Modelling and Analytics for Supply Chain Management
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Lecture 41- Technique of Order Preference by Similarity to Ideal Solution (TOPSIS) Method

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Hi, welcome to our course on Modelling and Analytics for Supply Chain Management. In this lecture number 41 of module 9, we are going to cover another multiple criteria decision-making technique, popularly known as TOPSIS. TOPSIS stands for Technique of Order Preference by Similarity to Ideal Solution.

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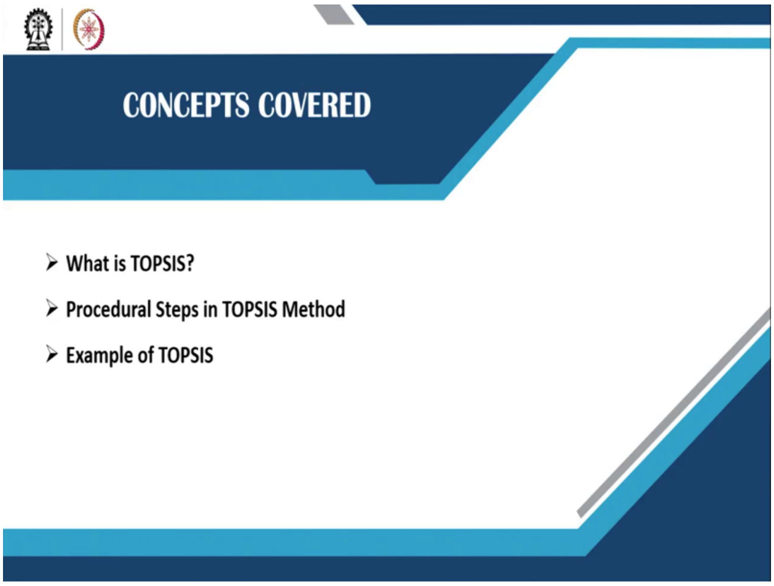

So the concepts covered is, what is TOPSIS? The procedural steps in TOPSIS Method and one example of TOPSIS.

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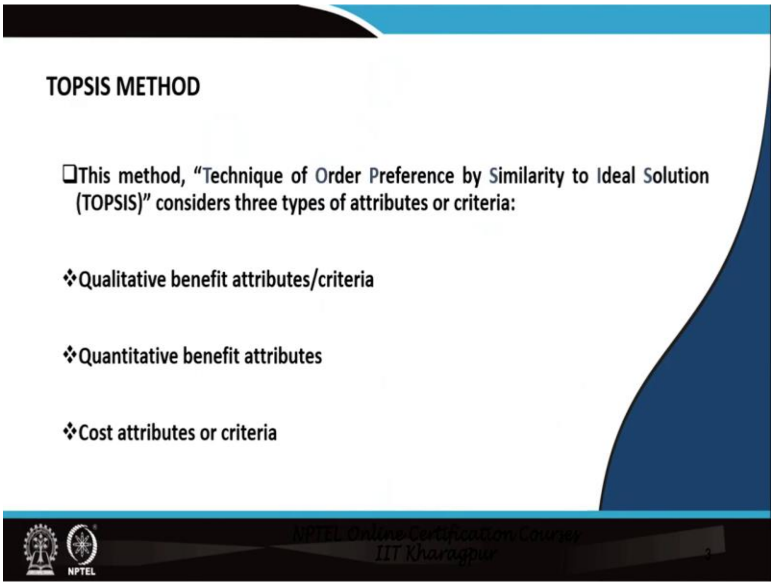

This method, technique of order preference by similarity to ideal solution considers three types of attributes or criteria. First one is the qualitative benefit attributes or criteria, second one is the quantitative benefit attributes and the third one is cost attributes or criteria.

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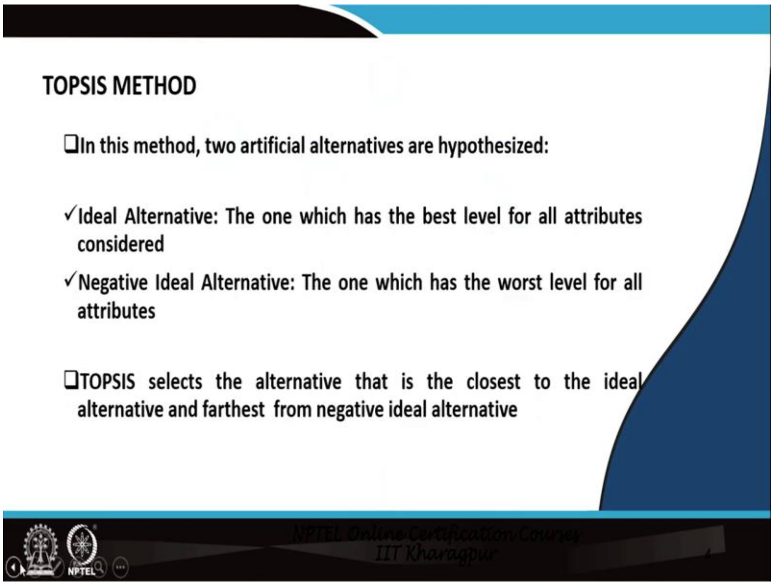

