Course Name - Operations and Revenue Analytics

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Lecture - 39

Welcome friends! As we are already discussing in our last two three sessions that how pricing can play important role in our revenue maximization. And we are going to discuss in this particular session a very interesting type of situation which is possible in various other domains also. Other domains when I say that if you go to supply chain management, if you go to marketing management in that cases also we know that many a times we have a main price or full price and then for promotion of our products, for clearing the inventory stocks, we may reduce the price that is known as Mark Down Pricing. Now, we know that always demand follows a particular relation with price and that is known as demand rate.

Now, if you see that can you sell all your products at a particular price, there is no question of markdown pricing. If you have total inventory of let us say 1000 units and if you are sure that if you can anticipate that all 1000 products can be sold at a particular optimal price the question of markdown pricing will not come. But in all practical scenario we see that it is not possible. You see generally in the fashion products that how you have a price during the main season and as season is getting over we have to reduce price for clearing the inventory so that we can now procure items for the next cycle. Similarly, In airlines, the examples which we are discussing, we may have a particular price and generally the price will increase as we are coming to day of service.

But there can be a reverse situation also. If large number of inventory is unfilled, you may have to reduce the price so that some of the customers who are looking for a cheaper options, those who are price sensitive customers they may avail that particular service.

Like in case of vegetables also we see that when the market is opening, at that time vegetables will be at a particular price and when the vendor is almost coming to the let us say closer of his shop whatever is left out he will sell that items at a lower price. So, there are variety of practical uses of markdown pricing. Markdown pricing is generally you will see in all those cases where perishability of your item is a very important criteria.

If you can carry that inventory for subsequent periods or cycles, you will not mark down your item because you will always want to sell the product at the best possible price. But you know that if we have to get value from whatever leftover items there are for that purpose, we do this by lowering the price. And this lowering of the price is the markdown pricing system. So, in this particular session, we will see what the markdown policy is. We will see, with the help of some examples, the issues related to segmentation—how many different types of prices you are planning for your product.

That means one price is the full fare price, and another price is the discounted price. There can be other companies with full fare prices, discounted prices, and even deep discounted prices. So, it depends on how many segments you are going to offer in your pricing policy. In this particular class, customers are not aware whether a new type of pricing scheme will be available. But in a practical scenario, it is generally the trend.

We know that if a company is going to reduce the price—how many times the company is going to reduce the price—that becomes a kind of trend, and customers anticipate that prices will be lowered at this particular time of the year and accordingly wait for those lowered prices. Then there is the concept of cannibalization, which means that when you are lowering the price, the customer is ready, knowing that the price will be lowered in, say, October. I am preparing, thinking, 'Okay, this is the month of September.' So, I will postpone my purchase decision until October. Or if I am lowering the price in September, I may go for forward buying.

I will need the product in the month of October or November, and I will purchase it in the month of September. That is the concept of cannibalization rather than increasing the market because of the lowering price. In fact, I can add more customers whenever the price is lowered, but it is always happening. Research has shown that there may be some

new customer additions, and there may also be market growth whenever you lower the price. But there will be a lot of cannibalization, and the demand may shift from one period to another period where you have lower demand and lower prices. And then we will see how we can optimize the issues related to markdowns. So, as we just spoke, the policy of markdown means decreasing your product's price in a sequential manner until you are able to sell it or the selling period is over.

Here, you always need to understand—though we are not going to take this point in our particular session—that I need to fix a lower bound for reducing the price. Let us say I am starting with the price of 100 rupees, reducing it to 90, then to 80, and maybe I keep the lower bound at 50 because I also need to consider the cost of this particular product. So, in all practical cases, I have a lower bound for reducing the price. Beyond that, I will not reduce it further to increase demand because you will always see that if I make the price equal to 0. I will have the maximum demand for that particular product. But theoretically, it is okay; practically, it is not okay because you can never sell a product at zero price.

So, this is an impractical situation. However, theoretically, in all our demand curves, we see this type of situation: if the price goes to zero, what will be the maximum demand? The markdown policy is used for perishable items where you have limited supply, especially as their desirability decreases near expiration. For example, flights, vegetables, flowers, and all such products—you can think of perishability as a very important aspect for markdowns. However, in fashion-type items, though they are not physically perishable, the season is changing, and fashion is changing.

So, the value which you can expect from a product which is currently in fashion that value will decrease and therefore, before its value is decreased you will like to offer a mark down policy so that you can push that product to the market. So, there are different reasons for which you are doing the markdown time of use a product is used at a particular time. If the product is not sold at that particular time particularly for example, let me tell you about newspapers generally when you purchase newspapers in the morning you get a newspaper at full price which is the printed price on that newspaper. You may try somewhere that if you buy the same newspaper in the evening you will get

this newspaper may be 1 rupee or 50 paisa cheaper than the morning price. So, time of use itself is a very important thing because in the morning the newspaper carries more value as compared to evening time.

