MEDICINE INVENTORY FORECASTING AND REORDER SYSTEM USING PYTHON FOR U.S. HEALTHCARE CLINICS

1. Background

A regional U.S. healthcare provider managing 12 outpatient clinics across three states faced regular challenges in managing medicine inventory. Stockouts of critical items like insulin, antibiotics, and vaccines affected patient care, while overstocking led to expired medicine losses.

The client needed a centralized forecasting and inventory model that could account for clinic-specific consumption patterns, supplier lead times, and seasonal spikes. The model had to be scalable, support monthly ordering, and fit within their current operational structure.

2. Objective

- To develop a Python-based model that forecasts medicine usage per clinic
- To calculate reorder points and quantities dynamically based on historical demand and supplier variability
- To flag potential shortages or expiry risks across SKUs and locations
- To generate a clinic-wise reorder schedule and dashboard for monthly planning

3. Data Used

Sources: Clinic-level inventory logs, prescription data, supplier delivery records

Dataset Details:

- 300+ medicine SKUs
- Daily dispensation records (2021–2023)
- Lead time data per supplier (in days)
- Item details: SKU_ID, Medicine_Name, Dosage_Form, Storage_Constraint, Shelf_Life
- Historical purchase and delivery timelines

4. Methodology

4.1 Forecasting Monthly Consumption

- Aggregated daily records to monthly demand per SKU per clinic
- Applied Holt-Winters seasonal method (using statsmodels)
- Generated monthly forecasts for 6-month horizon

4.2 Reorder Point and Quantity Logic

- Calculated:
    - **Reorder Point** = (Average Monthly Usage × Lead Time in Months) + Safety Stock
    - **Safety Stock** = Z-score × Std. Deviation of past 3 months' usage
    - **Reorder Quantity** = Target Stock – Current Stock
- Incorporated shelf life and temperature sensitivity into safety stock level decisions

4.3 Python Implementation

- Used pandas, numpy, statsmodels, matplotlib, and openpyxl
- Created an interactive script that accepts:
    - New monthly usage data
    - Updated delivery records
    - SKU constraints

5. Optimization Results

- **Stockout incidents**: Dropped from 19/month to 3 across all clinics
- **Expired inventory value**: Reduced by 41% after 3 months of rollout
- **Forecast Accuracy (MAPE)**:
    - Antibiotics: 8.7%
    - Insulin: 6.4%
    - Vaccines: 9.1%
- Alert system flagged low-stock SKUs 10–14 days before breaching reorder point

6. Insights and Recommendations

- **Three clinics** had consistent under-forecasting due to undocumented seasonal outreach programs
- Recommended storing low-velocity, high-cost drugs centrally to reduce wastage
- Added flag for SKUs with <3 months shelf life and low turnover
- Proposed monthly central procurement with weekly clinic-level redistribution

7. Reporting Output

- **Python Script**:
  - Input: usage data + supplier table
  - Output: forecast table, reorder points, visual reorder timeline
  - Auto-generates .xlsx reorder list by clinic and by SKU
- **PDF Report (15 pages)**:
  - Forecast trends and SKU-level accuracy metrics
  - Clinic comparison charts
  - Reorder strategy recommendations and risk flags
- **Excel Dashboard**:
  - Tabs per clinic
  - Traffic light alert system (Green: Sufficient, Yellow: Near threshold, Red: Critical)
  - Monthly auto-generated reorder form

8. Operational Impact

- Improved medicine availability compliance (SLA) to 98%+ across 12 clinics
- Pharmacy managers now spend **less than 1 hour per month** on reorder planning
- Central team tracks demand spikes faster (e.g., flu season, vaccine drives)
- Long-term integration plan underway with clinic's EHR for auto-triggered restock requests