PharmaTrack: A Web-Based Inventory Management System for Tracking Medicine Expiration and Stock in Pharmacies

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Jamaica Ruri C. Augusto
Bachelor of Science in Computer Science

Mr. Mark Anthony Cabilo
Special Problem Adviser

Chapter 1. Introduction

1.1 Background of the Study

Pharmacies play a crucial role in healthcare by ensuring that medicines are available, safe, and effective for patient use. However, many small and medium-sized pharmacies still rely on manual or semi-digital methods, such as logbooks or spreadsheets, to manage medicine inventory and expiration dates. These methods are prone to human error, delayed updates, and overlooked expired medicines, which may lead to financial losses and potential risks to patient safety.

While Point of Sale (POS) systems are commonly used in pharmacies to handle sales transactions, not all pharmacies utilize advanced inventory features, and many are unwilling or unable to integrate external systems due to operational risks, privacy concerns, or testing limitations. During the conduct of this study, no pharmacy was available to serve as a live testing environment for system integration. As a result, this research focuses on the development and evaluation of a standalone, web-based pharmacy inventory and expiration monitoring system tested in a simulated environment.

This study proposes PharmaTrack, a web-based inventory management system designed to monitor medicine stock levels and expiration dates without requiring direct integration with an existing POS system. The system allows manual and bulk entry of medicine records into a structured database and automatically generates reports for medicines that are low in stock or nearing expiration. By focusing on essential inventory functions, PharmaTrack provides a practical and low-risk solution suitable for small and medium pharmacies seeking to improve inventory monitoring without modifying their current sales systems.

1.2 Research Objectives

The main objective of this study is to design and develop PharmaTrack, a standalone web-based pharmacy inventory management system adapted from an open-source application, focusing on medicine stock and expiration monitoring.

Specifically, the study aims to:

- Develop a system that supports two user roles: administrator and pharmacist, with clearly defined access permissions.
- Enable administrators to add medicines individually or import bulk medicine records using a file-based data migration approach.
- Provide real-time visibility of medicine inventory, including quantities and expiration dates.
- Generate inventory reports related to near-expiry medicines and low-stock quantities.

- Allow pharmacists to efficiently view and search inventory records and access inventory reports without modification privileges.

1.3 Significance of the Study

The study will benefit the following stakeholders:

- **Pharmacists and Pharmacy Staff** – By reducing manual tracking errors and providing timely reports, the system helps them manage stocks more efficiently and avoid dispensing expired medicines.
- **Pharmacy Owners** – Accurate inventory data prevents overstocking or understocking, reducing losses and improving profitability.
- **Customers/Patients** – Ensures that only safe and effective medicines are available, improving patient trust and safety.
- **Future Researchers** – The study can serve as a reference for those exploring pharmacy management systems, digital inventory solutions, or healthcare IT systems.

1.4 Scope and Limitation

Scope:

The study focuses on the development of PharmaTrack, a web-based pharmacy inventory management system with role-based access control. The system supports two user roles: administrator and pharmacist. Administrators have full access to inventory management features, including adding new medicines, importing bulk medicine records, editing or deleting records, and viewing inventory reports. Pharmacists are limited to viewing inventory records through a search interface and accessing reports related to expiration and quantity.

The system includes a bulk data migration feature that allows administrators to import medicine records using a structured file format. The system is evaluated in a simulated environment using sample datasets.

Limitations:

- The system is not integrated with any existing pharmacy POS system or live operational database.
- The evaluation is limited to simulated data and user-based testing rather than real-world pharmacy deployment.
- The bulk import feature supports only a predefined file format and does not include automatic data validation against external pharmacy systems.
- The system does not cover other pharmacy operations such as billing, insurance claims, prescription handling, or customer management.

- Advanced tracking technologies such as RFID, barcode scanners, or mobile device support are not included.
- The system is designed for desktop or laptop use only.

1.5 Definition of Terms

Administrator – A user with full access rights to manage inventory data, import records, and generate reports.

Inventory Management – The process of overseeing the ordering, storage, and use of medicines in a pharmacy.

Pharmacist – A user with restricted access, limited to viewing inventory records and reports.

