# Inventory Management Decision Model Report

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# Introduction

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Effective inventory management is a cornerstone of operational efficiency in manufacturing, directly impacting cost control, production continuity, and overall customer satisfaction. The challenge lies in striking a balance between maintaining adequate stock levels to meet demand while minimizing excess inventory costs. This report presents an Inventory Management Decision Model aimed at optimizing inventory decisions for a critical engine component.

To achieve this, a deterministic model was developed using Excel, and a probabilistic simulation was conducted using R to assess the model's robustness under varying demand conditions. The primary objective was to identify the optimal order quantity (Q) that minimizes Total Inventory Cost, which is the sum of Annual Ordering Cost and Annual Holding Cost.

This report outlines the methodological framework, including key parameters and formulas, and presents findings derived from both Excel analysis and R simulations. A sensitivity analysis is also performed to evaluate how changes in Order Quantity (Q) and Holding Cost (H) influence Total Cost. Finally, actionable recommendations are provided to enhance the company's inventory management strategy, reduce costs, and improve overall efficiency.

# Methodology

**Data and Parameters**

The following parameters are used in the analysis:

| Parameter | Value |
|---:|---:|
| Annual Demand (D) | 15000 |
| Unit Cost (C) | 80 |
| Holding Cost Rate (H%) | 0.18 |
| Ordering Cost (S) | 220 |
| Holding Cost (H) | 14.4 |
| Daily Demand | 41.09589041 |

**Total Cost Calculation**

The Total Cost is calculated as:

**Total Cost = Annual Ordering Cost + Annual Holding**

Where:

- **Annual Ordering Cost:** D/Q×S

- **Annual Holding Cost:** Q/2×H

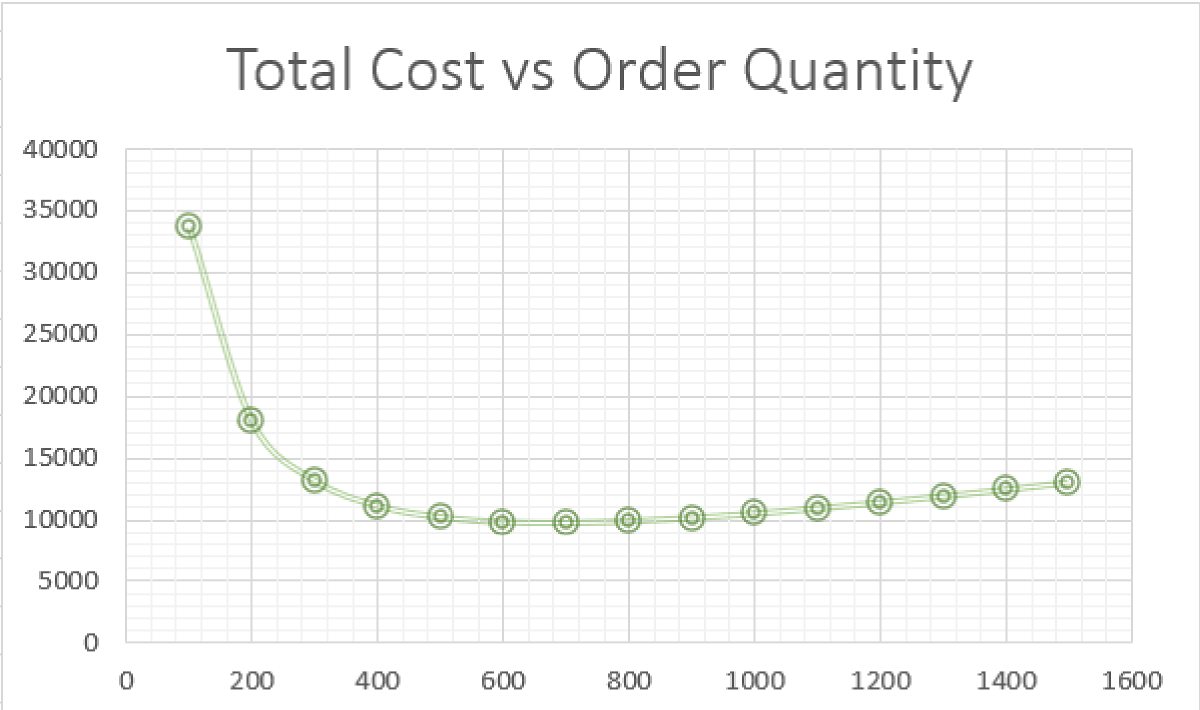
## Excel Analysis

A data table was constructed to evaluate how Total Cost varies with different order quantities (Q):

- Order Quantity (Q): Number of units ordered per batch.
- Annual Ordering Cost: Decreases as Q increases, since fewer orders are placed annually.
- Annual Holding Cost: Increases as Q increases, due to higher storage costs.
- Total Cost: The sum of ordering and holding costs, with an optimal Q minimizing the total.

| | Data Table | | |
|---|---|---|---|
| **Order Quantity(Q)** | **Annual Ordering Cost** | **Annual Holding Cost** | **Total Cost** |
| 100 | 33000 | 720 | 33720 |
| 200 | 16500 | 1440 | 17940 |
| 300 | 11000 | 2160 | 13160 |
| 400 | 8250 | 2880 | 11130 |
| 500 | 6600 | 3600 | 10200 |
| 600 | 5500 | 4320 | 9820 |
| 700 | 4714.285714 | 5040 | 9754.285714 |
| 800 | 4125 | 5760 | 9885 |
| 900 | 3666.666667 | 6480 | 10146.66667 |
| 1000 | 3300 | 7200 | 10500 |
| 1100 | 3000 | 7920 | 10920 |
| 1200 | 2750 | 8640 | 11390 |
| 1300 | 2538.461538 | 9360 | 11898.46154 |
| 1400 | 2357.142857 | 10080 | 12437.14286 |
| 1500 | 2200 | 10800 | 13000 |

A graphical analysis was conducted to visualize the Total Cost vs. Order Quantity, revealing a clear minimum point where Total Cost is at its lowest.




