**MediInSight: AI-Driven Medicine Demand Predictor**   
A thesis submitted

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This thesis has been

Accepted by the faculty

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Generative AI and Originality Declaration

We, the following students, solemnly declare that the work presented in our undergraduate project, titled “**MediInSight: AI-Driven Medicine Demand Predictor**”, is solely our work with no significant contribution from any other person or Generative AI Tools. Small contribution/help wherever taken has been duly acknowledged/cited and that complete project has been written by us in accordance with the latest plagiarism policy declared by HEC and our respective university in-line with the policy for use of Generative AI Tools.

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**Abstract**

Accurate demand forecasting for medicines optimizes inventory, reduces stock-outs, and ensures better responsiveness in health care. In this project, with **pharmaceutical data**, a hybrid intelligent system is proposed by incorporating **weather and other environmental variables** into the model to provide an improved predictive performance over traditional approaches using only historical sales-based models. This proposed model will be holistic in nature, considering climatic factors-temperature, humidity, rainfall-that eventually shape the seasonal prevalence of diseases and, thereby, medicine consumption.

The architecture is composed of three major components: a **Data Integration and Preprocessing Module** that fuses historical sales and weather datasets; a **Forecasting Engine** utilizing AI and machine learning techniques like Neural Prophet Model, Random Forest, XGBoost, and LSTM networks to model both linear and nonlinear dependencies; and a Visualization Dashboard that displays the regional and temporal predictions as interactive charts. Comparative analyses between weather-independent and weather-integrated models will be conducted to assess improvements in forecast accuracy and model interpretability.

Integrating data analytics with climate-aware forecasting, this work provides a practical framework for pharmaceutical distributors, healthcare providers, and policymakers. The result will be to facilitate proactive inventory management, enhance supply chain resilience, and promote evidence-based decision-making in the face of seasonal and environmental variability.

The main goal of this project is to deliver a comprehensive solution that enables efficient forecasting of medical needs and disease trends. It envisages intelligent data analysis and AI-driven predictions as the means toward meeting this objective by reducing medicine shortages, enabling timely interventions, and strengthening overall responsiveness in health systems against seasonal and regional variations.

# **SDGs Feedback by Students**

|  |  |  |
| --- | --- | --- |
| **SDG Name** | **Target** | **Feedback by Student** |
| |  |  | | --- | --- | | Good Health and Well-being (SDG3) |  | | This project supports sustainable healthcare development by leveraging Artificial Intelligence to forecast medical sales and disease outbreaks based on seasonal trends. By enabling early detection of medicine demand and potential public health risks, the system contributes to better preparedness, efficient resource allocation, and enhanced access to essential medicines. It promotes a data-driven healthcare infrastructure, ensuring timely interventions and supporting universal health coverage efforts. | Through this project, we gained valuable experience in applying artificial intelligence to real-world healthcare challenges. We enhanced our understanding of predictive modeling, data visualization, and ethical AI use, while also learning how technology can support public health goals. This project not only strengthened our technical skills but also deepened our awareness of the social impact of innovation, especially in improving medical accessibility and disease preparedness. |
| **Industry, Innovation and Infrastructure (SDG 9)** | This project builds resilient healthcare infrastructure by integrating weather analytics with supply chain management using machine learning. | We developed an innovative forecasting system to modernize pharmaceutical inventory management. |
| Sustainable Cities and Communities (SDG 11) | This project helps create climate-resilient health systems in urban and rural areas by preparing for weather-related health impacts. | We aimed to make communities more prepared for climate-sensitive diseases through better medicine planning. |
| Climate Action (SDG 13) | This project supports climate adaptation in healthcare by using weather data to anticipate climate-related medicine needs. | We connected climate patterns with public health planning to build climate-responsive healthcare systems. |

# **CCP Feedback by Students**

|  |  |
| --- | --- |
| **Attributes** | **Feedback by Student** |
| **Prototype Level and Depth of Analysis** | Developed an AI-powered forecasting application capable of analyzing historical medicine sales data in conjunction with seasonal patterns to predict future demand and potential disease outbreaks. Integrated machine learning algorithms to identify seasonal trends and generate forecasts based on weather periods (monsoon, winter, summer). The system enables season-wise analysis and forecasting, allowing healthcare providers and suppliers to plan and allocate resources efficiently according to seasonal requirements. Emphasized ethical AI use by ensuring unbiased data processing and maintaining transparency in prediction results. The prototype incorporates user-friendly dashboards for seasonal trend interpretation, promoting informed decision-making across various healthcare and pharmaceutical stakeholders based on time-based weather patterns rather than geographical divisions. |

# **PBL Feedback by Student**

|  |
| --- |
| **Feedback by Student** |
| The following problems were solved:  Addresses the problem of unpredictable medicine demand and slow response to seasonal disease outbreaks, this paper presents an AI-driven forecasting tool. The system analyzes historical sales data and seasonal weather parameters for predictive modeling with high accuracy for future medical needs. It provides healthcare providers and pharmaceutical distributors with season-aware, data-driven insights to make the needed drugs available at the proper time. The whole project encourages proactive planning, reduces the risk of stock shortages or overstocking, and enhances public health preparedness by leveraging demand anticipation based on seasonal trends and weather-related health patterns. |

# CHAPTER # 1

**Introduction**

## Introduction

## Background

The pharmaceutical and healthcare industries have not been able to respond adequately to unpredictable demand for medicines due to seasonal changes in disease patterns. These demand fluctuations directly impact patient care and public health outcomes, creating critical challenges for medical providers. Seasonal factors like temperature, humidity, and rainfall predominantly make a difference in the demand for certain medicines, while traditional methods of forecasting are incapable of using such dynamic environmental factors. Current systems lack the analytical capability to correlate weather patterns with medicine requirements, leading to inefficient resource allocation.

Many healthcare providers and pharmacies still have to rely on historical sales data and manual estimations that do not take into account real-time weather influences. Due to this fact, medical inventories frequently suffer from such problems as overstocking or shortages, especially during seasonal outbreaks of weather-sensitive illnesses like flu, allergies, or some types of respiratory infections. This inefficiency not only affects healthcare delivery but also results in significant financial losses due to expired medicines or emergency procurement.

Artificial Intelligence and machine learning now provide a modern solution to this challenge. By leveraging the historical sales of medicines against seasonal weather, AI models identify subtle patterns and make far more accurate predictions about future demands. These systems enable timely, informed decisions that help ensure adequate supplies of lifesaving medicines when and where they are needed. The integration of machine learning algorithms with weather analytics represents a paradigm shift in healthcare inventory management.

The following project presents a seasonal medicine demand forecasting system based on artificial intelligence that uses combined sales data with weather parameters. The application leverages machine learning to identify trends, take proactive planning measures, and ensure wastage reduction for healthcare stakeholders in order to maintain better responsiveness in public health, while only considering seasonal influences and not regional or supply-chain factors. This approach aims to transform how healthcare providers anticipate and address seasonal medicine requirements through data-driven insights.

## Problem Statement

The accurate prediction of medicine demand during different seasonal periods remains a persistent challenge within the healthcare and pharmaceuticals industries. Traditional forecasting methods often rely on historical data that is out-of-date, generalized assumptions, or manual inventory reviews which cannot capture the dynamic nature of health trends influenced by seasonal variations. The results are critical inefficiencies: medicine shortages during peak seasonal demand and overstocking during off-peak periods, compromising both patient care and resource management.

Seasonal health patterns are influenced by various factors, including climate conditions, weather changes, and historical sales data during specific seasonal periods. In practice, however, these variables are rarely combined in real-time analytics with the aid of intelligent systems. Lacking a comprehensive AI solution, healthcare providers and pharmaceutical suppliers are not equipped to anticipate seasonal changes in demand or emerging health risks associated with weather patterns.

What is required to overcome this challenge is a predictive application that integrates multiple data sources and deploys artificial intelligence to generate accurate seasonal forecasts. Accordingly, season-specific planning and distribution of medicines can be done in a timely fashion, improving healthcare delivery and helping to manage seasonal demand fluctuations effectively.

## Objectives

The primary objective of this project is to develop an intelligent, accurate, and ethically responsible forecasting system that uses Artificial Intelligence to predict seasonal trends in medicine sales and potential disease outbreaks. The application aims to support better public health planning, efficient pharmaceutical distribution, and timely interventions by delivering data-driven insights through intuitive visualizations such as heatmaps and graphs. The key objectives are as follows:

## Train and Apply Predictive AI Models:

The goal of this objective is to develop and train predictive machine learning models capable of analyzing historical data and generating forecasts for medicine demand and disease outbreaks. The models will be trained on curated prototype datasets, which include factors such as seasonal variations, regional health patterns, and historical sales data. Various machine learning algorithms, including regression models, decision trees, and time-series analysis, will be evaluated and fine-tuned to ensure accuracy and robustness. Once trained, the models will be applied to predict future medicine needs and identify regions at high risk for disease outbreaks, enabling proactive healthcare planning. These predictions will form the foundation for data-driven decision-making in pharmaceutical supply chains and public health interventions.

## Implement Advanced Data Collection Techniques:

To simulate realistic forecasting conditions, utilizing prototype datasets representative of historical medical sales and seasonal disease trends. These curated datasets serve as a foundation to train and test AI models in the absence of real-time data, ensuring the system architecture will be ready for future integration of live inputs.

## Summarize Retrieved Data:

Once the predictive AI models have generated forecasts, it is crucial to present the results in a way that is both clear and actionable. This objective aims at summarizing the retrieved data by turning complex outputs from AI models into concise insights. The data summary shall include key metrics such as forecasted medicine demand, periods of seasonal risk, and weather-driven trends. These summaries will be provided using dynamic visualizations like trend graphs, seasonal analysis charts, and diagrams of forecasting, making the findings easy to interpret for healthcare professionals, pharmaceutical distributors, and policymakers alike. The goal is to provide a streamlined overview that facilitates quick decision-making and resource allocation.

## Enhance User Experience through Intuitive UI/UX Design:

The goal of this module is to design an intuitive and user-friendly interface that is accessible to a wide range of users: health professionals, pharmaceutical distributors, and policymakers. The UX will be streamlined, making it easy for a user to navigate between the different features with ease and speed to relevant insights. Key features will include:

**Interactive Dashboards:** Visual representations of data, such as heatmaps and graphs, that allow users to easily explore medicine demand forecasts and disease risk patterns across regions and seasons.

**Real-Time Forecast Display:** A clear, real-time display of predictions and trends, enabling users to see up-to-date medicine needs and regional disease outbreaks at a glance.

**Filter and Search Functions:** Tools that allow users to filter predictions based on location, season, or disease type, helping them focus on the most relevant data for their needs.

**Alerts and Notifications:** A system for notifying users about significant trends or changes in medicine demand or disease outbreaks, allowing for quick responses and action.

