# ASSIGNMENT # 4 - Solutions
# INVENTORY MANAGEMENT

**Total Mark: 20 Points**

**Problem # 1**

Ontario Medical Supply (OMS) is a distributor of medical/surgical products in Ontario. OMS has a warehouse in Ottawa that carries thousands of items, one of which is item #345-5870, Micro-Touch Surgical Glove, size 7. The demand for this item (in cases) during the September to November 2002 was 25, 57, and 50, respectively. OMS's inventory manager uses a three-month moving average to forecast next month's demand for the items. The three-month moving average forecast for December's demand for size 7 gloves is 44 cases. Suppose that he uses the Fixed Order Quantity Model to replenish this item. The surgical gloves are purchased from Ansell Limited in cases of 200 units at a cost of $120 per case. Using the three-month moving average forecast for December, ordering cost of $15 per order, inventory holding cost rate of 15 percent (of price) per year, and purchase lead time of two days,

**Note: because this is not mentioned specifically in the question, you can consider month of December as 30 or 31 day.**

**a)** Calculate the EOQ for this item (rounded to a whole number).

Forecast D = 44 cases per month, Price = $120 per case
S = $15 per order, i = .15, LT = 2 days

$$EOQ = \sqrt{\frac{2DS}{iR}} = \sqrt{\frac{2(44\times 12)(\$15)}{.15(\$120)}} = 29.66$$ round to 30 cases

**b)** Calculate the total annual holding and ordering cost if order quantity is 30 cases.

TC = (Q / 2)(iR) + (D / Q)S = (30 / 2)(.15)($120) + (44×12 / 30)($15) = 270 + 264 = $534

**c)** Using lead time service level of 96 percent and standard deviation of monthly demand of 16.82 cases, calculate the ROP (rounded to a whole number).

SL = 96% → z = 1.75 from Normal table , and $\sigma_d$ (monthly) = 16.82 cases,

$$ROP = \bar{d}(LT) + z\sigma_d\sqrt{LT} = \left(\frac{44}{30}\right)(2) + 1.75\left(\frac{16.82}{\sqrt{30}}\right)\sqrt{2} = 2.93 + 7.60 = 10.53$$

Round to 11 cases

**d)** Now assume OMS uses the fixed order interval model for replenishing this item. Calculate Maximum inventory level ($I_{max}$) for this item (rounded to a whole number) if it is ordered every two weeks and the desired service level is 94 percent.

Fixed Interval model, OI = 2 weeks, SL = 94% → z = 1.555 from Normal table,

$$I_{max} = \bar{d}(OI + LT) + z\sigma_d\sqrt{OI + LT} = \left(\frac{44}{30}\right)(14+2) + 1.555\left(\frac{16.82}{\sqrt{30}}\right)\sqrt{14+2} = 23.47 + 19.10 = 42.57$$

Round to 43 cases

**Problem # 2**

A fish store buys fresh tuna daily for $4.20 per kg and sells it for $5.70 per kg. At the end of each day, any remaining tuna is sold to a producer of cat food for $2.40 per kg. Daily demand for tuna at the fish store can be approximated by a Normal distribution with a mean of 80 kg and a standard deviation of 10 kg. What is the optimal stocking level?

Cost = $4.20 / kg
Rev = $5.70 / kg
Salvage = $2.40 / kg
Normal demand

$\bar{d}$ = 80 kg / day
$\sigma_d$ = 10 kg / day
Optimal stocking level?

$C_s$ = Rev - Cost = $5.70 - $4.20 = $1.50 / kg
$C_e$ = Cost - Salvage = $4.20 - $2.40 = $1.80 / kg

$$SL = \frac{C_s}{C_s + C_e} = \frac{\$1.50}{\$1.50 + \$1.80}$$

SL = .4545 → z = -.115 from normal table (interpolate).

