News Vendor Problem

Consider a newspaper vendor selling papers on at intersection. Each morning, the vendor must decide how many papers to buy at the wholesale price. The vendor then sells the papers during the day at a retail price higher than the wholesale price. At the end of the day, any unused papers can no longer be sold and are scrapped (or possibly sold back to the wholesaler at a price less than the wholesale price). How many papers should the vendor buy?

Characteristics of the problem are:

1. Single period problem – ordering decision made every period

2. Demand is uncertain

3. Order is placed before demand materializes

4. We can only order once per period

5. There is a cost for ordering too much and a cost for ordering too few items.

**Problem 1.** Swell Productions is sponsoring an outdoor conclave for owners of collectible and classic Fords. The concession stand in the T-Bird area will sell clothing such as official Thunderbird racing jerseys. Suppose the probability of jerseys sales quantities is uniformly (and continuously) distributed between 100 and 400. Suppose sales price is $80 per jersey, purchase cost is $40, and unsold jerseys are returned to the manufacturer for $20 per unit.

How many Jerseys Swell Production orders?

What is underage cost? The cost of having the demand, but not having the product.

Sales Price = P = 80.

Purchase cost = c = 40

Underage Cost = Cu= 80-40 = 40.

What is overage cost? The cost of having the product, but no demand for it.

Purchase cost = c = 40

Salvage Value = v = 20

Overage cost =Co = 40-20 = 20

Cu = $40, Co = $20.

The demand is distributed Uniformly between 100 and 400. The question is how much to order? Consider Q in the following graph. The gray side is the probability of demand being ≤ Q, while the white side is the probability of demand being ≥ Q. The overage cost wants the gray area as small as possible and, therefore, the white area as large as possible. It tries to pull Q to the left with a force of Co=20. The underage cost wants the white area as mall as possible and , therefore, the gray area as large as possible. It tries to pull Q to the right with a force of Cu=40. Therefore, the relative force of Cu compare to all available forces (Cu+Co) is Cu/(Cu+Co). Accordingly, since the big rectangle (the probability distribution) have an area of 1, Cu/(Cu+Co) of it is occupied by the gray rectangle. Service level (SL) = = Gray/(White + Gray) = Cu/(Cu+Co). Computation of Q is then straight forward.



SL\* = Cu/(Cu+Co) = 40/(40+20) = 2/3. That is Probability of Demand ≤ Q = 2/3.

The width of the probability distribution function is 400-100 (and in general is b-a). The total area of the probability distribution function is 1. Therefore, the height of the distribution is 1/300 [and in general f(x) = 1/(b-a)].

The gray area is computed as

(Q-100)(1/300) = (Q-100)/300 = 2/3

Q = 300

The expected number of participants in a conference is uniformly distributed between 100 and 700. The participants spend one night in the hotel and the cost is paid by the conference. The hotel has offered a rate of $200 per room if a block of rooms is reserved (non-refundable) in advance. The rate in the conference day is $300. All rooms will be single occupied. How many rooms should we reserve in the non-refundable block to minimize our expected total cost.

Service level (Probability of demand not exceeding what we have ordered) SL\* = Cu/(Cu+Co)

Co: Overage cost 🡺

Co = 200.

Cu: Underage cost

Cu = 300-200 = 100

Swell Productions (The Retailer) is sponsoring an outdoor conclave for owners of collectible and classic Fords. The concession stand in the T-Bird area will sell clothing such as official Thunderbird racing jerseys. The following table shows the probability of jerseys sales quantities.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Probability | 0.05 | 0.10 | 0.30 | 0.20 | 0.20 | 0.15 |
| Demand | 100 | 200 | 300 | 400 | 500 | 600 |

Jerseys are purchased from Columbia Products (The Wholesaler) for the wholesale price of $40 each. They are sold during the event for $80 each. Salvage value of each T shirt when returned by the retailer to the whole seller is $20.

A) Compute the average demand (units that can be sold) for Swell Productions jerseys.



B) Given the average demand you have obtained in the previous part. How many units should Swell Productions order to be able to have the average number of units sold equal to the average demand.

C) Supposed Swell Productions has ordered 400 units. Compute the marginal profit of ordering one more unit.

40(0.35) = 14

D) Supposed Swell Productions has ordered 400 units. Compute the marginal cost of ordering one more unit.

20(0.65) = 13

E) Suppose your computations indicates that it is at Swell Productions’ benefit to order 401 units (this may or may not the correct answer). How many units should Swell Productions order?

500

F) Suppose Swell Productions has ordered 500 units. Compute the expected value of the number of units salvaged.

0.05(400)+0.1(300) +0.3 (200) + 0.2 (100) =

20+30+60+20 = 130

G) Suppose Swell Productions orders 500 jerseys. Compute the expected number of

jerseys that can be sold.

500-130= 370



H) Supposed Swell Productions has ordered 500 units. Compute the expected value of Swell Productions’ total net profit.

-130(20) + 370(40) = -2600+ 14800 = 12200

I) At what purchasing price (current purchasing price is $40 and current salvage value is 20) will you order 600 units?

MC=0.85 (c-20) = 0.85c -17

MP = 0.15(80-c) = 12- 0.15c

12-0.15c> 0.85c-17

29> c

It really does not make sense to say the break-even point is where

385(40) = 215X

Because in X and 40 are not independent. To correct the above statement, one may say: the break-even point is where

385(80-c) = 215(c-20)

And one may try to solve the above equation. But it does not make sense because in that case and under the price of c, we will make 0 profit if we order 600. While we already make $12200, by ordering 500. Therefore no matter what c value comes out of the above equation, it makes our profit equal 0. Why we should order 600 for 0 profit compared to 500 with $12200 profit.

A correct second procedure to solve the problem is to say; we order 600 if its total expected revenue is greater than ordering 500.

Ordering 500

# of units sold is 370 and salvaged 130

Ordering 600

# of units sold is 385 and salvaged 215

For sale we get (80-c) for salvage we pay (c-20)

Therefore, total revenue of 600 must be greater than that of 500

385(80-c) – 215(c-20) > 370(80-c) – 130(c-20)

By solving this equation we will get 29>c

Indeed we could have also said that by ordering 600 we sell 15 units more and salvage 85 units more. And the sale revenue must be greater than salvaged marginal cost

15(80-c) > 85(c-20)

29>c

J) At what salvage value (current purchasing price is $40 and current salvage value is 20) will you order 600 units?

MC=0.85 (40-v) = 34 - 0.85v

MP = 0.15(80-40) = 6

6> 34 - 0.85v

0.85v > 28

v> 32.9

References

<https://ocw.mit.edu/courses/sloan-school-of-management/15-772j-d-lab-supply-chains-fall-2014/calendar/MIT15_772JF14_Newsboy.pdf>