Modelling and Analytics for Supply Chain Management
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Lecture 42- TOPSIS and VIKOR Method

Hello, and welcome to modelling and analytics for supply chain management. We have covered a long way and we are now into week 9, lecture 42.

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As you all know, this module was on MCDM techniques that is multi criteria decision making techniques as well as forecasting in supply chain. Now in week 9, lectures 40 and 41, you have learnt AHP, that is Analytic Hierarchy Process and TOPSIS.

Now, so let us spend a few minutes on a broad overview what is, about what is an MCDM technique. MCDM technique is basically multi criteria decision making that means, when you have many criteria for enabling a decision making, that is called as a multi criteria decision making, okay.

For example, you are late for your office or you are late for your college etcetera, and you have to reach because there is an exam, so what is the criteria at that time? Perhaps, there is only one criteria, and that criteria is speed, so you choose a train or a taxi, that means there will be no stoppages like a bus because the criteria was speed, okay.

But the same you, as a person, you do not have exams that day, you do not have classes in the first half that day, so you have enough time. So then, for reaching your institute what is the

criteria? The criteria is what is the cost of travel means how much you are paying for the bus fare or the train fare, the criteria is again speed, how much time you are taking, the criteria is again whether you are getting a seat on the bus or on the train.

So criteria now becomes many, cost, time as well as your comfort. So criteria now is not speed like in the first case when you had exams, okay. Like in the first case, when you had exams that was only single criteria. Now, because you do not have that much of urgency you have many criteria and that is why it is called as a multi criteria. And decision-making that is based on so many criteria like bus fare, speed of the bus, comfort that is called as a multi criteria decision making, okay.

So if you see, this is what we call as multi criteria decision-making in supply chain management. And in real life, you will see almost all decisions that we take is multi criteria, okay. All decisions that we take is multi criteria. So to this light, this week the focus was on multi criteria decision making and supply chain forecasting and the first two weeks you have done multi criteria.

Now, because it is multi criteria, there are different ways to approach such a decision-making problem. What are the different ways to approach such a decision-making problem? One approach is AHP, where you have learnt that we do not have a numerical value attached to certain things what we have is I am better than him and he is better than her or she is better than him. So it is basically a comparison. So when we have comparison type of a situation then we are converting that into numbers to get a meaningful analysis and some sort of a hierarchy that was a analytic hierarchy process, okay.

In similar lines, there is another method called TOPSIS. What did we learn in TOPSIS method? In TOPSIS method we learnt a similar manner but then how far we are from ideal point, that distance was calculated, okay. In analytic hierarchy, we looked at I am better than him, he is better than her or she is better than him, okay, but TOPSIS we calculate how far you are from the ideal solution and how far you are from the negative ideal solution. So that is the basic difference between AHP and TOPSIS method, okay. So today, we will continue with the bit of a TOPSIS, and then we will move on to your another method called VIKOR.

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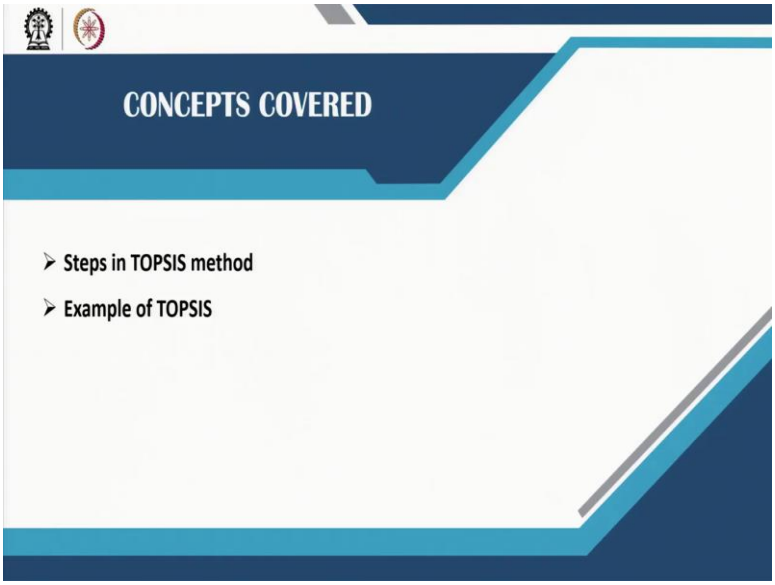

Now, so let us, let us move on, you have in TOPSIS you had learnt about the difference between the ideal solution, etcetera. Now, and you have also calculated and you have also solved one example with TOPSIS, okay. Now, just again what is the outcome or what is the application of TOPSIS method.

Application of TOPSIS method is for different areas of supply chain modelling. For example, application of TOPSIS is in supply selection, okay, how do you select suppliers when there are different criterias and there is a list of suppliers. So how do you select suppliers, that is one area of application.

Application of TOPSIS may also be in choosing which person should be deployed in which zone or which area in the supply chain. For example, just like supply ranking you do your employee ranking, just like supply ranking you do your employee ranking. And then, the criteria that you choose for employee ranking is basically the skill sets that are required in different supply chain functions. And you give a weightage or you give marks or you give points to each employee against the particular skillset, okay.

So TOPSIS method can be used as we said, for supply selection for employee allocation in the entire supply chain setting, okay. Now, then you will ask me that is it something which AHP cannot do? No, it is not that. AHP can also do it but as we know different situations, different systems, different ways of method. When there is an order of preference, sometimes we will use TOPSIS method, okay. Now today, so that is where your TOPSIS comes into picture.

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Today, we will learn another method called VIKOR method, okay. Now VIKOR method is basically a method by which again there are multiple criterias and you have to take a decision on which criteria and how which criteria can be set on top. And number 1 and number 2 which supplier or which situation can be ranked as 1, 2, 3 based on some technique which is called as VIKOR.