PharmaTrack – The proposed system that monitors medicine stocks and expiration dates in pharmacies.

POS (Point of Sale) – A system used to process sales transactions at the counter but not necessarily for inventory or expiration monitoring.

Role-Based Access Control – A security mechanism that restricts system access and functionalities based on user roles such as administrator and pharmacist.

Web-Based Application – Software that runs on a web browser, accessible via internet-connected devices.

Chapter 2. Review of Related Literature

2.1 Pharmacy Inventory Management Systems

Effective inventory management is fundamental to pharmacy practice because medicines represent one of the largest and most dynamic assets of a pharmacy. Studies and reviews consistently show that inventory management goals include balancing availability with cost, minimizing both stock-outs and wastage due to expiry, while also maintaining traceability of batches and lot numbers. Literature reviews in pharmacy practice emphasize that poor inventory control increases operational costs, reduces service quality, and can directly threaten patient safety when expired or improper stock is dispensed [1].

The literature also demonstrates that inventory challenges vary across settings. Hospital inpatient pharmacies face unique requirements, such as high turnover, emergency drug availability, and strict ward dispensing flows. In contrast, community pharmacies typically manage a wide range of stock keeping units (SKUs) in lower volumes with more variable demand patterns. The chapter on pharmaceutical inventory and analysis in Springer notes that hospital systems often employ structured classification and prioritization of medicines to ensure timely availability for critical care, but these approaches are not always feasible or cost-effective for smaller community pharmacies [2].

Local studies on information system design for pharmacy businesses highlight that a systems approach, such as combining ABC/XYZ or ABC-XYZ analysis with digital record keeping, can significantly improve reorder decisions and reduce expiry losses. Case studies report measurable improvements in stock turnover and fewer expired items after the adoption of computerized inventory tools [3], [4]. These findings indicate that even limited digitalization, such as basic data entry with automated checks, can outperform purely manual recording.

Despite these benefits, the literature also notes barriers to adoption. High implementation costs, staff training requirements, workflow disruptions, and system complexity remain key obstacles. Many small pharmacies continue to rely on manual records or simple spreadsheets because commercial pharmacy systems are often perceived as expensive or over-featured. This gap suggests an opportunity for simpler web-based systems that focus on the core inventory challenges of stock quantity and expiry monitoring, without requiring full enterprise resource planning (ERP) or point of sale (POS) functionality [1]−[4]. PharmaTrack is positioned to address this gap by offering a focused and accessible web solution for stock and expiry monitoring.

2.2 Point of Sale (POS) Systems in Pharmacies

Point of Sale (POS) systems are widely used in retail and pharmacy settings for transaction recording, receipt generation, and basic stock decrementing on sales. The literature on POS adoption in pharmacies indicates that POS improves transactional efficiency and provides sales reports, but conventional POS platforms often lack batch-level tracking and automated expiry monitoring [5]. As a result, pharmacists frequently maintain separate manual logs to track expiries and restocking needs.

Empirical studies and practitioner reports, including research conducted in Southeast Asia, show that the typical POS workflow subtracts a unit when a sale is made but rarely ties that sale to a specific batch or expiration date. Consequently, while POS systems can provide aggregate

consumption data, they do not inherently prevent the sale of a near-expiry lot unless combined with additional inventory modules or manual procedures [6]. This separation creates a blind spot in expiry control for many small and independent pharmacies.

Operations research and systems design literature emphasizes integrating POS with inventory control to produce traceable, batch-aware records. Several studies propose architectural or process modifications, such as augmenting POS workflows with batch selection prompts or integrating batch import tools so that incoming deliveries are recorded with batch and expiry metadata at the time of receipt [7]. However, such integrations often require vendor cooperation or additional middleware, which increases cost and complexity.

Since many small pharmacies cannot afford fully upgraded POS or integrated solutions, lightweight web applications that provide importable inventory tables, expiry checks, and alerts can complement existing POS setups. A focused tool that is interoperable through CSV imports and exports is often more feasible and practical than a complete POS replacement, which is precisely the niche PharmaTrack seeks to serve.

