Course Name - Operations and Revenue Analytics

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Lecture - 36

Welcome friends. In our earlier sessions in last few weeks, we were focusing revenue maximization by appropriate distribution of available capacity that whatever capacity is there of a system where capacity is the constraint and not only constraint but after a particular time that capacity may perish also. And therefore, our idea was to allocate the capacity in different fare classes, different price classes so that all the capacity is used in such a manner that it maximizes your revenue. When we were discussing that we discussed different types of issues that there are situations of networking, there are situations of overbooking also and there may be situation of overbooking in networks also. So, you may increase the complexity of that capacity allocation as much as you want.

And now we are going to start another type of revenue maximization issue, where our revenue maximization may come by appropriate pricing of your products. In those cases the cases which we discussed price we already fixed and then we see that how to allocate the capacity by appropriate allocation for a particular price was the basis of earlier discussions. Now, in this case we are going to discuss that what is the optimal price levels so that our capacity will be used and it will give us good amount of or maximum profit for that particular price if the capacity is already known. So, this is revenue management using the pricing as your appropriation tool. Now, in this particular video we are going to discuss the issue of pricing in the constraint resources.

You may remember that in one of the lecture we discussed that if you have unlimited supply where resources are not constrained, we have a law of demand and by applying

that law of demand you know that what can be the optimal price. But, whenever we have constraint of resources for getting the good amount of profit, you need to see that you have to increase the price for that limited capacity and that price is going to give you some kind of a profit which may not be the profit equal to the unconstrained supply. But with that limited constraint supply that profit will be the maximum possible profit. So, we will discuss some issues related to constraint supply pricing and then we will in detail about some important type of pricing systems which are applicable for revenue maximization. Before we go into the detail of pricing, the pricing can be discussed from different aspects.

There are people coming from an economics background; they discuss pricing as equilibrium in the market of demand and supply. Those who come from a marketing background discuss pricing based on the purchasing power of the customer. You have to segment the market, assess the purchasing power of the customer, and, accordingly, decide the price of your product. Those who come from a finance background also deal with pricing issues, and they say that pricing can determine your profit. You estimate the cost, and that cost plus some expected profit gives you the pricing.

So, those perspectives—financial, marketing, economics, etc.—are already well-established. Now, in this particular session, we will examine pricing more from an operations perspective—what operations can contribute to setting the price—which will also be an agenda item during this session's discussion. So, let us first discuss the broad overview of pricing in constrained-resource scenarios where supply is limited. The multiple examples we have discussed in the last few weeks—airlines, hotels, car rentals, etc.—are all cases of constrained resources. Now, in this particular case, there are different types of pricing schemes. One important thing to understand is that whenever resources are constrained, pricing will be higher compared to similar products.

But if resources are unconstrained. So, this is one fundamental theorem you should keep in mind. Even with constrained resources, there can be market fluctuations, significant demand uncertainty, seasonal variations, and random variations. To address these issues —uncertainties in the external environment—various pricing strategies exist, such as personalized pricing, where limited products are offered with customized pricing based

on customer requirements. You have only 10 units. So, you will approach 10 different customers, and the price may vary for each.

Markdowns, you have limited supply, and you just want to clear that inventory. So, whether you call it a markdown or clearance sale, you know that you have to reduce the price. So, this particular case of a markdown clearance sale is opposite to what I just mentioned. I say that for a constrained case, you have to increase the price to maximize revenue. But in the case of markdowns and clearance sales, the purpose is to clear your inventory, and therefore, you are reducing the price in this case of constrained resources.

You may also go for display and trade promotions to increase your demand so that you can fulfill your inventories. Coupons, discounts—all these are part of trade promotions. So, all these things you apply, other than what we have already discussed in our last few sessions. Then, coming to a scenario where we understand that dynamic pricing is applicable in all such cases of constrained supply. For example, you have a flight with 100 seats. Maybe at the beginning of the booking period, you have a price of 1000 dollars.

After one week, it remains 1000. But after the second week, there is an increase in the demand for this particular flight, and then you start increasing the price: 1200, maybe after that 1400, and immediately after that, it may be 1500. Like that, your price may increase as you get closer to the period of your service. So, this is dynamic pricing. Everywhere now, particularly when booking flight tickets, when going for hotel bookings, when going for car rentals—even you see services like Ola and Uber.

They also follow this dynamic pricing. When the demand is high during peak office times, the prices of these rentals are also high. Electricity prices are dynamic because of demand patterns. So, these days, dynamic pricing is very common, and it is affecting the demand pattern also. If the peak demand is high, you increase the price, and because of that higher price during the peak period, some of the customers who are price-sensitive may not like to use that product at that time, and by that, you are able to reduce the peaks also.

