BUSINESS ANALYTICS

ADVANCED MANAGEMENT SCIENCE (QBUS 3310)

Practice questions – EOQ Model

Problem 1

Square city appliance orders four types of washing machines. The following table gives the annual demand, the purchasing cost, and annual holding cost (as a percentage of purchase cost), and the fixed cost of ordering a product. Determine an ordering policy that minimizes the sum of fixed and holding costs. Determine an ordering policy to minimize annual cost of meeting demand.

	PRODUCTS			
	Product 1	Product 2	Product 3	Product 4
Annual demand	10,000	3,000	4,000	500
Unit purchasing cost	$400	$300	$200	$900
Holding cost percentage	0.2%	0.2%	0.2%	0.2%
Product order cost	$1,000	$1,000	$1,000	$1,000

Problem 2

In problem 1, suppose that Square City can manufacture the washing machines. The company can manufacture at a rate of 30,000 units per year. What manufacturing policy will minimize cost of meeting demand?

Problem 3

A firm buys a product using the price schedule given in the following table. The company estimates holding costs at 10% of purchase price per year and ordering costs at $40 per order. The firm's annual demand is 460 units.

1. Determine how often the firm should order.
2. Determine the size of every order.
3. At what price should the firm order?

Price per unit	Quantity
$20.00	0-99
$19.50	100-199
$19.00	200-499
$18.75	500 or more

Solution:

Problem 1

First stage: find EOQ for all products –

$$q_1^* = \sqrt{\frac{2KD}{h}} = \sqrt{\frac{2 \cdot 1,000 \cdot 10,000}{0.002 \cdot 400}} = 5000$$

$$q_2^* = \sqrt{\frac{2 \cdot 1,000 \cdot 3,000}{0.002 \cdot 300}} = 3162.28$$

$$q_3^* = \sqrt{\frac{2 \cdot 1,000 \cdot 4,000}{0.002 \cdot 200}} = 4472.14$$

$$q_4^* = \sqrt{\frac{2 \cdot 1,000 \cdot 500}{0.002 \cdot 900}} = 745.36$$

Second stage: find cycle length for all products –

$$t_1^* = \frac{q_1^*}{D_1} = \frac{5,000}{10,000} = 0.5 = 180\,days$$

$$t_2^* = \frac{q_2^*}{D_2} = \frac{3,162.28}{3,000} = 1.0541 = 379.5\,days$$

$$t_3^* = \frac{q_3^*}{D_3} = \frac{4,472.14}{4,000} = 1.118 = 402.5\,days$$

$$t_4^* = \frac{q_4^*}{D_4} = \frac{745.36}{500} = 1.491 = 544.1\,days$$

Third Stage: find power of two intervals

PRODUCT	CYCLE	INTERVAL	m_i	$\sqrt{2} \cdot 2^{m_i}$	ORDERING INTERVAL

1	180	$2^7 = 128 \le 180 \le 2^8 = 256$	7	181	128
2	379.5	$2^8 = 256 \le 379.5 \le 2^9 = 512$	8	362	512
3	402.5	$2^8 = 256 \le 402.5 \le 2^9 = 512$	8	362	512
4	544.1	$2^9 = 512 \le 544.1 \le 2^{10} = 1024$	9	724	512

Problem 2

Recall that:

$$q^* = \sqrt{\frac{2KDr}{h(r-D)}} = \sqrt{\frac{2KD}{h}} \cdot \sqrt{\frac{r}{r-D}} = Basic\ EOQ \cdot \sqrt{\frac{r}{r-D}}$$

Therefore,

$$q_1^* = \sqrt{\frac{2KD}{h}} \cdot \sqrt{\frac{r}{r-D}} = 5000 \cdot \sqrt{\frac{30,000}{30,000-10,000}} = 6123.72$$

$$q_2^* = 3162.28\sqrt{\frac{30,000}{30,000-3,000}} = 3333.33$$

$$q_3^* = 4472.14\sqrt{\frac{30,000}{30,000-4,000}} = 4803.85$$

$$q_4^* = 745.36\sqrt{\frac{30,000}{30,000-500}} = 751.65$$

At this stage, repeat procedure shown in problem 1 for new values. This solution is based on the assumption that 30,000 units of each products can be produced each year. The problem can be solved under the assumption that 30,000 of all products can be produced. This can be broken up to 4 different rates (based on the ratio of demands).

Problem 3

For $q < 100$:

$$EOQ_1 = \sqrt{2 \cdot 40 \cdot 460 / 20 \cdot 0.1} = 135.65$$

$$\Rightarrow q_1^* = 99$$

$$\Rightarrow TC = 460 \cdot 20 + \frac{40 \cdot 460}{99} + 0.1 \cdot 20 \cdot \frac{99}{2} = 9484.86$$

For $100 \le q < 200$:

$$EOQ_2 = \sqrt{2 \cdot 40 \cdot 460 / 19.5 \cdot 0.1} = 137.37$$

$$\Rightarrow q_2^* = 137.37$$

$$\Rightarrow TC = 460 \cdot 19.5 + \frac{40 \cdot 460}{137.37} + 0.1 \cdot 19.5 \cdot \frac{137.37}{2} = 9237.88$$

For $200 \le q < 500$:

$$EOQ_3 = \sqrt{2 \cdot 40 \cdot 460 / 19 \cdot 0.1} = 139.17$$

$$\Rightarrow q_3^* = 200$$

$$\Rightarrow TC = 460 \cdot 19 + \frac{40 \cdot 460}{200} + 0.1 \cdot 19 \cdot \frac{200}{2} = 9022$$

For $q \ge 500$:

$$EOQ_4 = \sqrt{2 \cdot 40 \cdot 460 / 18.75 \cdot 0.1} = 140.09$$

$$\Rightarrow q_4^* = 500$$

$$\Rightarrow TC = 460 \cdot 18.75 + \frac{40 \cdot 460}{500} + 0.1 \cdot 18.75 \cdot \frac{500}{2} = 9130.55$$