**University Clinic Inventory with Dengue Forecasting and Dental Appointment**

An

Application Development Project

Presented to the Faculty of

**Mindoro State University Calapan City Campus**

Masipit, Calapan City

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Bachelor of Science in Information Technology

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**CHAPTER I**

**INTRODUCTION**

In this chapter, the researchers will discuss the overview of the project, including its project context, objectives and scope and limitations.

**Project Context**

Healthcare services are essential for maintaining the health and well-being of students, with university clinics often serving as their primary source of medical care. At Mindoro State University, the clinic offers vital services such as medical consultations, first aid, and student health monitoring. However, it faces challenges due to outdated management systems, including inefficient manual processes for tracking inventory, difficulties in scheduling appointments, limited communication between healthcare providers and students, and an absence of tools for anticipating health-related concerns. These issues can lead to delays, mismanagement of resources, and dissatisfaction among students relying on the clinic's services (Gonzales & Rivera, 2019).

To address these challenges, the development of a University Clinic System with Dengue Forecasting and Dental Appointment Management is proposed. This system will introduce several features to improve the clinic's operations. The dental appointment will allow students to schedule and reschedule appointments online, making the process more convenient and reducing waiting times. The system will also log dental visits and list available services, including tooth filling (pasta), extraction, and cleaning. To ensure better communication, dentists can send messages to their patients, and students will be able to reply through the system. Monthly reports will also be generated to summarize patient visits, treatments, and overall clinic activity.

The inventory management will allow admins to add, delete, and monitor supplies and medicines, ensuring efficient inventory tracking. A log history will maintain records of transactions for transparency and accountability. The system will also produce reports on stock levels, usage, and replenishment needs, helping the clinic maintain an adequate supply of resources.

To strengthen the clinic’s preparedness, the system will include dengue forecasting using the Seasonal Autoregressive Integrated Moving Average with Exogenous Variables (SARIMAX) model. This forecasting tool will analyze historical health data and external factors to predict the likelihood of dengue cases. With this information, the clinic can prepare resources, implement preventive measures, and address potential outbreaks in advance.

This system will integrate dental appointment scheduling, inventory monitoring, and health forecasting to transform the operations of the Mindoro State University Clinic. By improving processes, communication, and ensuring readiness for potential health concerns, the system will enhance the clinic's efficiency and the overall satisfaction of its users.

**Objectives**

The researchers aim to develop a smart clinic management system to address the inefficiencies in the current operations of the Mindoro State University clinic. By integrating smart technologies and predictive analytics, the study seeks to improve healthcare service delivery, enhance student satisfaction, and enable dengue forecasting through SARIMAX models.

Specifically, the objective of this study aims to:

1. Implement secure user authentication and access control for both students and healthcare personnel to ensure data privacy and security.
2. Establish an efficient inventory system that allows real-time tracking of medical supplies, ensuring the clinic remains fully stocked and prepared for student healthcare needs.
3. Introduce an appointment system that enables students to schedule consultations online, reducing waiting times and improving convenience.
4. Integrate a visit log feature in the dental appointment system to simplify and automate the check-in process, ensuring accurate and efficient recording of clinic visits.
5. Enhance communication between healthcare providers and students by integrating a messaging system that facilitates uninterrupted information exchange.
6. Provide the capability to generate customized reports and data analytics to support clinic management in making informed decisions about healthcare services.
7. Utilize the SARIMAX model for predictive analytics, enabling dengue forecasting and allowing the clinic to better prepare for and manage potential healthcare needs.

**Scope and Limitations**

This study aims to develop a University Clinic Management System for Mindoro State University to improve clinic operations and enhance healthcare access. The system is designed to address inefficiencies in current processes and provide better healthcare services. Key features include predictive tools for dengue forecasting, an appointment management system for dental services, inventory tracking, and user-friendly interfaces for both students and clinic staff. The goal is to streamline appointment scheduling, manage resources efficiently, and provide proactive health solutions.

The system uses a dengue forecasting tool powered by the SARIMAX model, which predicts dengue case trends based on historical and environmental data. This helps the clinic prepare for potential outbreaks and allocate resources in advance. Additionally, the dental appointment system allows students to schedule appointments online for services like tooth filling, extraction, and cleaning, and provides real-time updates. The inventory management feature ensures real-time tracking of medical supplies, sends low-stock alerts, and tracks product expiration. The system also includes a Patient Portal and Admin Dashboard for easy appointment scheduling, health data analysis, and reporting.

Despite these benefits, there are some limitations. The accuracy of the dengue forecasting model depends on the quality and availability of historical data, which may affect its reliability. While the system operates on a local network, ensuring smooth operation without the need for an internet connection, any issues with the network infrastructure could still affect the system’s performance. While the system follows privacy standards like HIPAA and GDPR, it remains vulnerable to cyber threats, so regular security updates are necessary. The system is focused specifically on clinic-related tasks such as dental services, inventory management, and dengue forecasting, and does not cover broader health monitoring. Lastly, the system’s success depends on its consistent use by clinic staff and students, which will require proper training and active engagement to ensure effective adoption.

**Definition of Terms**

* **SARIMAX (Seasonal Autoregressive Integrated Moving Average with Exogenous Variables)**- A predictive modelling technique used to analyse time-series health data, incorporating seasonality and external factors, to forecast potential illnesses and assist clinic staff in proactive decision-making.
* **HIPAA** **(Health Insurance Portability and Accountability Act)** - The system must comply with HIPAA regulations to protect patient health information. This includes enforcing data encryption, role-based access, and ensuring that sensitive health records are only accessible by authorized personnel. Clinic staff will undergo multi-factor authentication before accessing or updating health records.
* **GDPR** **(General Data Protection Regulation)** - As the system may serve users within the European Union (e.g., exchange students), it must comply with GDPR regulations. This includes allowing users to view, download, and request the deletion of their personal data. The system must also implement consent management, where users provide explicit consent for data usage in analytics.
* **API** **(Application Programming Interface)** - As the system may serve users within the European Union (e.g., exchange students), it must comply with GDPR regulations. This includes allowing users to view, download, and request the deletion of their personal data. The system must also implement consent management, where users provide explicit consent for data usage in analytics.
* **UI** **(User Interface)** - Refers to the design and layout of the system’s web and mobile interfaces. The UI will include the patient portal for health record viewing, the appointment booking interface, and the wellness program dashboard. A user-friendly UI is essential to ensure students, faculty, and clinic staff can interact seamlessly with the system.
* **Restock Level**: This is the minimum amount of stock you need to have before it's time to reorder. When your inventory drops to this level, it’s a signal to restock so you don’t run out.
* **Disbursement**: This is the act of giving out or distributing goods or resources. For example, it’s when you release products from storage to be used, sold, or delivered to customers.
* **Clinic Staff**: Personnel responsible for managing the operations and services of the university clinic, including inventory, patient care, and scheduling.
* **Student**: A registered individual at the university who can access the clinic’s healthcare services, including appointments and medical support.