2.3 Advantages of Expiration Tracking Systems

Medical and management literature highlights that proactive expiration tracking has multiple benefits: it reduces clinical risk by preventing expired medicines from reaching patients, decreases economic loss by enabling stock rotation or discounted use before expiry, and improves regulatory compliance by maintaining audit trails for disposal. Quantitative and qualitative studies report substantial reductions in expired stock and associated financial losses when automated expiry monitoring systems are adopted [8].

Technical literature also describes different mechanisms for expiry management, including scheduled processes that flag near-expiry lots, dashboard visualizations that display “expiring soon” reports, and automated notification channels such as email or push alerts. Comparative studies suggest that systems combining visibility through dashboards with automated reminders are most effective in changing daily behavior and reducing expiry incidents, as they reduce reliance on manual record scanning [9].

Beyond preventing losses, expiry tracking supports procurement decisions. Systems that aggregate expiry dates across batches and SKUs allow purchasing decisions to prioritize high-turnover medicines while delaying replenishment of those with long remaining shelf life. This practice reduces both wastage and tied-up capital. Supply-chain and computing literature outlines how combining expiry metadata with forecasting models enhances inventory turnover and lowers carrying costs [10].

Nevertheless, the literature also warns of implementation challenges. Poor data quality during entry, insufficient staff training, and lack of integration with procurement workflows can reduce the benefits. For this reason, simple, well-designed interfaces for reliable manual entry and bulk import functionality are recommended. These insights inform PharmaTrack’s design choices, which prioritize minimizing data-entry friction, validating expiry dates at input, and providing bulk import tools so pharmacies can transition from spreadsheets with minimal disruption.

2.4 Security and Data Privacy in Pharmacy Systems

As pharmacy systems become digital, the importance of information security and data privacy rises accordingly. Pharmacy information systems may capture supplier details, pricing, transaction logs, and If extended in the future, patient or prescription identifiers. Academic reviews and policy reports emphasize that weak security in health and pharmacy systems risks data breaches, regulatory non-compliance, and erosion of trust among stakeholders [11].

Several studies and policy analyses point to core security controls that are applicable even to inventory-only systems: strong authentication (role-based access control), encrypted transport and storage of sensitive fields, audit logs for critical updates (for example, expiration date edits), and secure backups. The literature further emphasizes that security is not an add-on but must be designed into the system from the start to prevent misconfigurations that could expose data [12].

Legal and regulatory frameworks (for example HIPAA in the United States, or national data privacy laws like the Philippines' Data Privacy Act) shape required controls if systems process personal health information. Even if a system intentionally avoids collecting patient data (as PharmaTrack does in its core scope), the literature recommends adopting security best practices because supplier and transactional data still have business value and may be subject to regulation or contractual confidentiality [13], [14]. Beyond these frameworks, broader research on health information management highlights that both nursing and pharmacy professionals face shared challenges in protecting sensitive data, particularly in the context of digital transformation and cross-disciplinary workflows [15].

Finally, usability research in health IT underlines a trade-off: security measures that are too cumbersome (e.g., frequent forced password changes, complex multi-factor flows) can push staff to adopt insecure workarounds (shared credentials, paper backups). The recommended approach is to balance security with usability: role-based permissions, session timeouts, and optional multi-factor authentication for admin roles provide strong protection without crippling daily tasks.

2.5 Current Solutions and Gaps

The commercial market for pharmacy systems includes both enterprise-grade solutions (such as hospital ERP modules) and smaller POS or inventory applications. Enterprise systems offer end-to-end functionality, including procurement, batch traceability, physician order integration, and disposal workflows. However, they are costly, complex, and generally designed for hospitals and large pharmacy chains [17]. By contrast, many POS and lightweight inventory tools primarily focus on sales and stock decrementing but lack robust expiry monitoring and batch handling, features that are crucial for minimizing expiry-related risks [16], [18].

Studies on pharmacy automation consistently reveal that functionality critical to preventing expiry, such as batch entry at receipt, batch-aware dispensing, and expiry-based reporting and alerts, is typically available in higher-end solutions but either missing or poorly implemented in mass-market tools. Furthermore, vendor lock-in and high integration costs make it difficult for smaller pharmacies to adopt these advanced systems even when beneficial.

