Decision Support System for Managers
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Week – 12
Module – 05
Lecture – 59
Decision Support Systems for Operations Management (Contd.)

Hi, welcome to the 5th module of our course on 'Decision Support Systems for Operations Management'!

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In this session, we are going to cover very simple topics. One is on decision trees, and the second one is to give you an elementary concept on maximax, maximin, and the minimax decision criteria that sometimes managers deploy in solving decision problems.

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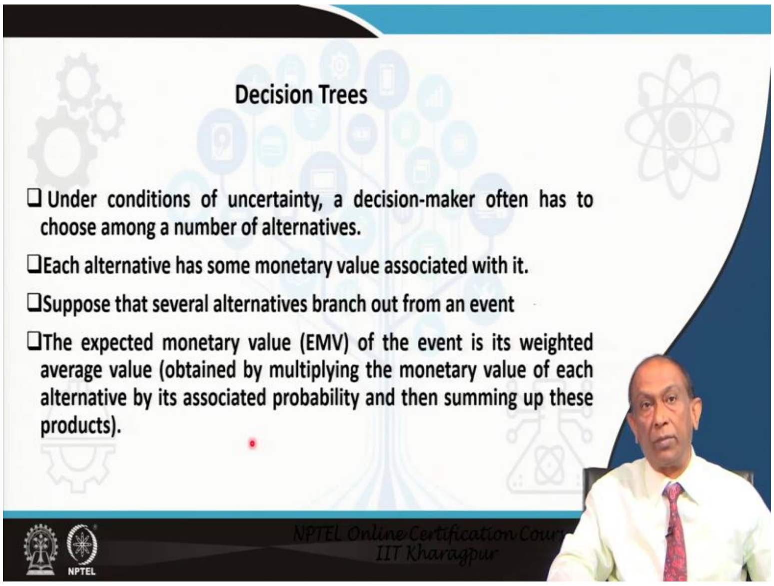

First we are going to talk about decision trees. Under conditions of uncertainty, a decision-maker often has to choose among a number of alternatives. And, each alternative has some monetary value associated with it. Suppose, that several alternatives branch out from an event.

Then the expected monetary value EMV, expected monetary value of a event is its weighted average value, which is obtained by multiplying the monetary value of each alternative by its associated probability and then summing up these products, as simple as that.

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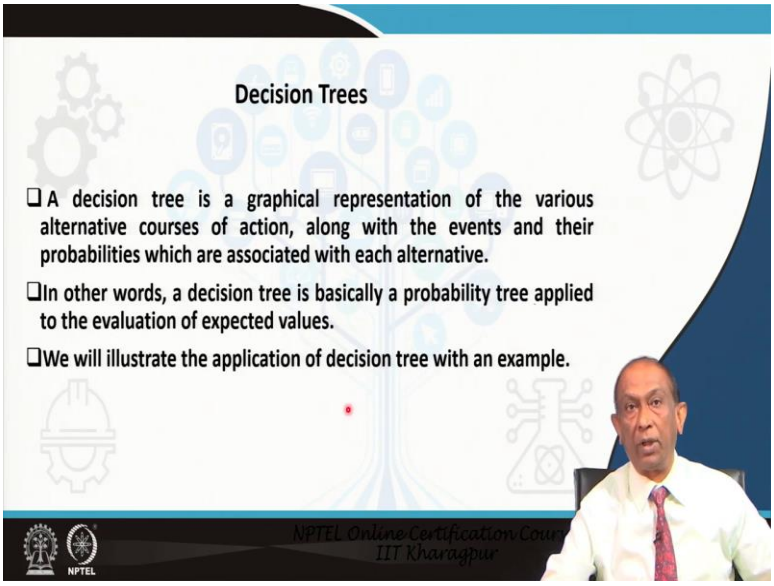

So, what is a decision tree? A decision tree is a graphical representation of the various alternative courses of action along with the event and their probabilities which are associated with each alternative that branches out from an event. In other words, a decision tree is basically a probability tree applied to the evaluation of expected values. We will illustrate the application of decision tree with an example.

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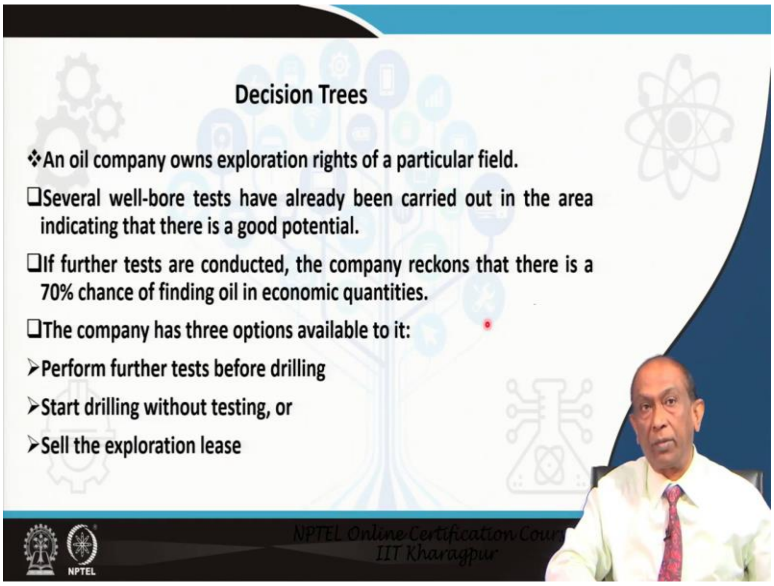

An oil company owns exploration rights of a particular field. Several well-bore tests have already been carried out in the area indicating that there is a good potential of finding out oil. Now, carefully note the data that is supplied. If further tests are conducted, the company reckons that there is a 70 percent chance of finding oil in economic quantities.

So, 70 percent chance is there of finding oil in economic quantities, if further tests are conducted. The company has three options available to it. The first option is perform further tests before drilling, the second option is start drilling without testing or the last option is sell the exploration lease.