Fashionability we just told deterioration. There may be some physical or quality wise deterioration in the product like all vegetables, flowers, milk products, sweets deterioration. I have seen in many shops where they are selling lot of sweet items maybe after 8 pm or 9 pm, they reduce their prices by 50% so that they can consume all their inventories before they close their shop. In fact, some such shops, I will like to tell my TAs, they can go and enjoy the sweet in the late evening from these places where the deterioration is a factor. Obsolescence, that is possible in case of, let us say, even automobiles also.

Whenever there are possibility of change of models, iPhones, all these are examples that because of the new models, new technologies, old models, old products are getting obsolete and therefore, a markdown policy is applied so that they can clear the inventory of these products. Now, let us see a particular simple example that how we are going to optimize our segmentation policy. Now, in this case we have a product where the price response function that is the demand rate is given like this 1000 minus 100p that demand of this product will depend upon the price and if you see this particular function.

$$\mathbf{d(p)= 1000-100p}$$

So, if you keep the price 0, I just told you it is just a theoretical thing practically for 0 price that is no meaning. So, if the price is 0 the demand is 1000 and if price you increase slowly and slowly and if you reach up to the level of 10 dollars the demand will be 0.

So, the maximum demand for this product can be 1000 only, and the minimum demand is 0. Now, if you want to know what should be the best price where you can get the highest, let us say, revenue. So, we can get the highest revenue. We will solve that demand into price, that is the revenue, and if I do the multiplication and after that multiplication, we do the differentiation with respect to price, the price p is coming to 5 dollars. Now, if I have 500 units with me, if I have 500 units with me at a particular time, I will sell 500

units at the rate of 5, and then I will earn 2500 as my revenue. Now, somehow, I got one more supply with me.

Somehow, I got one more supply which is coming closer to the period for which the products may be sold. But these products cannot be sold at 5 rupees now because the time of use is almost coming to an end. Now, how many more units I can sell at what price? That is the markdown pricing system, and for that purpose, if I apply the same rule and let me show you with the help of our Excel calculations, that will help us to understand how this markdown pricing will be applicable, and we can optimize. So, let me go to the Excel sheet and see how it is going to happen. So, here we see that we have a particular price. If you see our column C, row 4, C4.

Here, we are keeping the price at 5, we are selling 500 units, and then we are getting 2500 revenue. The demand function given to us is, now out of this demand function, we have already consumed 500 units. So, another price which I am setting is now, let us say, 2.5. So, we will see that at 2.5, I will be able to sell 250 units, and 250 units into 2.5 will give me 625. So, the total revenue will be 3125.

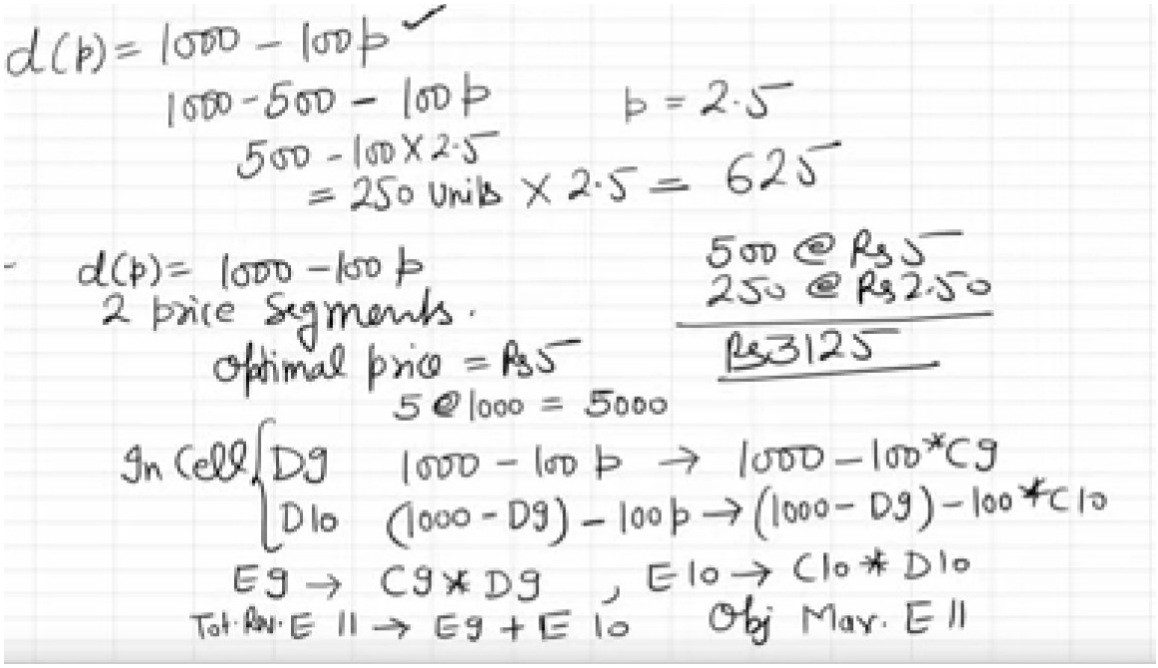
So, this is how we have calculated that we are going to sell 500 units at the rate of 5 and 250 units at the rate of 2.5, resulting in a total revenue of 3125. Now, let us change this scenario because these additional 250 units came to me after I had already sold 500 units. Now, at the beginning of this situation, when I have this demand curve, I have decided that I can have two price segments. I can have two price segments. Now, you understand that the optimal price was, if you remember, rupees 5, and I initially had 1000 units available with me.

