Course Name - Operations and Revenue Analytics

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Week - 08

Lecture - 40

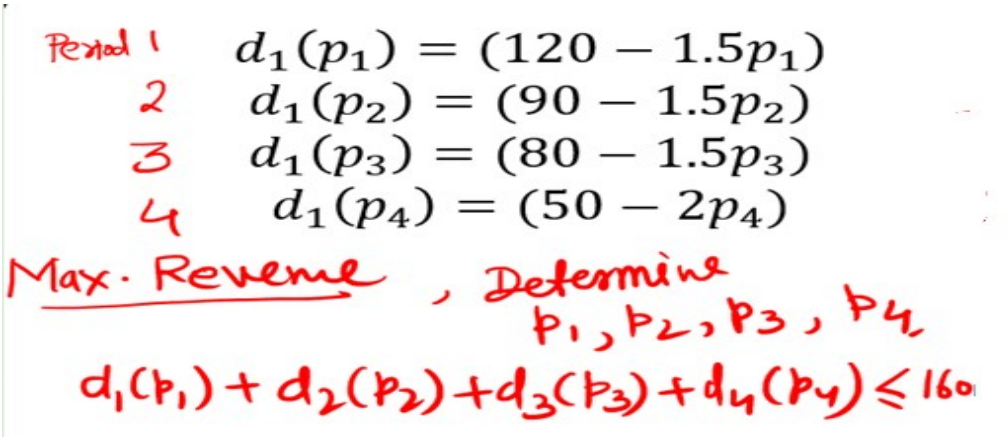
So, welcome friends. I hope you all had a good learning experience during the course. This is your final lecture in this particular course, where we discussed a large number of analytical applications in operations management and revenue optimization. Around 50 percent of our course focused on revenue optimization, whether it was quantity-based or price-based, and in our last session, we talked about marking down prices. We discussed how you need to decide in the beginning whether you want to have two price segments, three price segments, or more than that. We also discussed the process of cannibalization —that if you make it a habit of dividing prices into two or three segments, and if customers can anticipate it, it is quite possible that the benefits of segmentation, which we discussed in our previous class, may not be achieved at the highest level.

And how, at different levels of cannibalization, these benefits get reduced—that calculation is also available in our Excel sheet, which you can access from the course material. In this particular session, on one side, we have to complete the optimization part of our markdown approaches, but we will also like to give you a brief summary of what we have discussed in the last 39 sessions. So, this is your last session. You must have some important takeaways from this class—what have we learned in this particular course? But before that, let me start with markdown pricing, and let us see what we have and what we can do with the help of optimization tools in marking down. So, here we have a simple example to start with, and in this simple example,

Our total stock of this commodity is 160 units, and we see that the total life of this particular stock is 4 months. Then, if there are some unsold units after 4 months, all those

will become scrap. However, there is a value associated with scrap also—you can sell scrap at the rate of 5 dollars per unit. Now, for different types of months, these are period 1, 2, 3, 4. Now, for different periods, there is a different type of demand rate.

For period 1, the demand rate is given with these expressions: 120 minus 1.5p1, 90 minus 1.5 p2, 80 minus 1.5p3, and 50 minus 2p4. The objective is very clear. I want to maximize revenue and, for that purpose, determine p1, p2, p3, and p4. We have to determine p1, p2, p3, and p4 to maximize our total revenue, and d1(p1) + d2(p2) + d3(p3) + d4(p4) is less than or equal to 160. This entire problem can be formulated very easily in our Excel sheets.