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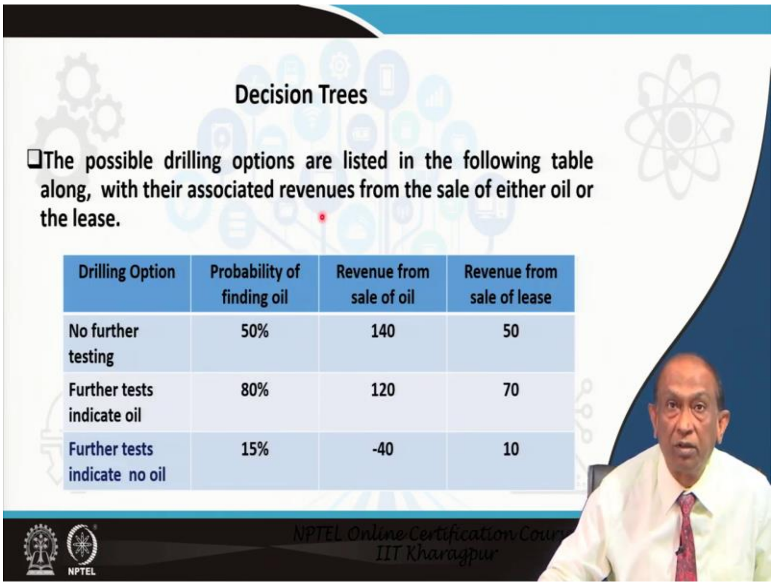

Now, if we a drilling options, possible drilling options are listed in this table; no further testing the probability of finding oil is 50 percent. And, in that case the revenue that you obtained from the sale of oil is this much units maybe in millions of dollars and revenue from sale of lease is given.

In the second option under drilling further tests indicates oil, the probability has been given as 80 percent and revenue from sale of oil is this much, revenue from sale of lease is this. Further tests indicate no oil, under that condition or under that option the probability of finding oil is 15 percent.

Once again note, the option is that the further tests it indicate that you may not get any oil. But, still there is a probability of finding oil under that situation and that is 15 percent. But in that case the revenue that, you get from the sale of oil is this much and the revenue from the sale of lease is this one.

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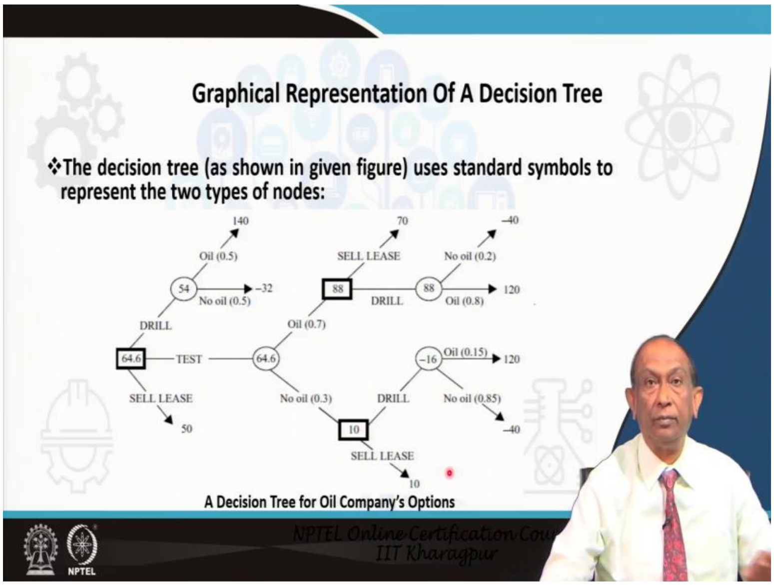

So, the decision tree as shown in the given figure corresponding to the data that has been given uses standard symbols to represent two types of nodes. This is one node square, here it is also square, this is a square. These are action nodes; that means, here you can either sell the lease or you can do some testing and then go ahead or this branch basically says that going for drilling without carrying out any further test. This circle they basically they are also another type of node and basically they are known as event node.

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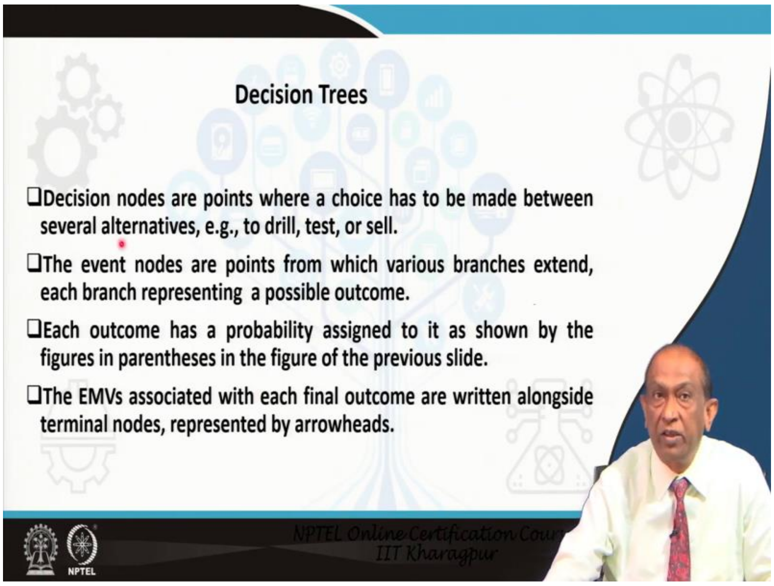

So, decision nodes also action nodes as popularly known are points, where a choice has to be made between several alternatives for example, to drill or to going for testing or selling that is what I had shown you in the previous slide. This is a decision node or an action node. Basically, here you have to exercise one out of the several alternatives or choices that you have.

The event nodes are the points from which various branches extend, each branch representing a possible outcome. And, each of these outcome has a probability assigned to it as shown by the figures in parentheses in figure of the previous slide. You see these are the probabilities, ok. In this case, the probability is 20 percent of getting no oil and the probability of finding an oil the probability is 80 percent; ok.

Where did we get it from? You see further tests indicate oil; the probability of finding oil is 80 percent and no oil 20 percent. So, you have to find out from the data given: what is the corresponding probability; ok. And, the also you have to is if further test indicate oil if 80 percent and the corresponding revenue is 120 units. Now, if you see these 120 is the revenue that you get, if you branch out from here and follow this route.

And, the probability of this getting this much revenue is 80 percent. So, if this branch has a probability of 80 percent, then the other branch no oil will have a probability of 20 percent. And, if there is no oil then corresponding revenue from the sale of that oil is minus 40. This value 88 that you are getting how did you get it?

120 into 0.8 its 96 minus 40 into 0.2 is 8; so, 96 minus 8 is 88 that is the expected monetary value corresponding to this node. In a similar manner you can calculate the expected monetary value at each of these nodes after drawing the decision tree from the given data. The expected monetary values associated with each final outcome are written alongside the terminal nodes represented by arrowheads.

That means, this is the expected monetary value, if you follow this branch, this is the expected monetary value if you follow this branch and this is the resultant value, ok. This is a terminal node. Similarly, here this is the terminal node. So this value how do you get it? This multiplied by 0.7 plus this multiplied by 0.3 will give you 64.6.

In here you see you have the monetary values 50 EMV if you follow this branch, if you follow this branch you will get this the expected EMV. And, if you follow this branch you will get these are the expected EMV. This 54 how you are getting? This 140 into 0.5 plus 0.5 into minus 32. Now these two values are the EMVs corresponding to this branch and this branch and the resultant EMV at this particular node is 54. The 140 into 0.5 70 minus 32 into 0.5 16, that is 54. This branch 64.6, this branch it is 50; right.