**CHAPTER II**

**REQUIREMENTS SPECIFICATION**

In this chapter, the researchers will provide the hardware and software requirements, as well as functional and non-functional requirements necessary for the project development.

**Software Requirements**

Software Specifications refer to the representation of the software used by the system. Table 1 below presents the software specifications to be used by the project.

|  |  |
| --- | --- |
| Software Used | Description |
| WebSocket | WebSocket enables full-duplex communication channels over a single TCP connection, providing a more interactive and real-time experience for web applications. |
| SARIMAX | SARIMAX to model that captures trends, seasonality, and external factors to predict illnesses like dengue for better clinic preparedness. |
| GitHub | GitHub to enable collaboration and project management. |
| Google Calendar | Google Calendar to enable scheduling, event management, and reminders for personal and professional use. |
| Web Scraping: CDC API | Offers various APIs to access public health data, including disease statistics and health programs from the Centers for Disease Control and Prevention. |
| Python | enable versatile programming for web development, data analysis, machine learning, and automation. |
| Node.js | enable server-side JavaScript execution and build scalable network applications. |
| Node Mailer | Enable to send emails easily from Node.js applications with support for various transport methods. |
| Vue.js | Vue.js v3.2.45 with Vue CLI for a simplified frontend development with intuitive API, fast rendering, and robust build setup. |
| Mysql | MySQL v8.0.32 for a high-performance relational database management system. |
| Pickle | Enable serialization and deserialization of Python objects for easy data storage and transfer. |
| RESTful API | Enable communication between client and server using standard HTTP methods for resource manipulation. |
| JWT (JSON Web Tokens) | Enable secure transmission of information between parties as a JSON object, often used for authentication and information exchange. |

**Table 1: Software Requirements**

**Functional Requirements**

This part enumerates the operations and activities that the system must perform. Table 2 represents the descriptions of data requirements, process requirements, and output requirements.

|  |  |
| --- | --- |
| **ID NO** | **Requirement Description** |
| **FR1** | **Data Requirements** |
| **General** | |
| 1.1 | User Authentication Data - Enable patient registration and login for students, with authorization from the university clinic staff. Role-based access control will be implemented to ensure data security and privacy for both patients and healthcare providers |
| **Inventory Management** | |
| 1.2 | Batch Item Addition   * Administrators can log in to the system and navigate to the Inventory Management section. * Administrators can select the option to Add Items in Batch and upload a CSV or Excel template with details such as item name, quantity, and expiry date. * The system will validate the uploaded data for consistency (e.g., no negative quantities, valid expiry dates). * The inventory list will be updated, and the administrator will receive confirmation of the items added. * The system will monitor inventory levels and automatically generate notifications when any item’s stock falls below a predefined threshold or when the expiry date is approaching. * Notifications will be sent via email to the administrator. * The Administrator can take necessary actions, such as placing a new supply or removing expired stocks. |
| 1.3 | Low Stock and Expiry Notifications   * The system will monitor inventory levels and automatically generate notifications when any item’s stock falls below a predefined threshold or when the expiry date is approaching. * Notifications about items nearing expiration will be displayed in the footer of the interface, providing administrators with real-time, easily accessible reminders to manage inventory. * The administrator can take necessary actions, such as placing a new order or removing expired stock. |
| 1.4 | Transaction and Audit Logs   * Every inventory transaction (e.g., adding new stock, updating quantities, removing expired items) will be logged automatically. * The log will capture details such as the user’s name, date/time of action, and type of transaction. * Administrators can access and review the log for transparency and accountability. * Log entries will be protected from alteration or deletion to maintain integrity. |
| 1.5 | Yearly Report Generation   * At the end of each year, administrators can generate transaction reports summarizing inventory usage, organized by medication, month, and day, including details such as total usage per item, stock-outs, wastage due to expiry, and restocking patterns. * These reports will be available for export in PDF or Excel format, ready for printing. |
| 1.6 | Inventory Dashboard   * Administrators will have access to the Inventory Dashboard, which will display key metrics such as:   + Current stock levels.   + Low-stock items and those near expiry.   + Recent inventory transactions. |
| **Dengue Forecasting** | |
| 1.7 | SARIMAX Forecasting Model   * The system will gather historical health incident data (e.g., past dengue cases) and external factors (e.g., weather conditions) from internal or third-party sources. * The SARIMAX model will analyze the data to identify trends and patterns in potential dengue outbreaks. * The model will predict dengue cases based on seasonal patterns and external variables such as rainfall. * Alerts will be triggered based on the predictions, recommending specific actions to prepare for potential outbreaks. |
| **Dental Appointment Scheduling** | |
| 1.8 | Student Portal for Booking Appointments   * Students will log in to the Dental Appointment Portal and select an available doctor and a time slot from the available options. * The system will prevent double bookings by validating the appointment time and notifying students of any schedule changes in real-time. |
| 1.10 | Appointment Management   * Clinic staff will have access to the Admin Dashboard, where they can manage appointments by rescheduling or canceling them as necessary. * Appointment changes will trigger automatic notifications to students about any modifications. |

**Table 2: Functional Requirements**

**Non-Functional Requirements**

These are requirements that pertain to behavior properties that a system must have. It defines how a system is supposed to be or its system properties. It contains the following:

**Operational Requirement**

Table 3 represents the requirement description that will specify the operating environment(s) in which the system must perform and how these might change over time.

|  |  |
| --- | --- |
| ID No. | **Requirement Description** |
| 1.1 | The system must maintain an uptime of 99.9%, ensuring availability during critical times, especially for dengue forecasting and dental appointment management. |
| 1.2 | Data must be automatically backed up every 24 hours and stored securely for at least30 days to protect against data loss. |
| 1.3 | The Patient Portal and Admin Dashboard must have a simple, intuitive interface to ensure easy navigation for both clinic staff and students. |
| 1.4 | The system should be built with a modular architecture, allowing easy updates and integration of new features, such as additional health services or updated forecasting models. |
| 1.5 | Full technical documentation will be provided, including system architecture, API specifications, and user manuals for system maintenance and future upgrades. |
| 1.6 | The system will seamlessly integrate with third-party services, such as GoogleCalendar for appointment scheduling and reminders. |
| 1.7 | The system must handle API changes without disrupting the core functionality. |

