DEVELOPING A REAL-TIME INVENTORY FORECASTING DASHBOARD USING R AND SHINY: A CASE STUDY FOR A U.S. AUTOMOTIVE PARTS RETAIL CHAIN

1. Background

A regional auto parts retail chain operating in Illinois and Indiana struggled with decentralized inventory management and delayed stock updates. Warehouses faced recurring problems of overstocking slow-moving parts and stockouts of high-demand SKUs. The client required a real-time inventory dashboard in R to visualize inventory levels, forecast future demand, and automate replenishment recommendations across multiple outlets.

2. Objective

- To create an interactive R Shiny dashboard for visualizing current inventory by location and SKU
- To generate short-term forecasts for high-velocity SKUs
- To build automated replenishment triggers based on predicted shortfalls and stock turn ratios

3. Data Used

Source: Retail POS and inventory ERP exports

Structure:

- Daily sales and stock levels from 23 store locations
- Time Period: Jan 2021 – Jan 2024
- Fields: SKU, Location_ID, Date, Units_Sold, Stock_On_Hand, Lead_Time_Days, Reorder_Point, Category

4. Modeling Methodology

4.1 Data Integration and Processing

- Unified sales and stock data using dplyr and lubridate

- Created SKU-Location combinations and indexed time series using xts
- Handled outliers and zero-sale days with rolling average smoothing

4.2 Forecasting Engine

- Implemented **simple exponential smoothing (SES)** for fast-moving SKUs
- For slow-movers, used a hybrid of **moving average + reorder threshold logic**

```
model_ses <- ses(ts_data, h = 14)
forecast_vals <- as.data.frame(forecast(model_ses))
```

4.3 Replenishment Logic

- Trigger alert if Forecasted_Demand > Stock_On_Hand - Reorder_Point
- Auto-generate replenishment quantity:
- suggested_qty <- max(0, forecasted_demand - current_stock + safety_stock)

4.4 Dashboard Development in Shiny

- Dashboard panels:
    - **Inventory Heatmap**: Real-time stock per SKU by location
    - **Forecast Tab**: 14-day demand projections
    - **Reorder Alert Tab**: Color-coded urgency flags (green/yellow/red)
- Used plotly, reactable, and shinydashboard for interactive components

5. Results

KPI	Before (Manual System)	After (R Shiny Dashboard)
Stockouts per month (avg)	74	29
Overstock items (>30 days)	112	44
Replenishment planning time	6 hours/week	40 mins/week
Reorder compliance across stores	63%	91%

6. Interpretation and Recommendations

- The forecast engine captured **day-of-week patterns**, especially relevant for weekend peak demand
- Reorder alert system helped store managers **act on predicted shortfalls in advance**
- Recommended training junior staff on using dashboard filters and exporting reports
- Suggested syncing with **vendor APIs** for live lead time updates in next phase
- Recommended **quarterly re-training of SES models** using updated data

7. Reporting Output

- **Live Dashboard URL** (restricted access)
    - Tabs for SKU Lookup, Forecasts, Alerts, and Settings
- **Documentation PDF** (18 pages)
    - User manual with screenshots
    - Inventory logic flowchart
    - Maintenance and support guidelines
- **Forecast Script Repository**
    - forecast_engine.R
    - generate_dashboard_data.R
    - shiny_ui.R and shiny_server.R for deployment

8. Business Outcome

- Achieved **~60% drop in stockouts** for high-demand brake pad and battery SKUs
- Saved **30+ man-hours per month** in inventory planning
- Real-time dashboard helped corporate HQ **track all locations** without needing daily email updates
- Identified **8 deadstock SKUs** and recommended discontinuation to finance team