Optimal stocking level = $\bar{d} + z\,\sigma_d$ = 80 - .115(10) = 78.85 kg

**Problem # 3**

A manager must set up inventory ordering procedures for two new production items, P34 and P35. P34 can be ordered at any time, but P35 can be ordered only once every four weeks. The company operates 50 weeks a year, and the weekly usage rate for each item is Normally distributed. The manager has gathered the following information about the items:

| | **Item P34** | **Item P35** |
|---|---|---|

| | | |
|---|---|---|
| Average weekly demand | 60 units | 70 units |
| Standard deviation | 4 units per week | 5 units per week |
| Unit cost | $15 | $20 |
| Annual holding cost rate | 30% | 30% |
| Ordering cost per order | $70 | $30 |
| Lead time | 2 weeks | 2 weeks |
| Acceptable stock-out risk | 2.5% | 2.5% |

**a)** At what inventory level should the manager reorder P34?

$ROP_{P34} = \bar{d} \times LT + z\sqrt{LT}\sigma_d$

$ROP_{P34} = 60(2) + 1.96\sqrt{2}\,(4) = 131.1$ round to 131 units

**b)** Calculate the economic order quantity for P34.

$$EOQ = \sqrt{\frac{2DS}{H}} = \sqrt{\frac{2(3{,}000)(\$70)}{\$4.50}} = 305.51$$ round to 306 units

**c)** Calculate the order quantity for P35 if 110 units are on hand at the time the order is placed.

Q? if on hand = 110 units

$Q = \bar{d}\ (OI + LT) + z\sqrt{OI + LT}\ \sigma_d$ - on hand

$Q_{P35} = 70\ (4 + 2) + 1.96\sqrt{4 + 2}\ (5) - 110$

$Q_{P35} = 420 + 24 - 110$

$Q_{P35} = 334$ units

**Problem # 4**

A small mail-order company uses 18,000 boxes a year. Holding cost rate is 20 percent of unit cost per year, and ordering cost is $32 per order. The following quantity discounts are available.

| Number of Boxes | Price per Box |
|---|---|
| 1,000 to 1,999 | $1.25 |
| 2,000 to 4,999 | 1.20 |
| 5,000 to 9,999 | 1.15 |
| 10,000 or more | 1.10 |

Determine:

**a)** The optimal order quantity.

$$EOQ_{R=\$1.10} = \sqrt{\frac{2DS}{iR}} = \sqrt{\frac{2(18{,}000)32}{.20(1.10)}} = 2{,}288.3 \quad \textit{boxes}$$

Bec. 2,288.3 < 10,000, this EOQ is not feasible. Try the next higher price $1.15:

$$EOQ_{R=\$1.15} = \sqrt{\frac{2DS}{iR}} = \sqrt{\frac{2(18{,}000)32}{.20(1.15)}} = 2{,}238 \quad \textit{boxes}$$

Bec. 2,238 < 5,000, this EOQ is not feasible. Try the next higher price $1.20:

$$EOQ_{R=\$1.20} = \sqrt{\frac{2DS}{iR}} = \sqrt{\frac{2(18{,}000)32}{.20(1.20)}} = 2{,}191 \quad \textit{boxes}$$

Bec. 2,000 < 2,191 < 4,999, this EOQ is feasible. Next, we need to compare the total cost of Q = 2,191 units with those of Q = 5,000 and Q = 10,000 units.

$$TC_{2,191} = \frac{2{,}191}{2}(.20)(1.20) + \frac{18{,}000}{2{,}191}(\$32) + \$1.20(18{,}000) =$$