**Table 3: Operational Requirement**

**Performance Requirement**

Table 4 represents the requirement description that will emphasize the response time, capacity, and reliability of the system.

|  |  |
| --- | --- |
| ID No. | **Requirement Description** |
| 1.8 | Data updates (e.g., appointment bookings, inventory changes) must reflect on all connected devices within 2 seconds to ensure real-time updates. |
| 1.9 | The system must handle up to 10,000 concurrent users without significant performance degradation. |
| 1.10 | The system must remain stable and responsive during peak periods, such as during health emergencies or high-demand appointment scheduling. |

**Table 4: Performance Requirement**

**Security Requirement**

Table 5 represents the requirement description that will address issues with security, such as who has access to the system's data and must have the ability to protect data from disruption or data loss.

|  |  |
| --- | --- |
| ID No. | **Requirement Description** |
| 1.9 | All sensitive information, such as health records and inventory data, must be encrypted using 256-bit encryption during transmission and while stored in the database. |
| 2.0 | Multi-factor authentication (MFA) should be required for clinic staff and sensitive actions like updating health records or accessing the admin portal. |
| 2.1 | The system must comply with HIPAA (Health Insurance Portability and Accountability Act) for healthcare data security and GDPR (General Data Protection Regulation) for user privacy, particularly for international students. |

**Table 5: Security Requirement**

**Chapter III**

**Design and Development Methodologies**

**System Design**

The University Clinic Management System is an integrated platform designed to enhance healthcare services and improve operational efficiency by managing key aspects like inventory tracking, dengue forecasting, and dental appointment scheduling. This system provides a streamlined approach to healthcare management, ensuring that resources are efficiently allocated, health risks are proactively managed, and appointments are easily scheduled.

The frontend of the system is developed using Vue.js, a progressive JavaScript framework that allows for the creation of dynamic, user-friendly interfaces. Vue.js ensures that the system’s user interface is responsive and interactive, making it easy for users to manage inventory, view forecasted health risks, and schedule or manage dental appointments. With Vue.js, the frontend seamlessly integrates with the backend, offering a smooth and intuitive experience for both clinic staff and patients.

The backend of the system is built using Node.js and Express.js, which provide a robust foundation for handling server-side logic and data management. Node.js ensures that the system can handle numerous simultaneous requests efficiently, while Express.js simplifies the creation of APIs for the system's core functions such as inventory management, appointment scheduling, and dengue forecasting. Together, these technologies ensure a scalable, secure, and fast backend that supports the functionality of the University Clinic Management System.

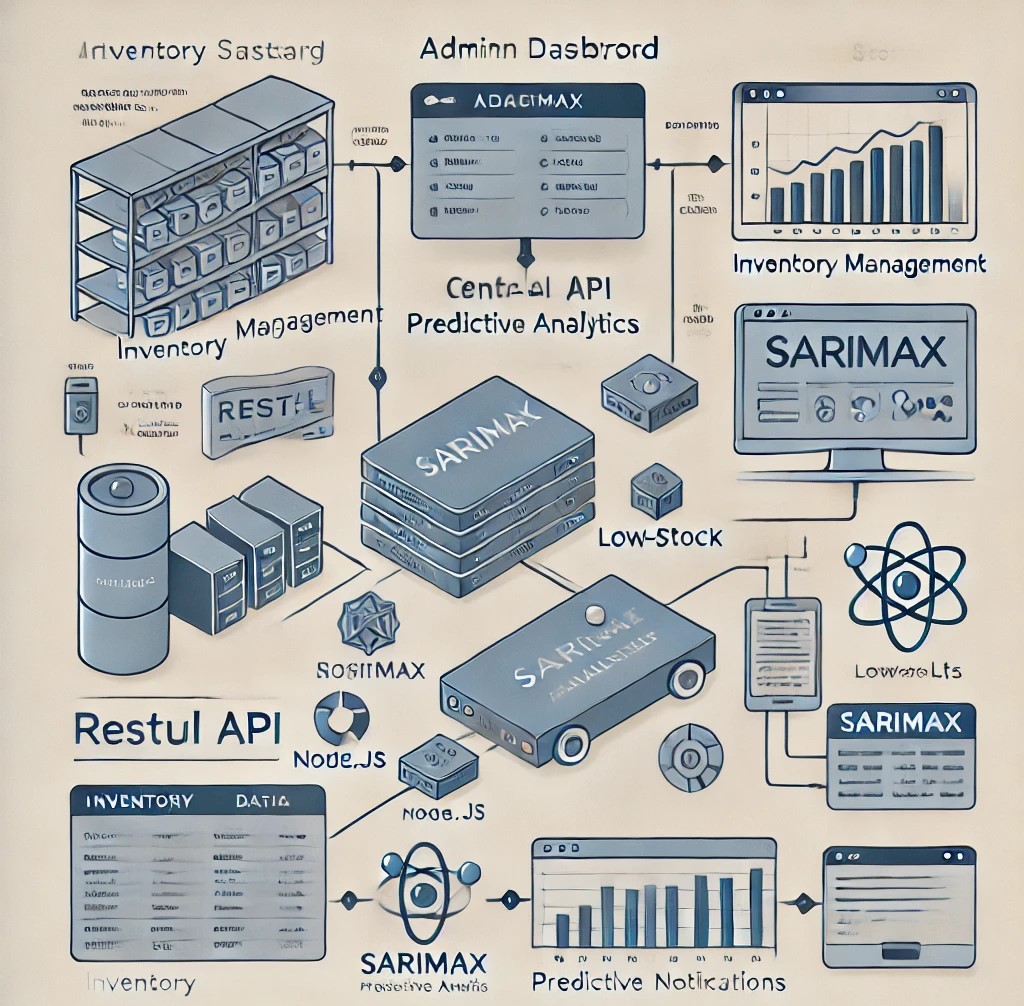
**Database Design**

The database design for the University Clinic Inventory with Dengue Forecasting and Dental Appointment System is a critical component of the application’s development. It serves as the backbone for managing clinic resources, monitoring public health trends, and scheduling dental appointments, ensuring that users can efficiently navigate and interact with the system. The design involves defining tables for each entity within the system, detailing the fields in use, their data types, and providing clear descriptions for each element. This process ensures that the data is organized effectively and can be easily accessed for operational and reporting purposes. Additionally, the design highlights the relationships between different entities such as inventory items, dengue cases, weather data, and appointment schedules.