## Ensure Security, Privacy, and Ethical Data Handling:

Given the sensitivity of healthcare data, it is very important to ensure that data security, privacy, and ethical treatment are guaranteed. The objective is thus to provide strong security measures in order to protect sensitive data, ensuring that all information is stored, processed, and transmitted securely. It should follow data privacy regulations such as GDPR or local healthcare data protection standards, so that it is compliant. Ethical AI practices would be followed, maintaining transparency in the way predictions are made, with the avoidance of bias in the forecast models. Privacy features, including data anonymization, encryption, and user consent protocols, will be part of the system to protect the privacy of individuals and help gain their trust. This ensures that the application is responsible in its use of data and reliable in the results it presents.

# CHAPTER # 2

**Literature Review**

## Literature Review

## **Introduction**

The rapid digital transformation of the healthcare industry, coupled with the increasing unpredictability of seasonal and climate-driven disease patterns, has intensified the need for intelligent and data-driven medicine forecasting systems. Traditional pharmaceutical demand estimation methods—largely dependent on historical sales data or manual judgment—are often insufficient to capture the complex, multi-factor dynamics influencing medicine consumption. These dynamics include seasonal illnesses, climatic variations, epidemiological trends, and regional population behavior.

Recent advancements in Artificial Intelligence (AI), Machine Learning (ML), and time-series analysis have enabled the development of intelligent forecasting systems capable of integrating heterogeneous data sources such as historical sales records, weather variables, and real-time analytics. Such systems not only improve prediction accuracy but also support proactive decision-making within pharmaceutical supply chains and public health infrastructures (Zhang et al., 2021).

This research focuses on the design of a weather-aware Medical Forecasting System that addresses challenges such as seasonal medicine shortages, inaccurate stock planning, and lack of integrated pharmaceutical intelligence. This chapter reviews the existing literature related to AI-driven medicine demand forecasting, time-series and climate-integrated prediction models, pharmaceutical authentication through barcode technologies, healthcare data summarization, system security and privacy, and ethical considerations

## Medicine Demand Forecasting and Recognition

Demand forecasting for medicines is a crucial aspect of successful healthcare supply chain administration. Various researchers have employed time series, as well as machine learning algorithms, for the prediction of medicine demand, disease trends, and medicine sales patterns. ARIMA, Prophet, Random Forest, LSTM, and Neural Prophet have proved to be effective for capturing the time series characteristics of the data, as stated by Taylor and Letham (2018).

Prophet has gained widespread adoption due to its ability to decompose time-series data into trend, seasonality, and holiday effects, making it suitable for healthcare environments characterized by seasonal disease cycles (Ghosh & Banerjee, 2020). More recently, Neural Prophet has extended these capabilities by integrating neural networks with classical time-series decomposition, enabling improved handling of non-linear patterns and anomaly detection. Literature indicates that Neural Prophet is particularly effective in identifying unexpected demand spikes that may indicate disease outbreaks or abnormal consumption patterns.

Several studies emphasize that forecasting accuracy improves significantly when models incorporate external variables rather than relying solely on historical sales data. However, despite these advancements, many existing systems lack real-time adaptability and fail to provide actionable insights such as alternative medicine recommendations or automated stock adjustment alerts.

## Weather-Influenced Disease and Medicine Prediction Models

The relationship between weather conditions and disease prevalence has been extensively documented in healthcare research. Climatic factors such as temperature, humidity, and rainfall play a significant role in influencing the spread of infectious and seasonal diseases including influenza, dengue, respiratory infections, allergies, and heat-related disorders (Mutheneni et al., 2017).

Recent studies demonstrate that integrating meteorological data into time-series and machine learning models substantially improves prediction performance. Li et al. (2022) showed that climate-aware models enable early detection of disease outbreaks and seasonal surges. Similarly, Rahman et al. (2021) proposed meteorology-based disease prediction frameworks that outperform traditional historical-only approaches

## Data Summarization and Visualization in Healthcare Analytics

Healthcare systems generate vast volumes of heterogeneous data that must be transformed into meaningful insights for effective decision-making. Data summarization techniques such as clustering, grouping, aggregation, and feature extraction are widely used to identify patterns in medicine usage, seasonal trends, and regional consumption behavior (Chen et al., 2020).

Visualization tools, such as dashboards, heatmaps, and time-series graphs, have been instrumental in enhancing the interpretability and usability of healthcare analytics systems (Wang & Alexander, 2019). Summarized data in pharmaceutical forecasting empowers the identification of top-demand medicines, regional shortages, seasonal surges, and anomaly patterns that are going to be important for inventory planning, manufacturing coordination, and public health preparedness.

## Security and Privacy Considerations

Healthcare and pharmaceutical data falls into sensitive topics. Therefore, the data must strictly adhere to global data protection regulations such as GDPR and HIPAA. Encryption, anonymization, role-based access, and multi-factor authentication are, of course, all key ingredients of security requirements within a healthcare system, as evidenced by Hernandez & Kim (2021). Besides the challenges of privacy exposure, serious threats to healthcare operations emanate from data integrity and system security based on unauthorized access, tampering, and cyberattacks. Aldekhail et al. (2020) raise the importance of secure pipelines of data, encrypted storage, audit logs, and API access control. Thus, modern AI-driven systems should embed appropriate security and privacy measures across the data lifecycle.

## ****Ethical Implications and Future Directions****

As AI-driven decision-making systems become increasingly prevalent in healthcare, ethical considerations have gained significant importance. Research identifies fairness, transparency, explainability, and avoidance of algorithmic bias as core principles of responsible AI (Floridi & Cowls, 2019). Biased datasets or opaque models may lead to unfair medicine recommendations or distorted pharmaceutical markets. Scholars recommend the adoption of explainable AI techniques, ethical auditing mechanisms, and transparency reports to ensure trust and accountability in healthcare AI systems (Raji et al., 2020). Ethical system design is particularly critical in medicine forecasting, where decisions can directly impact patient health and public welfare

## Literature Analysis

An extensive review of the literature reveals key insights and existing gaps. While traditional models focus separately on either demand forecasting or product authentication, few systems combine both aspects for a unified pharmaceutical intelligence platform. Our project addresses this by incorporating:

1. Time-Series Forecasting using Neural Prophet
2. Real-time Data Ingestion from IoT barcode scanners at pharmacies
3. Recommendation System for alternative medicines
4. Interactive Graphs comparing historical vs forecasted sales
5. Outbreak Detection using anomaly modeling

These components together address real-world challenges such as understocking, overstocking, and distribution of counterfeit drugs. By summarizing usage patterns and predicting needs per region and season, the system ensures preparedness. Its ability to adapt under uncertain conditions, such as new illnesses or unexpected demand surges, makes it a critical asset for public health infrastructure. As AI-driven healthcare advances, hybrid platforms like ours will set a precedent for scalable and secure pharmaceutical forecasting and validation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Year** | **Major Characteristics** | **Methodology** | **Link** |
| |  | | --- | |  |   Schisa & Farnè | 2025 | Analyzed effect of climate on respiratory pharmaceutical demand in Greece. | Compared Prophet, VARX, Random Forest, and LSTM models for forecasting | https://arxiv.org/abs/2505.10642 |
| Fan et al. | 2025 | Prediction of outpatient visits using AI LSTM; shows time-series AI models in healthcare context. | LSTM neural network on medical usage data. | https://dergipark.org.tr/en/pub/jeps/issue–/72838/1127844 |
| Çeliker et al. | 2024 | Medicine consumption forecasting with classical time-series methods. | Holt-Winters, exponential smoothing; evaluated with error metrics. | https://dergipark.org.tr |
| Muneza et al. | 2023 | Compares frequentist forecasting models in pharmaceutical index data. | ARIMA, GARCH, Neural Network Autoregression (NNAR). | https://dergipark.org.tr |
| Li et al. | 2022 | Linked climate variables with disease incidence and demand patterns. | Statistical & ML approaches to evaluate weather–disease relationships. | https://www.nature.com/articles |
| İmece & Beyca | 2022 | Integrated various forecasting models for pharmaceutical demand with real sales data. | Holt-Winters, Ridge, Random Forest, XGBoost & ensembles. | https://dergipark.org.tr |
| Zhang et al. | 2021 | Studied use of ML in pharmaceutical supply chain forecasting. | ML models on multi-source sales data to reduce stockouts and wastage. | https://www.sciencedirect.cm |
| Taylor & Letham | 2018 | Introduced Prophet, a scalable time-series forecasting model for seasonal data. | Decomposed time-series into trend, seasonality, and holiday effects; additive regression. | https://facebook.github.io/prophet/ |
| Chae et al. | 2018 | Deep learning models outperform traditional forecasting in disease prediction. | Used LSTM deep networks for temporal pattern modeling. | https://ieeexplore.ieee.org |

# **CHAPTER # 3**

**Methodology**

## Methodology

## **Functional Requirements**

## User Authentication and Role Management:

The system shall provide secure login functionality for different user roles (Administrator, Data Analyst). Each role shall have specific permissions - administrators can upload/modify datasets, analysts can view forecasting results, and pharmacists can access basic reports. This ensures data security and controlled access from the outset.

## Data Ingestion (CSV/API):

The system should collect and integrate historical medicine sales data and weather data from multiple sources. While weather data, such as temperature, humidity, and rainfall, can be retrieved from public APIs or uploaded via CSV files, sales data can be imported from a database that is connected. This guarantees that the forecasting model gets complete and accurate input data for dependable demand prediction and seasonal trend analysis.

## Data Preprocessing (Cleaning, Normalization):

All gathered datasets will be automatically preprocessed by the system prior to model training. Managing missing or duplicate entries, identifying outliers, normalizing numerical values, encoding categorical variables, and synchronizing time-series between weather and sales data are all included in this. Checks for data quality will guarantee consistency for accurate forecasting.

## AI Model Training and Forecasting:

An AI-based forecasting model that can account for seasonal and weather-dependent demand variations should be trained by the system using preprocessed data. The model should learn from past trends and environmental factors to predict future demand for each medicine type. For additional reporting and visualization, forecast results must be kept in the database.

## Interactive Visualization and Dashboard

The system will provide interactive dashboards with detailed graphical representations of the forecasting insights. These visualizations include comparisons of past and projected sales, line graphs and heatmaps that analyze seasonal trends, correlation charts featuring weather impact, and demand distribution by region. Consequently, stakeholders will be able to make decisions based on data and intuitively analyze patterns.

## Recommenation System:

The system shall make an inventory management recommendation based on demand forecasts. These recommendations will optimize stock levels based on matching predicted demand against current inventory positions with the aim of avoiding either stock shortages or excess stock within available lead times and operational constraints.

## Reporting:

The system shall automatically create and schedule robust reports that summarize key forecasting outputs, such as comparative analyses of predicted versus actual demand, model performance metrics, seasonal trend patterns, and inventory recommendations. These consolidated documents will emphasize significant anomalies and data-driven insights to enable stakeholders to make informed strategic decisions.