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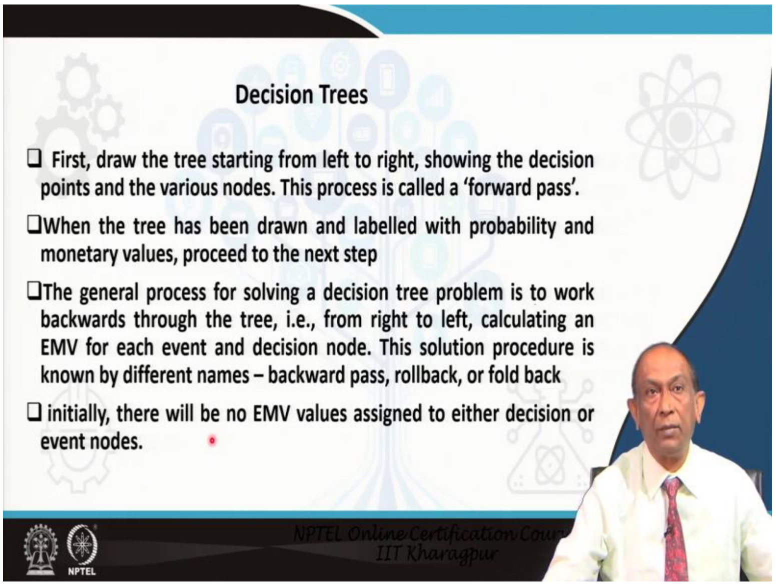

So, the procedure is like this. First, draw the tree starting from left to right, showing the decision points and the various nodes. This process is basically called a 'forward pass'. When the tree has been drawn and labelled with probability and monetary values, this probability value, then monetary value you will get from the table.

You will collect the data and then prepare similar table and from the table you will supply these values, while you are drawing the tree. The general process for solving a decision tree problem is basically to work backwards through the tree; that is say form for drawing you are proceeding from left to right and while solving you are coming from right to left.

Then calculate an EMV for each event and decision node. This solution procedure is known by different names - backward pass, rollback method or fold back method. Initially, when you draw the tree there will be no EMV values assigned to either decision or event nodes. That means, if you look at this picture, these boxes, this box will remain empty.

This node will remain empty, this will remain empty; this will remain vacant; this will remain vacant; this will remain empty; this will remain empty; when you draw the node initially, then based on the calculation, you have to fill up these nodes.

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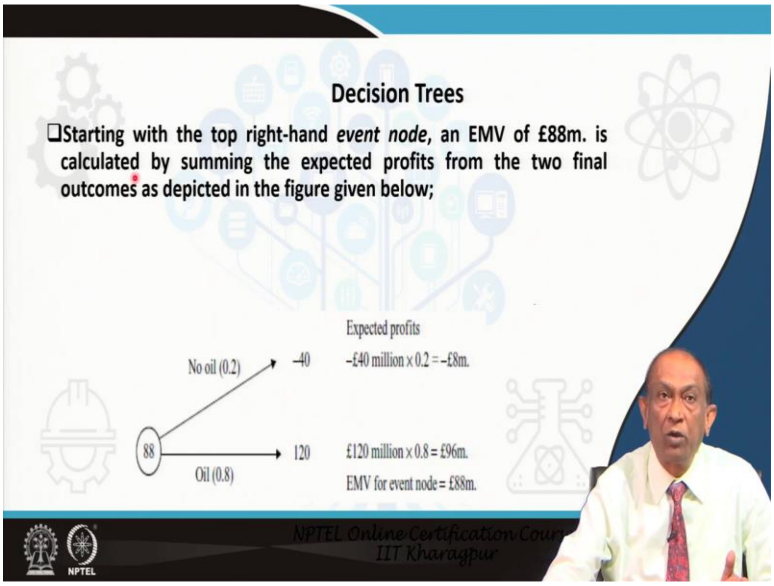

Like, I had already explained to you, starting with the top right hand event node, an expected monetary value of 88 million dollar million pound is calculated by summing the expected profits from the two final outcomes. These are the two outcomes emanating from this node. So, minus 40 expected profits is this plus this; so, EMV for the event node is 88 million. I have already explained to you: how did you get 88.

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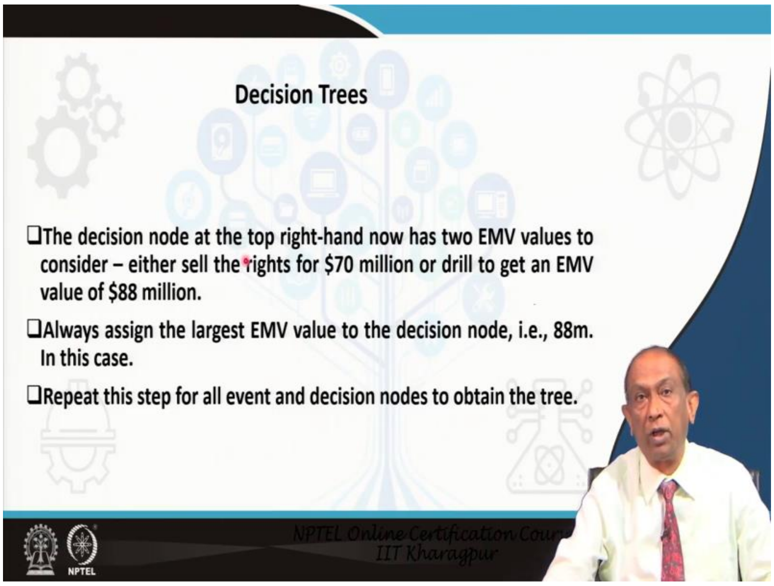

So, the decision node at the top right hand now has two EMV values to consider - either sell the rights for dollar 70 million or drill to get an EMV value of dollar 88 million. If you look at this, this particular action node here you have two alternatives either you can sell the lease and get a value of this much or you can go in for drilling.

So, what value you will assign to this particular node, to this decision node? You have to choose the maximum out of these two branches, EMVs related to these branches. Always assign the largest EMV value to the decision node that is in this case 88 million pound. And, you have to repeat this step for all event and decision nodes to obtain the tree. That means, these EMV values at each of these action points or action nodes and the EMV values for each of these event nodes have to be computed and filled up.

Now, if you look at this particular diagram, you see 64.6 if you go in for testing, if you just go in for drilling without testing; this is the expected monetary value. And, if you are selling the lease outright, you are getting this expected monetary value. So, what you will choose? This one obviously, so that is what has been written.

