Welcome friends. In our earlier sessions we were discussing cases, where we have to allocate capacity for our booking systems and we discuss that when we are booking our systems, there are cases of cancellations and we are adding that cancelled capacity to our available capacities. And we discuss that how we can start some closed classes or we only add that capacity to the existingly open classes. But, we also know that there may be some extreme cases of cancellations that you do not cancel but, you do not come for availing the service also. These are known as no-shows and these no-shows are very common in almost all the service examples.

When you are going for airline booking and at the time of boarding, you realize that maybe few passengers are not coming for the boarding. This is a case of no show. You are giving admission in MBA program and you have some 100 number of seats in your course. So, you offered 200 students who are top in the merit. But, while at the time of registration, you realize that that out of those 100 only 90 has registered, 10 are not registering.

So, in these cases there may be loss of your capacity. In the cases, where you are taking full charges while, you are giving the offer and there may be a refund policy because of the legal issues. So, almost all the service organizations they have a refund policy also. So, there will be some loss of revenue but not complete loss of revenue because of some advance you have taken. But, consider a case where revenue is only generated if a passenger is taking the service.

So, all those no-show cases will result into the loss of revenue. So, to minimize the loss of revenue because of no shows, because of no registration in an educational institute. We have a system of overbooking and almost in all the countries now the overbooking is a legalized activity. About in 1950s, 60s this was not approved by the law. Because, you are promising to serve more number of customers than your capacity.

So, there are issues related to ethical and legal aspects but, now considering the loss of services and there are customers who are willing to pay to avail the service. So, there are double losses you are not able to serve more number of customers and at the same time you are incurring the loss because of the no shows. So, overbooking is a system where we are giving offer, we are booking tickets then the more than the available capacity you have. So, in this particular session we are going to discuss about the various concepts, terminologies related to issue of overbooking. What is the cost of service denial?

What are the different models of customer overbooking? And some of the important prevalent policies under which overbooking is done that all we are going to discuss in this particular session. So, overbooking as I just mentioned is a case again, where you have constrained capacity and you are going to sell, you are going to offer more units than the available capacity you have. You have available capacity of C that is 50 but, you are offering seats to 55 candidates. So, you have done booking, overbooking of 5 seats and the reason is that you want to protect yourself against issues related to unanticipated no shows and last minute cancellations.

So, overbooking is very much applicable and legal also, where capacity is fixed and perishable and bookings are made for future use. Customers cancel tickets and do not simply show and there are little consequences of denying service to overbooked customers. I think out of these three characteristics for me the most important one is is this little consequences of denying service to overbooked customers. You are if let us say, you have overbooked by 5 seats and all the customers are there to avail the service, what will you do? If all 55 customers are there, so obviously you will deny service to 5.

And for denial the service, there will be some cost. The cost may be in terms of money, it can be non-money also. But that cost, that consequences is not really very very

significant. So, in these situations, this overbooking is possible. If the cost of denial is really very high in any way whether, it is monetary or non-monetary then probably you will be very careful in denial the services.

For example, in our school, colleges we have a main list and a waiting list. So, waiting list is a type of overbooking you are giving so that slowly you are transferring some of the candidates from the waiting list to the main list because here the cost of denial will be very very high. Because, if you have limited number of seats and you offer seats to more number of candidates and finally if you are not able to offer admission to that particular candidate who is overbooked that customer may go to serious problem for you. You have really very careful in the event of overbooking in your educational institutions. While, you can very easily overbook in many other cases like hotel rooms, like in airlines, etc., because the cost of denial may not be very high.

Here, as in the case of airlines, hotels, and rental cars, we have given the importance of overbooking as very high, high, high. Because you can compensate with money or re-accommodate the customers on some other flights. You can allocate some of the overbooked customers in the case of hotels to other hotels, or in the rental car system, you can delay offering rentals to your passengers or provide them a car from another company. All these things are possible in the case of airlines, hotels, rental cars, etc. Some of the important terminologies will be useful in understanding this concept of overbooking.

