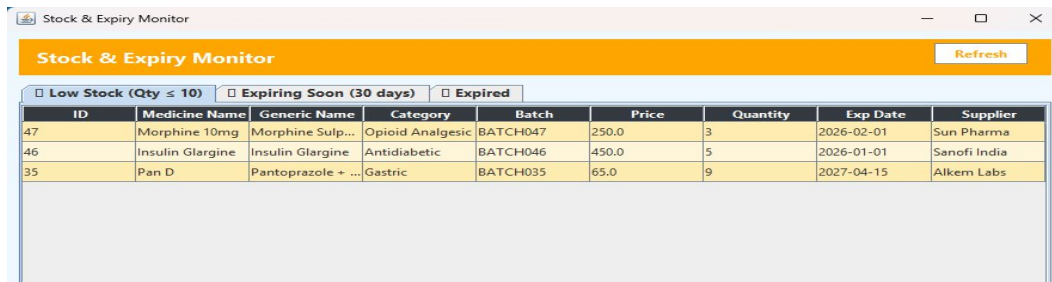


Fig 1

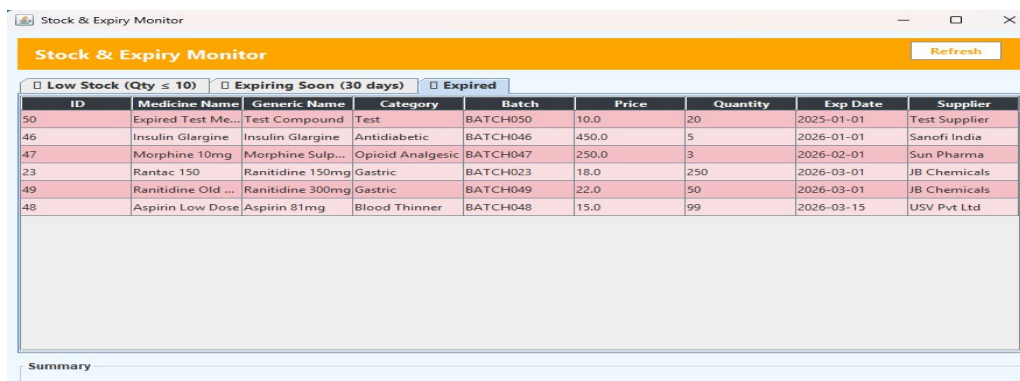
This screen shows the medicine management module of the system. Users can view, add, update, and delete medicine records. The table displays details such as medicine name, price, quantity, and expiry date. The system updates the data in real-time, allowing efficient inventory management. This module helps pharmacists maintain accurate stock information and quickly modify records when required.



ID	Medicine Name	Generic Name	Category	Batch	Price	Quantity	Exp Date	Supplier
47	Morphine 10mg	Morphine Sulp...	Opioid Analgesic	BATCH047	250.0	3	2026-02-01	Sun Pharma
46	Insulin Glargine	Insulin Glargine	Antidiabetic	BATCH046	450.0	5	2026-01-01	Sanofi India
35	Pan D	Pantoprazole + ...	Gastric	BATCH035	65.0	9	2027-04-15	Alkem Labs

Fig 2

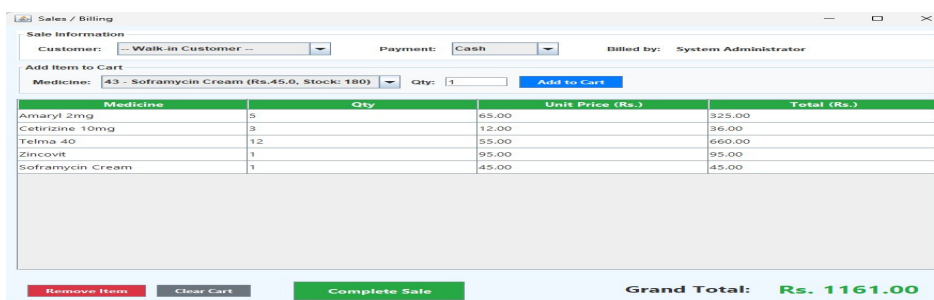
This screen shows the stock monitoring module, where medicines are categorized based on low stock and nearing expiry conditions. Each record includes details such as medicine name, quantity, expiry date, and supplier. The filtering options help users quickly identify items that need attention, enabling timely restocking and efficient inventory management.



ID	Medicine Name	Generic Name	Category	Batch	Price	Quantity	Exp Date	Supplier
50	Expired Test Me...	Test Compound	Test	BATCH050	10.0	20	2025-01-01	Test Supplier
46	Insulin Glargine	Insulin Glargine	Antidiabetic	BATCH046	450.0	5	2026-01-01	Sanofi India
47	Morphine 10mg	Morphine Sulp...	Opioid Analgesic	BATCH047	250.0	3	2026-02-01	Sun Pharma
23	Rantac 150	Ranitidine 150mg	Gastric	BATCH023	18.0	250	2026-03-01	JB Chemicals
49	Ranitidine Old ...	Ranitidine 300mg	Gastric	BATCH049	22.0	50	2026-03-01	JB Chemicals
48	Aspirin Low Dose	Aspirin 81mg	Blood Thinner	BATCH048	15.0	99	2026-03-15	USV Pvt Ltd

Fig 3

This screen displays the expired medicines monitoring feature, where medicines past their expiry date are automatically filtered and shown. Key details such as medicine name, quantity, and expiry date are included. This feature prevents the use of expired medicines and supports safe and effective inventory control.



Medicine	Qty	Unit Price (Rs.)	Total (Rs.)
Amaryl 2mg	5	65.00	325.00
Cetirizine 10mg	3	12.00	36.00
Telma 40	12	55.00	660.00
Zincovit	1	95.00	95.00
soframycin Cream	1	45.00	45.00

Grand Total: Rs. 1161.00

Fig 4

This screen represents the sales and billing module. Users can select medicines, specify quantities, and generate bills for customers. The system automatically calculates the total amount and updates the stock after each transaction. Transaction management ensures that all operations are completed successfully, maintaining data consistency during the billing process.

VI. CONCLUSION

The Digital Pharmacy Management System represents a significant step forward in improving the efficiency and reliability of pharmacy operations. By replacing traditional manual processes with a centralized and automated system, it effectively eliminates common issues such as inventory inaccuracies, delayed billing, and difficulty in tracking medicine expiry. The system transforms pharmacy management from a fragmented workflow into a streamlined and well-coordinated process.

The study demonstrates that the integration of modern technologies such as Java Swing for interactive interfaces, JDBC for secure database connectivity, and PostgreSQL for reliable data storage can create a robust and scalable solution. Key features such as transaction management, DAO-based architecture, and real-time inventory monitoring ensure that accuracy and system performance are maintained without compromising efficiency.

Finally, the system acts as a bridge between traditional pharmacy practices and modern software solutions. It highlights how well-structured system design and secure data handling can enhance healthcare service delivery. The successful implementation of this project emphasizes that in time-critical environments like healthcare, accurate data management and system synchronization are as important as the resources themselves.

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