MySQL has been chosen as the relational database management system (RDBMS) for the University Clinic Inventory with Dengue Forecasting and Dental Appointment System due to its ability to handle complex relationships between tables and its scalability for future growth. By leveraging MySQL’s capabilities, the system ensures that data is well-managed and that different modules of the clinic, including inventory management, forecasting, and appointment scheduling, work seamlessly together. This database design is tailored to meet the unique needs of the university clinic, providing a robust and efficient structure for handling critical healthcare and operational data.

**Architectural Diagram/ Block Diagram**

In this section, system architecture was designed to define the flow and behavior of the system’s functionalities to execute its high-quality performance. This covers the formal illustration and description of the project structure.

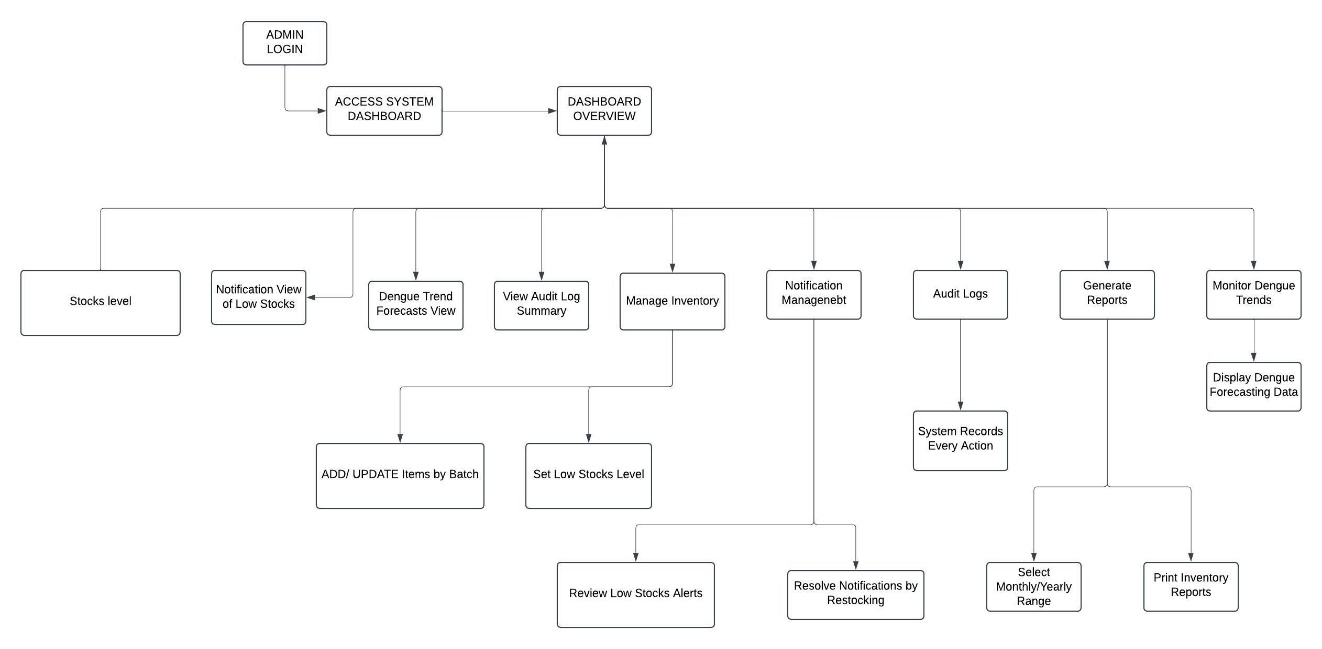


**Figure 1. System Architecture of Smart University Clinic Management**

Figure 1 shows the system architecture for the development of the University Clinic Inventory with Dengue Forecasting and Dental Appointment System with SARIMAX Predictive Analytics, outlining the key components and their interactions. The system consists of two primary interfaces: the Admin Dashboard for managing inventory and generating reports, and the central RESTful API powered by Node.js and Express.js, which acts as a communication bridge between the frontend interfaces and the backend. This API facilitates secure and efficient data flow for inventory tracking, low-stock notifications, and predictive forecasting. The backend includes a database where inventory data, transaction logs, and forecast results are stored. The SARIMAX module, integrated within the system, processes historical inventory data and external variables to predict future stock trends. This predictive capability enables administrators to proactively manage inventory by forecasting needs, reducing stock outs, and optimizing stock levels. The architectural design ensures seamless data management, secure interactions, and an intuitive user experience for administrators in managing inventory and generating actionable insights.

**DFD Level 0**

The Level 0 Data Flow Diagram is an enhanced representation of the context diagram that provides a thorough analysis of the project's operating processes. It serves as a roadmap, visually showing the complicated connections and data flows throughout basic activities, allowing for a thorough knowledge of the system's performance.