Industry	Importance	Consequence
Airlines	Very high	Compensate and re accommodate at other flights
Hotels	High	Re accommodate at other hotels
Rental cars	High	Delay/backorder or re accommodate at other company

Bumping a customer is one term that means denying a customer boarding on a particular flight or, more generically, denying a customer service. That is in a more generic manner. So, if airlines do not overbook, they may suffer revenue loss due to operating below capacity. Because earlier, there was a system where only if you booked and took the service would you pay, but even today, if you have 100 seats booked and 95 passengers travel, 5 are no-shows. So, you earn some partial revenue from these 5 customers due to the refundable nature of their tickets.

But still, this capacity goes underutilized. So, there is a possibility that you could have 5 additional overbooked customers who could be served due to these 5 no-shows, allowing you to maximize revenue. In fact, I myself was a beneficiary of this overbooking system when there were no-shows on a flight where I was overbooked, and I received the service due to the no-shows of regular customers. Now, in this particular case, there are two types of denied boarding. One is voluntary denied boarding, and the second is involuntary denied boarding.

Voluntary denied boarding means that when an airline offers vouchers and reaccommodate the passengers of the overbooked flight. You are having 100 capacity, 105 is the overbooked number. Now, all the passengers have come to the airport. So, you cannot take all 105. So, you have to deny boarding to 5 passengers.

Now, for these 5 passengers, you are offering, you give offer to all 105 that we are ready to give some kind of complimentary vouchers, we are ready to give some kind of overnight hotel stay or we are going to give some kind of compensation those who will not like to board this particular flight. So, this is a voluntary denied boarding because of these offers some of the customers says hey I am not going to board, I want to take the offer, I want to do a night stay in Dubai and I want to enjoy the Dubai life and I am not going to travel tomorrow morning. So, this is because of the offer given by the airline some of us, some of the passengers will not like to travel and that is known as voluntary denied boarding. But, it is quite possible that if airline is offering such type of coupons, some type of adjustments even then nobody comes forward. All 105 they want to travel and if nobody is coming forward but, you cannot give service to all 105 customers.

So, now airline will pick some 5 customers on their own and they will be denied boarding in the flight this is known as involuntarily denied boarding because they are on the choice of airline. Now that choice of airline may be random, may be non-random, it is up to the airline that how they are choosing, these five customers who will be denied boarding because, none of the passenger is coming forward to deny his or her own boarding. So, these are the two types of denied boarding which are happening in the case of overbooking, voluntary, involuntary. Voluntary because of the offers of the airline or the server, we ourselves want to avail those offers and in that we are leaving our seats for other customers. The other important thing, we should know in this particular case that is the cost of denied services.

When, whether it is voluntary denied or involuntary denied services, there are different types of cost associated with this denial. The first type of cost is direct cost or compensation. So, you are giving vouchers, vouchers for hotel stay is the most common. Most of the airlines, they have tie-ups with different types of hotels, generally, these star hotels so they give you the vouchers for future travel also or a hotel stay or both because, when you are denied boarding in any case you have to travel, so they will give you a hotel stay also and a voucher for future travel the provision cost that is the second. Generally, if, the second flight for which you are now given the offer if it is maybe at a difference of 2, 3, 4 hours.

So, they will give you complimentary meals, lodging facilities for the denied passengers. So, this is a small cost not a big issue. Third is recommendation cost. Now, sometime if you are flying with flight A and maybe you are adjusted to flight of operator B. So, in this case now a very big risk is there that you are giving your customer to other flight and this is known as recommendation cost. Flight A operated by this operator A and flight B is operated by another operator.

So, you may lose your customer to a different flight, different operator because of better services when the customer is on board. And then another type of non-monetary cost is loss of goodwill. Whether, you are offering any kind of hotel voucher, you are offering vouchers for future travel, good meals, all those things. But, you are forcing a passenger to reschedule his entire itinerary. And that may lead to loss of goodwill also.