In this method, what we do? Two artificial alternatives are hypothesized. One is the ideal alternative, that is the one which have the best level for all attributes considered. And the other hypothesized alternative is the negative ideal alternative, the one which has the worst level for all attributes. And TOPSIS selects that particular alternative, which is closest to the ideal alternative and farthest from the negative ideal alternative.

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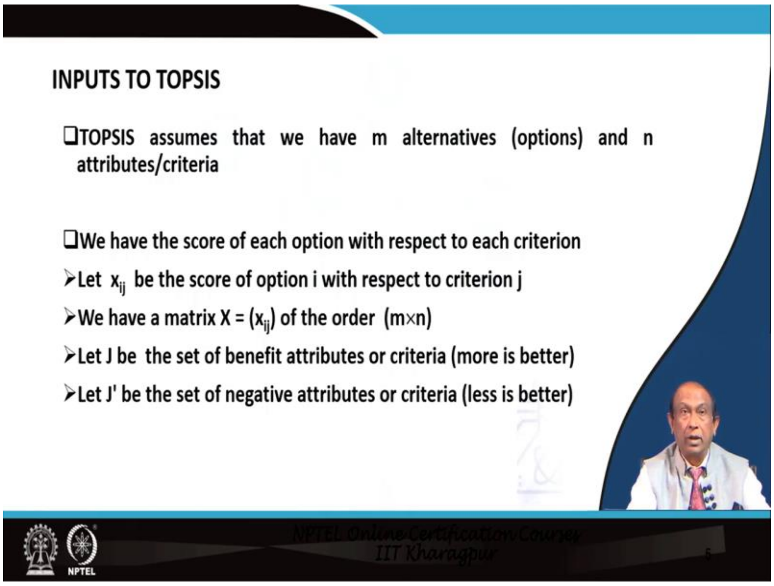

TOPSIS assumes that we have m alternative or options and n attributes or criteria. And what we will do here, that we have the score of each option with respect to each criteria. See this will be easily understood if we first take one example.

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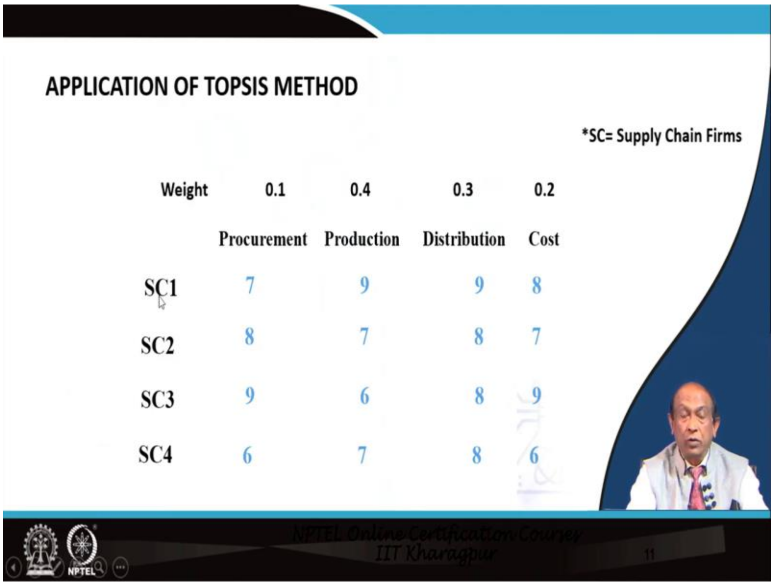

Suppose we have 4 suppliers, supplier 1 which is denoted by SC1 and supplier 2 which is denoted by SC2, supplier 3 which is denoted by SC3 and supplier 4 is SC4. We have to choose the best supplier, which satisfies multiple criteria with respect to say, procurement is one, production is one, distribution is another criteria and cost is another criteria.

