Assignment of Business Mathematics

Experimental Condition No.1

a.

1) the buyer’s EOQ(=Q\*)

**Q\* = = = 1000**

2) the optimal quantity discount rate(=d(K)\*)

For calculating d(K), first we should calculate K(K).

When YNP is maximized, K is found.

YNP = DP1 – [ – (DS2/kKQ1) – (k – 1)KQ1H2P1/2

To figure out how YNP function is drawn, we have to make second derivative test.

Thus, YNP is concave downward function in K, K . Thus, the optimal K is obtained by dYNP/dK equal to zero for a given k, which gives:

K = {[1 + S2/kS1] / [1 + (k - 1) H2/H1]}1/2

Now, we can start with k = 1, find optimal K and this process is repeated for k = 2, 3, … and so on. (k is natural number)

To figure out how K changes, we make first derivative test.

Thus, K is decreasing function about k when k is natural number.

(1) When k = 1, K = 3.3166, YNP = 762,934.0034, d(k) = 1.6181%

(2) When k = 2, K = 1.6928, YNP = 759,290.2125, d(k) = 0.2836%

->Because YNP begins to decrease, stop the process.

**Thus, optimal k = 1, K = 3.3166, YNP = 762,934.0034 and d(k) = 1.6181%.**

3) the buyer’s optimal order quantity(=KQ)

**KQ = 3316.6248**

4) the supplier’s production lot size(=kKQ)

**kKQ = 3316.6248**

b.

For estimating the buyer’s annual cost in total, estimate buyer’s purchase cost, holding cost and inventory cost.

1. Buyer’s purchase cost = DP1{1-d(k)} = 787,054.9109
2. Buyer’s ordering cost = DS1 /(KQ) = 2,412.0908
3. Buyer’s holding cost = KQH1P1/2 = 26,532.9983

**Thus, buyer’s annual cost in total is purchase cost + ordering cost + holding cost = 816,000.**

Also, estimating the supplier’s total annual profit in total, estimate supplier’s revenue less discounts, production cost, ordering cost and holding cost.

1. Supplier’s revenue less discount = DP1{1-d(k)} = 787,054.9109
2. Supplier’s production cost = DP2 = 560,000
3. Supplier’s ordering cost = D1S2/(kKQ) = 24,120.9076
4. Supplier’s holding cost = (k-1)KQH2P1/2 = 0

**Thus, supplier’s annual profit in total is revenue less discount – production cost – ordering cost – holding cost = 202,934.0034.**

c.

To figure out how much of profit has improved for the supplier after using the optimal quantity discount approach, calculate supplier’s profit before using it.

When YNP(before) is maximized, k(before) is found. To figure out how YNP(before) function is drawn, we have to make second derivative test.

Thus, YNP(before) is concave downward function in k(before), k > 0.

1. When k(before) = 1, YNP(before) = 720,000
2. When k(before) = 2, YNP(before) = 751,250
3. When k(before) = 3, YNP(before) = 755,833.3333
4. When k(before) = 4, YNP(before) = 753,750

->Because YNP(before) begins to decrease, stop the process.

Therefore, maximum YNP(before) = 755,833.3333, when k(before) = 3.

Supplier’s profit before using the optimal quantity discount approach

= YNP(before) – production cost = 195,833.3333

**Finally, profit improving by the optimal quantity discount approach**

Experimental Condition No.2

a.

1) the buyer’s EOQ(=Q\*)

**Q\* = = = 800**

2) the optimal quantity discount rate(=d(K)\*)

For calculating d(K), first we should calculate K(K).

When YNP is maximized, K is found.

YNP = DP1 – [ – (DS2/kKQ1) – (k – 1)KQ1H2P1/2

To figure out how YNP function is drawn, we have to make second derivative test.

Thus, YNP is concave downward function in K, K . Thus, the optimal K is obtained by dYNP/dK equal to zero for a given k, which gives:

K = {[1 + S2/kS1] / [1 + (k - 1) H2/H1]}1/2

Now, we can start with k = 1, find optimal K and this process is repeated for k = 2, 3, … and so on. (k is natural number)

To figure out how K changes, we make first derivative test.

Thus, K is decreasing function about k when k is natural number.

(1) When k = 1, K = 4, YNP = 592,000, d(k) = 2.8125%

(2) When k = 2, K = 2.1292, YNP = 592,125.1223, d(k) = 0.7485%

(3) When k = 3, K = 1.4771, YNP = 591,007.6928, d(k) = 0.1926%

->Because YNP begins to decrease, stop the process.

**Thus, optimal k = 2, K = 2,1292, YNP = 592,125.1223 and d(k) = 0.7485%.**

3) the buyer’s optimal order quantity(=KQ)

**KQ = 1703.3301**

4) the supplier’s production lot size(=kKQ)

**kKQ = 3406.6601**

b.

For estimating the buyer’s annual cost in total, estimate buyer’s purchase cost, holding cost and inventory cost.

1. Buyer’s purchase cost = DP1{1-d(k)} = 635,209.3535
2. Buyer’s ordering cost = DS1 /(KQ) = 3,757.3457
3. Buyer’s holding cost = KQH1P1/2 = 17,033.3007

**Thus, buyer’s annual cost in total is purchase cost + ordering cost + holding cost = 656,000.**

Also, estimating the supplier’s total annual profit in total, estimate supplier’s revenue less discounts, production cost, ordering cost and holding cost.