Now what is the basic difference between AHP, TOPSIS and VIKOR? Now VIKOR method takes care of, suppose you have different criteria, different criteria there and you have to take a decision. Now, it is not always possible to reach the optimal solution, okay. We, human being always move within a band, it is not exactly pinpointed that I need this or I need exactly that. It always moves within a band, within a particular band, okay. So VIKOR

method allows you to work within that band, that is the advantage of the VIKOR method, okay.

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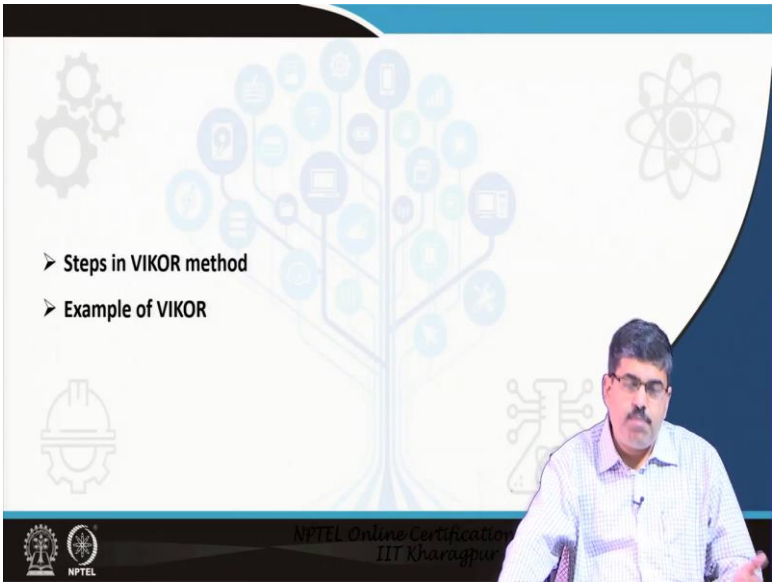

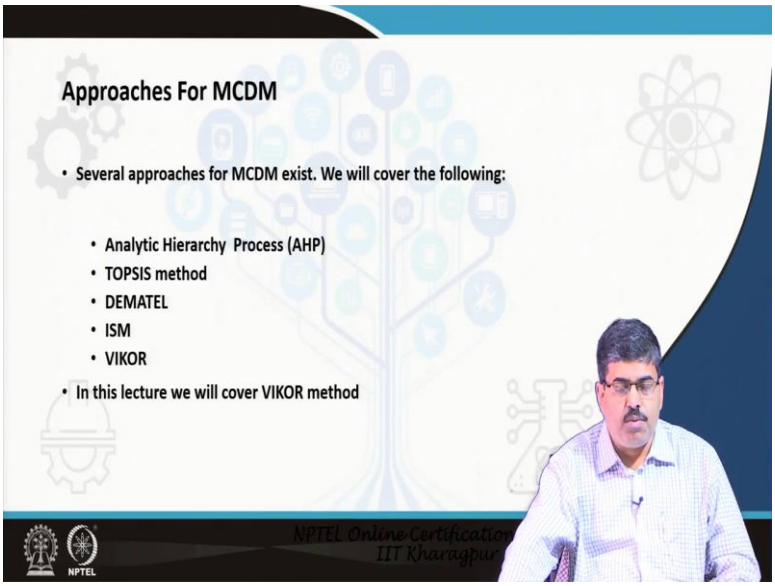

Now, so what is, so we will come to the steps in VIKOR as we move about, okay. As we, just a brief recap we had AHP, we have TOPSIS, we have ISM, we have VIKOR and of course there is another method called DEMATEL. In this lecture we will cover VIKOR method we will continue with the VIKOR method in the next lecture also, portion of it, okay.

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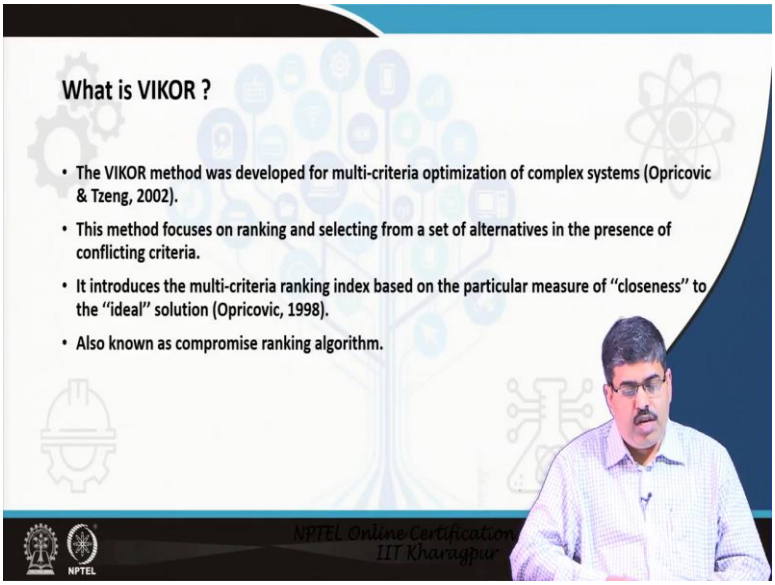

Now as you see the VIKOR method was developed for MCDM optimisation of complex systems. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. Now that last word, conflicting criteria is the key differentiator between the VIKOR method and the earlier methods, okay.

It introduces the multi-criteria ranking index based on closeness to the ideal solution, okay. Now remember, when we have done supply selection models there also we used LP method, the Linear Point method, and we tried to find out what how far you are from the ideal point, okay. Ideal value was taken as 1 okay.

So here, it introduces the ranking index is based on the particular measure of closeness to the ideal solution. And so, because as we said that human beings are not always pinpointed that I need this, I need that, it is a compromised ranking algorithm, okay. But most importantly, the second bullet point, that is it is a set of alternatives in the presence of conflicting criteria.