## Non Functional Requirements

## Performance:

It needs to be ensured that the system delivers responsive performance for all functions, with the data processing and forecasting operations completing within practical timeframes. Efficient algorithms and optimized data pipelines ensure timely generation of insights without compromising usability.

## Scalability:

The architecture should support increasing data volumes and an extended operational scope. It addresses the growing number of products and historical records through scalable storage solutions and parallel processing, which allows it to keep performance consistent as the dataset grows.

## Accuracy:

Forecast accuracy is another critical quality benchmark. Such predictions should undergo verification techniques to ensure that they meet established standards of reliability through mechanisms for continuous monitoring to identify deviations in accuracy and their causes.

## Cross Platform Compatibility:

The solution shall function across heterogeneous computing environments. Web-based components shall maintain functionality across major browsers and operating systems, while backend processes support standard hardware configurations to assure broad accessibility.

## Reliability:

The system offers robust operational reliability through its comprehensive handling of errors, systematic logging, and backup protocols. The system must preserve data integrity during disruptions and ensure secure access to historical records for consistent performance.

* + 1. **Response Time:**

The system should be responsive concerning user interactions, queries, and requests for visualizations. Forecasting results need to be provided within acceptable time frames, considering even large sets of data, to enable timely decision-making.

## Algorithms

#### Data Collection

#### Import historical sales data from structured sources, such as CSV files or database exports.

#### Retrieve supplementary weather data through CSV uploads or API integrations.

#### Data Preparation

#### Address data quality issues by performing imputation and handling outliers.

#### Normalize numerical features and encode categorical variables.

#### Align all datasets to consistent time intervals to make them suitable for forecasting.

#### Model Training

#### Set up a forecasting model that considers trend, seasonality, and weather influences.

#### Incorporate external factors such as weather variables and holidays as model inputs.

#### Train on historical patterns across medicines considering seasonal variations.

#### Forecasting

#### Generate demand predictions for specified future horizons

#### Store outputs in structured formats for use in downstream applications or visualization

#### Recommendation Engine

#### Compare forecasts with inventory levels.

#### Flag products below reorder thresholds

#### Calculate optimum order quantities

#### Visualization & Reporting

1. Update interactive dashboards with analytical views showing historical versus predicted sales and seasonal trends.
2. Prepare periodic performance reports highlighting key metrics and forecast accuracy.
3. Highlight critical findings to support decision-making

#### Error Handling

#### Validate data inputs/formats

#### Retry failed API/data transmissions

#### Fallback to cached data during outages

1. Notify the user with detailed error messages and suggestion for resolution

## Hardware Requirements:

#### Processor (CPU): Intel Core i5 5th generation or equivalent

#### RAM: 4 GB or higher

#### Storage: 256 GB HDD or 256 GB SSD for faster access

## Software Requirements:

#### Use Window 10 (x64 bits or x86 bits)

# 

# **CHAPTER # 4**

**User Interface**

## User Interface

## Application User Interface

## 4.1.1 Home Page:

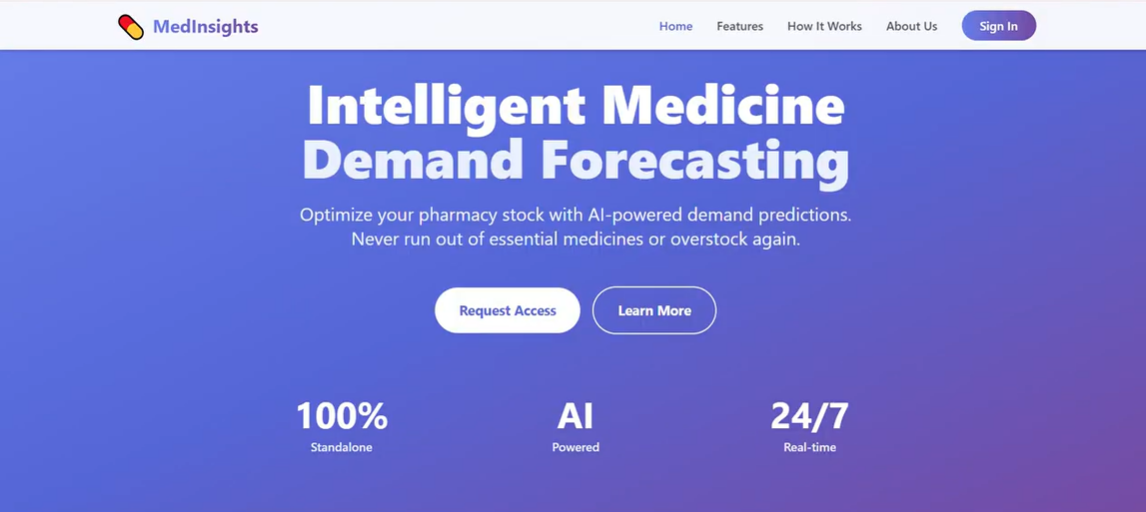


Figure 4.1.1

The homepage serves as the primary entry point to the MedInsight platform. It features a clean and professional navigation bar, providing immediate access to key sections: Home, Features, How It Works, About Us, and Sign In. Centrally, the page highlights the platform's core value proposition for AI-driven medicine forecasting. Primary call-to-action buttons (Request Access and Learn More) are prominently placed to guide user engagement.

## Features Overview Page:

## 

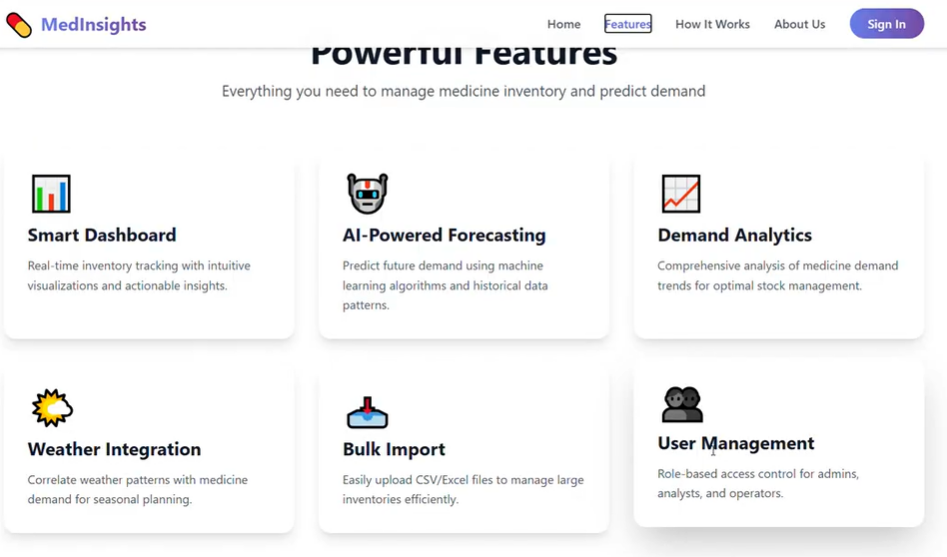


Figure 4.1.2

Each feature is displayed as a distinct card, highlighting key tools: the Smart Dashboard for real-time tracking, Weather Integration for seasonal demand correlation, AI-Powered Forecasting for predictive analytics, Bulk Import for data upload, Demand Analytics for trend insights, and User Management for role-based access

## How It Works Page:

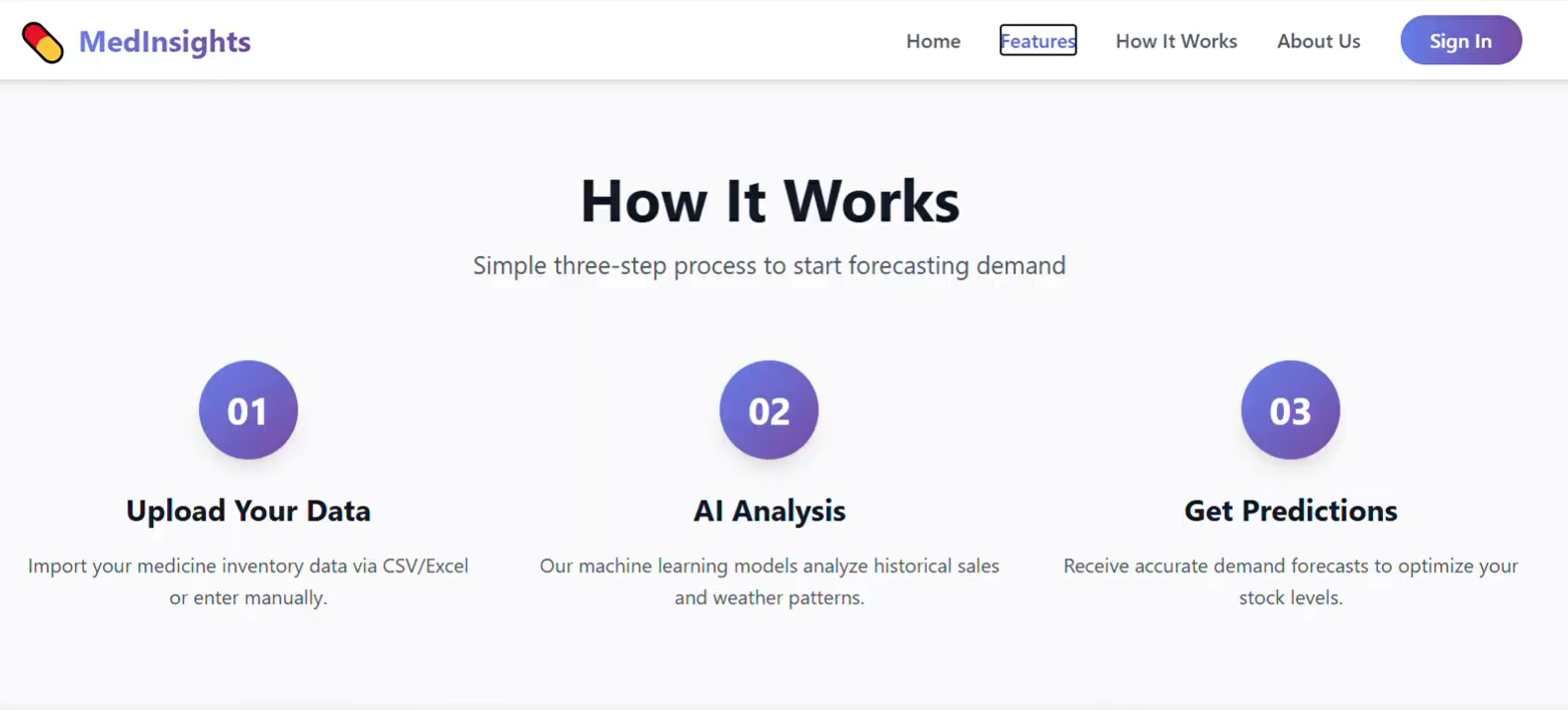


Figure 4.1.3

This page visually communicates how MedInsight works through a clear, three‑step process. It starts with Step 01: Upload Your Data, where one can import inventory records either through CSV/Excel or via direct input. Then, Step 02: AI Analysis describes how machine learning models process historical sales and integrated weather data to identify demand patterns. Finally, Step 03: Get Predictions sums up the output in actionable forecasts, designed to optimize stock levels. The layout successfully communicates the platform’s end‑to‑end, user‑friendly forecasting pipeline.