So, if I can sell all 1000 units at this level. So, the maximum revenue possible in this scenario is 5000. But, I realized before the period started that it is not possible for me to sell all 1000 units at 5 rupees. I realized that there may be a few customers who can give me more than 5 also, and therefore, I need to see what the two price segments I can operate are. So, here you see in this part of the Excel table where we have done this optimization for two segments.

Here, I have created three columns, C, D, and E. Column C is for the possible prices I can have. I want to have two prices, and for each price, how much will I sell? Then, my objective is to maximize total revenue. So, this becomes a small linear programming problem, and we will use Excel Solver to solve this particular problem. Now, if I go to cell C9, if I go to cell C9, here you see that these values are coming, which are our decision variables. Then, you can go to cell D9, where we have the formula in cell D9. If I go to cell D9, the formula initially I am keeping is 1000 minus 100p, and p we have taken from cell number C9.

So, actually, the same formula will be what we have inserted here, which is 1000 minus 100*C9, because in C9 we have entered the price. Then we come to sell D10. Now, whatever value comes in D9, which we have consumed, we need to see at what best price the remaining items can be sold. So, what we are going to do is, out of 1000 total units, we will subtract the values of D9, and then the same function, 100p, will come. Now, this new p will be at a new price level. So, this new price level is coming from cell C10.

So, this becomes like this. So, you get these values in cells D9 and D10. Then we come to cell E9, where we are writing the revenue calculations, which is simply the price multiplied by the sale. That is, in E9, it will be C9 multiplied by D9. Similarly, for E10, it is C10 multiplied by D10. Finally, in E11, which is the total revenue, it is simply the sum of E9 and E10. And that is what we want to maximize. The objective is the maximization of E11. This is what we have inserted in this particular area, which is encircled here, from C9 to E11. These are the formulas we have used.



After entering these formulas, we will go to Excel Solver. Let us take you to the Excel Solver, and you can do it on your own. Once you operate the Excel Solver, the initial values of the price will be kept at 0. The initialization values of the decision variables will be 0, and the initial total sale available to us is 1000. Now, if I proceed, the objective function will be set at E11, which is the objective function. We want to maximize this objective function by changing the values of our decision variables, which are in C9 and C10. When we solve it, you will see that we have run Excel Solver, and the values are now on your screen. The price is coming in two labels. One price label is 6.7, and another price label is 3.3. At each of these price labels, we are able to sell 333 units each.

So, in a way, you can say that around 333 units are unsold, and the revenue you are getting is around 2022 and 1111, and the total revenue available to you is 3333. Now, you see that since we are taking this call at this level, we did not know that we were going to do any kind of segmentation. So, we started working with the original, you can say, best price available to us, which is 5 rupees. So, we have two levels of prices in the first case: 5 and 2.5, because the original plan was not to have two levels. However, we are selling more items—500 plus 250, totaling 750 items in the first case—but the revenue is still 3125.

In the second case, we planned to offer two prices, as we have two segments. However, we are selling only 666 items, fewer than 750, but we are still getting more revenue, which is 3333. So, 3125 is less than 3333 because we had a plan in this case. Similarly, I have shown you the calculations for 3 segments. In the lower part here, this calculation shows 3 segments: from the beginning, I decided we would have 3 segments—full fare, discount, and deep discount. Now, in this case, we are actually selling around 750 items, the same as in the first case, but here our revenue is 3750.