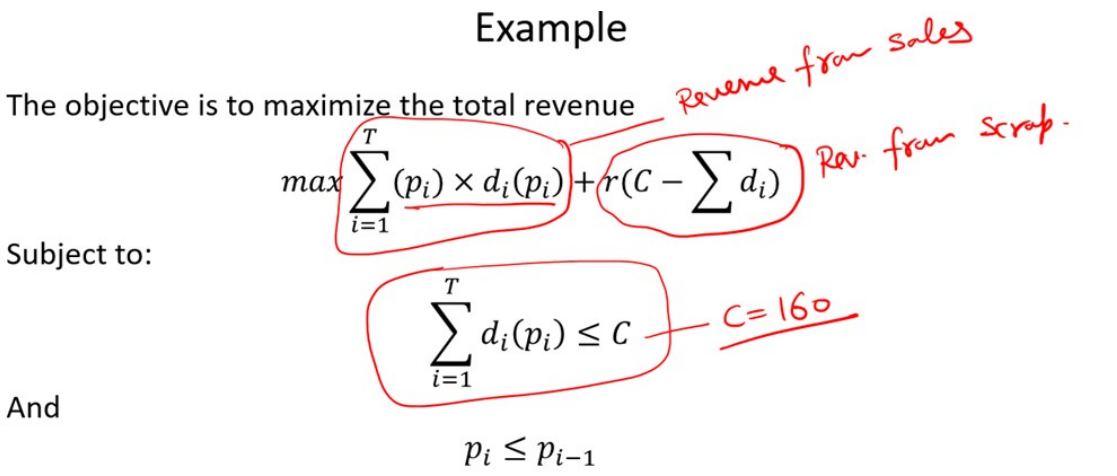


So, let us go to Excel and see how we can formulate this problem in Excel and then perform the optimization algorithms to get the values of p1, p2, p3, and p4. Here, if you see, the objective function is the maximization of the revenue, as I just mentioned. Now, this objective function has two components: one is revenue from sales, and the second part is revenue from scrap. One is this component, which is revenue from sales, and the second part is revenue from scrap. So, whatever is unsold is sold as scrap at the rate of 5.

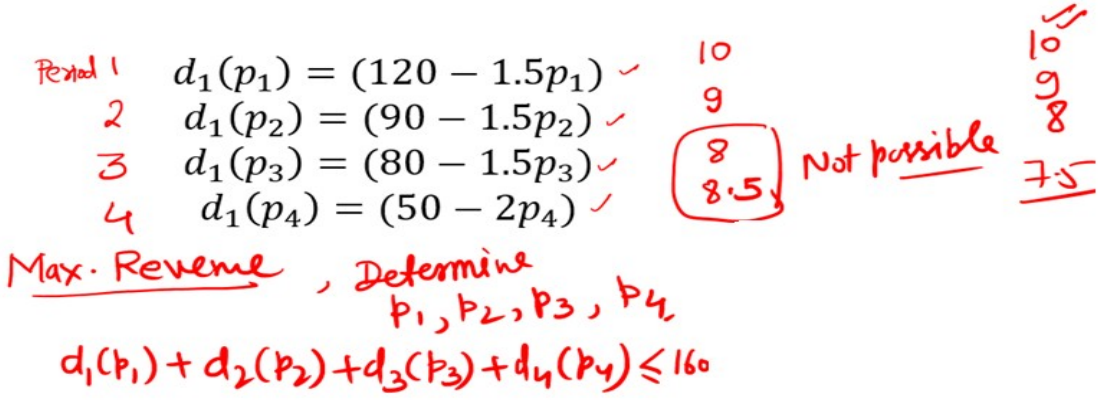
So, obviously, in the most optimal scenario, we should be able to sell all the units, and the maximum revenue should come from sales only. But it is quite possible that some unsold units may remain, and those will go as scrap. The constraint is that the total

demand of all four periods should be less than or equal to the capacity. In this example, C is 160, which is the total capacity. Also, pi is less than pi minus 1.

So, as we move into different time zones, the pricing changes sequentially. It is not possible for the pricing to increase if it was decreasing. For example, if this is 10, the next



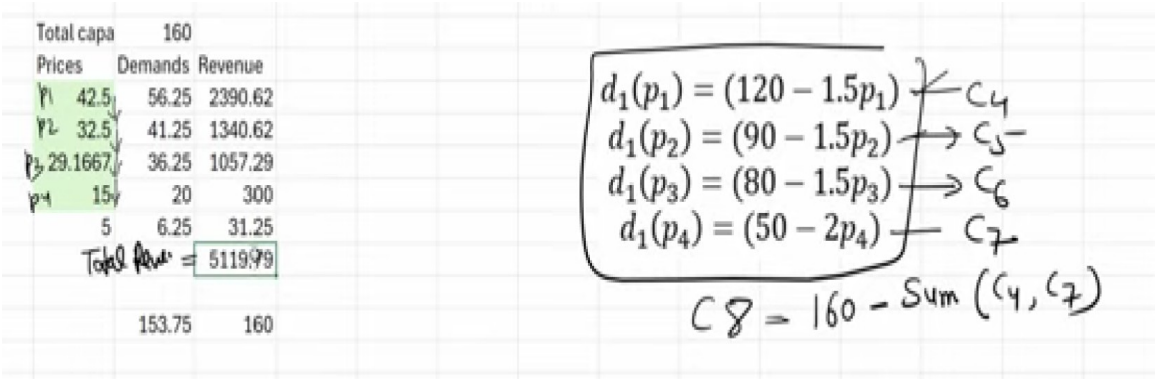
must be 9, then 8. It cannot be 8.5 in this case; that is not possible. So, there has to be a sequence in the decreasing of the price; it can be 10, 9, 8, 7.5, which is acceptable, but this is not acceptable.



