Module 4 Project

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An Inventory Model – A Prescriptive Model for Strategic Decision Making

Introduction

Effectively managing stock levels is essential to achieving both operational efficiency and financial stability in manufacturing environments. This report outlines a structured model designed to support smarter decision-making regarding a critical engine part. The goal is to reduce inventory-related expenses by identifying the best order quantity across different demand conditions.

<u>Part 1: EOQ Model Analysis and Results</u>

The initial analysis applied the Economic Order Quantity (EOQ) framework to determine the most efficient order size and the related inventory cost, assuming a constant demand throughout the year.

Model Design Summary:

- External Inputs: Yearly demand volume, unit purchase cost, holding cost rate, ordering cost/procurement costs.
- Model Parameters: Holding cost per unit/year, ordering cost per order.
- Decision Element: Order Quantity to be determined(Q).
- Objective: Reduce overall inventory expenditure y selecting the most suitable order size.

Key Inputs:

- Annual Demand- 15,000 units
- Cost per Item- $80
- Holding Fee- 18% of unit cost = $14.40 per unit per year
- Cost Incurred per Order- $220

Formulas Used

- Ordering Cost = (Annual Demand / Order Quantity) * Ordering Cost
- Holding Cost = (Order Quantity / 2) * Holding Cost
- Total Inventory Cost = Ordering Cost * Holding Cost

Using Excel Solver, the optimal order quantity was determined to be approximately 677 units. This resulted in a minimum total inventory cost of approximately $9748.85. The cost was evenly distributed between ordering and holding costs, both around $4874.

A chart was plotted to visualize the relationship between Total Inventory Cost and Order Quantity. The cost curve showed a U-shape, indicating an optimal point of minimum cost around 677 units.

A sensitivity analysis was conducted using a two-way data table in Excel to evaluate the impact of changes in ordering and holding costs. The analysis showed that total cost increases more significantly with rising holding costs compared to ordering costs. The results emphasize the importance of controlling holding costs to maintain optimal cost levels.

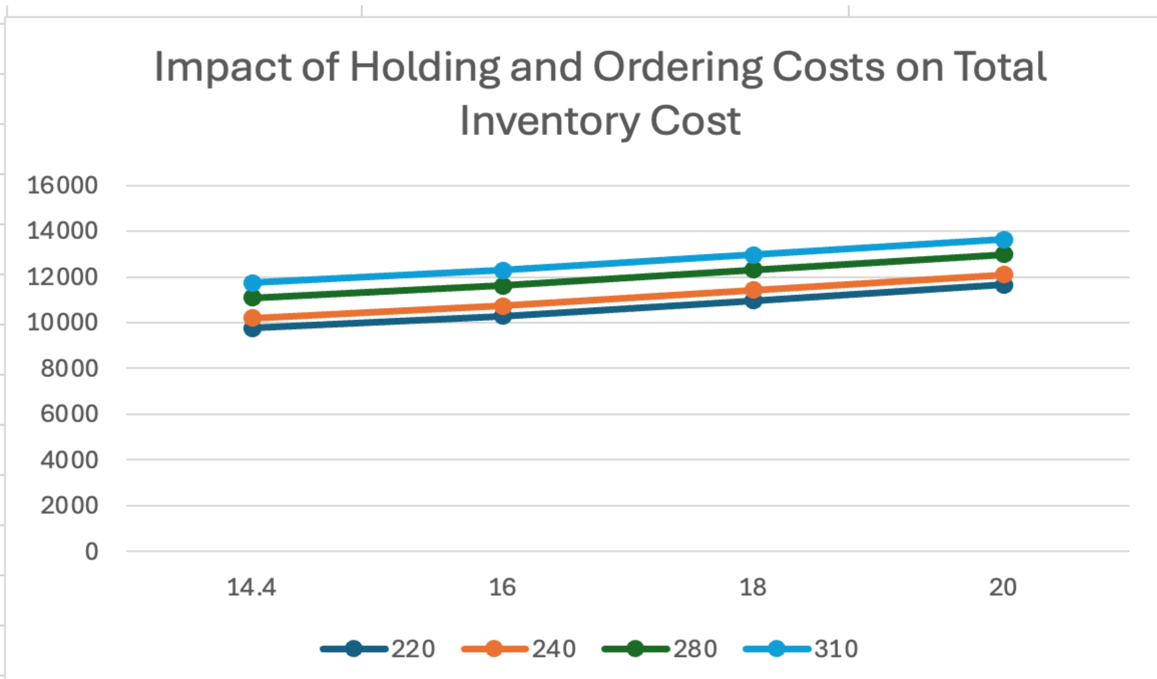

Figure 1: Total Inventory Cost vs Holding Cost for Different Ordering Costs (Excel Sensitivity Analysis)

Part 2: Simulation Under Demand Uncertainty (Using R)

To evaluate the robustness of our inventory model under uncertain demand conditions, we conducted a simulation analysis in R using a triangular probability distribution for annual demand. All other model parameters (ordering cost, unit cost, holding cost rate) remained the same as in Part I. This analysis aims to estimate key metrics (total cost, order quantity, annual number of orders) and assess how they vary under demand fluctuations.