## Sign-In Page:

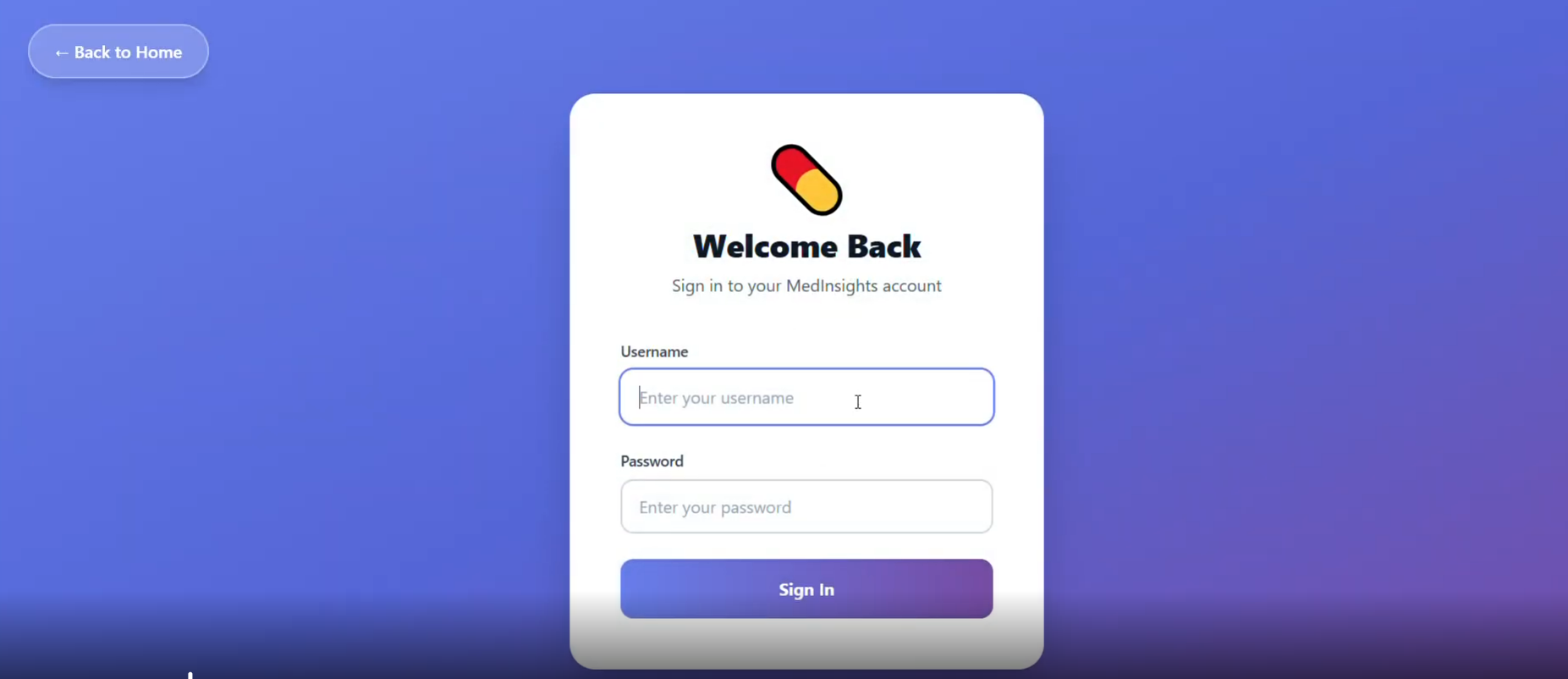


Figure 4.1.4

This page enables secure user authentication for the MedInsight platform. It contains a standard login form with fields for Username and Password, a Sign In button, and a "Back to Home" link for easy navigation.

## User Dashboard:

### 4.2.1 User Dashboard:



Figure 4.2.1

The dashboard serves as the main control panel accessed after signing in, providing users with a quick overview of their medicine inventory. The top section displays key stock metrics: total medicines, low‑stock items (where current stock falls below forecasted demand), out‑of‑stock items, and medicines currently in stock. Below this, the Quick Actions section is basically followed by crucial functions such as sale entry, AI-powered demand predictions, and weather-related correlations.

## 4.2.2 Activity Log Interface:

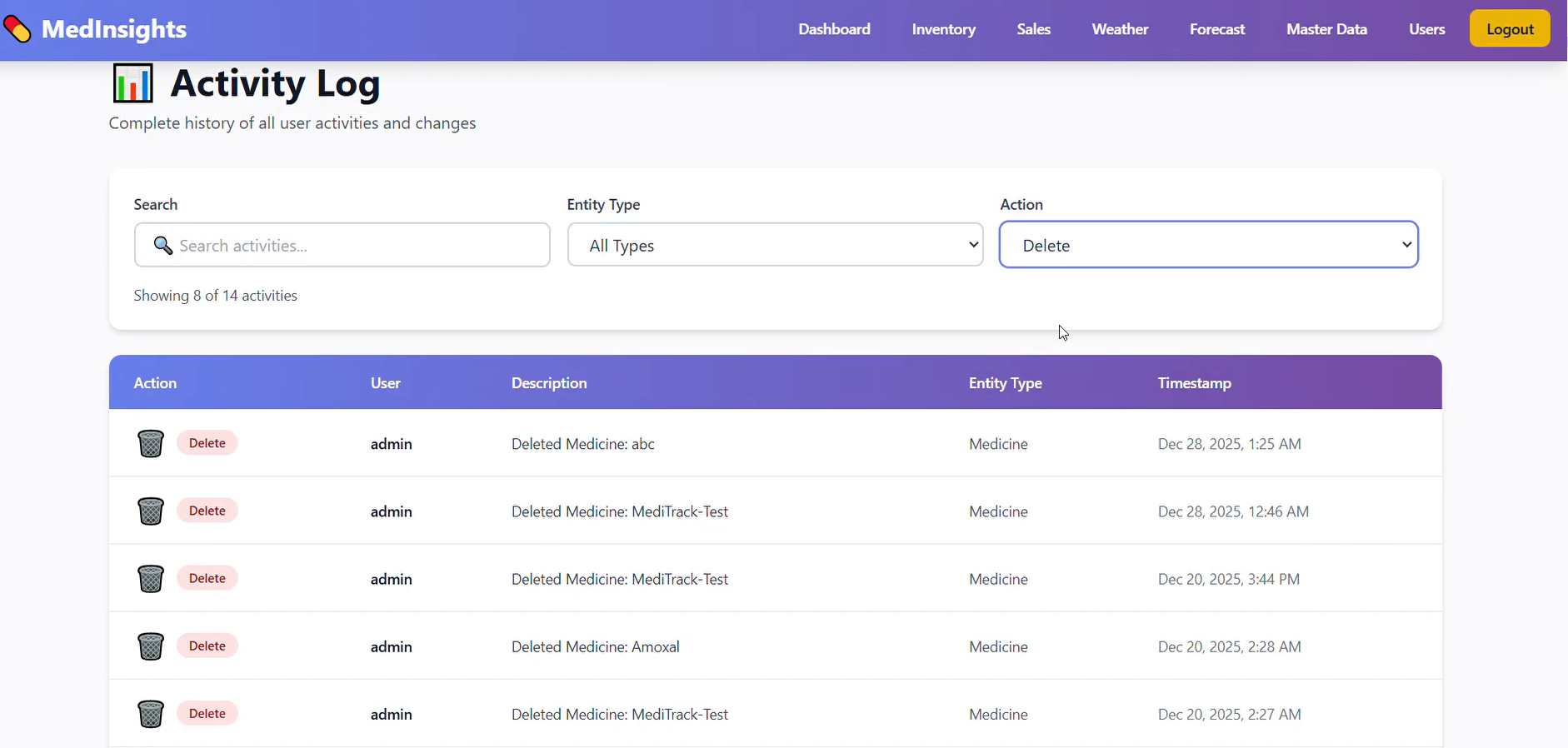


Figure 4.2.2

This page lists all user actions on the system, accessible from the dashboard. Users can search, filter by type or action, and view details like user, action, type, and date for easy tracking, such as when medication is added or deleted.

## User Management Interface:

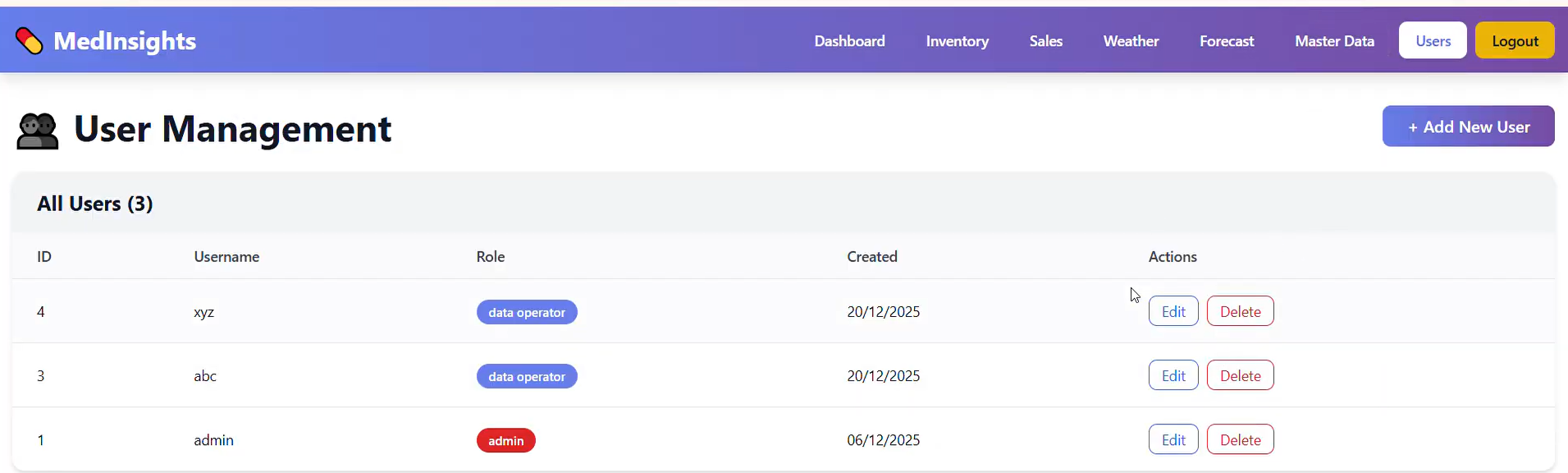


Figure 4.3

This interface provides administrative control over platform access. It displays all user accounts in a table with their username, assigned role. Administrators can add new users via the "Add New User" button, assigning one of three available roles: Admin, Analyst, or Data Operator, ensuring appropriate permission levels across the forecasting and inventory system.

