ME4001 Engineering Management Summer '08

Statistical Inventory Management + MRP

3.

- In statistical inventory management, all of the parameters (d, Sd, LT, SLT, etc.) are found using statistical methods. P is found from machine capabilities/constraints and is generally regarded as a constant.

All of these quantities must be found for all the items in the inventory and the corresponding EOQ calculated. This is acceptable for distribution type of inventory as the demand for each item is independant.

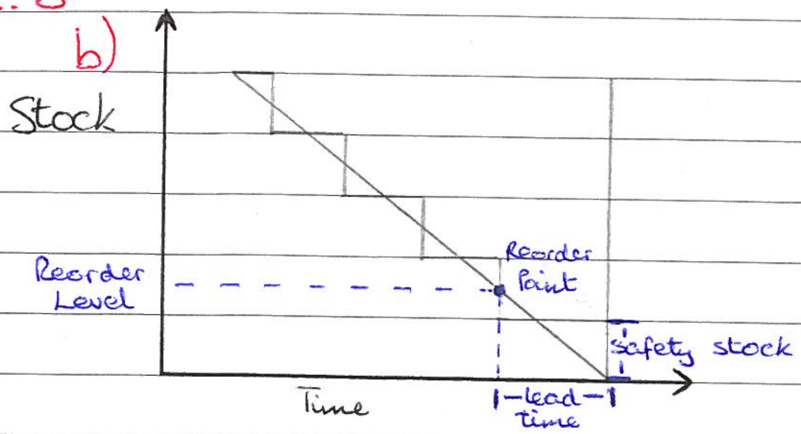
- For manufacturing inventory, EOQ and other quantities need not be calculated for all items in the inventory. As the products are built from components, only the product (parent item) requirements are necessary. If the demand for the parent item is known, then the demand for the components can be worked out using a bill of materials.

This system is known as "Materials Requirement Planning" (MRP). MRP is also used as a scheduling tool. If the date the parent item is required is known we can then work out the date the components are required.

ME4001 Engineering Management Summer '08

Q.3

b)



Lead time = 4 weeks

$p = 5000$ items/week

$M = €25$

$C_S = €1500$

$C_H = 26\%$ of M per year

$d = 1000$/week

Economic Order Quantity: $Q_{econ} = \sqrt{\dfrac{2C_S d}{C_H(1-d/p)}}$

Proof:

Average Stock Level $= B + \frac{x}{2}$

$\therefore$ Stock Holding Cost p.u. time $= C_H(B + \frac{x}{2})$

But $x = (p-d)T_p$ and $Q = pT_p$

$\therefore x = (p-d)\frac{Q}{p}$

$\therefore$ Stock holding cost p.u. time $= C_H\left(B + \frac{Q}{2p}(p-d)\right)$

Setup cost p.u. time $= \frac{C_S}{T_c}$

But batch quantity $Q = dT_c$

$\Rightarrow$ Setup cost p.u. time $= \frac{C_S}{Q}d$

Total cost p.u. time $= C = M.d + C_H\left(B + \frac{Q}{2}(1 - d/p)\right) + \frac{C_S}{Q}d$

For optimum: $\frac{dC}{dQ} = 0$

$\Rightarrow \frac{C_S d}{Q^2} = \frac{C_H}{2}(1 - d/p)$

C_H per week $= 0.26\left(\frac{25}{52}\right) = €\frac{25}{200}$ per week

$Q_{econ} = 5{,}477$ items

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3.

Mean Demand During LT = $d_{\phi} \times LT$

$= 4{,}000$ items

Std. Deviation of LT Demand $= \sigma_d \sqrt{LT}$

$= 400$ items

95% service level (from table) $\Rightarrow z \simeq 1.645$

$$R.O.L. = dLT + z(\sigma_d LT)$$
$$= 4{,}658 \text{ items}$$

Safety Stock = 658 items

c) We know:

$$C = \underbrace{Md + C_H B}_{\text{Fixed}} + \underbrace{C_H\left(\frac{Q}{2}\left[1 - d/p\right]\right) + \frac{C_s d}{Q}}_{\text{Variable}}$$