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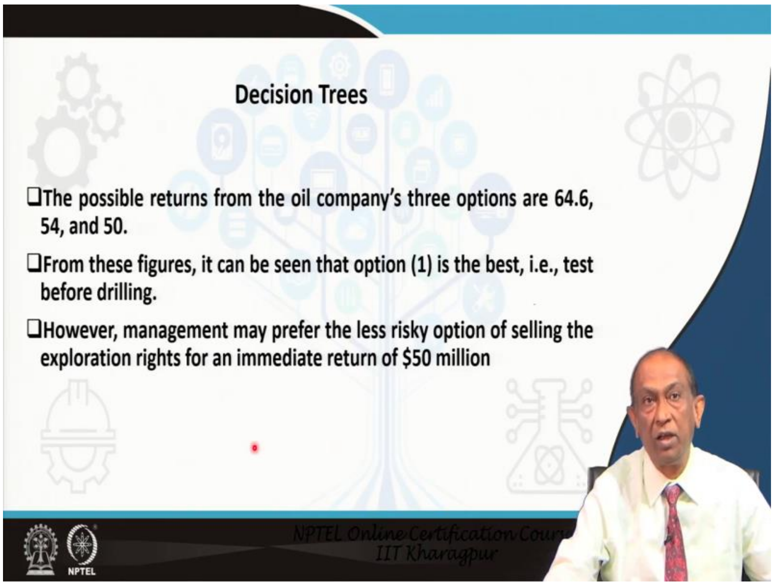

The possible returns from the oil company's three options are 64.6, 54 and 50. From these figures, it can be seen that option 1 is the best that is you going for testing before drilling. However, depending on the mental makeup of the management, the management may prefer the less risky option of selling the exploration rights for an immediate return of 50 million dollars; it depends.

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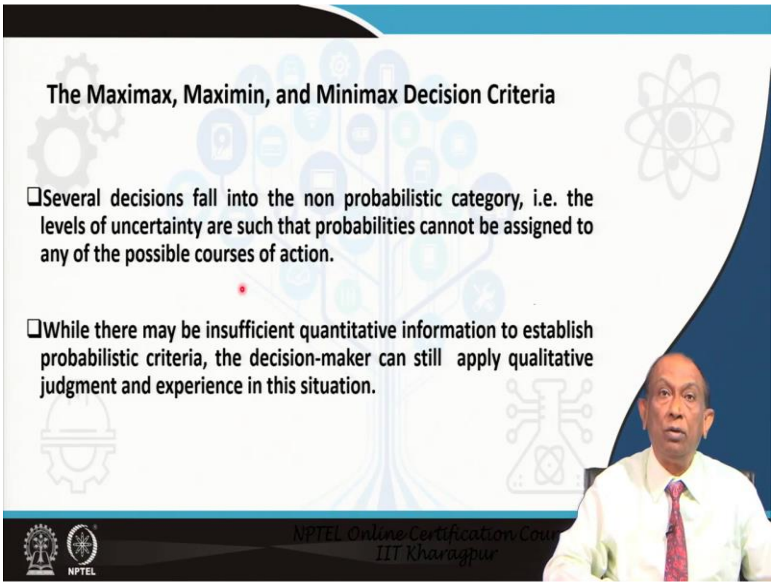

Now, let us look into the other aspect of today's deliberation that is I would like to mention about the maximax, maximin and minimax decision criteria. Several decisions fall into the non-probabilistic category that is the levels of uncertainty are such that probabilities cannot be assigned to any of the possible courses of action.

While there may be insufficient quantitative information to establish probabilistic criteria, the decision-maker can still apply qualitative judgment and experience in this situation.

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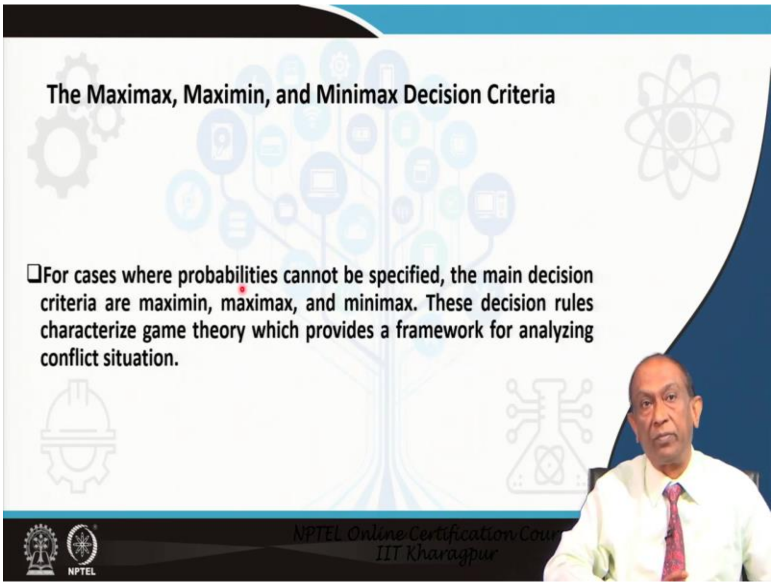

For cases, where probabilities cannot be specified, the main decision criteria are maximim, maximax and minimax. These decision rules characterize game theory which provides a framework for analyzing conflicting situations.

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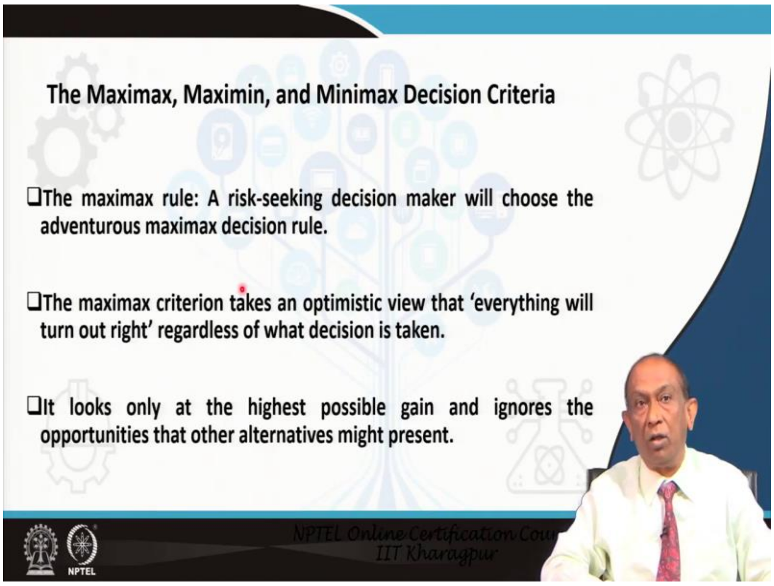

What is this maximax rule? A risk-seeking decision maker; a risk seeking decision maker will choose the adventurous maximax decision rule. The maximax criteria basically takes an optimistic view that everything will turn out right' regardless of what decision is taken. It looks only at the highest possible gain and ignores the opportunities that other alternatives might present.