**4.4 Master Data**

## Master Data Management Interface:



Figure 4.4.1

Master Data Management Interface is designed to centrally manage core reference data required by the system. This interface provides structured control over areas, medicine formulas, and medicine records, ensuring data consistency across forecasting and analysis modules.

## Area Management Interface:

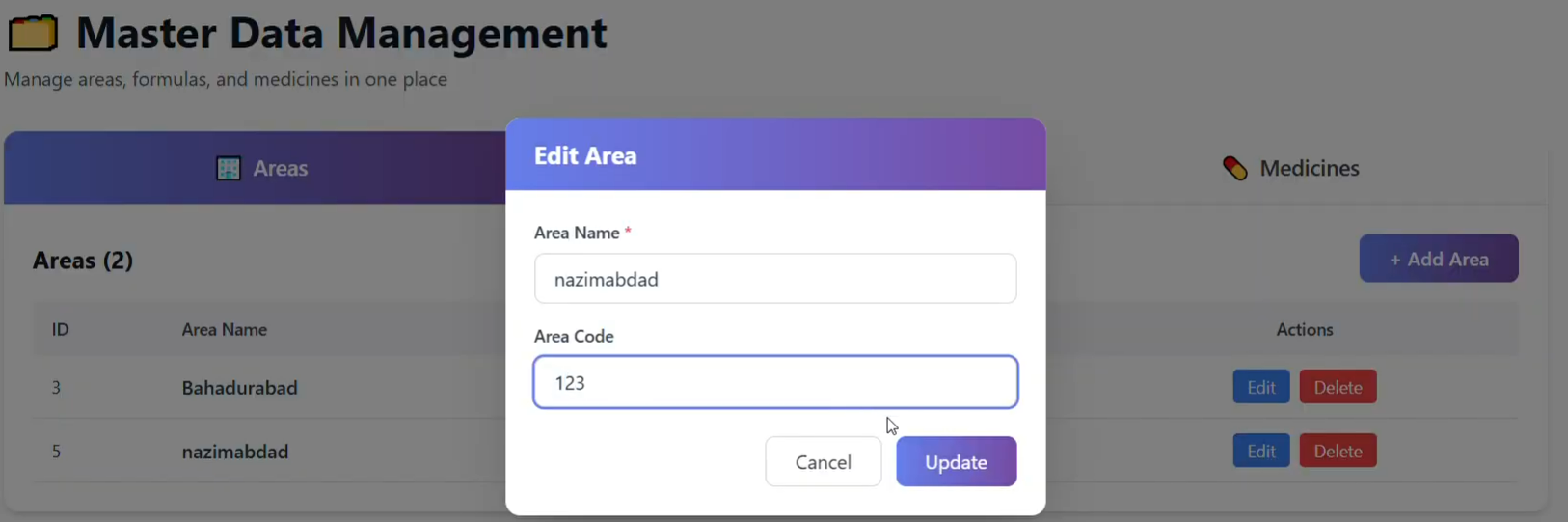


Figure 4.4.2

Area Management Interface provides functionality for authorized users to enter new areas and maintain the existing area database. Users can update area information or delete areas that are no longer in existence to have the most up-to-date area information.

## Formula Management Interface:

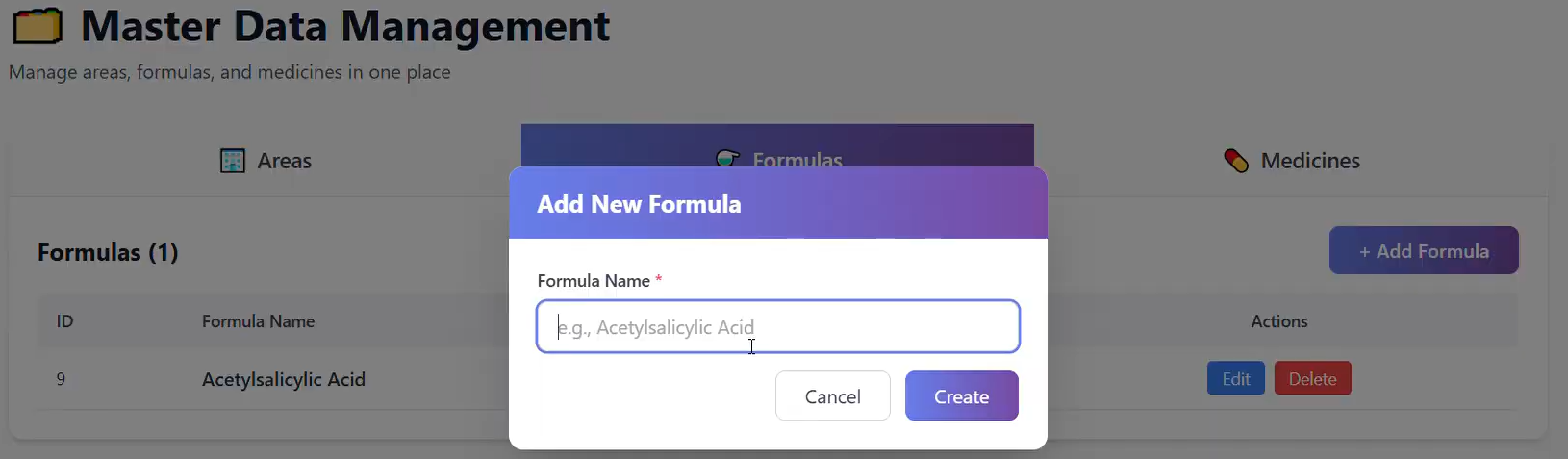


Figure 4.4.3

Formula Management Interface enables users to add, update, and remove medicine formulation records used within the system. This module helps maintain accurate associations between medicines and their formulas.

## Medicine Management Interface:

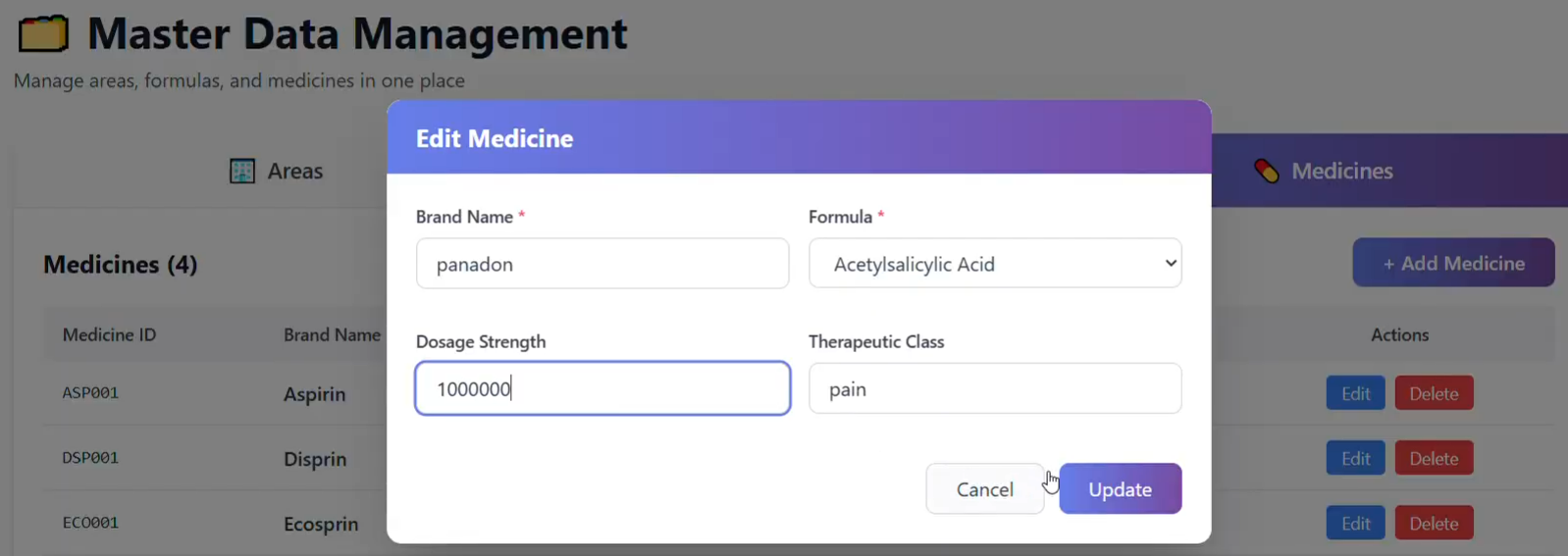


Figure 4.4.4

Medicine Management Interface allows users to add, edit, and delete medicine records within the system. Each medicine is linked to a predefined formula selected from the Formula Management module, ensuring data consistency. This module helps maintain accurate medicine information required for forecasting and analytical operations.