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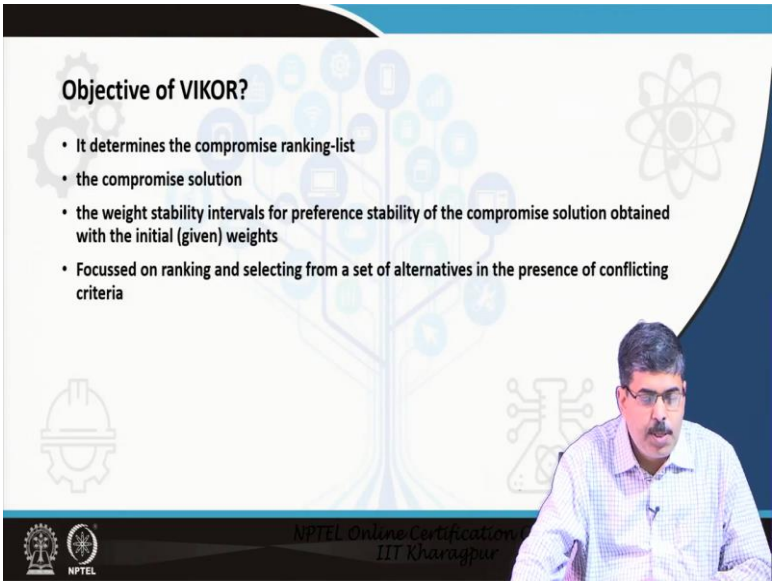

What is the objectives? It determines the compromise ranking list, okay. Now, and it gives us the compromised solution and the weight stability intervals for preference stability of the compromise solution obtained with the initial given weights. So you have given, you are started off with the weight or importance and then it also gives you the weight stability intervals for the preference stability.

Then, focusing on the ranking and selecting from a set of alternatives in the presence of conflicting criteria. As we said this word conflicting will come to you regularly. You do not worry about it, when we solve one example you will see it is very, very easy. See, all multi criteria decision-making models are very, very easy. It is not physics, it is not chemistry, not too many formulas, it is very easy. Only thing is that you will have to keep yourself confident that I can understand, okay. Nothing is non-understandable, right. So, focusing on ranking in the presence of conflicting criteria, okay.

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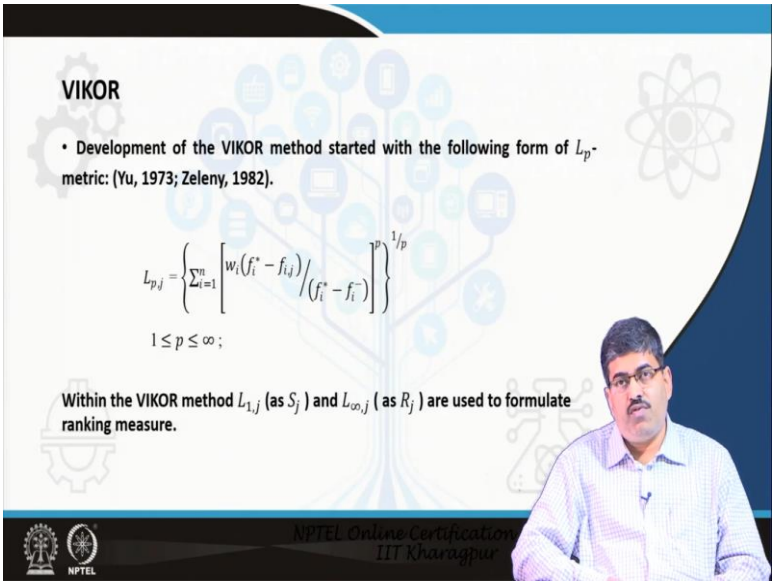

Now, development of the VIKOR methods starts with the following form of Lp matrix, that is weight if you look at it very carefully into fi, there is a value at that particular cell, highest value, minus fij divided by fi star minus fi minus, okay. Into to the power p to the power 1 by p. Now forget all these things. What is fi star? fi star is the value at a particular cell, right. Sorry, fi star is the highest value, sorry, fij is the value at a particular cell, ith row and jth column, okay. fij is the ith row and jth column.

Now, f star, fi star is the highest value, okay for that particular column and fi minus is the lowest value in that column okay. So highest and lowest values. This is your formula. Now within the VIKOR method, we will use to formulate the ranking measures. Do not worry about these terms when we explain you will understand. So up till now just know what is fi star, and what is fij, and what is fi minus. fi star is basically the highest value in that column, fi minus is the lowest value in the column and fij is that particular value, okay.

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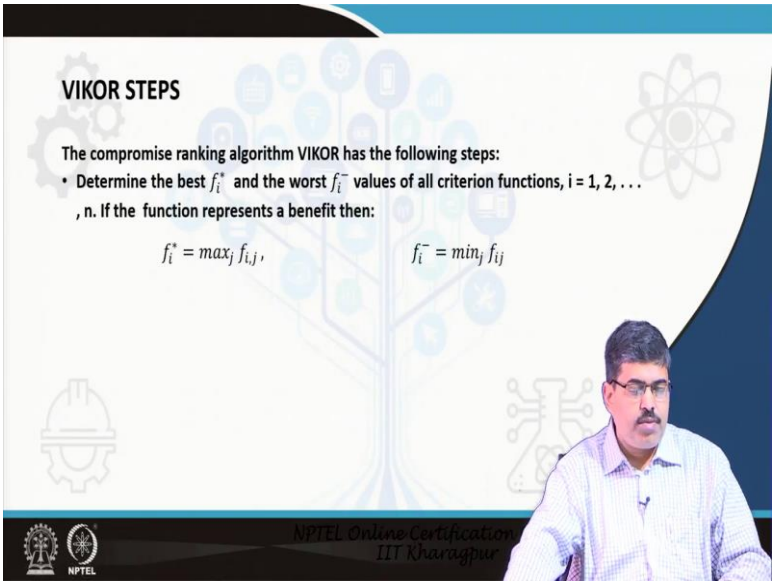

Now, the compromised ranking algorithm has the following steps. Determine the best fi and the worst fi, that is determine the highest values of the f stars and the lowest values of all the f minuses, okay. So fi star is as you see max and fi minus is the min, okay.