So, these are the conditions, these are the equations which we are going to insert in our Excel form, and if I go to the Excel. So, here we see that in the Excel, the problem is formulated readily for your ready reference. These are the demand rates which we were discussing there. Now, prices are our p1, p2, p3, p4; these are the prices which are available to us after the calculations.

These are the decision variables, and with these prices, you can see that automatically it is in the particular order. As we are coming closer to the fourth period, the prices are continuously decreasing. Now, here I see that if I go to cell C4, we see what the demand function is. We have directly inserted this demand function: 120 minus 1.5p1, which is B4. Similarly, if I go to C5, this is putting in, let us say, C4; this is in C5, this is in C6, and this is in C7.

And then, if you see C8, C8 is the demand which is total capacity 160 minus the sum of (C4 to C7) that comes under C8. And now we see the revenue calculations. The revenue calculation will be directly, if you see D4, it is the multiplication of B4 and C4, and then you are copying the same D4 to all the other cells of column D, and finally, this is the total revenue. This is our total revenue, and if I go to this formula of total revenue, which



is in D9, you can see the formula in D9 that is in the formula bar, which is the sum of D4 to D8 that we want to maximize.

Now, after putting these formulas and the initial values of prices, we will be putting equals to 0 to start our solution process.

So, all these prices are 0 in the beginning. So, that is our initial revenue that is minus 900 which is not practically possible that actually the initial revenue will be this does not meet anything. Now, we will set our objective function D9 for the maximization purpose and that is to be maximized by changing the variable cells that is the price which is from B4 to B7. And then we are going to apply the process of optimization here we have to see that yes. So, after applying that excel solver and doing the optimization we got the total revenue coming to be 5120 and this is this revenue says that around 6 units you are unsold which are going for scrap these are scrap.

You are selling in the first period 56 units, in the second period 41 units, in the third period 36 units and in the last period fourth month you are selling 20 units and 6 units are almost unsold which are given in the form of scrap. So, this way you are able to actually complete your process of optimization of marking down. So, with this we are able to see that how by deciding now in this particular case we have readily given you 4 different rate of demand functions 120 minus 1.5p1, 90 into 1.5p2, 80 minus 1.5p3 and 50 minus 2 p4.

$$d_1(p_1) = (120 - 1.5p_1)$$
$$d_1(p_2) = (90 - 1.5p_2)$$
$$d_1(p_3) = (80 - 1.5p_3)$$
$$d_1(p_4) = (50 - 2p_4)$$

Sometime it may not be possible that you are able to get different demand rate for different time periods or for different prices. You may have a single like what we did in our last session that you have only single demand function and as we are going to the subsequent periods, we were subtracting from this total possible demand the capacity used in that particular session.

So, whether you have four different functions which is okay in the classroom, because I am giving you readymade demand functions, but in the practical cases developing so many different demand functions may not be feasible. So, even if you have a single demand function like this. So, here like in this particular problem I request you, you can try using only one **demand function d(p) = 120 - 1.5p1** and see if I have only one

demand function not these four demand functions only thing which I know that I have to do four segments. I have to do four segments how much difference you are going to get in your total optimization sorry total revenue collection. So, that may be a kind of a homework for all of you who have understood how have we calculated using this excel solver approach.

Now, going back to our class, in fact, we have covered the markdown optimization process, and so now with this, we have completed the pricing-related discussions with the variety of cases we have already discussed. Now, finally, we will take the last 10-15 minutes to give you a complete overview of whatever we have discussed in this particular course. We started this course with these number of topics. This is the slide which is giving you an overview of what we have covered in this particular course. We discussed the introduction and scope of the use of analytics in operations management.

We discussed that there are a large number of areas where we have to make decisions on a regular basis. And in these decision-making processes, earlier we were very static; once we used to make a decision, the same decision would remain, maybe for one year. You may remember when we discussed EOQ systems that once a year we calculate our economic order quantity, and that is totally becoming obsolete in the present environment, where we are getting so much data at such a fast rate that every month, every week, every quarter, you are able to update your annual demand. And therefore, whenever you have a new update in your forecast, accordingly, your new EOQ will be calculated. So, these types of scopes are there in our decision-making.