So, two important points emerge: if we can plan before starting the period, we may have better revenue calculations and better revenue generation from limited sales. The second important outcome of this discussion is that if you can create more segments—if it is possible at all—your revenue will further increase because you will have multiple prices, and there are customers available to take advantage of each price level. So, this kind of calculation shows that you need to plan. It is up to you whether you want two segments,

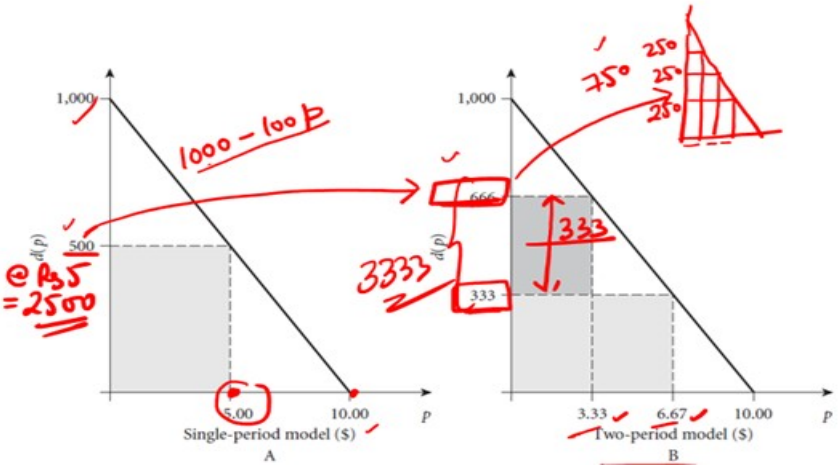
three segments, or four, because the calculation shows that more segments are better than fewer. But it is also true that not every product can have more than two or three segments at most. So, practically, you will see that in most cases, we have only two or three segments.

Now, going further in our discussion so, this diagram gives us the idea that when we are having this demand function and in the beginning we know that we are going to operate with only one single price 5. So, this gives us the demand of 500 and at the rate of rupees 5 the revenue will come to be 2500 and when in the beginning itself, we know that we may have two types of pricing and one pricing gives us demand of 333, another pricing gives additional demand of 333. So, the total demand which is possible in this case is 666. So, there are two important things which are happening that in place of 500, now you are able to reach to 666 customers. Then further, if you go back to your Excel calculation, when we have three price segments, in that three price segments, we are able to touch three different categories with the help of 250 each.

So, now you are able to reach to 750 customers but that is only possible when in the beginning itself you are able to know that you are going to have three different price segments. So, that is how the segmentation of price in the beginning will not only increase your market share that 500, 660 and 750 but it also helps in increasing your overall revenue. After this another important issue is cannibalization, where we are reducing the price and with this reduction in price we may increase our demand at a particular time which is coming because of future demands. Those customers who are expecting to buy products in a future period, they will come and buy the products. So, here if you see from a practical point of view that a 10 percent capitalization fraction means that 10 percent of customers who would pay the first period price wait for the markdown that now customers are anticipating that ok there is going to be a lowering of price for any reason and they will come for taking the advantage.

So, they are keeping the purchase decision postponed or in the forward mode so that they can take the benefit of this lower price. So, like effect of cannibalization in this two period model cannibalization fraction when it is no cannibalization independent demands of two periods. So, in one period we see that 6.67 was the price and in the another period

the price was 3.33 and the total revenue which is coming around 3290 precisely if I go with the excel calculation it was 3333. But because of the rounding effects because in that it was 6.6666 and 3.3333 and the demands were also into 333 point something and so on. Now, If I consider the cannibalization factor of 20 percent that 20 percent demand is shifted from one period to another period and because of that you see the prices like if I keeping the 6.87 and 3.75 some of the customer are shifting from this period to this period.



Some of the customers are shifting from this period to this period, this period to this period, this period to this period and because of that effect, my total revenue is decreasing as the effect of cannibalization is increasing. Because customers know that there will be a markdown in some particular time and they will wait for that lowering of the price and even though even though you can understand that 7.37 and 4.74 both these prices are much higher than these 6.67 and 3.33 respectively. But still the revenue total, total revenue coming because of this effect is much lower than the revenue which we are getting with 6.66 and 3.33.

Effect of cannibalization in the two-period model

Cannibalization fraction	First-period price	Second-period price	Total revenue
0%	$6.67	$3.33	$3,290
20	6.87	3.75	3,125
40	7.06	4.12	2,914
60	7.22	4.44	2,778
80	7.37	4.74	2,632

So, it also becomes important thing for the policy makers to decide whether we need to create the markdown policy as a regular habit for our customers, because if it becomes a regular habit then probably you will not be able to take the advantage because customers know and they anticipate that how things are going to change in future. So, therefore, it is advisable that whenever we are going for markdown it has to be some kind of a random efforts.

So, that in one cycle you are doing the marking down another cycle you may not do the markdown. So, it is always a kind of a surprise to the customer. So, that the demand of two markdown periods or three markdown periods whatever you have is totally independent. Otherwise, the effect of cannibalization will actually neutralize all the benefits of marking down. So, with this we come to end of this particular session.

Thank you very much.