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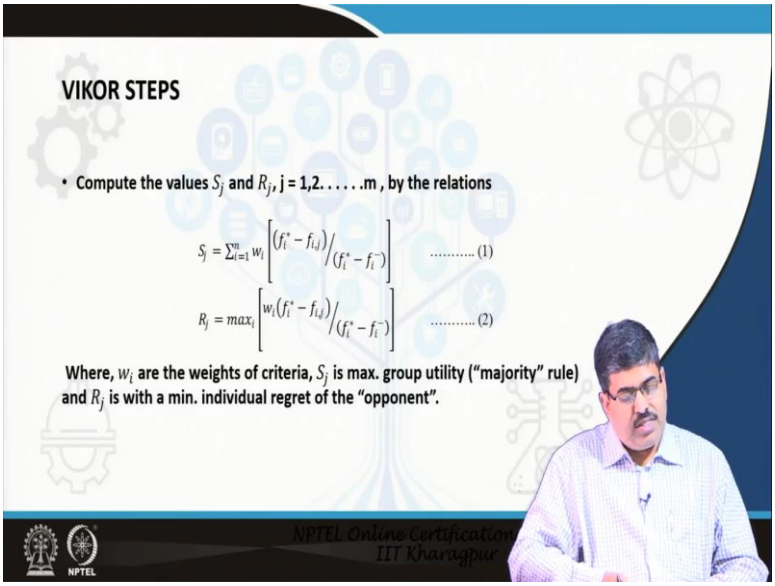

And then compute the values of Sj and Rj, you see what is Sj and what is Rj? Sj is basically the highest minus cell value divided by the range multiplied by the weight, and Rj is the regret option as the opponent which is again the maximum value of the weights multiplied by this situations. The only difference lies in here, only difference lies in here, okay. Other one was, weight is multiplied by the entire thing, this one is weight is multiplied by the individual variables, the numerator, okay.

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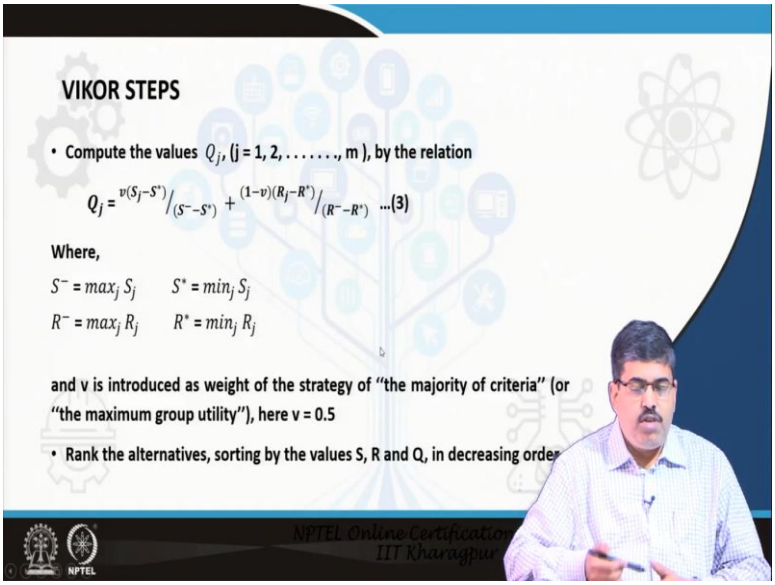

Now compute the values of Q okay, and Q formula is given by this, Sj minus S star, okay. And so what you get is S star is max j and S star is min Sj, okay and R minus is max Rj and R minus is the min j. v is introduced as the weight of the strategy, okay.

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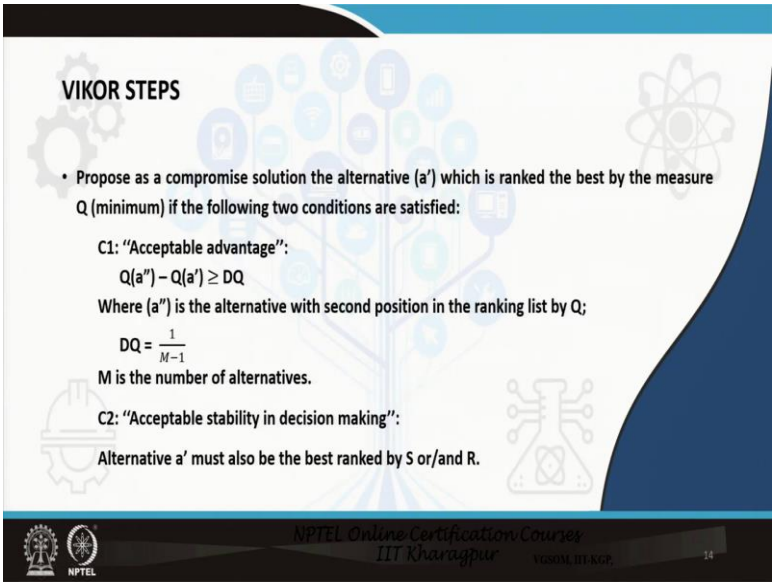

Now C1 is the acceptable advantage range, okay. Now, let us go to this, okay. Let us look at this problem.