A two-way sensitivity analysis was performed, showing that:

- As Q increases, Total Cost initially declines and then rises.
- As H increases, Total Cost rises, highlighting the importance of optimizing inventory policies to control storage expenses.

| | | | **Two-Way Table** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | **Holding Cost(H)** | | | |
| **Order Quantity(Q)** | **9754.285714** | **10** | **12** | **14** | **16** | **18** | **20** | **22** |
| | **100** | 33500 | 33600 | 33700 | 33800 | 33900 | 34000 | 34100 |
| | **200** | 17500 | 17700 | 17900 | 18100 | 18300 | 18500 | 18700 |
| | **300** | 12500 | 12800 | 13100 | 13400 | 13700 | 14000 | 14300 |
| | **400** | 10250 | 10650 | 11050 | 11450 | 11850 | 12250 | 12650 |
| | **500** | 9100 | 9600 | 10100 | 10600 | 11100 | 11600 | 12100 |
| | **600** | 8500 | 9100 | 9700 | 10300 | 10900 | 11500 | 12100 |
| | **700** | 8214.285714 | 8914.285714 | 9614.285714 | 10314.28571 | 11014.28571 | 11714.28571 | 12414.28571 |
| | **800** | 8125 | 8925 | 9725 | 10525 | 11325 | 12125 | 12925 |
| | **900** | 8166.666667 | 9066.666667 | 9966.666667 | 10866.66667 | 11766.66667 | 12666.66667 | 13566.66667 |
| | **1000** | 8300 | 9300 | 10300 | 11300 | 12300 | 13300 | 14300 |
| | **1100** | 8500 | 9600 | 10700 | 11800 | 12900 | 14000 | 15100 |
| | **1200** | 8750 | 9950 | 11150 | 12350 | 13550 | 14750 | 15950 |
| | **1300** | 9038.461538 | 10338.46154 | 11638.46154 | 12938.46154 | 14238.46154 | 15538.46154 | 16838.46154 |
| | **1400** | 9357.142857 | 10757.14286 | 12157.14286 | 13557.14286 | 14957.14286 | 16357.14286 | 17757.14286 |
| | **1500** | 9700 | 11200 | 12700 | 14200 | 15700 | 17200 | 18700 |

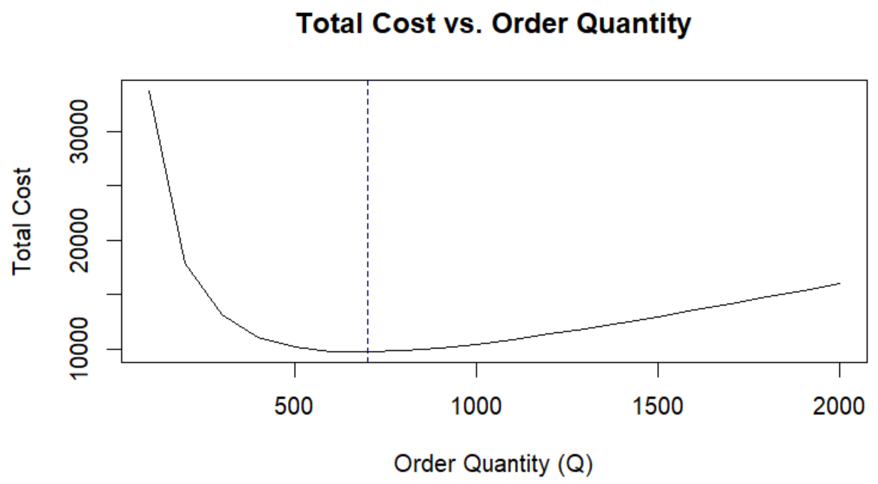
## R Output

Given the potential variability in demand, a triangular probability distribution was used to simulate annual demand fluctuations:

- Minimum demand: 13,000 units
- Most likely demand: 15,000 units
- Maximum demand: 17,000 units

```
> cat("Optimal Order Quantity:", optimal_Q, "\n")
Optimal Order Quantity: 700
> cat("Minimum Total Cost:", optimal_cost, "\n")
Minimum Total Cost: 9754.286
```

```
> cat("Expected Minimum Total Cost:", mean_cost, "\n")
Expected Minimum Total Cost: 9742.768
> cat("95% Confidence Interval for Total Cost:", ci_cost, "\n"
95% Confidence Interval for Total Cost: 9226.344 10240.34
>
```




On implementing the simulation in R to evaluate the stability of the optimal order quantity under different demand conditions. The simulation confirmed that the optimal Q remained stable at 700 units, demonstrating the model's robustness despite fluctuations in demand.

## Conclusion

### Key Insights

- The optimal order quantity was identified as 700 units, minimizing Total Inventory Cost.
- Excel and R analyses produced consistent results, reinforcing the model's accuracy and reliability.

- The two-way data table analysis underscored the sensitivity of Total Cost to variations in Q and H, emphasizing the need for precise inventory planning.
- The simulation results validated the robustness of the model, ensuring stable inventory decisions even under fluctuating demand scenarios.

**References**


- Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2020). *An introduction to management science: Quantitative approaches to decision making*. Cengage Learning.
- R Core Team (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.