1. Supplier’s revenue less discount = DP1{1-d(k)} = 635,209.3535
2. Supplier’s production cost = DP2 = 448,000
3. Supplier’s ordering cost = D1S2/(kKQ) = 28,180.0931
4. Supplier’s holding cost = (k-1)KQH2P1/2 = 14,904.1381

**Thus, supplier’s annual profit in total is revenue less discount – production cost – ordering cost – holding cost = 144,125.1223.**

c.

To figure out how much of profit has improved for the supplier after using the optimal quantity discount approach, calculate supplier’s profit before using it.

When YNP(before) is maximized, k(before) is found. To figure out how YNP(before) function is drawn, we have to make second derivative test.

Thus, YNP(before) is concave downward function in k(before), k > 0.

1. When k(before) = 1, YNP(before) = 520,000
2. When k(before) = 2, YNP(before) = 573,000
3. When k(before) = 3, YNP(before) = 586,000
4. When k(before) = 4, YNP(before) = 589,000
5. When k(before) = 5, YNP(before) = 588,000

->Because YNP(before) begins to decrease, stop the process.

Therefore, maximum YNP(before) = 589,000, when k(before) = 4.

Supplier’s profit before using the optimal quantity discount approach

= YNP(before) – production cost = 141,000.

**Finally, profit improving by the optimal quantity discount approach**

Experimental Condition No.3

a.

1) the buyer’s EOQ(=Q\*)

**Q\* = = = 607.6436**

2) the optimal quantity discount rate(=d(K)\*)

For calculating d(K), first we should calculate K(K).

When YNP is maximized, K is found.

YNP = DP1 – [ – (DS2/kKQ1) – (k – 1)KQ1H2P1/2

To figure out how YNP function is drawn, we have to make second derivative test.

Thus, YNP is concave downward function in K, K . Thus, the optimal K is obtained by dYNP/dK equal to zero for a given k, which gives:

K = {[1 + S2/kS1] / [1 + (k - 1) H2/H1]}1/2

Now, we can start with k = 1, find optimal K and this process is repeated for k = 2, 3, … and so on. (k is natural number)

To figure out how K changes, we make first derivative test.

Thus, K is decreasing function about k when k is natural number.

(1) When k = 1, K = 4.5826, YNP = 423,399.8391, d(k) = 4.6093%

(2) When k = 2, K = 2.5641, YNP = 428,022.6321, d(k) = 1.5702%

(3) When k = 3, K = 1.8077, YNP = 428,794.2567, d(k) = 0.5939%

(4) When k = 4, K = 1.4097, YNP = 428,555.8906, d(k) = 0.1960%

->Because YNP begins to decrease, stop the process.

**Thus, optimal k = 3, K = 1.8077, YNP = 428,794.2567 and d(k) = 0.5939%.**

3) the buyer’s optimal order quantity(=KQ)

**KQ = 1098.4341**

4) the supplier’s production lot size(=kKQ)

**kKQ = 3295.3022**

b.

For estimating the buyer’s annual cost in total, estimate buyer’s purchase cost, holding cost and inventory cost.

1. Buyer’s purchase cost = DP1{1-d(k)} = 477,149.2342
2. Buyer’s ordering cost = DS1 /(KQ) = 4,369.8572
3. Buyer’s holding cost = KQH1P1/2 = 14,279.6427

**Thus, buyer’s annual cost in total is purchase cost + ordering cost + holding cost = 495,798.7341.**

Also, estimating the supplier’s total annual profit in total, estimate supplier’s revenue less discounts, production cost, ordering cost and holding cost.

1. Supplier’s revenue less discount = DP1{1-d(k)} = 477,149.2342
2. Supplier’s production cost = DP2 = 336,000
3. Supplier’s ordering cost = D1S2/(kKQ) = 29,132.3815
4. Supplier’s holding cost = (k-1)KQH2P1/2 = 19,222.5960

**Thus, supplier’s annual profit in total is revenue less discount – production cost – ordering cost – holding cost = 92,794.2567.**

c.

To figure out how much of profit has improved for the supplier after using the optimal quantity discount approach, calculate supplier’s profit before using it.

When YNP(before) is maximized, k(before) is found. To figure out how YNP(before) function is drawn, we have to make second derivative test.

Thus, YNP(before) is concave downward function in k(before), k> 0.

1. When k(before) = 1, YNP(before) = 322,012.6587
2. When k(before) = 2, YNP(before) = 395,689.4477
3. When k(before) = 3, YNP(before) = 416,703.7896
4. When k(before) = 4, YNP(before) = 424,552.5197
5. When k(before) = 5, YNP(before) = 427,135.0050
6. When k(before) = 6, YNP(before) = 427,084.3681

->Because YNP(before) begins to decrease, stop the process.

Therefore, maximum YNP(before) = 427,135.0050, when k(before) = 5.

Supplier’s profit before using the optimal quantity discount approach

= YNP(before) – production cost = 91,135.0050.

**Finally, profit improving by the optimal quantity discount approach**