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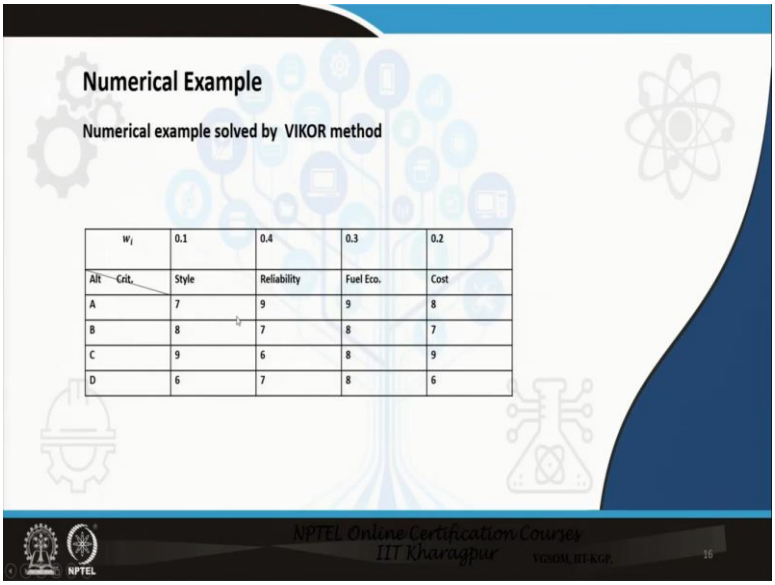

An individual, so we will come back to the formulas, do not worry. Numerical examples solved by VIKOR method. Let us see, now we have, we are buying something, we are planning to buy something. What are the criteria that we have chosen? Criteria that we have chosen is style, reliability, fuel economy and cost, okay. Now, and we have, there are four alternatives, A, B, C and D.

So there are basically 4 products A, B, C and D and each product we are measuring on four criteria that is style, reliability, fuel economy and cost. Four products, four alternatives A, B, C, D and we are evaluating on the basis of four criteria, style, reliability, fuel economy and cost, okay. Now, and weights also we have given. See on the top, the top row that is 0.12, 0.4, 0.3, 0.2, okay. So this is we have given.

Now, and customers have been asked to rank or you are yourself ranking that is a style you have given a 7 to product A, product B has the style score of 8, so product B is much more this thing. Product C has 9 and product D has 6, okay. So what is S asterix? S star is basically highest value, that is 9, okay. And what is the lowest value in that column? 6, right. The 7, 8, 9, 6, what is the highest value? 9. What is the lowest value? 6, okay.

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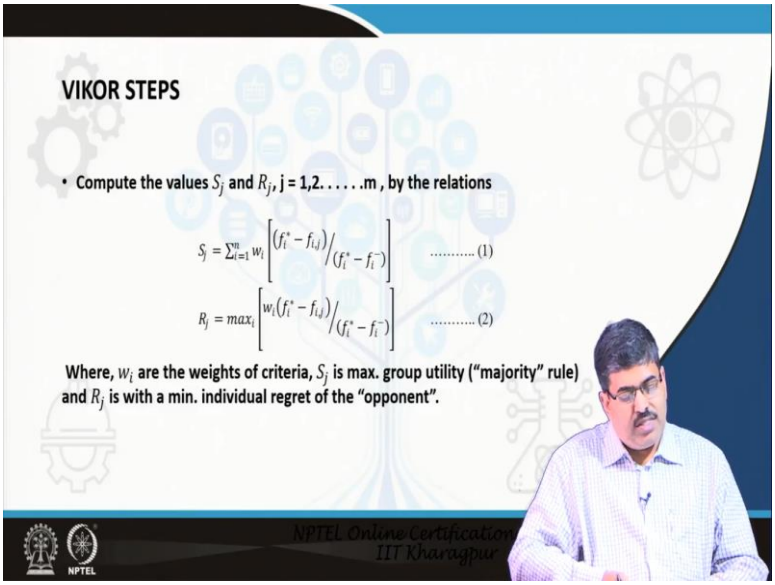

Now, so this 9 minus 6 is your range, okay? So let us go back to our old formula, let us go back to our old formula. Here, you see, fi star minus fi minus. fi star is what, the highest value, and fi minus is the lowest value. So what is your range now? Your range now is highest value minus lowest value that is 9 minus 6 that is 3, okay. Now what is, let us go back, let us go back. That is why I said you ignore the formulas for some time, we will come back, okay.

What is, so we have got fi star, highest value, we have got fi minus, lowest value, what is fij? fij is the value at that particular cell. So in this problem what is the fij value? In this problem, the fij value is 7, okay. So 7, just remember these three numbers 7, 9 and 6. 7, 9 and 6, right. So let us go back to the formula. fi star is highest, so 9 minus fij is 7. 9 minus 7 is 2 divided by 9 minus 6, 3. So 9 minus 7, 2 divided by 9 minus 6, 3. So 2 divided by 3 is 0.66 multiplied by weight of that particular cell, okay. So in this way we calculate it, right.