What type of line balancing outputs were we having at the start of a plant? Now, that is again possible to improve a lot because you may have variable demand on a daily basis, and when you have variable demand on a daily basis, the line balancing problem will keep changing according to what is your throughput from your systems. So, different types of roles of decision-making with respect to data we discussed; we discussed that the environment has become very, very uncertain. Earlier, the environment was quite static. It was homogeneous.

But the current environment is more uncertain. There is so much volatility in the environment. And because of these fluctuations, uncertainty, because of these sudden jumps, sudden spikes, the role of analytics has become even more significant. So, we discussed in almost about 10 to 12 lectures, different types of uncertainties which may be there in different types of operation management decision-making, particularly in case of forecasting, particularly in case of inventory management, particularly in case of aggregate planning and management. In all these cases, there are a lot of uncertainties, and how with the help of analytics we are able to take better decisions in the interest of our organizations.

Supply chain is a very integral part of operations management. Initially, we discussed supply chain as a single chapter in operations management classes. But over a period of time, supply chain has become such an important competitive force for the organization that entire operations management is now a subset of supply chain. And as a result of that, a lot of research, a lot of teaching, and a lot of courses are being developed on supply chain. I was referring to uncertainty.

So, nowadays, we are talking more in terms of uncertainties related to supply chains. Uncertainties related to supply chain come from the supply side and from the demand side as well. So, you can use analytics in a very strong manner for handling or managing the uncertainties of both these sides: the supply side and the demand side. Supply side uncertainties can be handled in a more convenient way because all the suppliers are under your control. But it becomes very difficult to handle the demand side uncertainties because customers are not in your hand.

So, there are so many factors may be visible, may be invisible are always operating in the environment and these are resulting into supply side uncertainties. Then handling the issues related to optimal level of product availability that on one side we have issues related to more and more revenue collection by selling the products, by selling the products whenever a customer is coming. But for improving our product availability and from product availability, revenue optimization, you need to keep large amount of inventory. So, that will be another set of cost. So, it is not only revenue you also need to see the profitability which is coming from your entire operational activities.

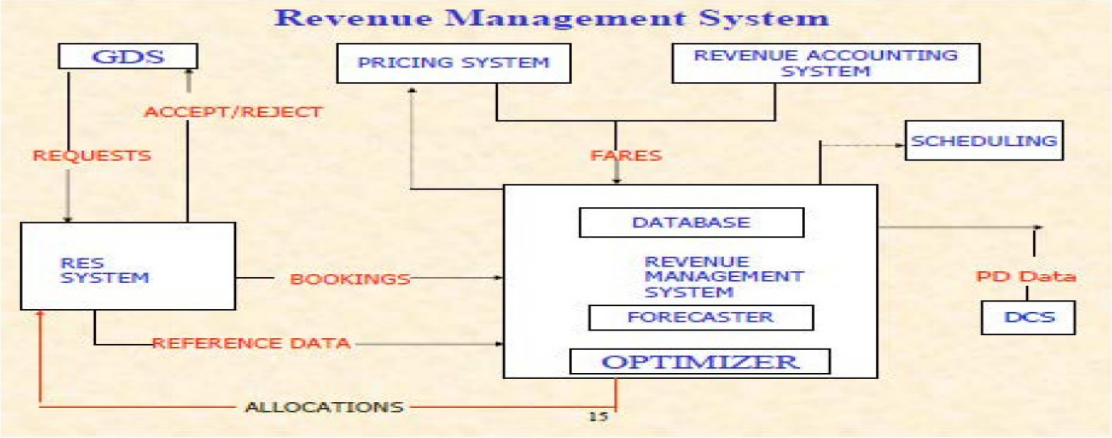
So, when I talk of profitability the revenue which you are getting and the cost you are incurring for maintaining that type of product availability you need to do optimization. So, a very important part of analytics was related to optimal level of product availability. so that you have a particular level of cost and you are also able to provide a decent level of customer services, decent level of product availability you can. So, lot of qualitative and quantitative discussions are needed for deciding the customers happiness as well as profitability of your organization. And then 50 percent of our course was devoted on this revenue optimization, revenue management, revenue maximization whatever you say.