**Figure 2. Data Flow Diagram Level 0**

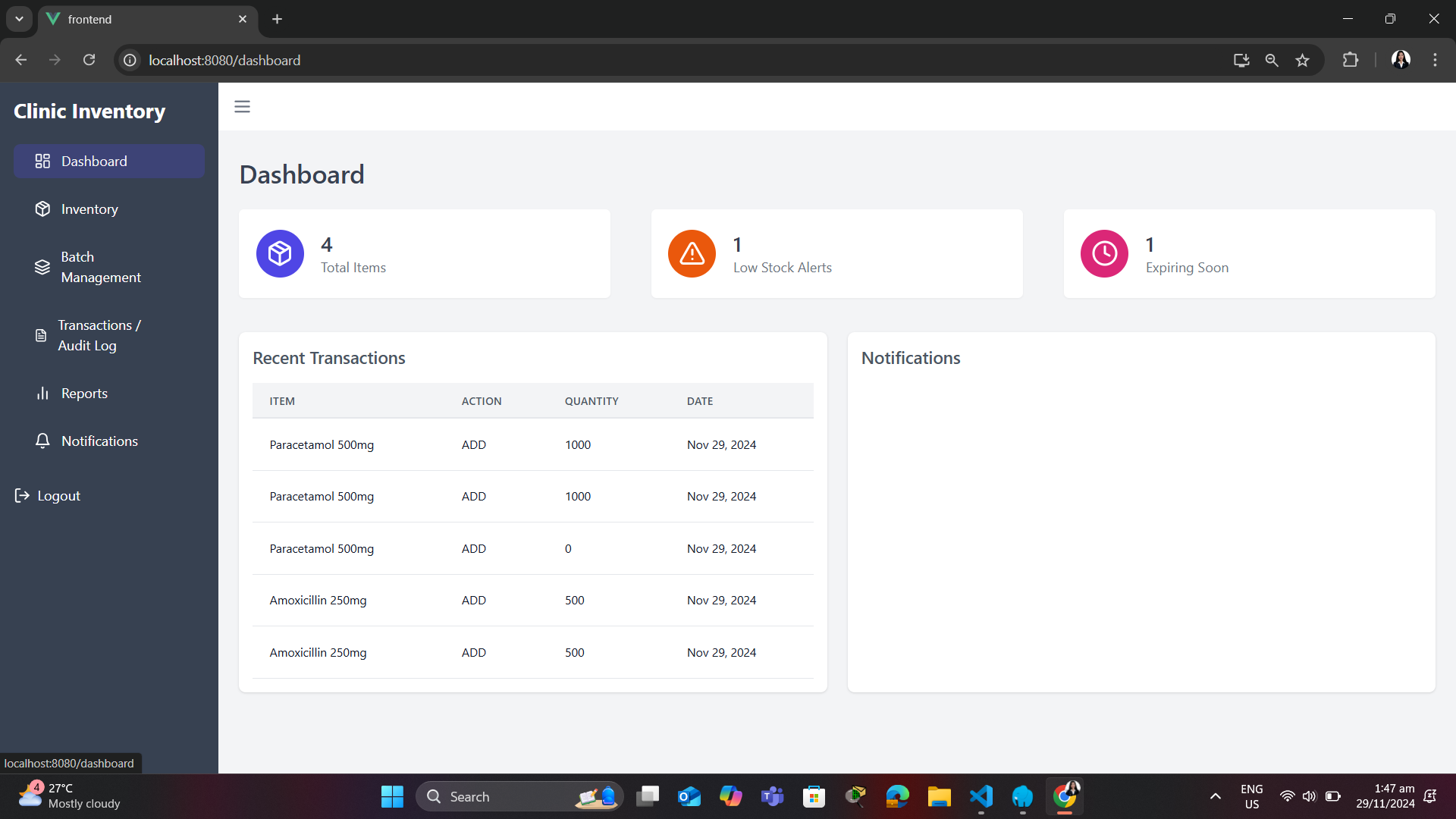
Figure 2 outlines the University Clinic Inventory with Dengue Forecasting and Dental Appointment System, highlighting the administrator's role in keeping stock levels efficient. The Admin Dashboard acts as the central hub, showing real-time stock levels, low-stock alerts, dengue trend forecasts, and audit logs.

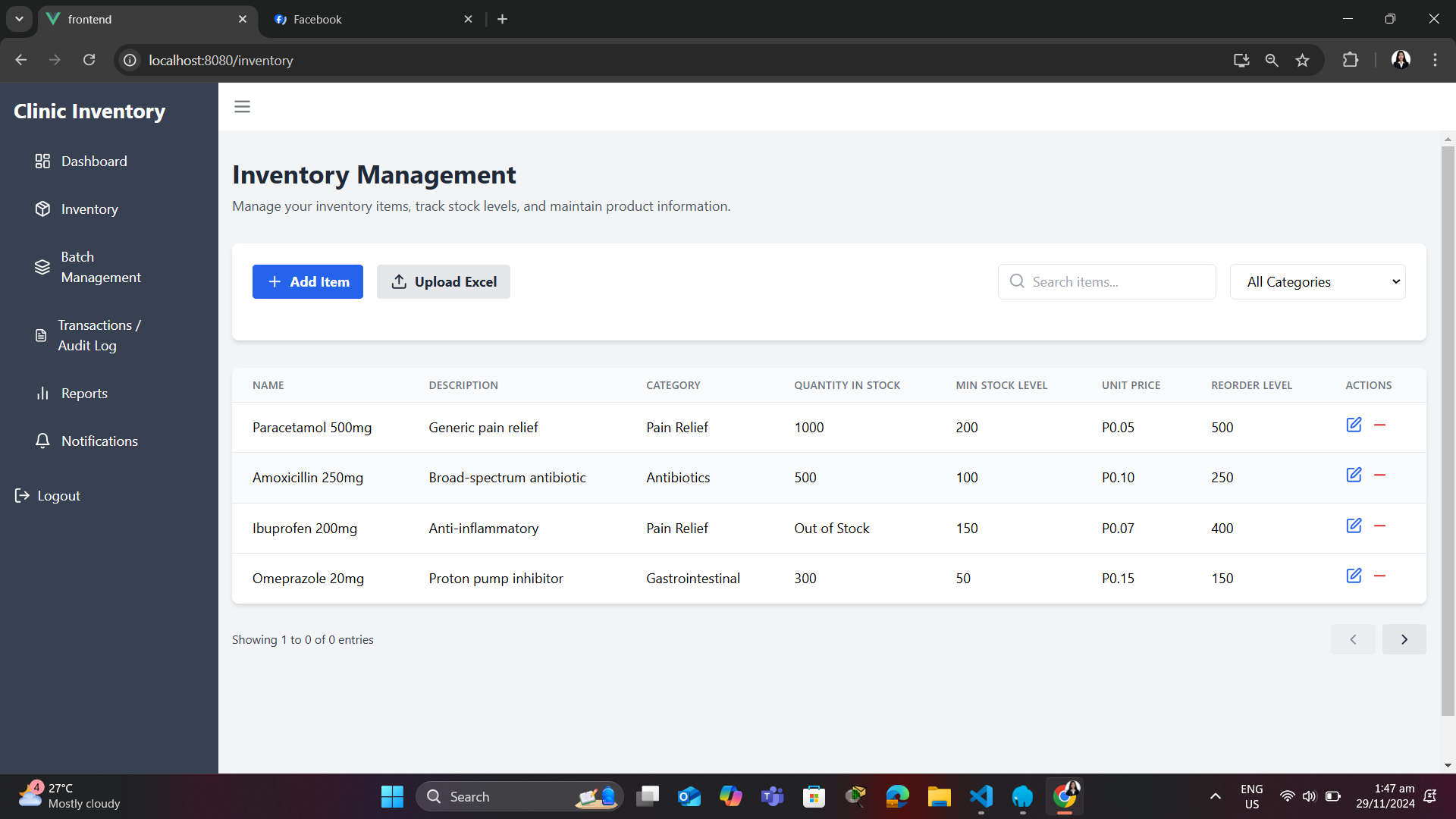
The system allows administrators to update items in batches, set low-stock thresholds, and receive notifications when inventory needs restocking. All actions, such as item updates and resolving alerts, are automatically logged in the Audit Logs for accountability.