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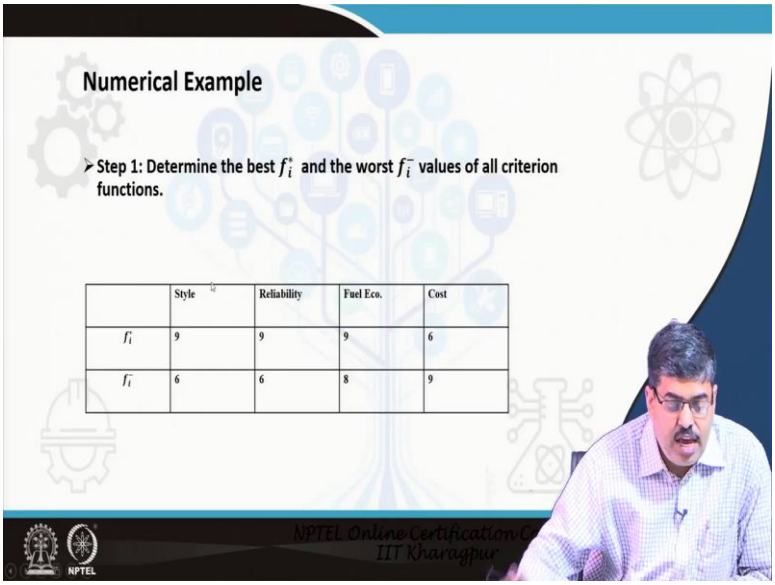

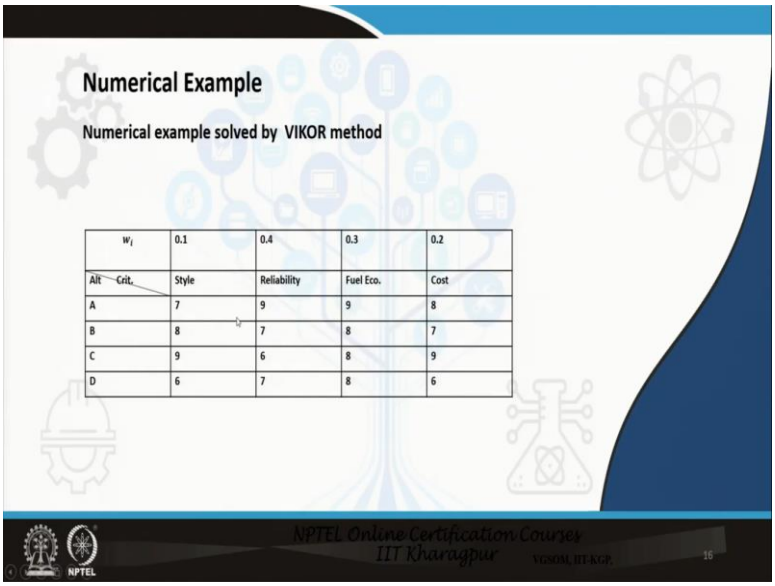

So if we look at it, we have just given that here, fi star is 9 and fi minus is 6 for style. Let us go to reliability. Reliability what is the highest value? 9. What is the lowest value? 6. Again, same, 9 and 6. Let us go to fuel economy. 9 is the highest value, 8 is the lowest value. So see 9 and 8. Let us go to cost. 9 is the highest value, 6 is the lowest value. So again, this is that. So this is your fi star and this is your fi minus, right. This is your fi star and this is your fi minus, right, okay.

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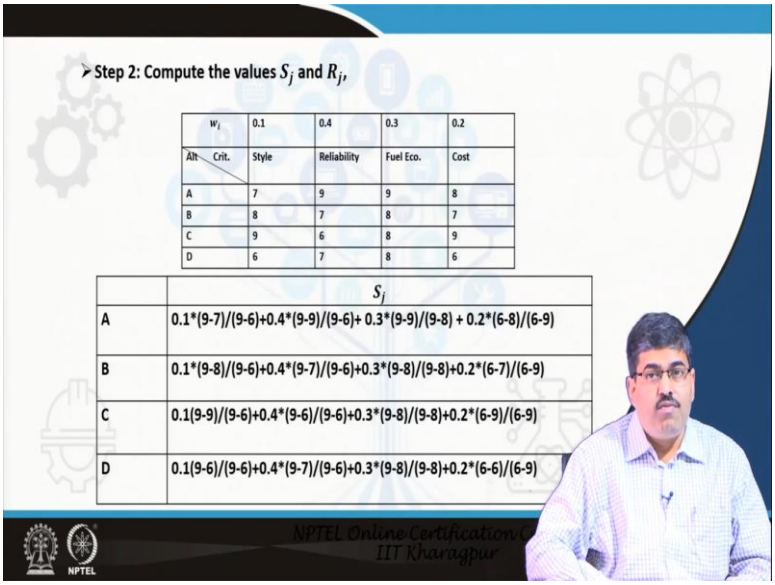

Now, compute the values of Sj and Rj. Now this is what we were talking about, right. 9 minus 7 that is 2 divided by 9 minus 6 that is 3 multiplied by 0.1. So in this way you get this score for this entire row, right. You get this score for the entire row. Now same is with your B, same with C and same with D, okay. Are you getting it or shall I explain it to you once again?

Now you see, here what is happening. 9 minus 6 is this one, the range. Highest value fi star, 9, cell value fij, 7. So fi star minus fij, 9 minus 7 divided by range. This whole thing multiplied by weight plus again, 9 is the highest value, 6 is the lowest value, this is the range, okay. Highest value 9 minus cell value 9, so 9 by 9, weight is 0.4, okay. So 0.4 into fi star minus fij divided by fi star minus fi minus so this range.

So what will be the computation for this? 9 minus 9 is zero so when you do anything whatever you do with 0, this portion, this second column, this thing is zero. Similarly, for here also, highest value is 9, this cell value is 9, so this 9 minus 9 becomes 0 so this entire portion, entire product is 0. So this value plus 0, plus 0, plus, again highest value is cost. This is the opposite criteria, just remember this, this is the max and min criteria, so be very careful about it.

So 6 minus 9 by 6 minus 8, okay, this is the opposite, right. You always want to maximise the style, maximise reliability, maximise fuel economy, but you want to minimise cost so this number gets changed, this number is not now in anyway the highest value minus the cell value. It is the lowest value minus the cell value, so be very careful about this. So this is A's score. Similarly you have B's score, C's score, D's score, right. Okay.