## Inventory Management:

## 4.5.1 Inventory Management Interface

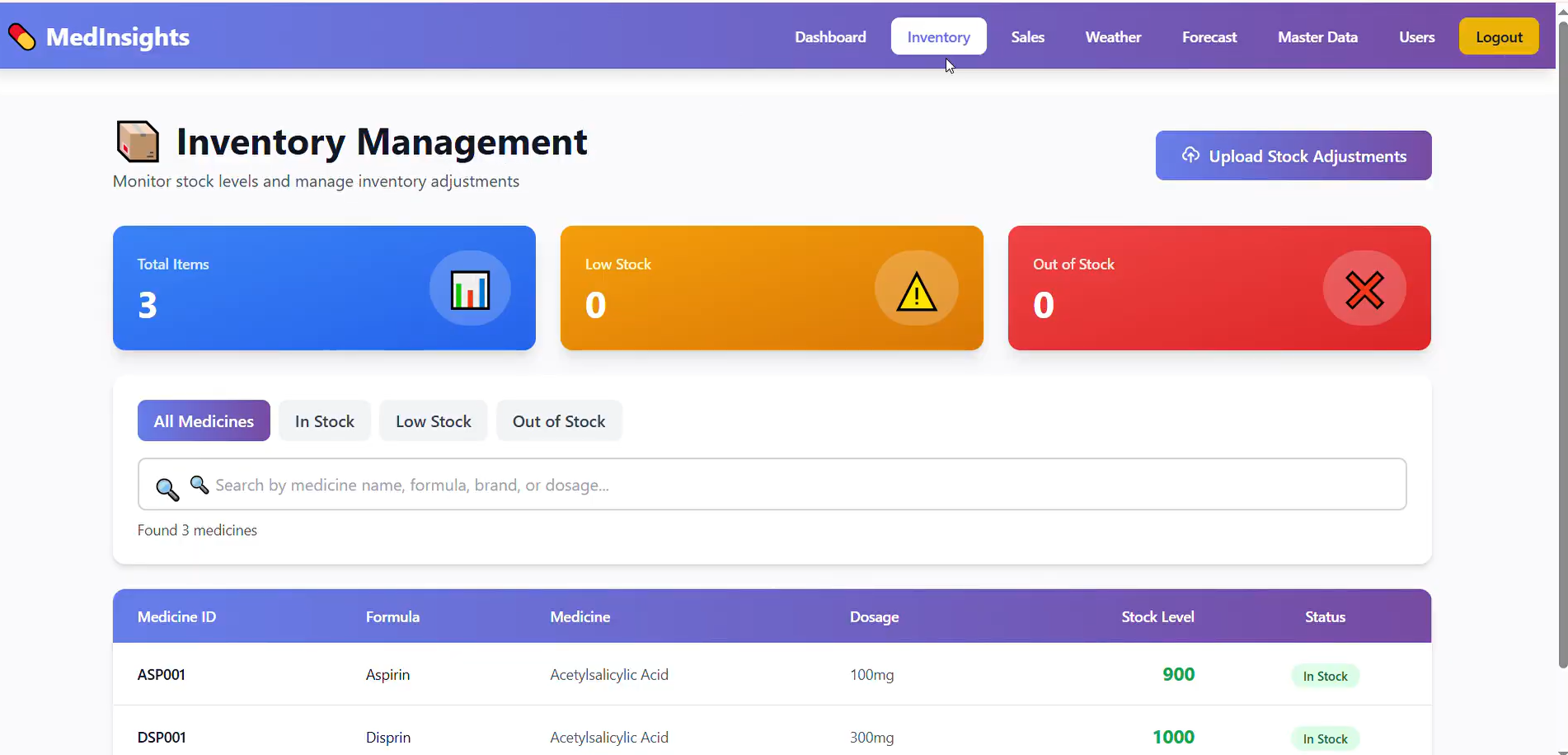


Figure 4.5.1

Inventory Management Interface provides a summarized view of medicine stock through total items, low stock, and out-of-stock indicators displayed on the dashboard. The interface also includes a search functionality that allows users to locate medicines using name, formula, or dosage criteria. This module supports efficient monitoring and management of inventory levels across the system.

## 4.5.2 Upload Stock Adjustments Interface:

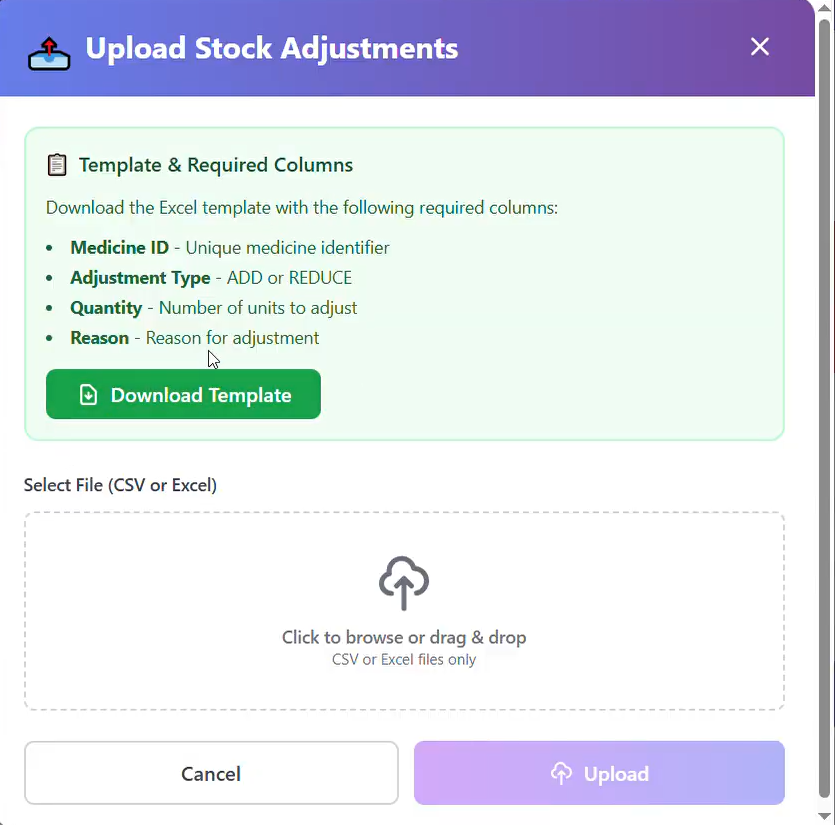


Figure 4.5.1

This modal interface allows bulk updates to medicine stock levels through file uploads. Users must first download a predefined Excel or CSV template containing the required columns. After filling out the template, users can upload the file using the designated area, which supports drag-and-drop or browsing. This feature enables efficient and error-controlled batch adjustments to the inventory, eliminating the need for manual entry.

## Sales Management:

## Sales Management Interface:

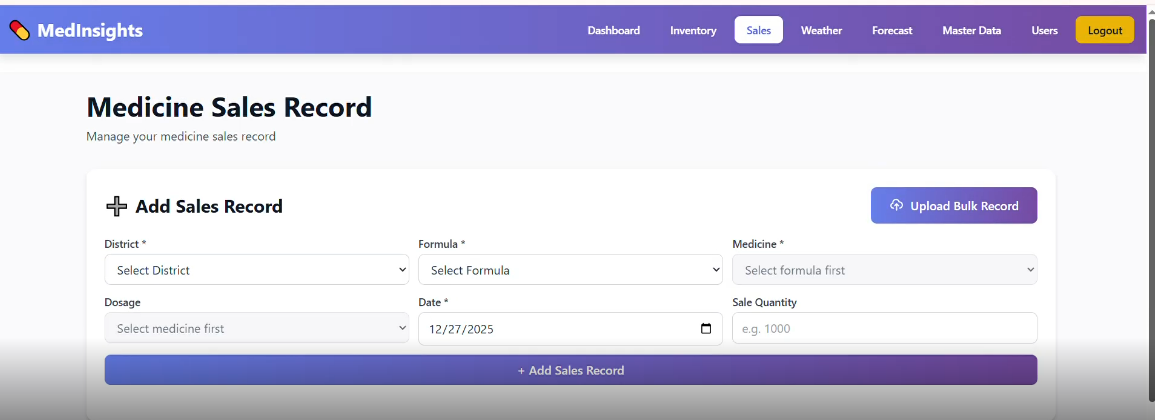


Figure 4.6.1

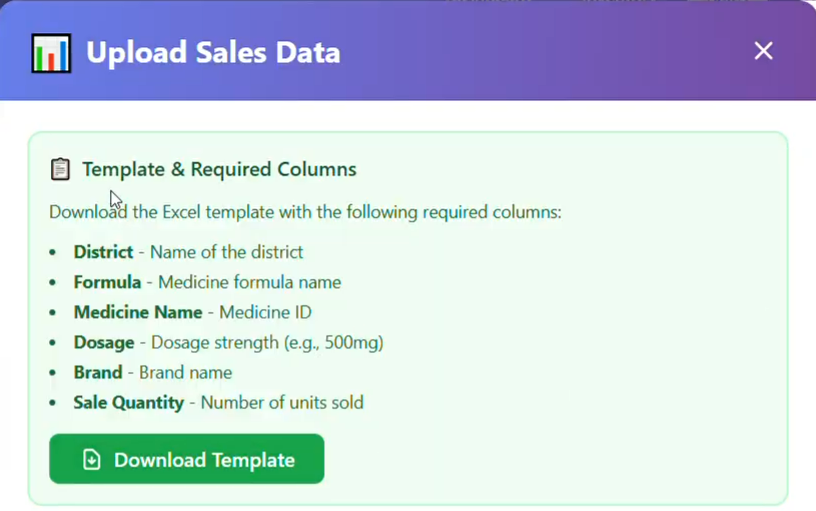


Figure 4.6.2

The Sales Management interface allows recording medicine sales via manual entry or bulk upload. The Add Sales Record form includes: District, Formula, Medicine, dosage, Date, and Sale Quantity. For bulk updates, users can download a template (figure 4.6.2) fill multiple records offline, and upload for batch processing. Below the form, a table displays all historical sales with details like date, district, formula, medicine, dosage, and quantity for easy tracking and auditing.

## Weather Management:

## 4.7.1 Weather Analytics Interface:

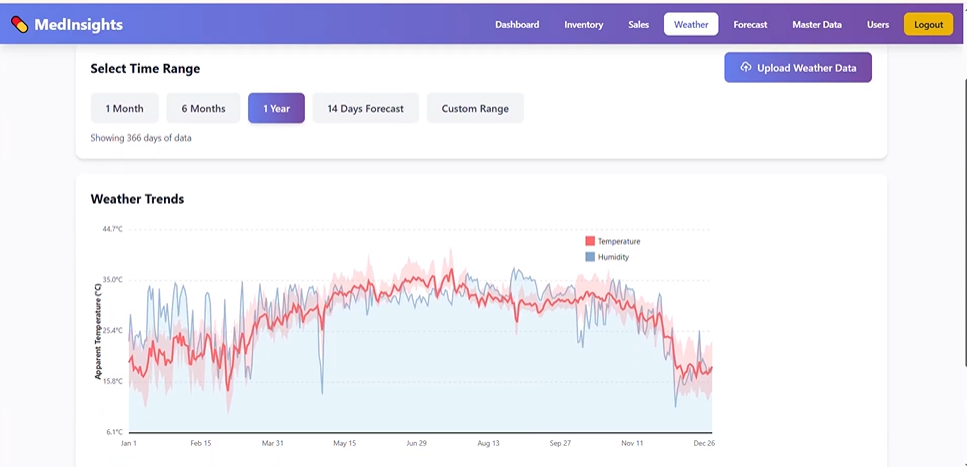


Figure 4.7.1

This page shows weather trends using a visual graph. Users can pick a time period (1 month, 6 months, 1 year, or custom) to view past data. It also displays a 14-day weather forecast for upcoming conditions. An option to upload external weather data is provided to update the system's climate information.