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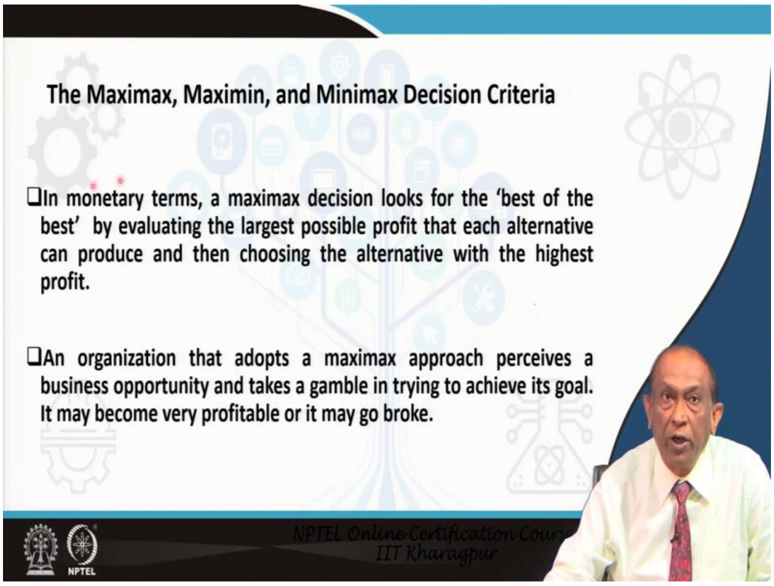

In monetary terms, a maximax decision looks for the 'best of the best' by evaluating the largest possible profit that each alternative can produce and then choosing that alternative with the highest profit. An organization that adopts a maximax approach perceives the business opportunity and takes a gamble in trying to achieve its goal. It may become very profitable or it may go broke.

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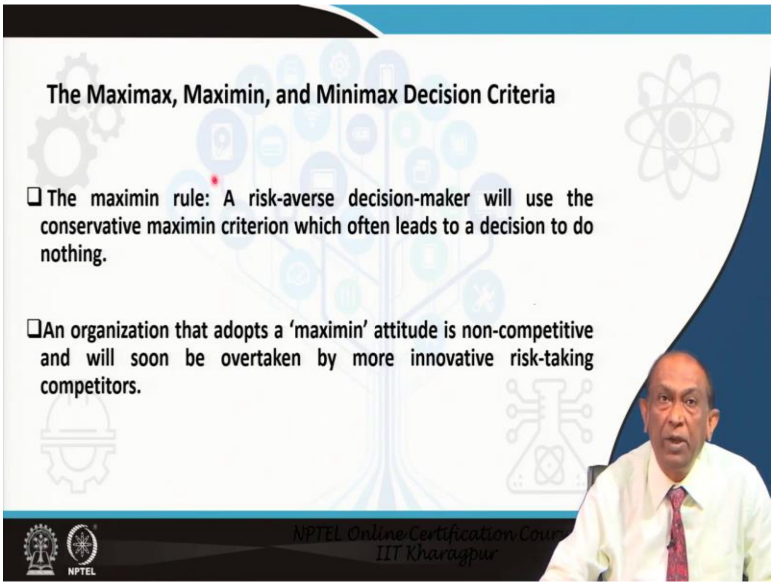

The maximin rule: A risk-averse decision maker will use the conservative maximin criteria which often leads to a decision to do nothing. An organization that adopts a 'maximin' attitude is non-competitive and will soon be overtaken by its competitors or by more innovative risk-taking competitors.

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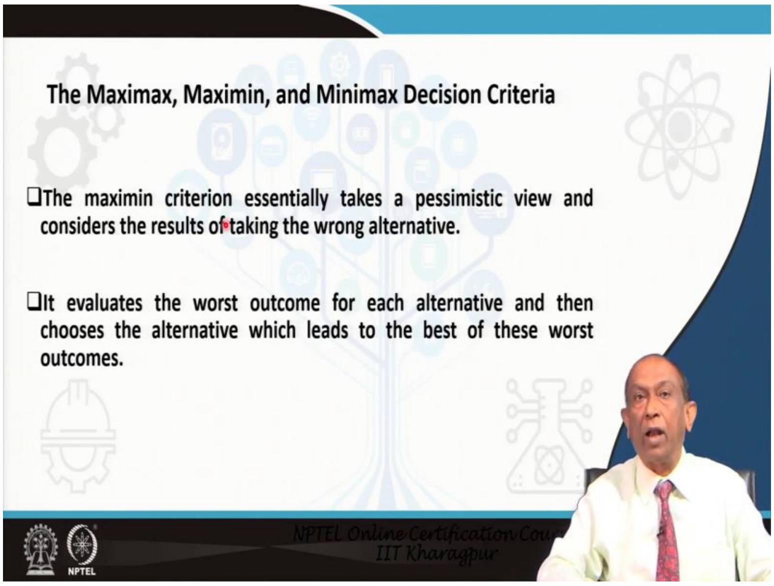

The maximin criteria essentially takes a pessimistic view and considers the results of taking the wrong alternative. It evaluates the worst outcome for each alternative and then chooses that alternative which leads to the best of those worst outcomes.

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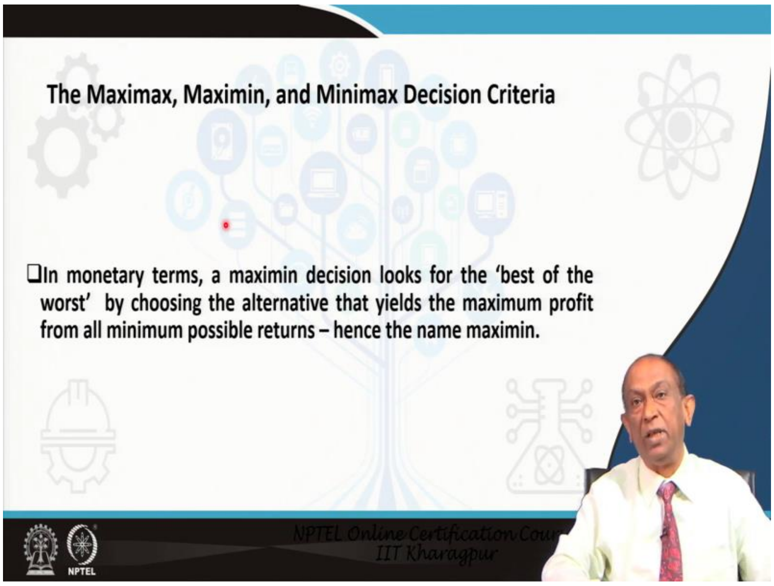

In monetary terms, a maximin decision looks for the 'best of the worst' by choosing the alternative that yields the maximum profit from all minimum possible returns; hence, the name: maximin.

