IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 1, December 2025
Impact Factor: 7.67

An ECRM System Design for CLINIC and PHARMACY Management

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Abstract: *Operational inefficiencies present a major hurdle for small to medium-sized healthcare facilities, stemming primarily from disconnected digital solutions and reliance on manual record-keeping for inventory and sales. This paper details the development of an Electronic Customer Relationship Management (eCRM) system specifically designed to streamline the operations of clinics and pharmacies. The system utilizes the Flutter framework, enabling cross-platform deployment to web, mobile, and desktop environments from a single codebase. The backend is powered by Supabase, leveraging PostgreSQL for a secure, relational database and offering built-in authentication and real-time capabilities. Key functionalities include medicine inventory management with automated expiry date tracking, sales recording with automated calculations, and systematic tracking of vendors, stockists, and medical representative (MR) visits. The implementation adheres to modern clean architecture principles, utilizing the Provider pattern for efficient state management. Testing confirms successful, efficient database operations and a responsive user interface, thereby offering an affordable and scalable solution for digital transformation in local healthcare settings.*

Keywords*:* eCRM, Healthcare Management, Flutter, Supabase, Inventory Management

I. INTRODUCTION

Operational inefficiencies present a major hurdle for small-scale healthcare providers, including clinics and pharmacies, due to reliance on traditional paper-based or disconnected digital systems[8]. This lack of integration leads to several critical issues:

- **Inventory Inaccuracy:** Manual record-keeping causes stock-outs or wastage from expired medications.
- **Time-Consuming Reporting:** Generating reports for sales tracking and business analysis is inefficient without an integrated system.
- **Fragmented Relationship Management:** Organizing documentation for relationships with multiple vendors, stockists, and medical representatives (MRs) is inefficient using paper-based methods.

The objective of this project was to develop a **comprehensive, user-friendly, and affordable digital solution** that manages all aspects of clinic and pharmacy operations across multiple platforms (web, mobile, and desktop).

A. Key Objectives

The primary objectives guiding this development include:

- To develop a cross-platform application using the **Flutter framework**.
- To implement a comprehensive **medicine inventory management system** that tracks batch numbers, expiry dates, and quantities.
- To create a **sales recording module** that automates calculations and maintains historical sales records.
- To design modules for managing doctors, vendors, stockists, staff, and medical representative (MR) visits.
- To create an intuitive dashboard providing **real-time analytics** and low-stock alerts.
- To ensure data security and integrity using proper authentication and **Row Level Security (RLS)** policies.

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II. LITERATURE REVIEW

The evolution of **Customer Relationship Management (CRM)** systems has demonstrated their importance for competitive advantage. In the healthcare domain, **Healthcare Management Information Systems (HMIS)** are essential but often face implementation challenges like high costs. Pharmaceutical inventory management poses unique difficulties due to expiration dates and regulatory needs. Automated tracking systems, utilizing technology like barcodes, have proven effective in reducing waste and improving accuracy.