For min. Cvar, Q = Qecon

$$C_{var_{min}} = €547.72$$

For 10% Deviation:

$$1.1 \times C_{var_{min}} = €602.49$$
$$= 0.05Q + \frac{1.5 \times 10^6}{Q}$$
$$\Rightarrow Q^2 - 12049.8Q + (1.5 \times 10^6 \times 20)$$
$$Q = 8{,}534 \text{ or } 3515$$

3.b $B = 0$ $\quad C_{SM} = €1{,}500$

$P = 10{,}000$ /week $\quad C_T = €2{,}000$

$d = 1{,}000$ /week $\quad C_H = €0{\cdot}125$ /week

$M = €25$

Manufacture:

$$\text{Average Stock Level} = \frac{Q/2 \times T_p}{T_c} = \frac{Q/2 \times Q/p}{Q/d} = \frac{Qd}{2p}$$

$$Q = pT_p = dT_c$$

$$\text{Cost p.u. time of holding stock} = C_H \frac{Qd}{2p}$$

$$\text{Setup cost p.u. time} = \frac{C_S}{T_c} = \frac{C_S d}{Q}$$

Assembly:

$$\text{Average Stock Level} = \frac{Q}{2}$$

$$\text{Cost p.u. time of holding stock} = C_H \frac{Q}{2}$$

$$\text{Setup (Transport) cost p.u. time} = \frac{C_T}{T_c} = \frac{C_T d}{Q}$$

Total Cost:

$$C = C_H\left[\frac{Qd}{2p} + \frac{Q}{2}\right] + \frac{d}{Q}(C_T + C_{SM})$$

$$= C_H \frac{Q}{2}\left[1 + d/p\right] + \frac{d}{Q}(C_T + C_{SM})$$

Optimum Batch Size:

$$\frac{dC}{dQ} = 0$$

$$\Rightarrow \frac{d(C_{SM}+C_T)}{Q^2} = \frac{C_H}{2}\left[1 + d/p\right]$$

$$Q = \sqrt{\frac{2d(C_{SM}+C_T)}{C_H(1+d/p)}}$$

$$Q_{OPT} = 7{,}135 \text{ items}$$

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3c $C_{VAR} = C_H \frac{Q}{2}\left(1 + d/p\right) + \left(C_{SM} + C_T\right)\frac{d}{Q}$

For min C_{var}, $Q = Q_{OPT}$

$$C_{VAR_{min}} = €981.07$$

$1.1\, C_{VAR_{min}} = €1{,}079.18$

$= 0.06875Q + \frac{1}{Q}(3.5 \times 10^6)$

$Q = 11{,}118$ OR $4{,}579$ items

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3. $P = 15{,}000$ $LT = 4$ weeks

$d = 1{,}000$ $\delta_{LT} = 1$ week

$M = €2$ $C_H = €0{\cdot}01$ per week

$C_{SM} = €500$ $z = 2{\cdot}328$

$Q = 3000x$ $Q = dT_c = pT_p$

i) $R.O.L. = dLT + zd\delta_{LT} = 6{,}328$ items

$$\text{Average Stock} = B + \frac{(p-d)T_p}{2} = B + \frac{Q}{2}(1 - d/p)$$

$$\text{Holding Cost} = C_H\left[B + \frac{Q}{2}(1 - d/p)\right]$$

$$\text{Setup Cost} = \frac{C_{SM}}{T_c} = \frac{C_{SM}d}{Q}$$

$$C = Md + C_H\left[B + \frac{Q}{2}(1 - d/p)\right] + \frac{C_{SM}d}{Q}$$

Optimum Quantity: $\frac{dC}{dQ} = 0$

$$\Rightarrow \frac{C_{SM}d}{Q^2} = \frac{C_H}{2}(1 - d/p)$$

$$Q_{EOQ} = \sqrt{\frac{2C_{SM}d}{C_H(1 - d/p)}}$$

$= 10{,}351$ items

Must be a multiple of $3{,}000$

$\Rightarrow Q = 9{,}000$ items

$$C_1 = Md + C_H\left[B + \frac{Q}{2}(1 - d/p)\right] + \frac{C_{SM}d}{Q}$$

$$= 2{,}000 + 0{\cdot}01\left[2{,}328 + 4500(^{14}/_{15})\right] + \frac{500{,}000}{9000}$$