Simulation Assumptions:

- Demand followed a triangular distribution, defined by a minimum value of 13,000 units, a most likely value (mode) of 15,000 units and maximum of 17,000 units.
- The simulation was run for 1,000 scenarios to capture variations in demand outcomes.
- Each unit was prices at $80
- Storage or holding expenses were estimated as 18% of the item's cost, equivalent to $14.40 per unit annually.
- Every replenishment order incurred a cost of $220.

For each simulated demand value, EOQ, total inventory cost, and annual number of orders were calculated using standard EOQ formulas.

(i) Estimated Minimum Total Cost – Confidence Interval and Distribution Fit

The simulation output showed that Total Inventory Cost varied between approximately $8000 and $11,000, forming a near-symmetric, bell-shaped distribution, which resembles a normal distribution.

95% Confidence Interval for Expected Total Inventory Cost:

- Mean Total Cost: $9737.85
- 95% CI: [$9697.73, $9777.97]

Distribution Fit Validation:
The histogram confirms an approximately normal distribution, validating the use of this model under uncertainty.

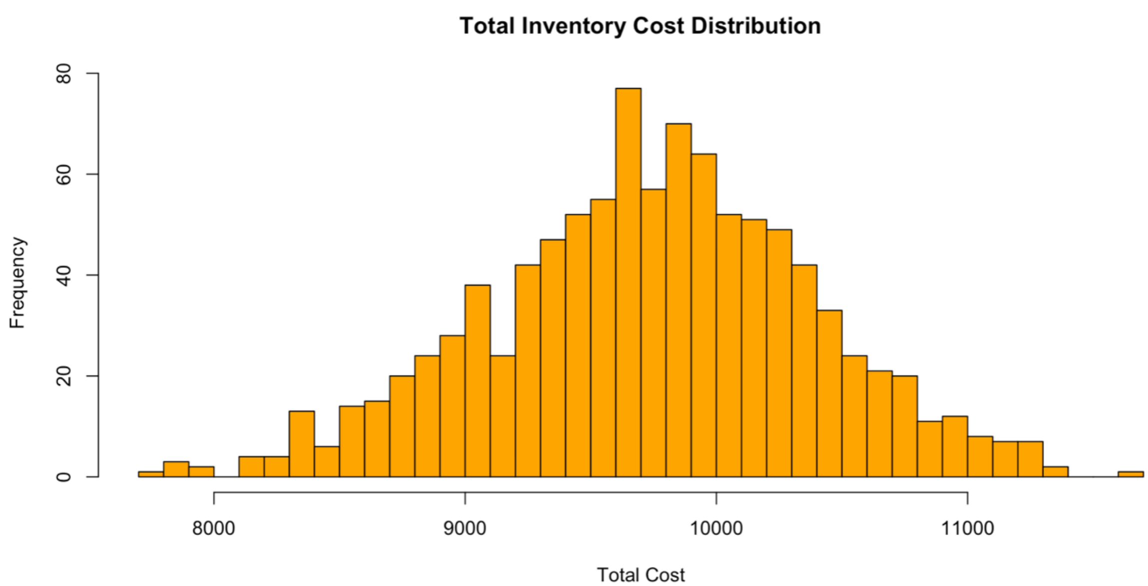

Figure 2: Total Inventory Cost Distribution under Triangular Demand

(ii) Estimated EOQ – Confidence Interval and Distribution Fit

The EOQ values derived from the simulation also formed a symmetrical bell-shaped distribution with minor skewness, again indicating a normal distribution fit.

95% Confidence Interval for Expected EOQ:

- Mean EOQ: 676.24 units
- 95% CI: [673.45, 679.03]

Distribution Fit Validation:
The distribution is well-centered and consistent with expectations from Part I, confirming model reliability.