Customer get upset, customer may think of that this airline is not a very reliable airline, so that customer may not like to travel in future from your airline. So, these two are in fact non-monetary cost and these two are monetary cost. People are trying to convert non-monetary cost also in terms of some kind of monetary cost, because of third and fourth you are losing a customer and the cost of losing the customer for one year or for lifetime, you can assess by using different kind of methodology. So, in a way this D is sigma of cost of denial from all the types of issues, whether it is direct, provision, goodwill or recommendation cost that is the cost of a denial a particular customer. So, therefore, on one side the issue is you have cost of denial that is D.

And on the other side marginal revenue by overbooking that what extra revenue you will be able to generate by overbooking, if that extra revenue marginal revenue by overbooking is more than this cost of denial then only the overbooking is justified. If cost of denial is significantly high, it is not advisable to go for overbooking. So, therefore, this concept of cost of service denial is very important because, the revenue which you are going to get from the extra customers, overbooked customers should certainly compensate the cost of denial services. Now, let us see the different types of models of customer booking or particularly overbooking. A supplier is planning to accept booking for a fixed capacity C. So, fixed capacity of the plane, fixed capacity of your hotel, fixed capacity of your any other service organization.

You are booking for b limits. Now, if b is less than equal to c, it means no overbooking. But, if b is more than c it is a case of overbooking and in this case we are discussing that b is more than c. So, what is the difference of b minus c? How much? That is the big question.

$$\text{(b)} \le c \rightarrow \text{No overbooking}$$
$$b > c \rightarrow \text{over booking}$$
$$(b-c) - \text{How much}$$

So, as long as you are getting more and more request and you are up to this limit, you are going to accept the booking, whether it is less than C or more than C. You are more concerned with as a booking control operator the one who is accepting and rejecting who is the decision making rule at the front office. So, that front office is more concerned with this booking limit b and based on that booking limit b, the front office will decide to accept and reject the request of the new bookings. Now, going further in this case. Whenever a time of the service, customers are arriving, booked customer who arrived are called shows. This is related to terminologies.

We all know and those who are not coming, they are known as no shows. We are assuming here that those who are arriving, those who are shows, they are paying you a price of P. But, as I already mentioned that in the modern day systems, we are actually charging price P from all the b customers who have booked. So, whether they are showing or they are not showing, we are charging fare from all the customers. However, because of the legal requirements we have to refund some of the amount to them if they are no showcases.

So, there will be some loss of revenue, but what servers are actually thinking that if the flight is or railways or hotels are going empty, there are other possibilities of revenue generation also. They may take a lot of value added services also these customers. And these value added services are also additional source of revenue. So, the source of revenue for the server is not just the price of the particular service, but there are large number of associated service also. So, we do not want that our capacity is perished without any use, we want our capacity to be used as much as possible.

And for that purpose, the supplier can accommodate up to C of the shows because C is the capacity. If the number of shows is less than or equal to C, they all are accommodated. If the number of shows exceeds C, exactly C customers will be served, and the rest will be denied service. So, it is simple to understand. Now, denied services are each paid, and denied service compensation is also there.

We just discussed that there are different types of costs of service denial. Let us say the total cost we are paying to the denied customers is capital D, and this cost, which we are

incurring for the denied customers, is more than the price we may earn from a customer who is availing our service. So, in a way, you can write this in qualitative form that the cost of denied service is more than the price charged. So, simply, the meaning is if a customer is going to give me the benefit of 1000 rupees, but if I am denying service to a customer, I may incur 1200 or 1500 rupees, which is more than the price I am going to earn. That is why it is a matter of concern for me that a denied customer is to be decided very carefully, considering what should be the number of overbookings.