$$= 262.92 + 262.89 + 21{,}600 = \$22{,}125.81$$

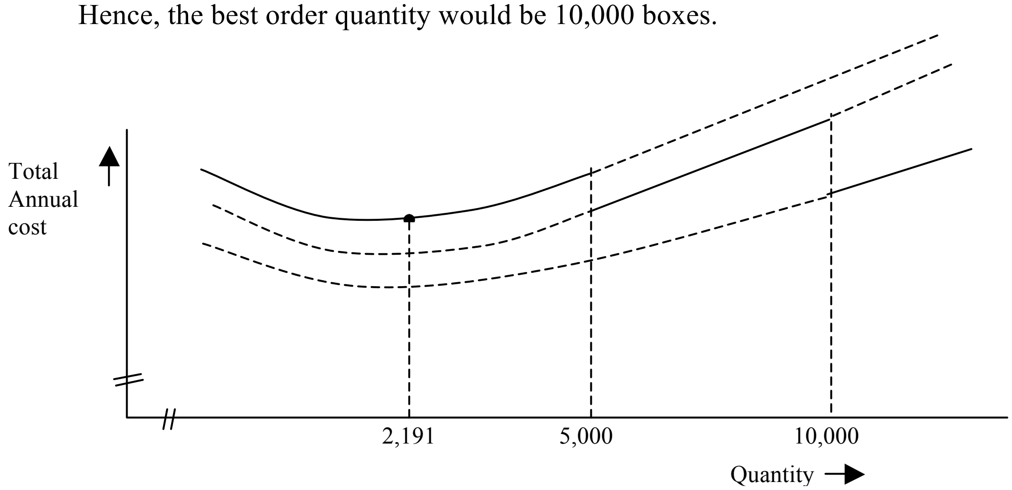
$$TC_{5,000} = \frac{5{,}000}{2}(.20)(1.15) + \frac{18{,}000}{5{,}000}(\$32) + \$1.15(18{,}000) =$$

$$= 575 + 115.2 + 20{,}700 = \$21{,}390.20$$

$$TC_{10,000} = \frac{10{,}000}{2}(.20)(1.10) + \frac{18{,}000}{10{,}000}(\$32) + \$1.10(18{,}000) =$$

$$= 1{,}100 + 57.6 + 19{,}800 = \$20{,}957.60 \quad \text{[lowest]}$$

Hence, the best order quantity would be 10,000 boxes.




**b)** The number of orders per year.

$$\frac{D}{Q} = \frac{18,000}{10,000} = 1.8 \text{ orders per year}$$

**Problem # 5**

A chemical plant produces sodium bisulfate in 100 kg bags. Demand for this product is 20 tonnes per day. The capacity for producing this product is 50 tonnes per day. Setup cost is $400, and storage and handling costs are $200 per tonne per year. The company operates 200 days a year. (Note: 1 tonne = 1,000 kg).

**a)** What is the optimal number of bags per production run?

**b)** What would the average inventory level be for this lot size?
**c)** Determine the approximate length of a production run, in days.
**d)** About how many production runs per year would there be?
**e)** How much could the company save annually in inventory control cost if the setup cost could be reduced to $200 per production run and the optimal production quantity is recalculated and used?

p = 50 tonnes / day
d = 20 tonnes / day
200 days / year
} D = 20 tonnes / day × 200 days / year = 4,000 tonnes / year
S = $400
H = $200 / tonne per year
Bag = 100 kg

a. $Q_o = \sqrt{\frac{2DS}{H}}\sqrt{\frac{p}{p-d}} = \sqrt{\frac{2(4,000)400}{200}}\sqrt{\frac{50}{50-20}}$ = 163.30 tonnes = 1633 bags

b. $I_{max} = \frac{Q}{p}(p - d) = \frac{163.30}{50}(50 - 20)$ = 97.98 tonnes

Avg inven: $\frac{I_{max}}{2} = \frac{97.98}{2}$ = 48.99 tonnes = 490 bags

c. Run length = $\frac{Q}{P} = \frac{163.30}{50}$ = 3.27 days

d. Runs per year= $\frac{D}{Q} = \frac{4,000}{163.30}$ = 24.5

e. If S = $200,

$$Q'_0 = \sqrt{\frac{2DS}{H}}\sqrt{\frac{p}{p-d}} = \sqrt{\frac{2(4,000)200}{200}}\sqrt{\frac{50}{50-20}} = 115.47 \text{ tonnes}$$

$I_{max}$ = (Q / p)(p - d) = (115.47 / 50)(50 - 20) = 69.28 tonnes

Avg inventory = $I_{max}$ / 2 = 69.28 / 2 = 34.64 tonnes

TC = ($I_{max}$ / 2)H + (D / Q)S

TC(S = \$400) = 48.99(\$200) + (4,000 /163.3)\$400 = \$9,798 + \$9,797.92 = \$19,595.92

TC(S = \$200) = 34.64(\$200) + (4,000 /115.47)\$200 = \$6,928 + \$6,928.21 = \$13,856.21

Saving = \$19,595.92 - \$13,856.21 = \$5,739.71