**4.7.2 Weather Analytics Interface:**

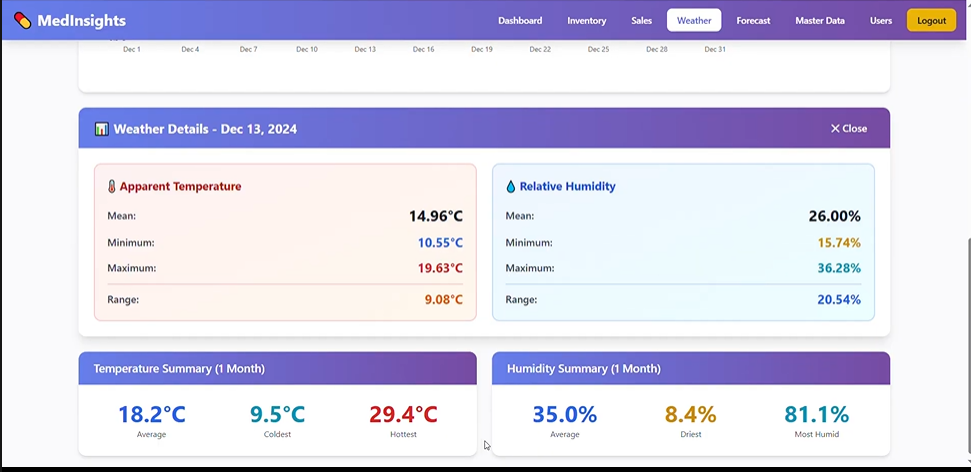


Figure 4.7.2

This feature lets users click on any point in the weather graph to see detailed stats for that day. A pop-up or side panel shows the average, minimum, maximum, and range of Apparent Temperature and Relative Humidity. It also includes a summary table for the selected period, showing overall averages, coldest, and hottest days. This helps analyze how daily weather affects medicine demand.

# **CHAPTER # 5**

**Testing**

## Testing

* 1. Test Cases
     1. **Test Case 1**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-101 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** High | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Sales Data Upload | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Upload Valid Sales Data | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Ensure system accepts correctly formatted medicine sales data. | |

|  |
| --- |
| **Post Condition:** Data stored successfully and ready for forecasting. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 2**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-102 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** Medium | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Sales Data Upload | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Reject Invalid Sales File | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Ensure system rejects incomplete or invalid Formats | |

|  |
| --- |
| **Post Condition:** Error message shown; data not saved. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 3**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-103 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** High | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Weather Data Integration | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Fetch Weather Data Successfully | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Verify weather data is retrieved for selected area. | |

|  |
| --- |
| **Post Condition:** Weather data available for forecasting. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 4**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-104 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** Medium | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Weather Data Integration | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Handle Weather API Failure | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Ensure system handles unavailable weather data gracefully. | |

|  |
| --- |
| **Post Condition:** Warning message shown; system remains stable. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 5**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-105 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** High | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Medicine Demand Forecasting | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Generate Demand Forecast | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Verify system generates future medicine demand forecast. | |

|  |
| --- |
| **Post Condition:** Forecast results generated successfully. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 6**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-106 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** Medium | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Forecasting Engine | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Forecast with Missing Weather Values | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Check forecasting behavior with partial weather data. | |

|  |
| --- |
| **Post Condition:** Forecast generated with warning message. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 7**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-107 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** High | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Area-Wise Analysis | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Generate Area-Specific Forecast | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Ensure system produces forecasts for selected region. | |

|  |
| --- |
| **Post Condition:** Area-wise forecast displayed. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 8**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-108 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** High | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Visualization | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Display Forecast Graph | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Verify visualization of historical vs forecasted data. | |

|  |
| --- |
| **Post Condition:** Graph displayed correctly. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 9**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-109 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** Medium | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Alert Management | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Generate High Demand Alert | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Ensure alert is triggered when demand exceeds threshold. | |

|  |
| --- |
| **Post Condition:** High-demand alert generated. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

* + 1. **Test Case 10**

|  |  |
| --- | --- |
| **Test Case ID:** SVAI-110 | **Test Designed by:** Wali Muhammad |
| **Test Priority:** High | **Test Designed Date:** 12-Nov-2025 |
| **Module Name:** Authentication | **Test Executed by:** Syed Zahab Ali |
| **Test Title:** Block Unauthorized Access | **Test Executed Date:** 16-Nov-2025 |
| **Description:** Verify system blocks invalid user login attempts. | |

|  |
| --- |
| **Post Condition:** Access denied message shown. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TEST CASE** | **DESCRIPTION** | **EXPECTED OUTCOME** | **ACTUAL OUTCOME** | **PASS / FAIL** |
|  |  |  |  |  |

## UC-01: User Login

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-01 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | User Login |
| Description | The user enters their username and password to access the system. The system verifies the credentials and grants access according to the user’s role, which can be Admin, Data Analyst, or Inventory Person. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | This function is used frequently as users are expected to log in daily. |  |  | | --- | |  | |
| Actor | |  | | --- | |  |  |  | | --- | | The actors include Admin, Data Analyst, or Inventory Person, each logging in to access their respective dashboards. | |
| Precondition | |  | | --- | | The user must have a registered account with valid login credentials. The system must be online and accessible for login to take place. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | Upon successful login, the user gains access to the system, their session becomes active, and they are redirected to their appropriate role-based dashboard. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The system allows access when valid credentials are entered. If invalid credentials are used, an error message is displayed. The user must always be redirected to their correct role-specific dashboard. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If the credentials are invalid, the system displays an “Invalid username or password” message. If multiple failed attempts occur, the account is temporarily locked. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the user knows their correct login credentials and has access to the system. |  |  | | --- | |  | |
| Constraint & Special Requirement | Passwords must be stored in encrypted form. The login process must operate over a secure HTTPS connection. The system should also limit the number of failed login attempts, for example, five attempts. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-02 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | |  | | --- | | Upload Weather Data |  |  | | --- | |  | |
| Description | The Data Analyst uploads weather-related data into the system either by manual entry or by importing a file. The system validates the data and stores it for generating weather-based medicine sales forecasts. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Regularly, especially when new weather data becomes available, to maintain accurate forecasting. |  |  | | --- | |  | |
| Actor | |  | | --- | |  |   Data AnalystData Analyst |
| Precondition | |  | | --- | | The user must be logged in as a Data Analyst. Weather data should be prepared in a valid format if using file upload. The system must be online and operational. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | The uploaded weather data is validated, stored, and made available for the forecasting system to generate predictions |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The system successfully accepts the weather data, validates it for correctness and completeness, and stores it in the database. Errors are displayed if the data is invalid or incomplete. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If the file format is incorrect or data values are invalid, the system displays an error message. The user can correct and re-upload the data. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the Data Analyst has access to accurate weather data and knows the required format for uploads. |  |  | | --- | |  | |
| Constraint & Special Requirement | The system must support multiple file formats such as CSV and Excel. The upload must efficiently handle large datasets and ensure data integrity before saving. |

**UC-02: Upload Weather Data**

**UC-03: Upload Sales Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-03 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Upload Sales Data |
| Description | The Data Analyst uploads/updates the medicine sales data into the system either through manual entry or by importing a file. The system validates the data and stores it for forecasting and analysis purposes. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Frequently, as sales data needs to be regularly updated for accurate forecasting. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst |  |  | | --- | |  | | |
| Precondition | |  | | --- | | The user must be logged in as a Data Analyst. The sales data should be available in a valid format if uploading via file. The system must be online and operational. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | The uploaded sales data is stored in the system and is available for forecasting, analysis, and reporting. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The system successfully accepts the uploaded data, validates it for correctness and completeness, and stores it in the database. Errors are displayed if the data is invalid. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If the data file is in an incorrect format or contains invalid values, the system displays an error message. The user can correct the data and attempt to upload it again |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the Data Analyst has access to correct sales data and knows the required format for file uploads |  |  | | --- | |  | |
| Constraint & Special Requirement | The system must support multiple file formats (e.g., CSV, Excel). The upload process should handle large files efficiently and validate all entries before saving. |

**UC-04: Generate Medicine Sales Forecast (Weather + Area Based)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-04 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Generate Medicine Sales Forecast |
| Description | This use case describes how the Data Analyst generates a sales forecast for different medicines based on historical sales data, weather conditions, and area-based trends. The system analyzes uploaded weather data and past medicine sales to produce an intelligent forecast indicating which medicines will be in higher demand within specific regions and time periods. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | This feature is used regularly, especially when new data becomes available or when updated predictions are required |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst |  |  | | --- | |  | | |
| Precondition | |  | | --- | | The system must already contain valid sales and weather data, and the Data Analyst must be logged in. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | A detailed forecast is generated, stored, and becomes available for viewing in graphical form or as a summary. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The system must successfully analyze available data and generate an accurate forecast without errors. The output should clearly show future sales predictions based on area and weather. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If required data is missing or incomplete, the system displays an error and asks the user to upload the necessary information. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the uploaded data is clean, correct, and sufficient for forecasting. |  |  | | --- | |  | |
| Constraint & Special Requirement | The forecast should be generated quickly, support multiple areas, and use weather–medicine correlation rules for accurate prediction. |

**UC-05:**  **Search and Filter Inventory Records**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-05 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Search and Filter Inventory |
| Description | This use case allows the Inventory Person or Admin to search and filter medicines in inventory using different criteria such as medicine name, formula, dosage, or category. This helps users quickly locate specific medicines and analyze stock status. |
| Priority | Medium |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Used frequently during inventory checks and stock analysis. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Inventory Person, Admin |  |  | | --- | |  | | |
| Precondition | |  | | --- | | The user must be logged in and inventory data must exist in the system. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | Filtered inventory results are displayed based on the selected search criteria. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The system must correctly display relevant medicines matching the search input. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If no matching record is found, the system displays a “No Results Found” message. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that inventory data is properly maintained. |  |  | | --- | |  | |
| Constraint & Special Requirement | Search results should be displayed quickly and support partial keyword matching. |

**UC-05: Select Forecast Time Range (Weekly/Monthly/Custom)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-05 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Select Forecast Time Range |
| Description | In this use case, the Data Analyst selects the time range for which they want to view or generate the sales forecast. The system allows the user to choose from predefined options such as weekly or monthly, or enter a custom date range. The selected time period determines how the system filters and displays forecasted results |
| Priority | Medium |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Used whenever a forecast needs to be viewed for a specific duration |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst |  |  | | --- | |  | | |
| Precondition | |  | | --- | | The system must already have forecast-generation functionality and available data for the selected time range. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | The system applies the chosen time range and updates the forecast results to match the user's selection. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The system should correctly filter the forecast based on the selected duration and must not show data outside the chosen period. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If the selected custom range is invalid or missing data, the system notifies the user and asks them to adjust the dates. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the user understands the time range they want and selects valid dates. |  |  | | --- | |  | |
| Constraint & Special Requirement | The system must support flexible date selection and ensure fast filtering of forecast data. |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | |  | | Use Case ID | |  |  | | --- | |  | | |  | | --- | |  |   UC-06 |
| |  | | --- | | Task Name |  |  | | --- | |  | | View Forecast Graphs |
| Description | In this use case, the Data Analyst views graphical representations of the forecasted medicine sales. The system displays charts showing predicted sales trends for different medicines based on the selected time range and area. These graphs help the user understand future demand visually and compare sales patterns easily |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Frequently used during analysis and reporting. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst |  |  | | --- | |  | | |
| Precondition | |  | | --- | | The system must already have generated forecast data. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | The graphs are displayed on the screen, and the user can interpret or download them. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The graphs should load correctly, show clear and accurate forecast values, and update according to the selected filters. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If no forecast data exists for the chosen range, the system shows a “No Data Available” message. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the system supports graphical rendering. |  |  | | --- | |  | |
| Constraint & Special Requirement | Graphs must be easy to read, visually clear, and load quickly. |