$C_1 = €2{,}120{\cdot}84$

ii) $M_2 = €2{\cdot}50$ $B = 2{,}328$

$C_{ORD} = €70$ $Q_{EOQ} = \sqrt{\frac{2C_{ORD}d}{C_H \cancel{(1 - d/p)}}} = 3{,}347$

$LT = 3$ weeks

$\delta_{LT} = 1$ week Avg. Stock $\Rightarrow$ N/A

$C_H = €0{\cdot}0125$/wk $\therefore Q = 5{,}000$

3. $$C_2 = Md + C_H\left[\frac{Q}{2} + B\right] + \frac{C_{ORD}\, d}{Q}$$

$$= 2{,}500 + 0{\cdot}0125\left[2{,}500 + 2{,}328\right] + \frac{70{,}000}{5000}$$

$$C_2 = €2{,}574 \cdot 35$$

∴ It is cheaper to manufacture

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5. $p = 10{,}000$
$d = 1{,}000$
$M = €30$
$C_s = €1{,}000$
$C_H = €0{\cdot}15$ /wk

Average Stock $= B + \frac{x}{2}$
where $x = T_p(p-d)$
But $Q = pT_p = dT_c$

Average Stock $= B + \frac{Q}{2}(1 - d/p)$
Holding Cost of Avg. Stock $= C_H\left[B + Q/2(1-d/p)\right]$

Setup Cost p.u. time $= \frac{C_s}{T_c} = \frac{C_s d}{Q}$

Total Cost $= Md + C_H\left[B + \frac{Q}{2}(1-d/p)\right] + \frac{C_s d}{Q}$
For Optimum : $\frac{dC}{dQ} = 0$

$\therefore \quad \frac{C_s d}{Q^2} = \frac{C_H}{2}(1 - d/p)$

$$Q_{eoq} = \sqrt{\frac{2C_s d}{C_H(1-d/p)}}$$

$Q_{eoq} = 3{,}849$ items
$Q = 10{,}000$ items

$C_{min} = Md + C_H\left(B + \frac{Q}{2}[1 - d/p]\right) + \frac{C_s d}{Q}$
$= 30{,}000 + 259{\cdot}81 + 259{\cdot}81$
$= €30{,}520$

$C_{VARmin} = C_H \frac{Q}{2}\left[1 - d/p\right] + \frac{C_s d}{Q}$
$= €519{\cdot}62$

$1{\cdot}1 C_{varmin} = €571{\cdot}58 = 0{\cdot}0675Q + \frac{1}{Q}(1\times10^6)$
$Q = 5{,}998$ or 2470 items

For $Q = 10{,}000$
$\Delta C = €(675 + 100) - €519{\cdot}62 = €255{\cdot}38$/week

2. $P = 5{,}000$ /week $\quad C_{SM} = 850$

$d = 1{,}000$ /week $\quad C_H = €0{\cdot}05$

$M = €10$ $\quad Q = pT_p = dT_c$

$$\text{Avg. Stock} = B + \frac{x}{2}$$

where
$$x = T_p(p-d) = \frac{Q}{p}(p-d) = Q(1 - d/p)$$

$$ROL = dLT + z\delta_d\sqrt{LT} = 3{,}000 + z\,100\sqrt{3}$$

$$z = 1{\cdot}882$$
$$= 3{,}326$$

$$\text{Cost of holding avg. stock} = C_H\left(B + \frac{Q}{2}(1 - d/p)\right)$$

$$\text{Setup Cost P.U. Time} = \frac{C_{SM}}{T_c} = \frac{C_{SM}d}{Q}$$

$$\text{Total Cost} \quad C = Md + C_H\left[B + \frac{Q}{2}(1 - d/p)\right] + \frac{C_{SM}d}{Q}$$

For Optimum: $\frac{dC}{dQ} = 0$

$$\Rightarrow \frac{C_{SM}d}{Q^2} = \frac{C_H}{2}(1 - d/p)$$

$$Q_{eoq} = \sqrt{\frac{2C_{SM}d}{C_H(1 - d/p)}} = 6{,}519$$

~~$C_{6000} = €10{,}278$~~

~~C_{7000}~~

$Q = 7{,}000$

Minimum Safety Stock = 326 items