So, that way, dynamic pricing is a very interesting operations management role also because you have a limited capacity; you cannot increase the supply in real-time, and therefore, by dynamic pricing, you will be able to reduce some of the demand from the peak period, and these sensitive customers may go to off-peak times. So, therefore, you will be able to increase the demand in the off-peak periods or in the low-demand period and reduce the demand in the peak periods. So, that is the dynamic pricing system. Now, the issue is, how are you going to model this dynamic pricing system? What can be the peak price?

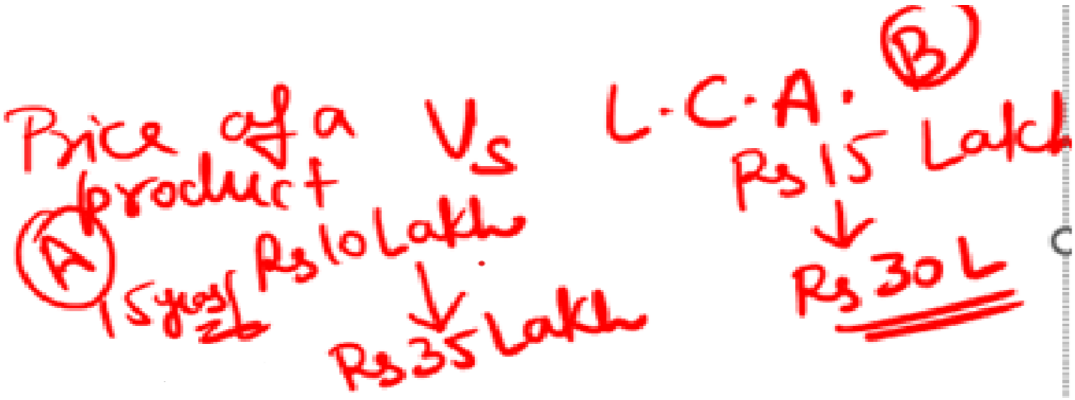
What can be the discounted price? That is the question we need to answer. So, we have to see how, individually or in a group, people are responding to changes in prices of your service. Here, you see the individual and aggregate—that is also important because a lot of behavioral issues are also important in this case. Maybe in a group setting, we will try to show that I am not so sensitive with respect to pricing, but when I am alone as an individual, I may have a very different take on that; I may behave like a very price-sensitive customer. So, how are we handling the demand with respect to individual behaviors or aggregate behaviors?

Here, two or three terms are important to understand: one is myopic versus strategic customer models. Myopic means those customers who have a very short vision, and that may be a customer who is just thinking, let us say, one day ahead. But there may be other customer models which are more strategic in nature, which are able to have a vision where you can see that, okay, with this pricing in the long term, I hope many of you may be aware of life cycle cost assessment (LCA). So, like the price of a product versus its life cycle cost. So, the life cycle cost of a product versus the price of the product.

You are buying a car, let me tell you, and that car costs you 10 lakh rupees. You are buying another car which costs you 15 lakh rupees. So, if I am a myopic person, if I am a myopic person, I will consider that, okay, the 10 lakh rupee car is a cheaper car; I should buy this cheaper car. But when LCA comes into the picture, maybe the car I am able to keep for 15 years, and in those 15 years, considering the fuel requirement and the maintenance requirement, this car costs me 35 lakh rupees and this car costs me 30 lakh

rupees. So, you see that because of my strategic vision, now I will try to buy product B rather than product A because, as a myopic person, I feel A is cheaper than B.

But if I see the strategic nature, then I realize that B is cheaper than A. So, there are customers of every type. So, I need to see which model is more appropriate. Infinite versus finite population models: these are the other types of models where you have a very large number of customers who are ready to wait for your service. Finite population



models where a limited number of customers are there. For example, I am in the management department; I want to develop a service for my MBA students.