Now, in overbooking, after understanding these basic terminologies, there are different types of policies that are applicable. The simplest type of policy is deterministic heuristics, which I think is the simplest of all our overbooking policies. And though it is simple—and generally, we say that a method which is very simple is not practically used —you will be happy to know that, though it is simple, it is very commonly used in a lot of situations wherever overbooking is allowed. Now, deterministic heuristics says that it calculates the booking limits based only on capacity and the expected no-show rate. So, you have calculated from some historic data what used to be the no-show rate in my particular case.

For example, in this data, we say that historically we have been getting this information: the customers who actually come to avail this particular service are 90 percent of those who have booked. And for example, let us say I have a hotel where the capacity is 250, and there are a large number of travelers who are booking my hotel. Now, historical data says that generally only 90 percent of customers turn up. So, if I book only 250 rooms for a particular day, my 10 percent of rooms—that means 25 rooms—will remain vacant because customers will not show up. So, therefore, I should book 250, which is the capacity, but out of that, only 90 percent of customers are coming to me.

So, I can—sorry. At maximum, I can have 250 customers—250 rooms. I am going to book 'b' number of rooms, and 90 percent of 'b' should be equal to 250. So, my 'b' will be 250 divided by 0.90, and 250 is basically the capacity, which is 'C.' So, the formula becomes 'b' equals 'C' divided by 0.9, or let me say in a more generalized manner, 'b' equals 'C' divided by 'rho,' where 'rho' is the show rate. So, this becomes a generalized

formula: the booking limit 'b' is equal to 'C'—where 'C' is the capacity of the server—divided by 'rho,' and 'rho' is the show rate.

So, that is a very simple way of calculating the overbooking amount, and many, many servers use this simple method to determine their overbooking limits. Then, so this is the simplest—simplest but popular. The other is risk-based policies, where you have to trade

$$b = \frac{C}{.9} \qquad b = \frac{C}{P} \quad \boxed{P \text{ is show rate}} \qquad C = 250 \text{ is capacity.}$$

$$90\%$$

$$250 = (b) \times .90$$

$$b = 250/.90$$

off the price 'P' against the cost of denial of service in a profit objective. In my deterministic heuristic, I am not considering the cost of denial at all. It is only based on the show rate—how many customers historically appear at the time of availing the service—and generally, this show rate is less than 100 percent.

So, there is no issue of cost of denial, but there is always a risk that all the customers who have reserved their seats, who have booked their seats, may come. And therefore, the cost of denial will also come into the picture. So, we have to take a trade-off between price P and the cost of denial, and that is the risk-based policy. Then, the third type of policy is service-level policies, which limit the probability of denial of the service. In our second case, the risk-based policy.

We are now trying to do a trade-off optimization between price and cost. Price means the benefit you are going to get, and the cost of denial is what you are going to incur—these are the two types of monetary terms. Now, in the service-level policies, we are talking in terms of probability, not in terms of money. The probability of denial of the service, and we want to minimize the probability of denial of the service and the percentage of customers who are denied the services. So, because of your overbooking, it is possible that some customers will be denied the services, and how many such customers are denied.

So, whether one customer is denied, two customers are denied, three customers—what is the probability that the question in this will become like this? What is the probability that at least one customer is denied service? What is the probability that two customers are

denied services? So, we want to minimize those probabilities. And also, out of the total lot of customers, how many customers in numbers are denied the services?

So, this is more in terms of the number of customers, and because every system has some benefits, we come to the hybrid policy, which is a mixture of risk-based and service-based. Risk-based is talking more in terms of benefits in rupee terms or in monetary terms, and service level is talking in terms of probability. So, when you have the probability and monetary terms coming at the same level, that is the hybrid policy. So, in a more robust way of overbooking, we would like to use the hybrid policy. So, these are the four popular policies for overbooking systems in our service organization: deterministic, which we just discussed.

Now, in our next session, we will be talking in detail about risk-based policies, service-level policies, and hybrid policies. So, with this, we come to the end of this particular session. Thank you very much.