**UC-06: View Forecast Graphs (Visual Representation of Sales)**

**UC-07: View Weather Trend Graphs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-06 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | View Weather Trend Graphs |
| Description | This use case allows the Data Analyst to view graphical trends of weather data such as temperature, humidity, and seasonal changes. The system displays visual charts that help the user understand how weather patterns relate to medicine demand and forecasting accuracy. |
| Priority | Medium |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Used whenever the user wants a visual understanding of weather behavior. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst |  |  | | --- | |  | | |
| Precondition | |  | | --- | | Weather data must already be uploaded and stored in the system. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | The system displays weather trend graphs that the analyst can view or compare with sales trends. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | Weather graphs must display correctly, reflect accurate data, and be easy to interpret. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If weather data is missing or incomplete, the system alerts the user about missing information. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the system contains valid weather records. |  |  | | --- | |  | |
| Constraint & Special Requirement | Graphs should display multiple weather variables clearly and must update quickly. |

**UC-08: Auto Comparison of Forecast vs Actual Sales**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-08 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Auto Comparison of Forecast vs Actual Sales |
| Description | The system automatically compares forecasted medicine sales with the actual sales stored in the database and highlights differences, accuracy percentage, and performance gaps. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Used whenever the analyst or admin wants to evaluate forecast accuracy. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst, Admin |  |  | | --- | |  | | |
| Precondition | |  | | --- | | Forecasted data and actual sales data must already be available in the system. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | A comparison report and graph are generated showing forecast vs actual sales. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | Comparison graph, accuracy percentage, and deviation results must display correctly and use accurate data. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If actual sales data is missing or incomplete, the system alerts the user that comparison cannot be generated. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that both datasets (forecast and actual) are properly formatted and stored. |  |  | | --- | |  | |
| Constraint & Special Requirement | Graphs must load quickly, handle large datasets, and clearly show differences between forecast and actual values. |

**UC-09: Compare Seasonal Demand (Winter/Summer Analysis)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-09 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Compare Seasonal Demand (Winter/Summer Analysis) |
| Description | The system compares medicine sales across different seasons, such as winter and summer, to identify changes in demand and seasonal trends. |
| Priority | Medium |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Used during analysis, reporting, or when checking seasonal buying behavior. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst, Admin |  |  | | --- | |  | | |
| Precondition | |  | | --- | | Season-based sales data must be available for the selected seasons. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | Seasonal comparison graphs and insights are displayed to the user. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The system must show accurate seasonal graphs, highlight demand differences, and clearly compare selected seasons. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If seasonal data for any selected period is missing, the system displays a data-missing alert. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that the system stores historical seasonal data for analysis. |  |  | | --- | |  | |
| Constraint & Special Requirement | Graphs must visually distinguish seasons, support large time ranges, and update quickly. |

**UC-10: View Current Stock Levels**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-10 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | View Current Stock Levels |
| Description | The Inventory Person or Admin can view the current stock levels of all medicines in the system. The system displays a complete list of medicines along with their quantities and locations, helping the user to track inventory and manage stock efficiently. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Used daily or whenever inventory status needs to be checked. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Inventory Person, Admin |  |  | | --- | |  | | |
| Precondition | |  | | --- | | User must be logged in, and medicine stock data must exist in the system. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | The system displays an updated inventory list showing the current stock levels. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | Stock levels must be accurate and reflect the latest data. The user should be able to view all medicines with their quantities and locations. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If no stock data exists, the system displays a message indicating that no inventory is available. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that stock entries are correctly maintained in the system. |  |  | | --- | |  | |
| Constraint & Special Requirement | The stock view should load quickly and handle large datasets without delay. |

**UC-11: Receive Low Stock Notifications (Auto Alert)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-11 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Receive Low Stock Notifications |
| Description | The system automatically generates alerts for medicines that are running low in stock. Notifications are sent to the Inventory Person or Admin to ensure timely replenishment. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Triggered automatically whenever stock falls below a predefined threshold. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Inventory Person, Admin |  |  | | --- | |  | | |
| Precondition | |  | | --- | | Medicine stock data must be maintained in the system and threshold levels predefined. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | The system generates a low stock alert, which is displayed to the relevant users. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | Alerts must accurately reflect medicines below the threshold and notify users promptly. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If threshold levels are not set or stock data is missing, the system notifies the user to update the configuration. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that thresholds are correctly configured for each medicine. |  |  | | --- | |  | |
| Constraint & Special Requirement | Alerts should be real-time and visible immediately on the dashboard. |

**UC-12: Generate Final Forecast Summary Report**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  | | --- | | Use Case ID |  |  | | --- | |  | | |  | | --- | | UC-12 | |
| |  | | --- | | Task Name |  |  | | --- | |  | | Generate Final Forecast Summary Report |
| Description | The Data Analyst or Admin generates a final summary report of medicine sales forecasts. The report includes all relevant forecast data, seasonal trends, stock alerts, and graphical visualizations. It can be exported as a PDF or Excel file for review or presentation. |
| Priority | High |
| |  | | --- | | Frequency of Use |  |  | | --- | |  | | |  | | --- | | Used whenever a complete forecast report is required, such as weekly, monthly, or quarterly. |  |  | | --- | |  | |
| Actor | |  |  | | --- | --- | |  | | | |  | | --- | | Data Analyst, Admin |  |  | | --- | |  | | |
| Precondition | |  | | --- | | Forecast data and all related information must be available in the system. |  |  | | --- | |  | |
| Postcondition | |  | | --- | | A complete summary report is generated and can be downloaded in PDF or Excel format. |  |  | | --- | |  | |
| |  | | --- | | Acceptance Criteria |  |  | | --- | |  | | |  | | --- | | The report must accurately reflect forecast data, include all selected parameters, and generate without errors. |  |  | | --- | |  | |
| Alternative | |  | | --- | | If forecast data is incomplete, the system displays a warning and allows the user to select a complete dataset before generating the report. |  |  | | --- | |  | |
| Assumption | |  | | --- | | It is assumed that all required forecast and stock data are available and up to date. |  |  | | --- | |  | |
| Constraint & Special Requirement | Report generation should be fast, handle large datasets, and preserve formatting for both PDF and Excel outputs |

# 

# **CHAPTER # 7**

**Conclusion and Future Work**

## Conclusion and Future Work

**7.1 Conclusion**

The aim of the proposed project, MedInsight, is to bridge this critical gap between unpredictable medicine demand and traditional static inventory management systems. Integrating AI-based forecasting techniques with real-time and historical weather data, like Neural Prophet, the system may prove that forecasting medicine demand will be far more accurate by considering both environmental and sales-related factors together.

It was designed based on clear-cut objectives, such as: demand forecasting with accuracy; smooth integration of weather analytics; and user friendliness for decision-making. These objectives were achieved in a structured architecture with Master Data Management, Inventory Management, Sales Analysis, Weather Monitoring, and Forecasting modules. Intuitive dashboards and management interfaces enable users to monitor stock levels efficiently, identify low or out-of-stock medicines, and take proactive actions.

One of the important contributions of the current project is to point out that there is a very close relationship between climatic conditions and medicine consumption. Seasonal changes, weather, and all other kinds of variations substantially affect the demand for certain medicines, which MedInsight manages to catch using machine learning and time-series models. This helps to advance the accuracy of forecasts and therefore enables much better planning of pharmacies, hospitals, and healthcare suppliers.

Overall, MedInsight meets its functional and analytical goals: to offer a central, intelligent, and scalable forecasting platform. Beyond technical implementation, the project places significant emphasis on predictive analytics as a core part of building resilient and sustainable healthcare supply chains. It represents a meaningful step toward adaptive medical inventory systems that are capable of responding to seasonal trends, sudden outbreaks, and environmental uncertainties.

**7.2 Future Work**

To further enhance the accuracy, scalability, and real-world impact of the MedInsight platform, several future improvements can be considered:

**7.2.1 Integration with Government Health Departments and NGOs**

A public-private partnership for the collaboration of government health institutions and NGOs can help in the deployment of the tool in a large scale, especially in rural or disaster-prone areas. This will help in the predictive stocking of crucial drugs during times of disease outbreaks and climate change emergencies

**7.2.2 Mobile Application with Offline Support**

Developing a mobile application with offline data entry and synchronization capabilities would improve accessibility for small pharmacies and field health workers operating in areas with limited internet connectivity.

**7.2.3 Cloud-Based Deployment**

The system can be extended into a cloud-based platform to support multiple pharmacies, distributors, and hospitals simultaneously. Cloud deployment would enable scalability, real-time access, and centralized data management across different locations.

**7.2.4 Integration with Disease Surveillance Data**

Future versions of the system may support multiple regions and languages, allowing adoption across different countries and healthcare systems and making the platform globally applicable.

**7.2.5 Integration with Disease Surveillance Data**

Incorporating anonymized disease surveillance reports and outbreak alerts alongside weather and sales data can significantly enhance forecasting accuracy, particularly for antibiotics, antipyretics, and vaccines.

**7.2.6 API-Based System Integration**

Secure APIs can be developed to integrate MedInsight with existing **Hospital Information Systems (HIS)** and **Pharmacy Management Software**, enabling automated data exchange and real-time inventory updates.

**7.2.7 Supplier and Distributor Collaboration Module**

A dedicated collaboration module can be introduced to share forecast-driven demand insights with suppliers and distributors, supporting just-in-time inventory and efficient supply chain coordination.

**7.2.8 Sector-Specific Forecast Customization**

Forecasting models can be customized for specific medical sectors such as veterinary medicine, maternal health, and chronic disease management, expanding the system’s applicability.

**7.2.9 Real-Time Alert and Notification System**

Future enhancements may include SMS, email, and in-app notifications to alert users about low stock levels, sudden demand spikes, or forecast anomalies in real time.

**7.2.10 Ethical and Regulatory Compliance Framework**

A built-in compliance framework ensuring adherence to data privacy and healthcare regulations (such as GDPR or HIPAA) can improve trust and facilitate institutional adoption.

**7.2.11 Public Health Analytics Dashboard**

A read-only, anonymized dashboard for policymakers and health authorities can provide insights into regional demand trends, supporting evidence-based public health planning and policy development.

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# **CHAPTER # 8**

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# **Annexure**