ECONOMIC ORDER QUANTITY AND REORDER POINT OPTIMIZATION FOR PERISHABLE INVENTORY: A CASE STUDY USING R

1. Background

A U.S.-based specialty food distributor supplying organic dairy, fresh produce, and artisanal bread to retail chains faced frequent stockouts and overstock situations. These inefficiencies led to customer dissatisfaction and high spoilage costs. The distributor sought a robust R-based inventory model to calculate optimal order quantities and reorder points, accounting for perishability and supplier lead times.

2. Objective

- To calculate optimal Economic Order Quantity (EOQ) and Reorder Points (ROP) for perishable SKUs
- To minimize holding and spoilage costs while avoiding stockouts
- To create a reusable R-based model that supports inventory decisions weekly

3. Data Used

Source: Internal inventory logs, POS data, and supplier schedules

Structure:

- 12 perishable SKUs (organic yogurt, mushrooms, spinach, sourdough bread, etc.)
- Weekly data from Jan 2022 to Jan 2024
- Columns: SKU, Date, Sales_Units, Lead_Time_Days, Order_Units, Spoilage_Rate, Cost _per_Unit

4. Modeling Methodology

4.1 Preprocessing in R

- Cleaned and merged POS and inventory records using dplyr
- Calculated average weekly demand and standard deviation for each SKU
- Modeled spoilage-adjusted demand using:

- effective_demand <- demand * (1 - spoilage_rate)

4.2 EOQ Calculation

- Applied classical EOQ formula:

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where:

  - D = average weekly demand × 52
  - S = ordering cost per order
  - H = holding cost per unit per year

Modeled in R using a custom function:

```
calculate_eoq <- function(demand, order_cost, holding_cost) {
sqrt((2 * demand * order_cost) / holding_cost)
}
```

4.3 Reorder Point Calculation

- Used safety stock logic with service level Z-score (90%)
- Formula:
- $ROP = (Lead\ time \times Avg\ weekly\ demand) + Z \times \sigma \times \sqrt{Lead\ time}$
- Modeled in R using:
- rop <- (lead_time * avg_demand) + (qnorm(0.90) * sd_demand * sqrt(lead_time))

4.4 Simulation & Validation

- Simulated inventory levels over 6 months using EOQ and ROP values
- Compared historical stockouts and spoilage to model-based projections

5. Results

SKU	EOQ (Units)	ROP (Units)	Spoilage Reduced	Stockouts Reduced
Organic Yogurt	350	225	↓ 31%	↓ 42%

Sourdough Bread	180	120	↓ 27%	↓ 38%
Fresh Spinach	260	200	↓ 36%	↓ 46%
Portobello Mush.	300	210	↓ 33%	↓ 40%

6. Interpretation and Recommendations

- **Stockout frequency dropped by 40%**, especially on weekends where past demand peaks were under-forecasted
- **Spoilage loss dropped by nearly one-third**, especially on SKUs with short shelf lives
- Recommends updating demand forecasts **every Monday** and adjusting EOQ every **3 months**
- Suggested using model outputs to **schedule staggered delivery slots** for items with varying perishability levels
- Urged integration with procurement dashboard for auto-recommendation of weekly orders

7. Reporting Output

- **R Markdown Report (PDF, 22 pages)**
    - EOQ vs. historical order volume graphs
    - Stockout/surplus simulations
    - Category-level EOQ & ROP dashboards
- **Excel Planning Tool**
    - Input: current inventory, lead time
    - Output: recommended EOQ, reorder point, next order date
    - Conditional formatting: "Order Now" alerts for critical SKUs
- **Reusable R Script**
    - inventory_optimizer.R
    - Main function: generate_inventory_plan(sku_data, service_level = 0.90)
    - Ready to integrate into weekly batch job

8. Business Outcome

- Reduced annual spoilage costs by ~\$64,000
- Achieved 95% order fill rate during Q4 holiday surge
- Increased SKU profitability margins by 3–5%
- Team now uses this model as a **weekly decision support tool**