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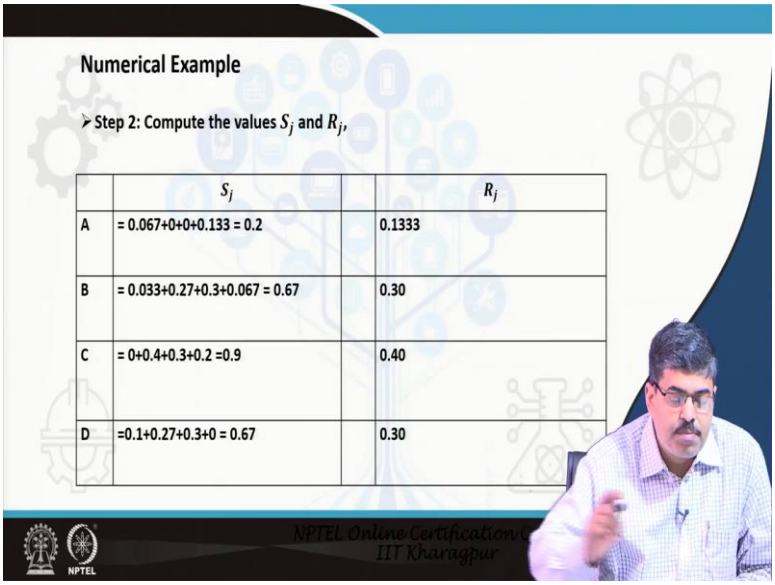

And then, so once you do that this A has 4 columns, remember. Just go back to the previous one, A had 4 columns, 1, 2, 3, 4, okay. A is style score, reliability score, fuel economy score, cost score. So reliability was 0 score, fuel economy was 0 score, so we only had this value and this value. That is what is shown here. This is the first column 0, this value, this value and the middle ones are 0 and 0. So A's score is 0.22, okay. A's score is 0.22, right. Okay, A's score is 0.22.

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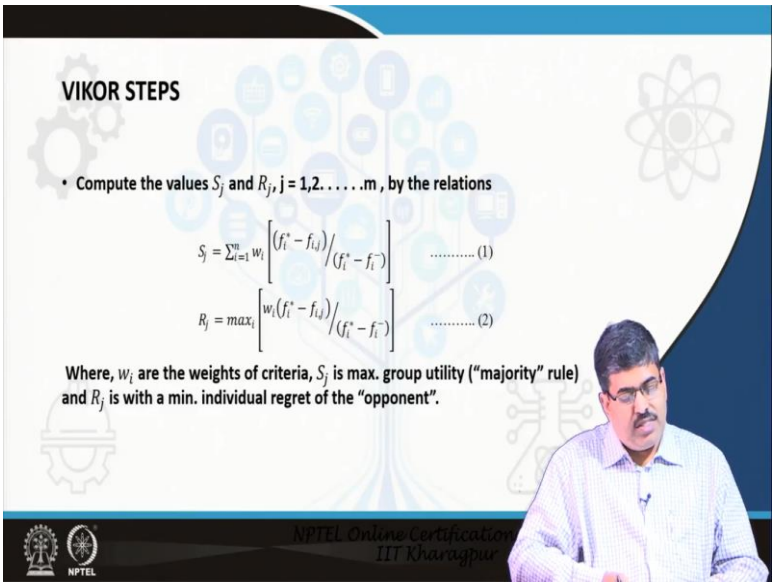

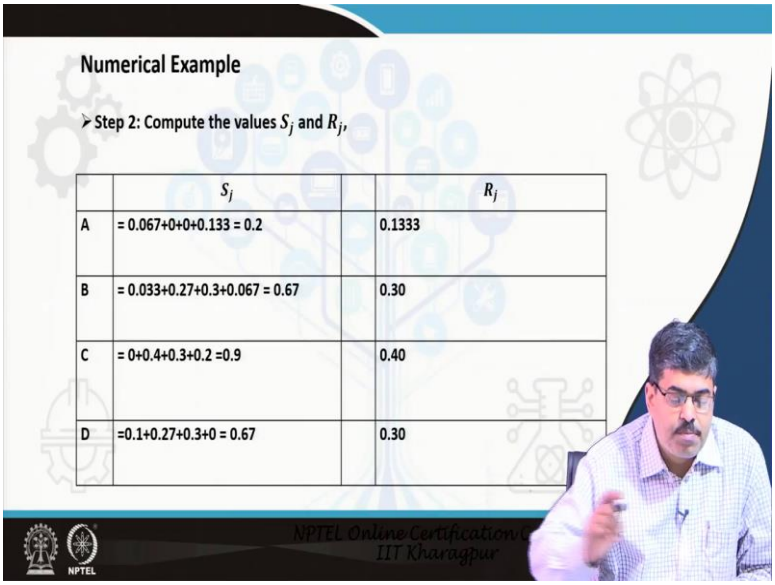

Similarly, what you can do is you can compute Rj values, okay. You can compute the Rj values. Same way you compute it and Rj will give you the max values of it, right. See in this, this part is clear, I hope. I hope this part is clear, okay. This is the multiplication. Now, among these, what is the lowest value? The difference between the ideal and the cell values. 0.133, this is your Rj.

Among these what is the lowest value? What is the lowest value? That is… sorry, I beg your pardon, what is the highest value? This is your Rj, okay. What is the highest value here, in this way? 0.3, 0.3. What is the highest value here? 0.4, 0.4. What is the highest value here, that is 0.3, 0.3. So in this way you calculate the Sjs and the Rjs, okay.