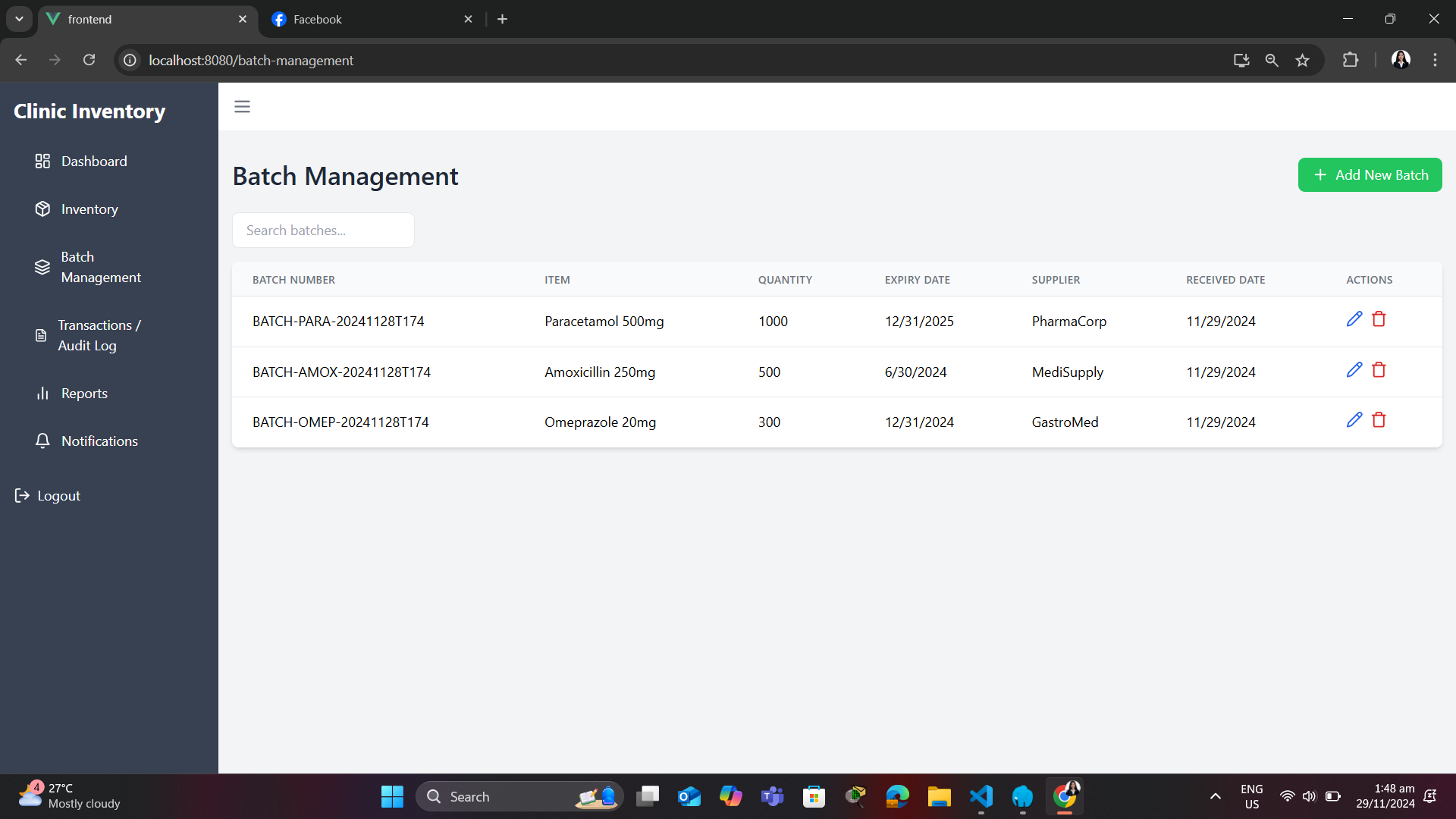
Administrators can generate detailed monthly or yearly reports for analysis and planning. The system also includes a Dengue Forecasting feature, helping admins plan inventory based on seasonal trends and potential health-related demands.