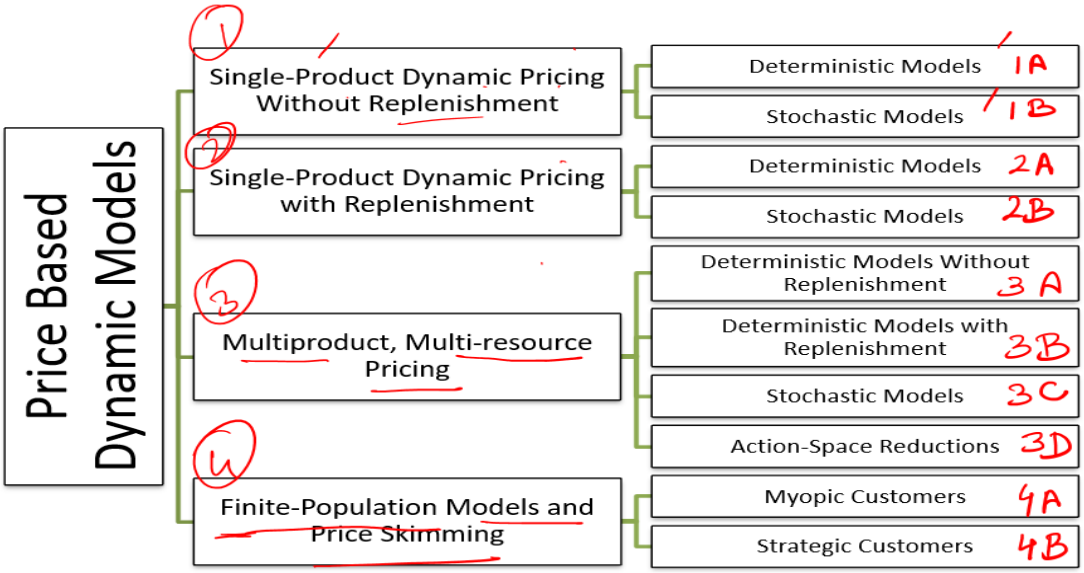
I know that I have only 200 students in my department doing an MBA. So, this is an example of a finite population. While infinite population models involve a sufficiently large number of customers looking for this type of product. And then you have monopoly, oligopoly, and perfect competition models as well. If you see this particular slide, here we have a good representation of most of the models we will be discussing in these dynamic pricing models.

You can classify them into these four broad categories. Single-product dynamic pricing without replenishment—in our subsequent slides, we will focus on these different models. So, single-product dynamic pricing without replenishment is what we will see, and in this case, you can have two types of models: deterministic models and stochastic models. Deterministic models are more definitive in nature, while stochastic models are more probabilistic in nature. Then, the other type of dynamic model may be single-product dynamic pricing with replenishment.

Here also, you have deterministic and stochastic models. Third is multi-product, multi-resource pricing, and here you have different types of branches, like deterministic models without replenishment, deterministic models with replenishment, then stochastic models —that is, probabilistic models—and then action space reductions, which is another way of pricing. Then, finite population models and price skimming. You know that only a very limited number of customers are there for using this particular service. Price skimming means you are keeping a slightly higher price, and here also you have myopic customers and strategic customers—both these types of customers are available here as well. Now, in our subsequent slides, let us see models 1, 2, 3, and 4 first, and then we will automatically understand what we mean by deterministic or stochastic models, or that there are multiple types of criteria, multiple types of branches in point number 3.

So, their meaning will also be clear to us when we go to subsequent slides. Now, coming to the first single-product dynamic pricing without replenishment. Single-product dynamic pricing without replenishment. So, if you remember from any of your production or operations management classes, the system of inventory management is like this. Here, we say this straight line is our replenishment line.

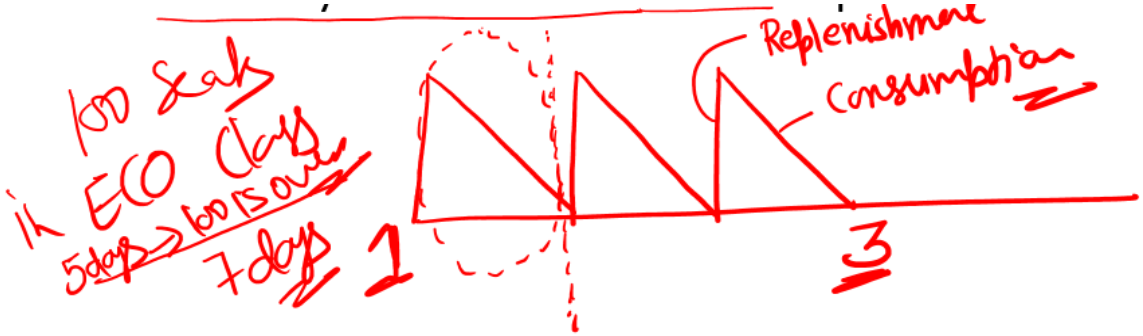
Replenishment means the stock is coming; you are receiving the stock, and therefore, the straight line is perfectly vertical, and the slant line is the consumption line. Now, this replenishment and consumption cycle sequence happens every round. So, let us say if I consider one single round from here to here. So, in this one single round, there are three replenishment cycles—there are three replenishment cycles—but in our case, there is no replenishment. So, you can consider that out of this entire system, we are focusing only on this particular part because here you have only a single replenishment, and the rest is consumption.