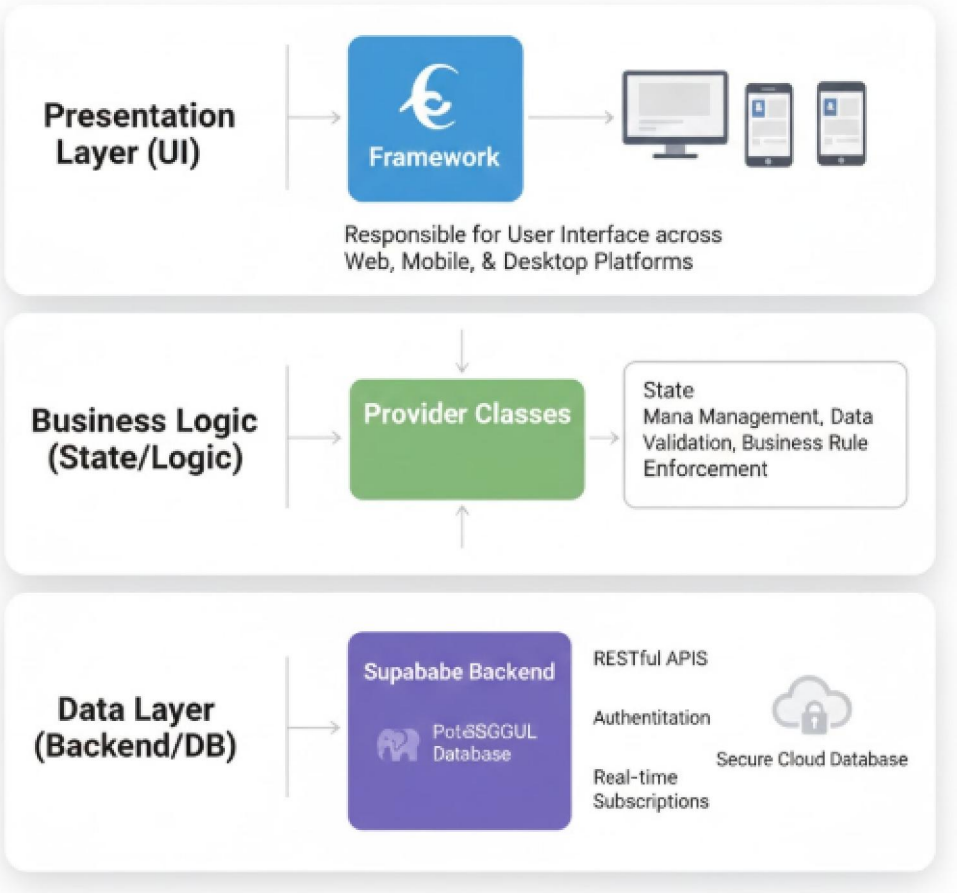
The technological choices for this system are supported by recent trends:

- **Database Systems:** The relational model remains foundational. Cloud-based Database-as-a-Service (DBaaS) platforms like **Supabase**, which offers PostgreSQL, provide enterprise capabilities to smaller organizations.
- **Cross-Platform Frameworks:Flutter** is recognized for achieving near-native performance while offering significant developer productivity through a single codebase.
- **Security:Row Level Security (RLS)** in PostgreSQL is critical for fine-grained access control, enforcing security policies directly at the database level.
- **State Management:** The **Provider pattern** is highly recommended in the Flutter ecosystem for its simplicity and efficiency.

III. MODELLING AND ANALYSIS

A. System Architecture

The eCRM system utilizes a **three-tier architecture** for improved maintainability and scalability.



DOI: 10.48175/IJARSCT-30103

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Explore

- **Presentation Layer:** Implemented using the **Flutter framework**, responsible for the user interface across web, mobile, and desktop platforms.
- **Business Logic Layer:** Managed by **Provider** classes, this layer handles state management, data validation, and business rule enforcement.
- **Data Layer:** Consists of the **Supabase** backend, providing a PostgreSQL database, RESTful APIs, and real-time subscriptions.

B. Database Design

The database schema includes nine primary tables: *Hospitals*, *Doctors*, *Staff*, *Vendors*, *Stockists*, *Medicines*, *Inventory*, *Sales*, and *MR Visits*. Relationships are primarily one-to-many, established through **Foreign Keys (FKs)**. Key features include:

- **Data Integrity:** Enforced by FK constraints and proper normalization.
- **Performance:** Optimized by creating indexes on foreign key columns (*doctor_id*, *medicine_id*, *vendor_id*, *stockist_id*).
- **Audit Trails:** Database triggers automatically update timestamp fields (updated_at) on record modifications.

C. Technology Stack

The stack was selected based on the need for cross-platform compatibility, development efficiency, and enterprise-grade reliability.