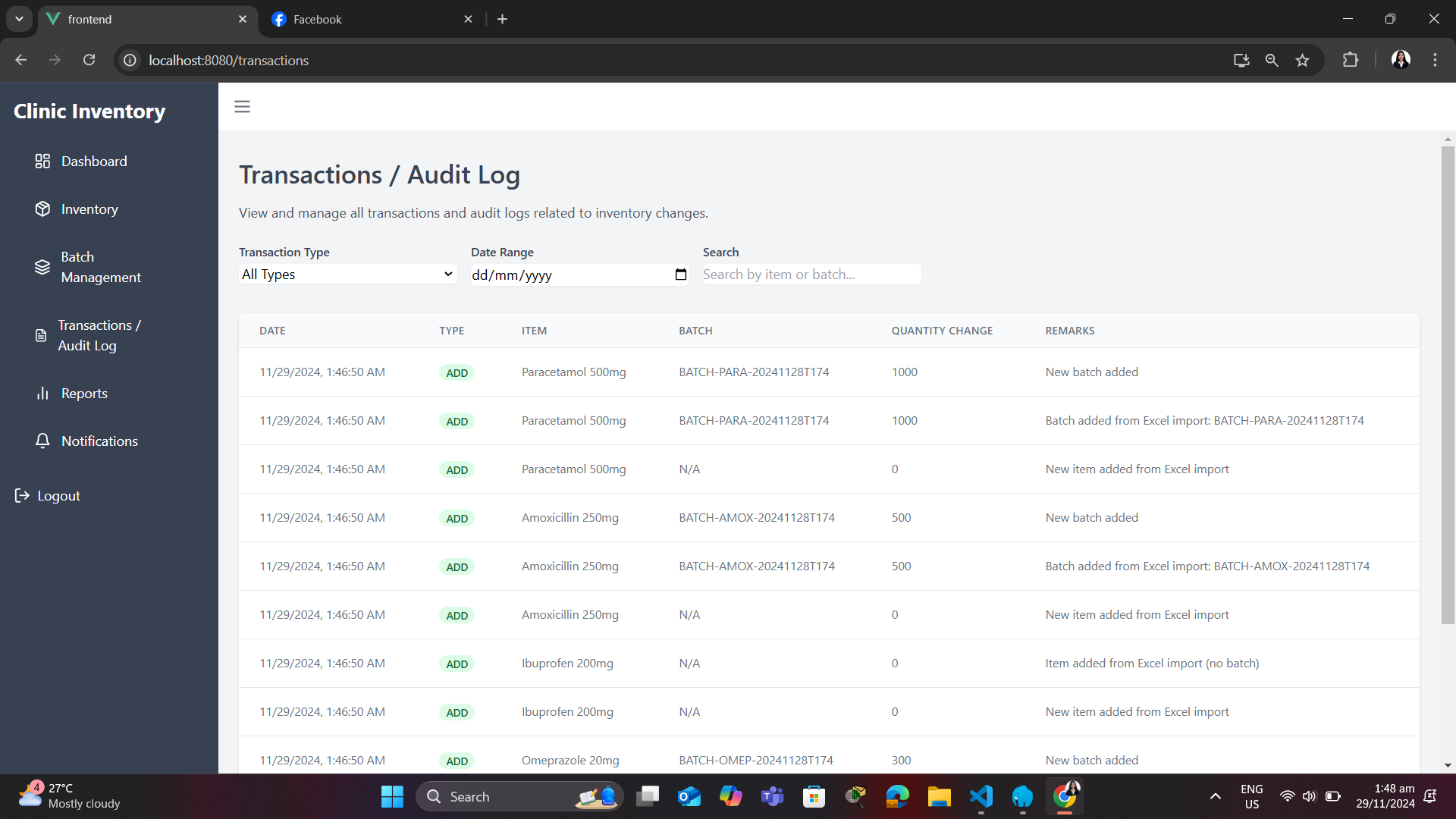
**Sample Mock-up**

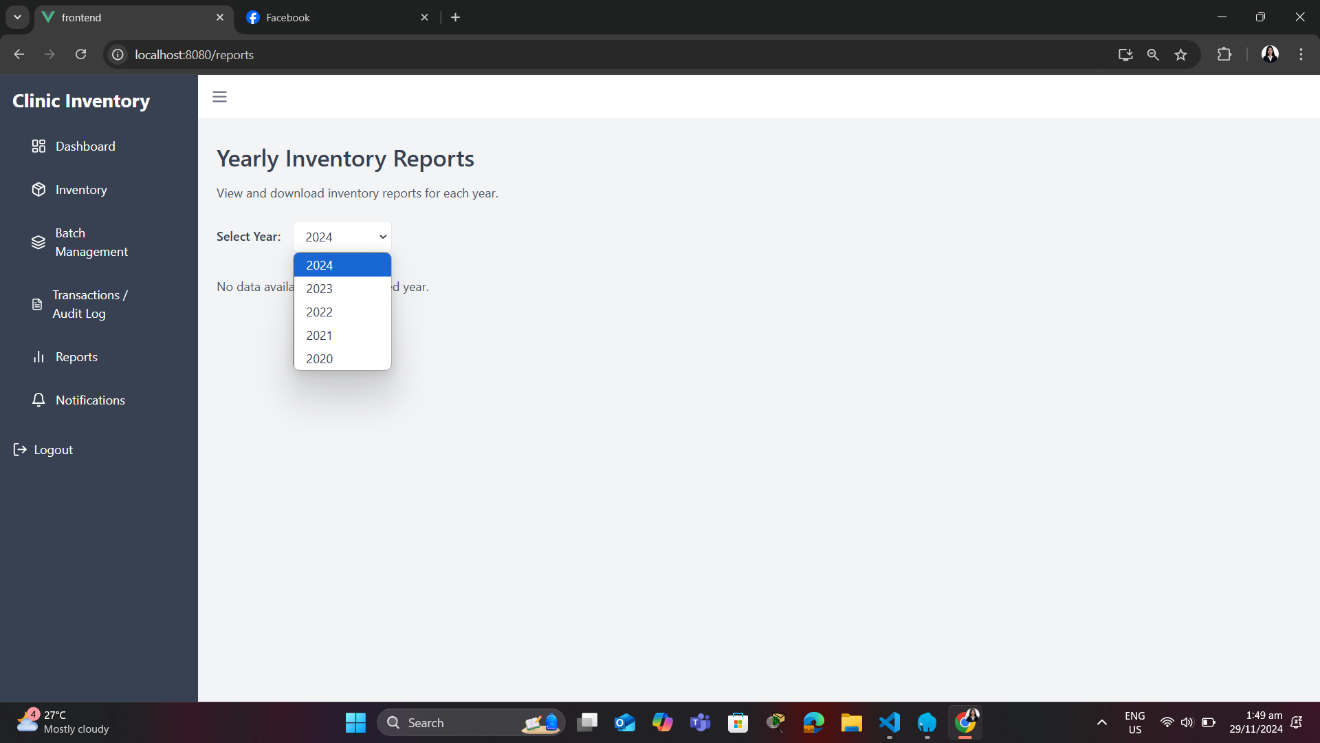
Sample mock-up is the visual representation of the website, that showing the functions and layout. It helps in considering the overall user experience, ensuring that the design meets user expectations and usability standards.