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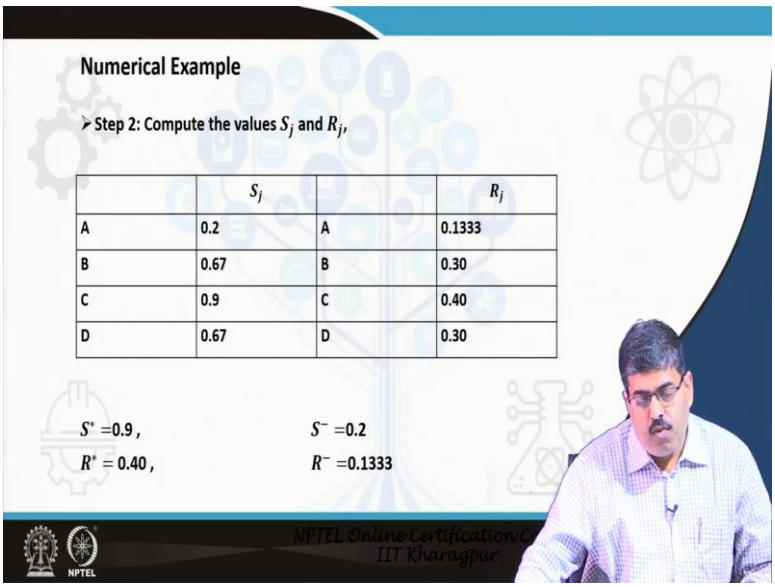

Now, once you have computed the value of Sj and Rj what you get is, you get something called S star, that is the highest among these, and you get something as S minus that is the lowest among these. The highest among Sj is your S star and the lowest among Sj is your S minus, and similarly, your highest among R star is this one, and lowest among R minus is this one, okay, lowest among Rj. So basically you get the highest value and you get the lowest value, okay.

Once you have done that you need to calculate something called Qj and once you have got this Qj you get the final values of Qj within using those formulas, okay. Now, what we will do is we will pick up from here in the next lecture session, okay So up till now what we have done in this lecture session is, we have identity, see always you need to know why I am doing or why I am using a particular method. Why?

If there are two, three methods available, why I am using a particular method? If the methodology is same also, why I am using method one instead of method two, what extra benefit is it giving me? So in that light we learnt AHP with professor Kunal Ghosh, we learnt TOPSIS with professor Kunal Ghosh and now you are learning VIKOR. What is the key difference among them?

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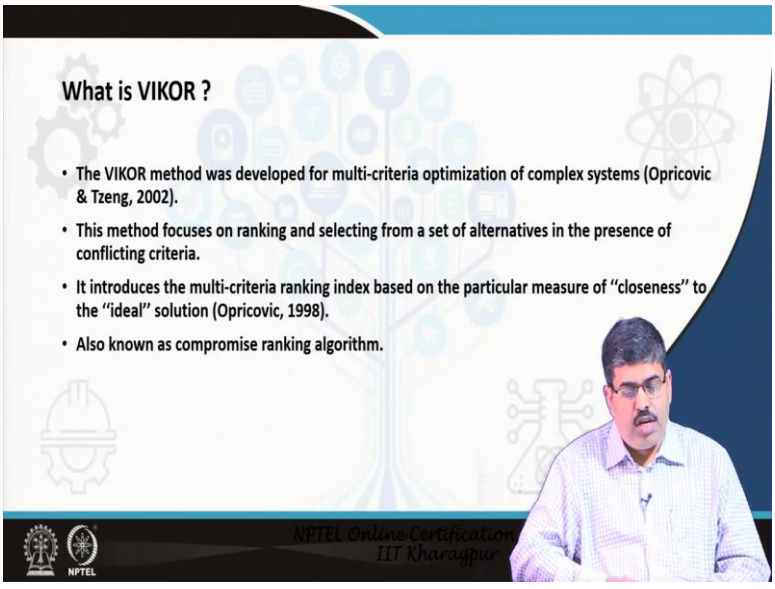

VIKOR, as we know, we had showed you in one point that is VIKOR helps you to get these conflicting criteria, that is the second point. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria, okay. So this VIKOR gives you this conflicting criteria. So how to go about it?

First, find out, as simple as just like your normalization that we did earlier in the same way you keep on doing this normalisation, okay. And then, once you have normalized it, get the distance from the ideal point, and we came up to this point, okay. Now, next is we come with something called a Qj value, okay. Now this Qj value onwards, we will take up in the next lecture session, okay.

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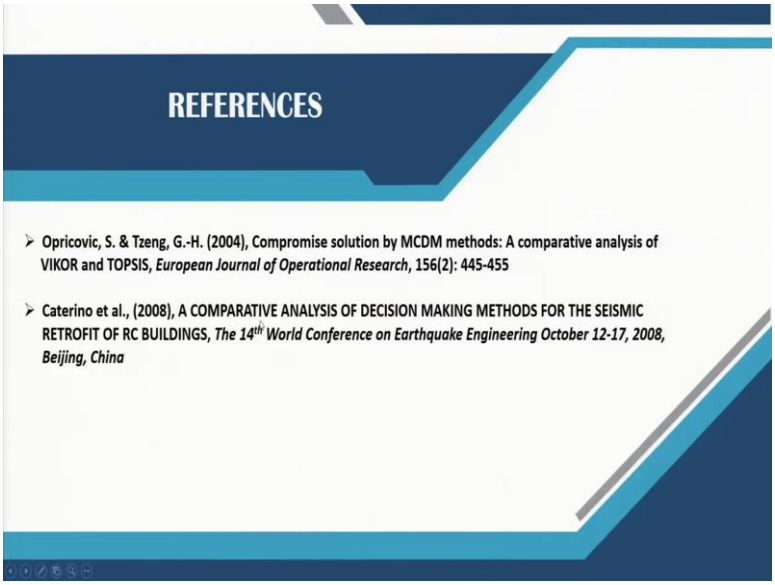

So for this up till this, you can use this reference. Particularly, we will use this particular chapter you may use for VIKOR and particular book also you may use for VIKOR, so we will pick up this with next one in the next class. Thank you.