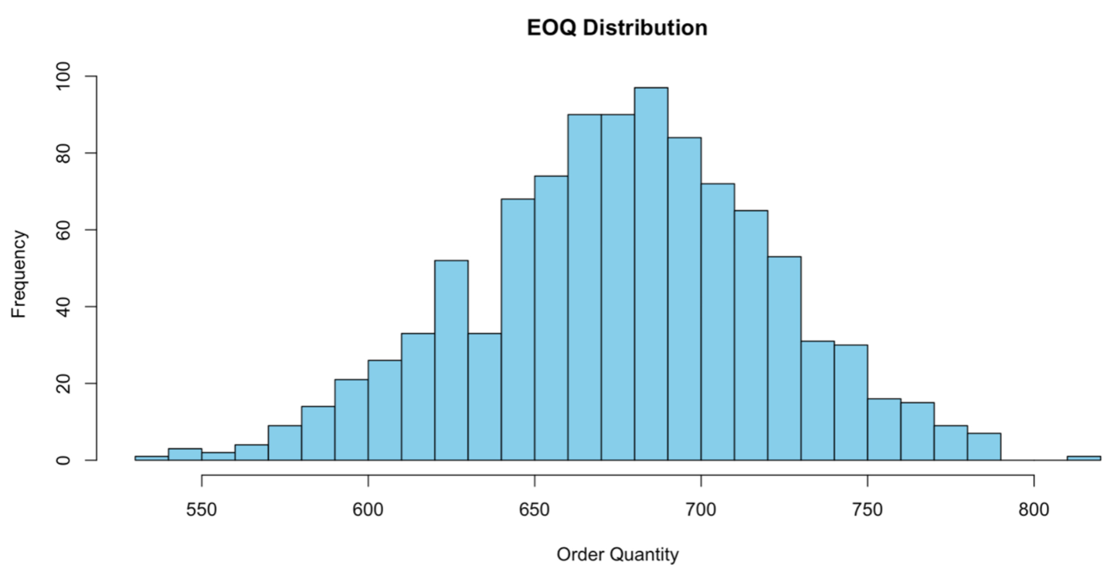

Figure 3: EOQ Distribution under Triangular Demand

(iii) Estimated Annual Number of Orders – Confidence Interval and Distribution Fit

The number of annual orders (Demand / EOQ) produced a distribution that is slightly right-skewed, though still fairly centered around the mean. This shape may still be approximated by a normal distribution with slight skew, or possibly a triangular distribution, given the inherited shape from the demand distribution.

95% Confidence Interval for Expected Annual Number of Orders:

- Mean Orders per Year: 22.27
- 95% CI: [22.15, 22.39]

Distribution Fit Validation:
Histogram confirms a slightly skewed but consistent distribution around the mean.

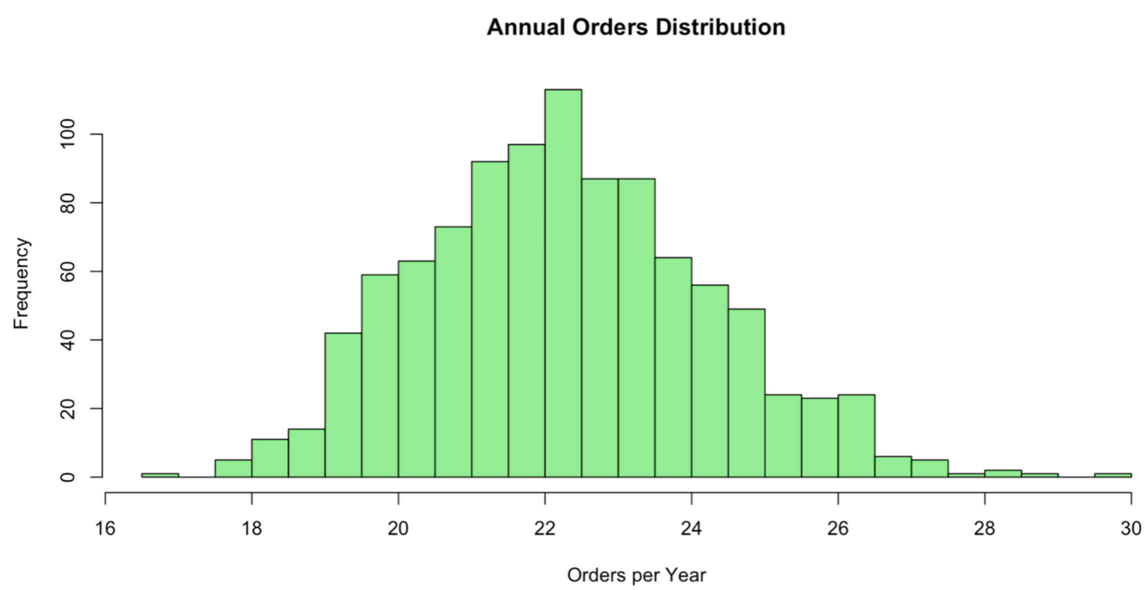

Figure 4: Annual Number of Orders Distribution under Triangular Demand

Conclusion

This report provides a comprehensive inventory decision model tailored for strategic management under both stable and uncertain demand conditions. In Part I, the EOQ model demonstrated that an optimal order quantity of approximately 677 units effectively balances ordering and holding costs, minimizing total inventory costs. Sensitivity analysis further highlighted that holding cost variations have a more significant impact on total cost than ordering cost changes.

In Part II, simulation under a triangular demand distribution validated the robustness of the EOQ model. The confidence intervals for total inventory cost, order quantity, and annual orders showed minimal variation, supporting the reliability of the recommended strategy. The observed distributions also confirmed a close fit to normal behavior for key variables, enabling confident decision-making even under uncertainty.

Overall, this prescriptive model equips the management team with a data-driven, cost-effective framework for inventory control — ensuring operational efficiency while safeguarding financial performance across varying demand scenarios.

References

1. Nahmias, S. (2013). *Production and Operations Analysis* (7th ed.). Waveland Press.
2. R Documentation: rnorm() function
3. Excel Help - Microsoft Office: How to use Solver and Data Tables in Excel