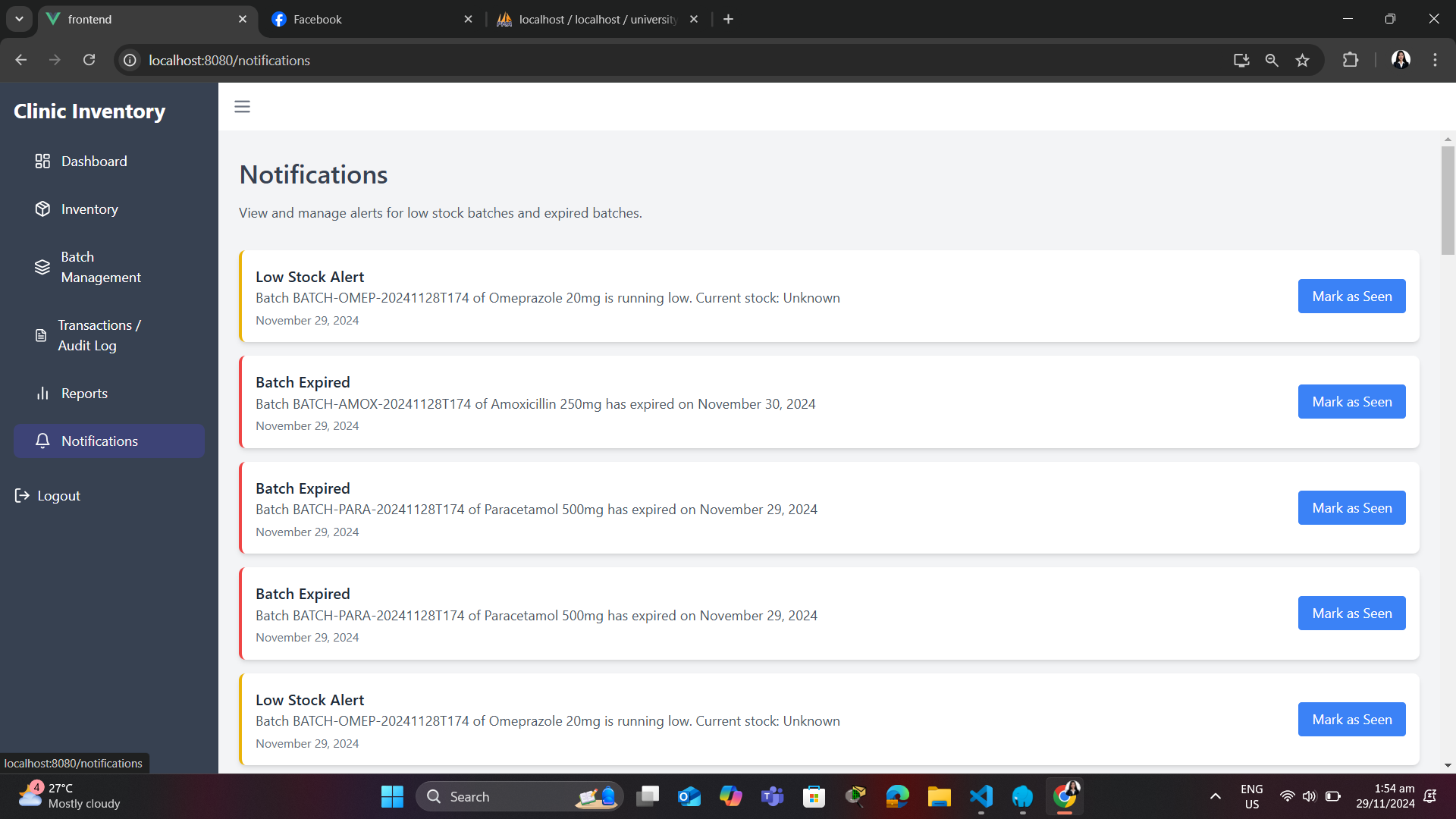
 **Figure 3. Admin Interface**







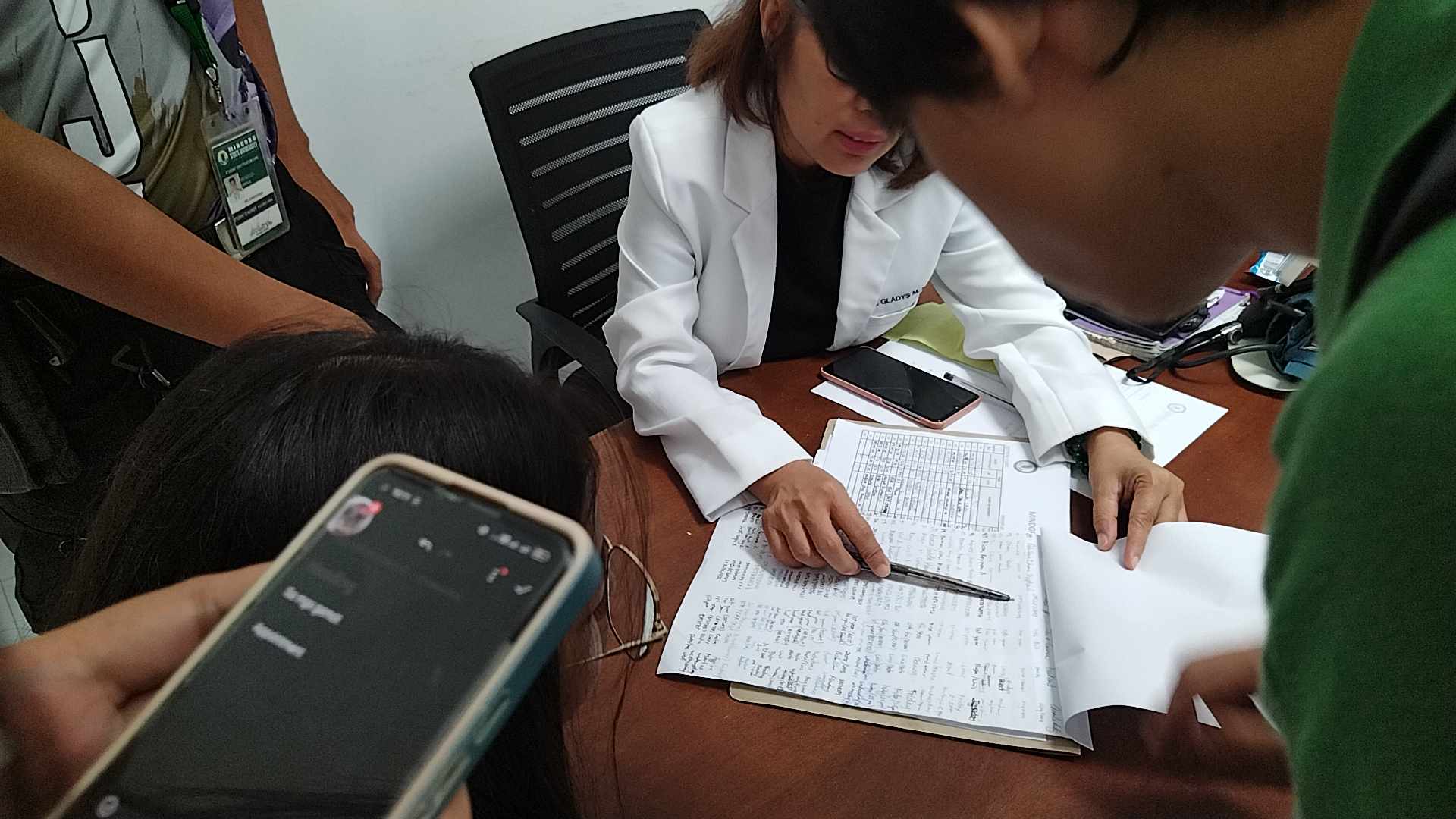


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**Picture During Development, Testing & Evaluation**



A group of people sitting at a desk

Description automatically generated