In that we discussed most of the cases where we had limited capacity available with us. Large number of examples we took from aviation sector, airlines that how and particularly we took the examples of airlines because most of the principles, theories etc which we used in our class were developed either from one airline or another airline. So, therefore, airlines always came in our discussions of revenue management. Now, we focused alot that how if some capacity is available to us, some quantity is available to us, how are we going to manage that quantity between various types of customers, various types of classes, various time periods, high paying customers, low paying customers etc etc with the objective of we should be able to utilize all our capacity on one side. Not only utilize the capacity, but also get the maximum benefit, maximum revenue from that capacity also.

And we also see that rather thinking in terms of quantity allocation, capacity allocation you can think of price based scenario also that what should be the optimal price which can give you maximum benefits. So, that also we discussed in detail in our this particular course. So, this give you the entire overview that whatever we have discussed in this particular case. During the course we discussed some of the examples, but if I see practically there are few examples where they have used these principles in practice also. Like one example which you can all refer and we will offer you that case also, the link will also be available in the list of references in this particular PPT, where the Taj group of hotels in India, which is one of the largest and very prominent respected group in India, not only India but entire South Asia.

And they have large number of hotels, every hotel is a star hotel, total these many numbers of rooms are available and so many other kind of facilities etc are available. Now, this particular case is about using the principles of revenue management for improving their revenues, total revenue and this diagram gives you a pictorial view which is taken from this particular case study which I am referring, where they have mentioned that what type of revenue management system as a framework they are applying at Taj group. So, they have used lot of optimization as well as qualitative factors also for improving or for giving the better customer services and through that they want to achieve higher and higher revenue. Here, some of the qualitative things like following the some SOPs, so that it is not person specific it is more system specific processes which are happening in this particular group. Then transactional systems so that proper data capturing can be done and using that data they are able to do lot of analytics for deciding the policies for the next periods.

A Generic Revenue Management system



Source: Taj Hotels

And information tools, infrastructure, compliance standards all these things are there and a very good focus on their human resource management, since we are in operations management class. So, I am not talking about HR aspects, but HR aspects are also giving a lot of you can say support to Taj group of hotels. And these are all the important type of standardizations which they have followed in their hotels and using the principles which we have just discussed in this particular course like they also go for various types of price

change. So, sometime they may upgrade the customer from one category to another category. Overbooking is also happening that okay and not only overbooking, but the concept of Network management, if you remember is also very effectively used by Taj group of hotels.

So, just I am trying to highlight that organizations are using and infact, you will be able to get more insights when you actually refer this particular case when you will see the case when you are going to do this particular course. We may discuss this course in our discussion forum also as well as our associates will give you more insights about the Tata management Tata group case in their discussions. So, this is the diagram the framework which I am talking they are following and they use Inventory Optimization Module and the Forecasting Module and not only the modules because that is being used by almost all the service organizations, manufacturing organizations, but they are doing it in real time. So, that the power of analytics can be used very effectively in their organization. Then you can, we will be giving you reference of some of the other interesting research papers which will give you more insights about the application of revenue management techniques.

And this is one example of a research paper which is giving you that how airline company is using the overbooking cancellations and no shows for maximizing their revenues which we have discussed in the class of overbooking. Then another paper where they have given which is the part A of our course, That in all those areas where we have to use analytics in operations management, wherever we have to do regular decision making analytics may help us in a significant manner like in transportation management risk analysis inventory management forecasting etc where regular decision making is required. Then another paper which will be available to you that is revenue and cost management for remanufactured products. So, remanufactured products are part of our circle economy also, where we want to reduce the negative impact of our manufacturing activities.

And in this case the author has highlighted, analyzed the operations and pricing strategy and you may recall that during the last part of this particular course, we were focusing on the pricing strategy. So, he infact, during our discussion, we never discussed the pricing

from a remanufacturing point of view, but this research paper will extend our discussion that how pricing can be important thing for success of a circular economy through remanufacturing products. So, all these discussions are available to you with the help of these different research papers. So, these are the research papers and this is the case study. So, whoever can access these research papers, they are they should infact access these research papers otherwise when you will be doing this course we will be helping you in getting the access of these research papers.

So, as you can see, this list is not exhaustive. Let me tell you. We could find these research papers, but as time progresses, I am sure more research papers will emerge in this area, and we will gain more practical insights into how organizations have used operations analytics for various types of activities in decision-making and revenue maximization. So, with this, we come to the end of not only this particular lecture but also the end of this course on operations analytics. I wish you all the very best for your final examination, which you will have after these video classes.

Thank you very much.