This situation presents a clear opportunity for innovation. A focused, web-based application that is affordable, easy to use, and tailored to community pharmacy workflows could address this gap. PharmaTrack is designed to provide: (1) search function for easy findings of data; (2) simple data input and bulk import through CSV/Excel, enabling a smooth transition from manual records; and (3) automated expiration checks with configurable alerts. By keeping the scope tight and the

interface intuitive, PharmaTrack aims to lower adoption barriers and deliver high-impact features needed by smaller pharmacies.

Summary

The literature consistently shows that inventory management and expiry control are essential to pharmacy operations for reasons of safety, compliance, and financial efficiency. While enterprise and hospital systems offer robust capabilities, many small and community pharmacies still rely on manual methods or basic POS tools that do not adequately support batch-level tracking or automated expiry alerts. Studies recommend practical solutions that combine simple digital entry, bulk import, automated checks, and usable dashboards. Security and data privacy considerations are also crucial but manageable if best practices are followed without overburdening staff. Overall, there exists a clear research and practical niche for a focused, web-based system such as PharmaTrack, which prioritizes manual/import data entry, search functionality, and effective expiration reports suited to the realities of small pharmacy operations.

Chapter 3. Methodology

3.1 Research Design

This study employs a developmental research design, focusing on the adaptation, enhancement, and evaluation of an existing web-based pharmacy management system. The goal of the research is to develop a functional prototype that supports inventory monitoring and medicine expiration tracking in a simulated pharmacy environment.

Instead of developing the system entirely from scratch, this study is based on an open-source pharmacy management system developed by Varshini E. The original system is a web-based application implemented using PHP and MySQL, designed to manage pharmacy inventory, customer records, employee data, suppliers, purchases, and sales.

For the purpose of this research, the source code was modified and customized to align with the study's objectives. Several modules not directly related to inventory and expiration tracking, such as customer management and sales processing were removed or de-emphasized. Enhancements were made to the inventory module to support expiration monitoring and low-stock alerts, and new medicine datasets were added to the database. The system was evaluated using simulated data rather than live deployment in an operational pharmacy.

3.2 System Overview

PharmaTrack is a standalone, web-based pharmacy inventory management system adapted from an existing open-source pharmacy management application developed using PHP and MySQL. The system is customized to focus on inventory tracking, expiration monitoring, and controlled data access through user roles.

The system supports **two user roles: administrator and pharmacist**. Administrators are responsible for managing employees and medicine records, including adding new medicines manually or importing bulk medicine records through file upload. Pharmacists are provided read-only access, allowing them to search and view inventory data and generate inventory reports without modifying records.

Bulk data migration is supported using a structured file format, enabling efficient population of the database with large sets of medicine records. The system processes the uploaded file, validates required fields, and inserts records into the database. Inventory data is continuously evaluated to identify medicines that are low in stock or nearing expiration, with results presented through reports.

3.3 Tools and Technologies

The system is implemented using a traditional web development stack commonly used in small- to medium-scale information systems. The technologies used are based on the original open-source implementation and were retained to ensure compatibility and ease of modification.

3.3.1 PHP

PHP is used as the primary server-side scripting language. It handles system logic, inventory processing, expiration checks, report

generation, and interaction with the database. PHP scripts process user requests and dynamically generate web content.

3.3.2 MySQL

MySQL serves as the Database Management System (DBMS) for storing all system data. This includes medicine inventory records, expiration dates, supplier information, and alert logs. For this study, additional medicine datasets were added to the database to simulate real pharmacy inventory conditions.

3.3.3 HTML5

HTML5 is used to structure the web pages of the system. It defines the layout of forms, tables, dashboards, and system notifications displayed to the users.

3.3.4 CSS3

CSS3 is used to design and enhance the user interface of the system. It provides styling for tables, alerts, buttons, and page layouts to ensure usability and readability of inventory information.

3.3.5 JavaScript

JavaScript is used to improve interactivity and user experience. It supports client-side validation, dynamic updates to tables, and visual alert indicators for low-stock and near-expiration medicines.