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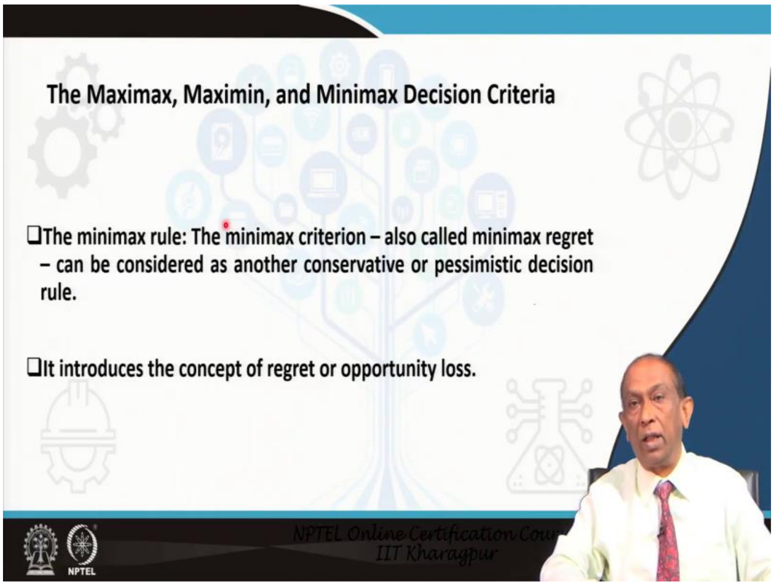

Now, comes the minimax rule. The minimax criteria also called minimax regret can be considered as another conservative or pessimistic decision rule. It introduces the concept of regret or opportunity loss.

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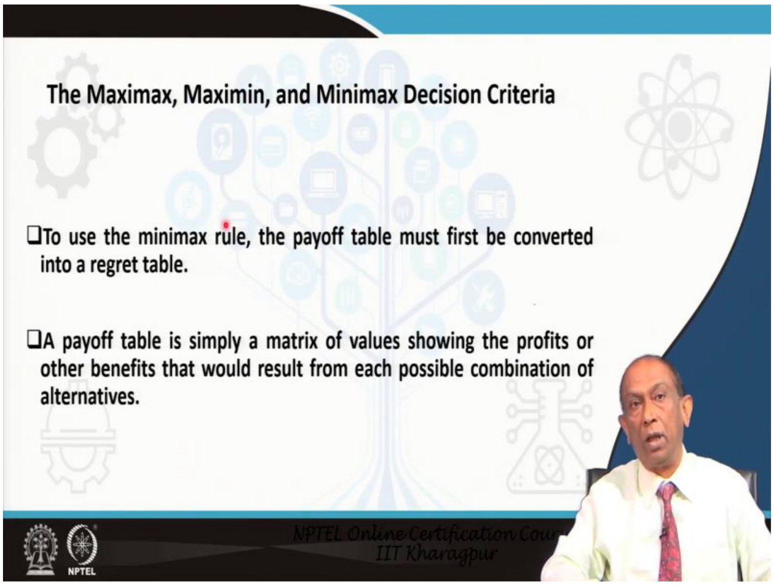

To use the minimax rule, first the payoff table needs to be converted into a regret table. Now what is a payoff table? A payoff table is simply a matrix consisting of values showing the profits or other benefits that would result from each possible combination of alternatives.

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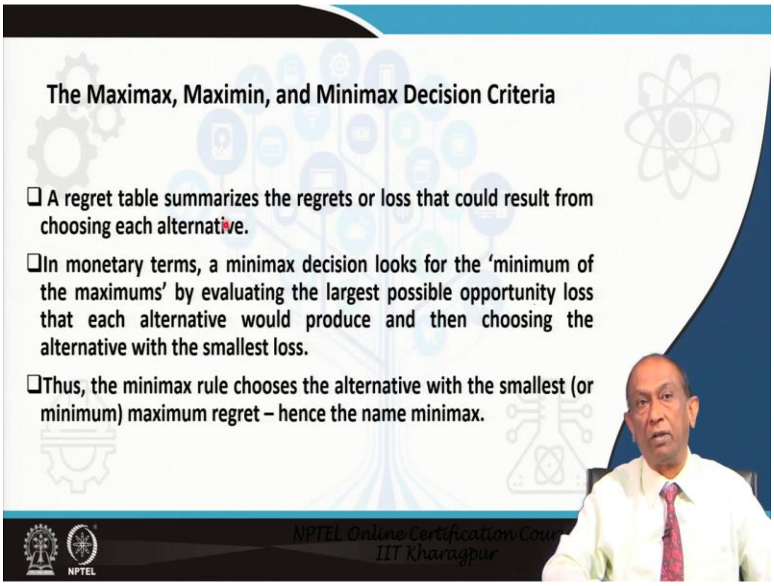

A regret table summarizes the regrets or loss that could result from choosing each alternative. In monetary terms, a minimax decision looks for the 'minimum of the maximums' by evaluating the largest possible opportunity loss that each alternative would produce and then choosing that alternative with the smallest loss. Thus, the minimax rule chooses that particular alternative with the smallest maximum regret - hence the name minimax.

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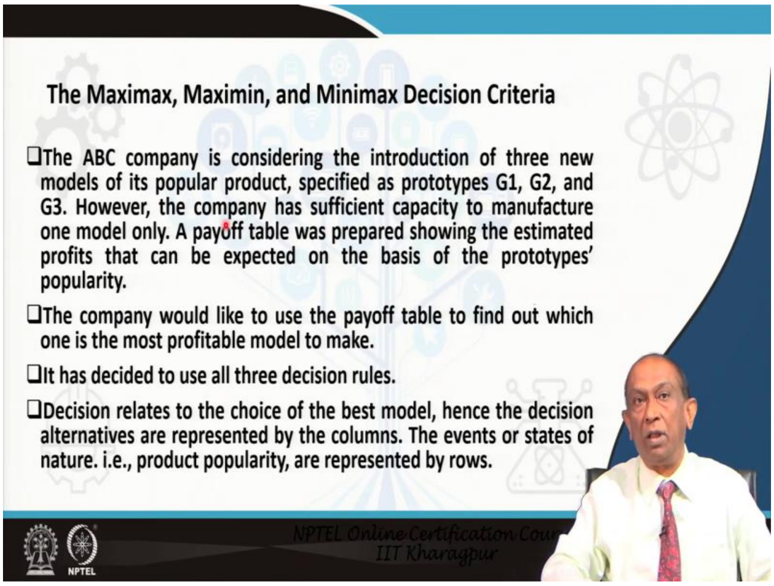

Now, this everything will be very clear when you look at one simple example. The ABC company is considering the introduction of three new models of its popular product, specified as prototypes G1, G2 and G3. However, the company has sufficient capacity to manufacture one model only. A payoff table was prepared showing the estimated profits that can be expected on the basis of the prototypes' popularity.

