CHAPTER 4
EOQ Model
Economic Order Quantity

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EOQ Assumptions

- Known & constant demand
- Known & constant lead time
- Instantaneous receipt of material
- No quantity discounts
- Only order (setup) cost & holding cost
- No stockouts
## Inventory Holding Costs

*Reasonably Typical Profile*

<table>
<thead>
<tr>
<th>Category</th>
<th>% of Inventory Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing (building) cost</td>
<td>6%</td>
</tr>
<tr>
<td>Material handling costs</td>
<td>3%</td>
</tr>
<tr>
<td>Labor cost</td>
<td>3%</td>
</tr>
<tr>
<td>Inventory investment costs</td>
<td>11%</td>
</tr>
<tr>
<td>Pilferage, scrap, &amp; obsolescence</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Total holding cost</strong></td>
<td><strong>26%</strong></td>
</tr>
</tbody>
</table>
EOQ Model

Annual Cost

Order Quantity
EOQ Model

Annual Cost

Order Quantity

Holding Cost
Why Order Cost Decreases

• Cost is spread over more units

Example: You need 1000 microwave ovens

1 Order (Postage $0.35) 1000 Orders (Postage $350)

<table>
<thead>
<tr>
<th>Purchase Order</th>
<th>Description</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microwave</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

Order quantity
EOQ Model

Annual Cost

Order Quantity

Holding Cost

Order (Setup) Cost
EOQ Model

- **Annual Cost**
- **Total Cost Curve**
- **Holding Cost**
- **Order (Setup) Cost**
- **Order Quantity**
EOQ Model

Annual Cost

Total Cost Curve

Order Quantity

Optimal Order Quantity (Q*)

Order (Setup) Cost

Holding Cost
**EOQ Formula Derivation**

**D** = Annual demand (units)
**C** = Cost per unit ($)
**Q** = Order quantity (units)
**S** = Cost per order ($)  
**I** = Holding cost (%)  
**H** = Holding cost ($) = I x C

Number of Orders = D / Q  
Ordering costs = S x (D / Q)

Average inventory
units = Q / 2  
$ = (Q / 2) x C

Cost to carry average inventory = (Q / 2) x I x C  
= (Q /2) x H

Total cost = (Q/2) x I x C + S x (D/Q)

Take the 1st derivative:

d(TC)/d(Q) = (I x C) / 2 - (D x S) / Q²

To optimize: set d(TC)/d(Q) = 0

DS / Q² = IC / 2

Q²/DS = 2 / IC

Q² = (DS x 2 )/ IC

Q = sqrt (2DS / IC)
Economic Order Quantity

\[ EOQ = \sqrt{\frac{2 \times D \times S}{H}} \]

- \( D \) = Annual demand (units)
- \( S \) = Cost per order ($)
- \( C \) = Cost per unit ($)
- \( I \) = Holding cost (%)
- \( H \) = Holding cost ($) = \( I \times C \)
EOQ Model Equations

Optimal Order Quantity: \[ Q^* = \sqrt{\frac{2DS}{H}} \]

Expected Number Orders: \[ N = \frac{D}{Q^*} \]

Expected Time Between Orders: \[ T = \frac{\text{Working Days / Year}}{N} \]

\[ d = \frac{D}{\text{Working Days / Year}} \]

\[ ROP = d \cdot L \]

- \( D \) = Demand per year
- \( S \) = Setup (order) cost per order
- \( H \) = Holding (carrying) cost
- \( d \) = Demand per day
- \( L \) = Lead time in days
You’re a buyer for SaveMart.

SaveMart needs 1000 coffee makers per year. The cost of each coffee maker is $78. Ordering cost is $100 per order. Carrying cost is 40% of per unit cost. Lead time is 5 days. SaveMart is open 365 days/yr.

What is the optimal order quantity & ROP?
SaveMart EOQ

\[ EOQ = \sqrt{\frac{2 \times D \times S}{H}} \]

\[ D = 1000 \]
\[ S = $100 \]
\[ C = $78 \]
\[ I = 40\% \]
\[ H = C \times I \]
\[ H = $31.20 \]

\[ EOQ = \sqrt{\frac{2 \times 1000 \times $100}{$31.20}} \]

\[ EOQ = 80 \text{ coffeemakers} \]
SaveMart ROP

ROP = demand over lead time
  = daily demand x lead time (days)
  = $d \times l$

$D = \text{annual demand} = 1000$
$Days / year = 365$
$\text{Daily demand} = 1000 / 365 = 2.74$
$\text{Lead time} = 5 \text{ days}$

$ROP = 2.74 \times 5 = 13.7 \Rightarrow 14$
SaveMart
Average (Cycle Stock) Inventory

Avg. CS = OQ / 2
= 80 / 2 = 40 coffeemakers
= 40 x $78 = $3,120

Inv. CC = $3,120 x 40% = $1,248

Note: unrelated to reorder point
Economic Order Quantity

\[ EOQ = \sqrt{\frac{2 \times D \times S}{H}} \]

D = Annual demand (units)
S = Cost per order ($) 
C = Cost per unit ($) 
I = Holding cost (%) 
H = Holding cost ($) = I \times C
What if …

1. Interest rates go up?
2. Order processing is automated?
3. Warehouse costs drop?
4. Competitive product is introduced?
5. Product is cost-reduced?
6. Lead time gets longer?
7. Minimum order quantity imposed?

\[ EOQ = \sqrt{\frac{2 \times D \times S}{H}} \]