3.3.6 File Format for Bulk Data Import

The system supports bulk import of medicine records using the Comma-Separated Values (CSV) file format. CSV files are lightweight, widely supported, and compatible with spreadsheet applications such as Microsoft Excel and Google Sheets. This format allows administrators to prepare and migrate large datasets efficiently while maintaining a simple structure for server-side parsing using PHP.

3.4 System Architecture

The architecture of PharmaTrack follows a three-tier web application model, consisting of the Data Layer, Application Layer, and Presentation Layer.

3.4.1 Data Layer

The Data Layer consists of a MySQL database that stores medicine records, expiration dates, stock quantities, and report status. The database is populated using sample and simulated datasets for testing and evaluation.

3.4.2 Application Layer

The Application Layer is implemented using PHP and contains the system's core logic. It manages user authentication, role-based access control, inventory processing, expiration monitoring, and bulk data import. Access permissions are enforced at this layer to ensure that only administrators can modify or import inventory data, while pharmacists are limited to viewing and reporting functionalities.

3.4.3 Presentation Layer

The Presentation Layer provides the web-based interface accessed by users through a browser. It is developed using HTML5, CSS3, and JavaScript, displaying inventory tables, report notifications, and search functionalities in a user-friendly format.

3.5 System Features

The adapted PharmaTrack system provides the following features:

- **Role-Based User Access**
    - Administrator: Full access to employee data, inventory management, bulk import, editing, deletion, and reports.
    - Pharmacist: Read-only access to inventory viewing, searching, and reports.
- **Bulk Medicine Record Import** – Allows administrators to upload CSV files containing multiple medicine records for efficient data migration.
- **Inventory Management** – Supports adding, editing, and deleting medicine records with quantity and expiration details.
- **Employee Management** – Supports adding, editing, and deleting employees data.
- **Expiration Monitoring** – Automatically identifies medicines nearing expiration and generates reports.
- **Quantity Monitoring** – Flags medicines with low stock quantities based on predefined thresholds.
- **Search Functionality** – Enables quick retrieval of medicine records using a search bar.
- **Inventory Reports** – Generates reports for expiration status and stock quantity levels.

3.6 Development Procedure

1. **Requirement Analysis** – Identify inventory, role-based access, and reporting requirements.
2. **Source Code Review** – Analyze the original open-source pharmacy management system by Varshini E.
3. **System Customization** – Remove unrelated modules and implement role-based access control.

4. **Bulk Import Implementation** – Develop a CSV file upload and parsing feature for bulk medicine data migration.
5. **Database Enhancement** – Populate the MySQL database with imported and manually entered medicine datasets.
6. **Interface Adjustment** – Modify the interface to reflect administrator and pharmacist access levels.
7. **Testing and Validation** – Test inventory accuracy, role restrictions, and bulk import functionality using simulated data.

3.7 Source Code Attribution and Modification

This study is based on an open-source web-based pharmacy management system developed by **Varshini E.**, implemented using PHP and MySQL. The original system was designed to manage pharmacy inventory, customer records, employee information, suppliers, purchases, and sales.

For this research, the source code was modified to align with the objectives of inventory and expiration monitoring. Several components unrelated to the study scope were removed, while new functionalities, such as bulk data migration and expanded inventory datasets were added. These modifications ensure that the resulting system reflects the specific goals of this study while maintaining proper attribution to the original developer.

In addition to feature removal and enhancement, a bulk data import mechanism was implemented to support efficient migration of medicine records. This feature was not part of the original system and was developed specifically for this study. User roles were also redefined to align with real pharmacy workflows, ensuring appropriate access control between administrators and pharmacists.

Summary

This chapter presented the methodology used in developing PharmaTrack as a standalone, web-based pharmacy inventory and expiration monitoring system. By adapting an existing PHP–MySQL open-source application, the study demonstrates how targeted system modification and dataset enhancement can produce a functional prototype suitable for academic evaluation. The methodology emphasizes simplicity, correctness, and alignment with real-world pharmacy inventory needs while avoiding integration with live POS systems.

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