The company would like to use the payoff table to find out which one is the most profitable model to make. It has decided to use all the three decision rules. So, the decision relates to the choice of the best model, hence the decision alternatives are represented by the columns of that matrix. The events or states of nature that is a product popularity, are represented by rows in that matrix.

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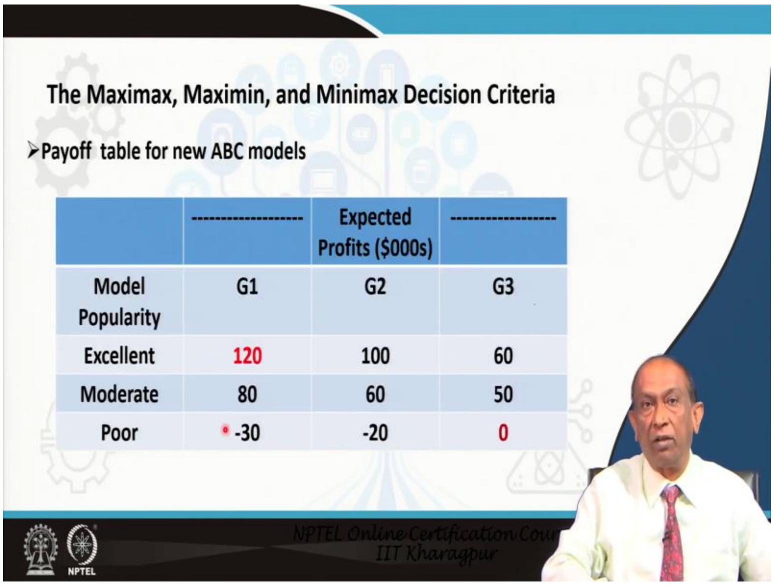

	------------------	Expected Profits ($000s)	------------------
Model Popularity	G1	G2	G3
Excellent	120	100	60
Moderate	80	60	50
Poor	-30	-20	0

That means, these are the three models G1, G2, G3 and if the model popularity is excellent, then these are the payoffs or the revenues that you will be getting. If the model popularity is moderate, then these are the payoffs for the three models. And, if the model popularity is poor then these are the payoffs for the three models G1, G2 and G3; expected profits in thousands of dollars.

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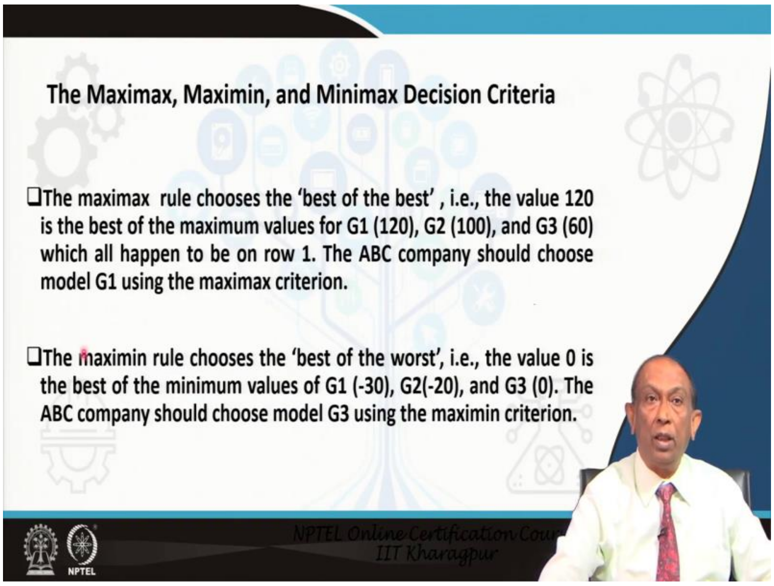

Now, if you use the maximax rule which basically chooses the 'best of the best' then in that case the value of 120 is the best of the maximum values. And, in that case the company should choose model G1; you see this is the maximax; 120, 100 and a 60 out of that 120 is the maximum. So, the company chooses this model.

The maximin rule chooses the ‘best of the worst’; in this case the value 0 is the best of the minimum values of; see these are the values say out of this 0 is the best. So, value 0 is the best of the minimum values. So, the company should choose model G3 using the maximin criteria.

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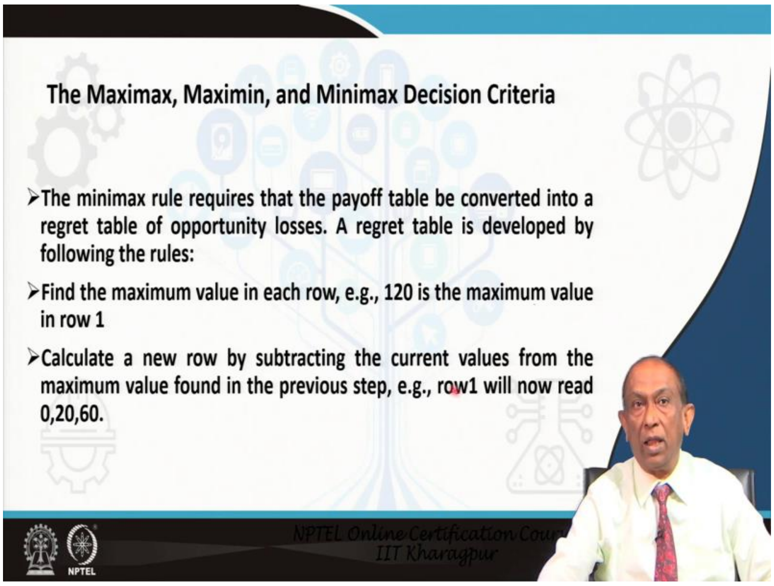

Now, if you want to apply the minimax rule, the minimax rule requires that the payoff table should first be converted into a regret table of opportunity losses. Now, how do we prepare a regret table? A regret table is developed by following these rules. What is the rule? Find the maximum value in each row for example; corresponding to row 1, you have seen that 120 is the maximum value.

Then you have to calculate a new row by subtracting the current values from the maximum value found in this previous step. For example: row 1 will then read as 0, 20 and 60. How did you get that? 120 is the maximum value in this row, 120 minus 120 is 0, 120 minus 100 20, 120 minus 60 is 60. So, the row 1 will now read 0, 20, 60 in the new matrix.