TABLE I	**TECHNOLOGY STACK SUMMARY**
Component	**Technology**
Frontend	**Flutter 3.8.1+ (Dart 3.0+)**
Backend	**Supabase**
Database	**PostgreSQL**
State Management	**Provider Pattern**

IV. EXPERIMENTAL ANALYSIS

The development process utilized an iterative and incremental approach, aligning with the Agile methodology.

A. Key Features Implementation

- **Data Modeling:** Dart classes were created with fromJson and toJson methods for seamless communication with the Supabase RESTful API.
- **State Management:** The **AppProvider** class, extending ChangeNotifier, maintains application state, with notifyListeners triggering UI updates when state is modified.
- **Sales Calculation:** The sales module implements **automated price calculation** by retrieving the medicine's unit price and multiplying it by the quantity sold, ensuring pricing consistency and eliminating manual errors.
- **Controlled Sales Workflow:** The system enforces that the medicine dropdown is filtered to show *only* stock assigned to the selected doctor, ensuring sales are recorded against available inventory.

B. Challenges and Solutions

- **Challenge: Schema Mismatches** Errors occurred due to inconsistent naming conventions (e.g., camelCase in Dart models vs. snake_case in PostgreSQL). **Solution:** Comprehensive auditing and standardization of field names were performed, with explicit mapping in JSON methods.

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- **Challenge: Foreign Key Violations** Records failed insertion when required relational entities (Vendors/Stockists) were missing[46]. **Solution:** The UI was updated to disable forms or display messages guiding users to add prerequisite data first.
- **Challenge: Missing Constraints** Medicine insertion failed due to a missing batch number field[48]. **Solution:** The model was updated, and the toJson method was modified to auto-generate a batch number if none was provided by the user.

V. RESULTS AND DISCUSSION

A. Testing Results

- **Functional Testing:** All CRUD operations were verified for correctness and adherence to data validation rules.
- **Validation Testing:** Thorough testing confirmed that the system prevents submission when required fields are empty, emails are malformed, or numeric inputs are invalid.
- **Cross-Platform Testing:** The application's UI layouts and functionality worked consistently across Windows, Chrome web browser, and Android platforms.

B. Performance Analysis

Performance testing yielded strong metrics:

- **Response Times:** Form submissions generally complete within **200–400ms**.
- **Database Efficiency:** Query performance is high due to optimized indexing on foreign key columns.
- **UI Performance:** Flutter maintains **60 FPS** during normal operations, with smooth scrolling achieved through Provider's efficient selective widget updates.
- **Network Efficiency:** API calls use efficient JSON serialization, and redundant network requests are reduced via caching in the AppProvider.

VI. CONCLUSION AND FUTURE SCOPE

A. Conclusion

This project successfully developed a comprehensive eCRM system that addresses the operational needs of clinics and pharmacies using modern cross-platform technologies. The successful integration of the **Flutter framework** and **Supabase backend** provides a scalable, efficient, and cost-effective digital solution. The system delivers core functionalities including expiry-aware inventory management, automated sales tracking, and complete relationship management, achieving significant improvements in data integrity and administrative efficiency.

B. Future Enhancements

Future development plans include:

- **Multi-Hospital Support:** Implementing true multi-tenancy with a hospital_id foreign key on all tables and strict RLS policies to enforce data isolation between different clinics.
- **Advanced Reporting:** Integrating interactive charts and graphs, and customizable date range selections for in-depth business intelligence and trend analysis.
- **Patient Management:** Adding basic patient demographics, visit history, and prescription management features to expand into a more comprehensive clinic management platform.
- **Mobile-Optimized Features:** Developing features like **barcode scanning** for medicine entry and implementing an offline mode with local caching and synchronization.

ACKNOWLEDGMENT

The author wishes to express sincere gratitude to Prof. N. S. Kulkarni for providing invaluable guidance, constant encouragement, and dedicated support throughout this project work[64]. The author is also thankful to the Head of

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Department, Prof. N. S. Kulkarni, and PG Coordinator, Prof. S. P. Salunkhe, for the opportunity to undertake this project[65].

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