So, you can say that our focus area is only this much. When I say 'with replenishment,' that means you may have 3 or 300 cycles—all are acceptable. So, this model represents the type used in style and seasonal goods retail distribution. Now, in this particular case, some examples exist, but since we are already discussing single-server examples. So, that is also like single-product dynamic pricing without replenishment.

You have aircraft and you are booking a particular flight. Now, in that flight replenishment is not possible because you cannot add one more flight with this first flight. So, there is no replenishment. And, you have only one type of product that all the seats are let us say economic class seats. So, the all seats are economic class seats.

So, 100 seats are available to you in economic class. And you have no opportunity of replacing the stocks. So, if you are having booking window open for 7 days and out of 7 days in let us say 5 days 100 is over. All 100 seats are booked in the 5 days. Now for remaining 2 days, 6th and 7th you cannot receive a new supply because this is a case of without replacement.



So, I want that 2 things that should I stock 100 or should I stock more than 100 so that I may be able to run my this particular work for entire 7 days and the possible minimization of my revenue can be ruled out. So, this model is very simple they consider only a single product in isolation and assume customers are myopic and therefore, demand is a function solely on time and the current price. So, it is like developing a demand function, where you have time and the current price and on the basis of that you are going to estimate the demand. So, aircrafts, hotels in hotels there may be some kind of replenishment because you may ask your neighboring hotels if you are not able to provide service then to get into the cost of denied booking it's better to offer a seat in a neighboring accommodation that is how replenishment is possible in some cases Now, other case is dynamic pricing with replenishment.

So, OK, in the first case, which we just discussed, single-product dynamic pricing without replenishment. So, these models can be deterministic and stochastic also. What is deterministic and what is stochastic? Let us see that also. Here, we are doing this pricing. It is possible that the demand for this particular period. Demand is known to you with a single digit, single digit meaning definite numbers.

So, when demand is given to you in definite numbers based on your historical data, then you will use deterministic models. But, in the majority of cases we just discussed, there may be a lot of uncertainty. And because of that uncertainty, you use probabilistic models where you can capture the different types of uncertainties that may be there. So, deterministic and stochastic models. Now, coming to the second type of models: dynamic pricing with replenishment.

So, here again, that same model will be applicable—sawtooth pattern. Now, here we are going to take all these cycles into our consideration, and you can see that during this duration, we are able to do three replenishments: replenishment one, replenishment two,

and replenishment three. So, three replenishments are possible in this particular duration. So, this is also the single-product case, but here we are able to replenish our stocks within a particular duration. Then, the third case is multi-product, multi-resource pricing.

In first two cases, it was only single product, but now you have multiple products and multiple resource pricing we have to see. Now, two very important basic factors which are linking the pricing decisions for multiple products. Demand for products may be correlated. So, you are selling product A, product B, product C. So, there is some kind of relation between the demand of A and B, between the demand of A and C or B and C etcetera. So, there may be some kind of correlation, may be positive, may be negative.

If demand of A is increasing, may be demand of B is also increasing. But it is quite possible that demand of A is increasing, while the demand of B may be decreasing also. So, that is also a possible. The second is, products may share joint capacity constraints requiring the same limited resources. Now, for these different types of products, different types of resources are also required.

So, for that purpose, if we have multiple products, so resources may be very easily shared and that will make the things more easier and smooth selling. And then, coming to the last type of case, that is Finite population models and price skimmimg. So, finite population models and price skimming that means you are keeping this is like this price skimming means you are keeping higher prices. So, this is the normal price this is hiked prices and this is a process which is known as skimming. That means I want to earn higher profit in the beginning and then the prices will go down and my revenue will also go down.

So, I am thinking to make, let us say, 1 million new iPhone 17s, and initially, the prices will be higher for the iPhone 17. As time passes, the market will grow, but prices will also decline. So, this is finite population models and price skimming, where you have some kind of dynamic pricing policy, and this dynamic pricing policy is very much based on the demand forecast you are going to have. With price skimming, we are going to take advantage of the maximum attractiveness of a particular product at its launch because you know that after some time, the demand for the product will decline, and the price will

also need to decline at that time. So, that is price skimming. So, we discussed in this particular session all these 1, 2, 3, 4 types of important pricing strategies for our scenario, and in all of them, we see that we have deterministic as well as stochastic models.

So, depending upon the availability of data, you are requested to use either deterministic or stochastic models. So, with this, we come to the end of this particular session. Thank you very much.