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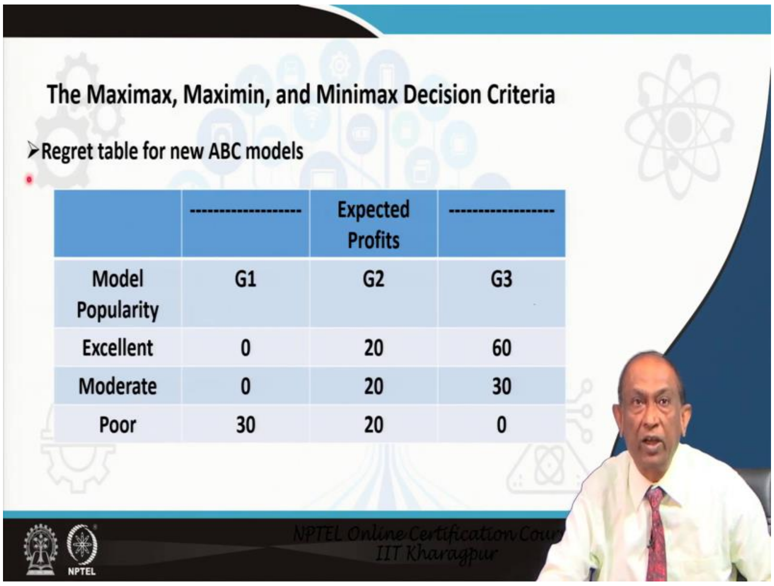

	------------------	Expected Profits	------------------
Model Popularity	G1	G2	G3
Excellent	0	20	60
Moderate	0	20	30
Poor	30	20	0

So, the regret table can thus be constructed in a similar manner by considering the opportunity loss for each of these rows and this is the retarget table.

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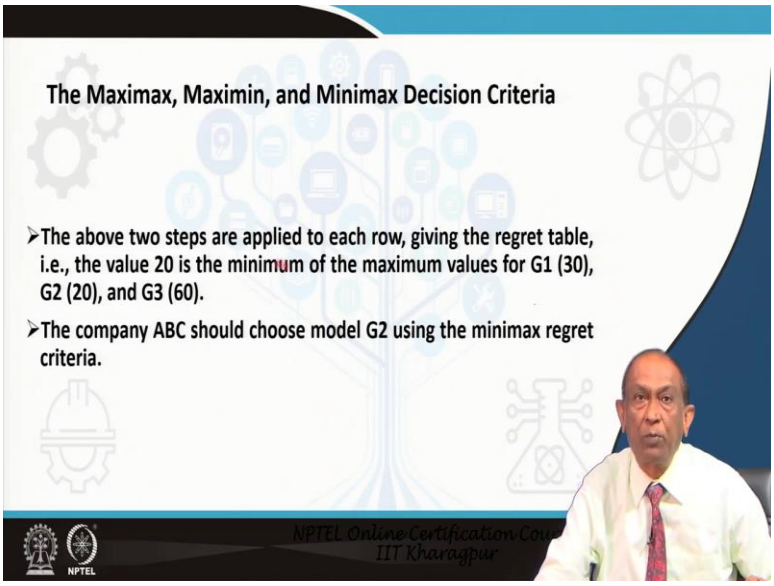

The above two steps are applied to each row, giving the regret table that is a value 20 is a minimum of the maximum values; you see maximum values for G1 is 30, for this it is 20 and for this it is 60. This is a minimax criteria, you are trying to minimize the regret maximum regret. So, in that case you should choose the model G2.

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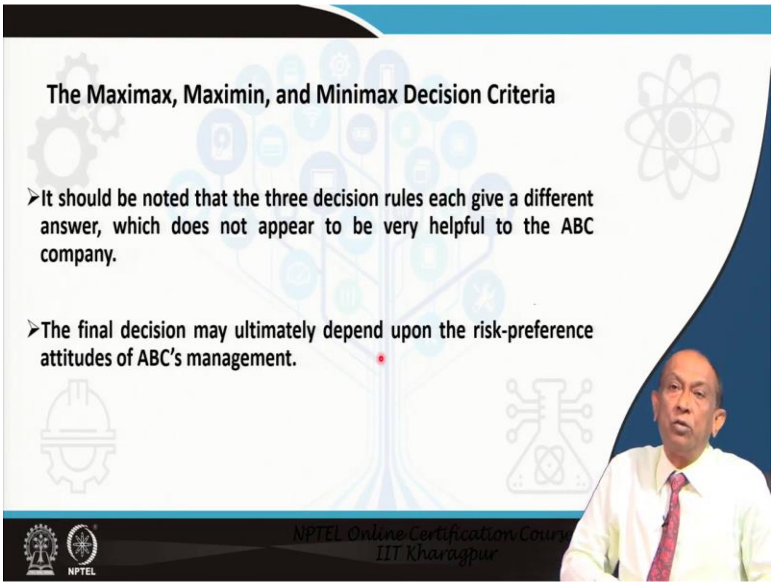

Now, one thing that you must have noted that the three decision rules, each of them give a different answer which does not appear to be very helpful to the company but these are different approaches and the final decision may ultimately depend upon the risk taking or the risk preference attitudes of the company's, ABC's management team. So, these are the different ways in which decisions are being taken in real life industry; this is an example of that.

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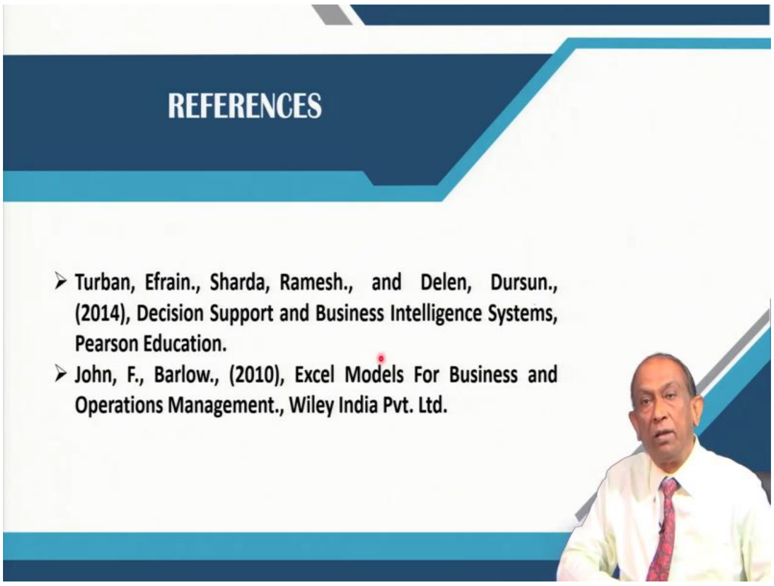

Thank you all for your patience! These are the references that I have used.