Now you see these suppliers will be rated on a scale of 1 to 10 with respect to each of these criteria. For example, with respect to their performance, supplier 1 gets a rating of 7 out of 10 when we consider ease of procurement as one of the criteria. Supplier 1 gets the score of 9 with respect to efficiency of distribution. Like this, the suppliers will be getting a score under each of these criteria.

Now you see here these three, procurement, production and efficiency in distribution, they are basically the benefit criteria and cost incurred for obtaining supplies from suppliers is the fourth criteria which is a cost criteria. And the relative importance of this criteria is given by weightage, the weights associated with the criterias are point 1, point 4, point 3 and point 2 that means production efficiency gets the highest importance then comes distribution efficiency. Like this the relative importance of this criterias are given.

In a real-life situation, these weights can be arrived at by taking expert opinion from four, five experts through some questionnaires or interviews, and then they arrive we can find out the averages of that, their opinion and can determine the weightages. In some cases, the relative importance of this criteria can be arrived at by the same method that we adopted in AHP.

That means we do a pair-wise comparison between these criteria and then arrive at the eigenvector corresponding to that preference matrix to get the relative importance of these weights, okay. So in that case, this particular method can be called a hybrid technique consisting of an add mixture of AHP and TOPSIS. Now in this matrix, these elements are referred to as xijs.

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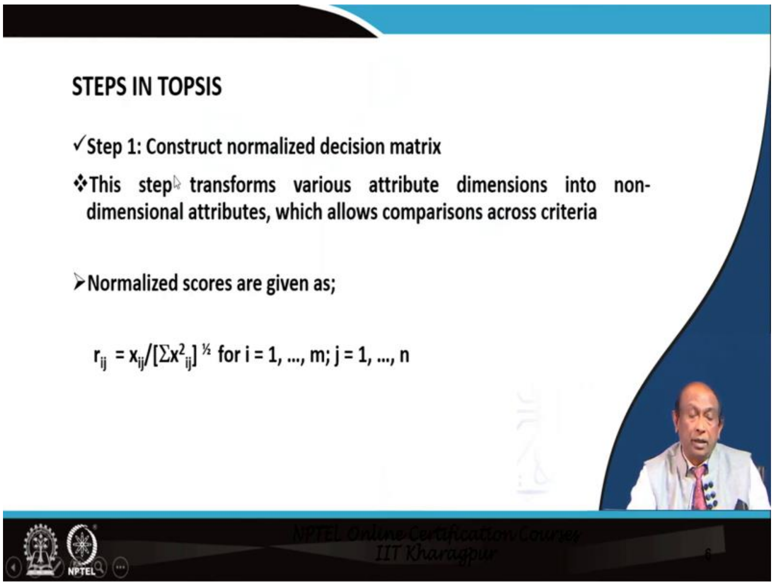

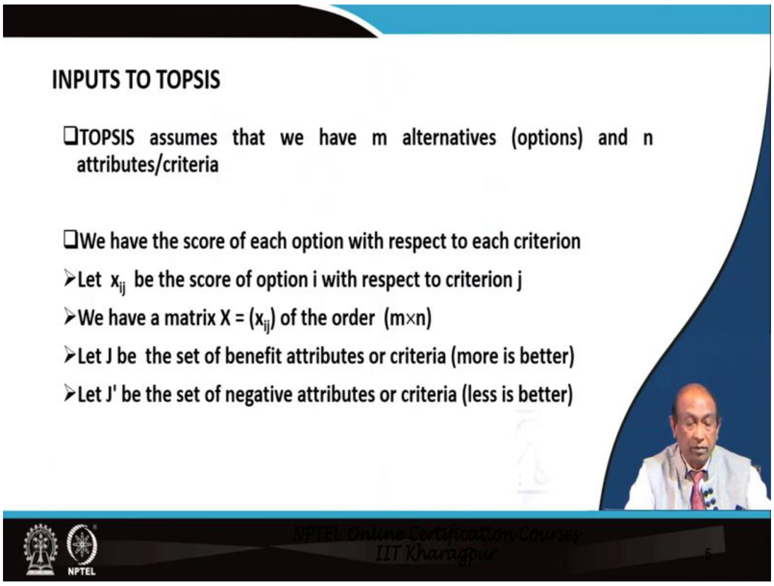

So the first step in TOPSIS is again normalization. So we had got the decision matrix of the order m into n, m alternatives and n criteria, and we denote J is a set of benefit of attributes or criteria with respect to benefit attributes, more the better and let J prime be the set of negative attributes or criteria, the less is better. When you take the example it becomes very easy to understand.

So first thing we have got that matrix. Now, the second thing is we have to normalise that decision matrix. So step 1, construct normalized decision matrix and then what we do, normalization can be done through several methods.

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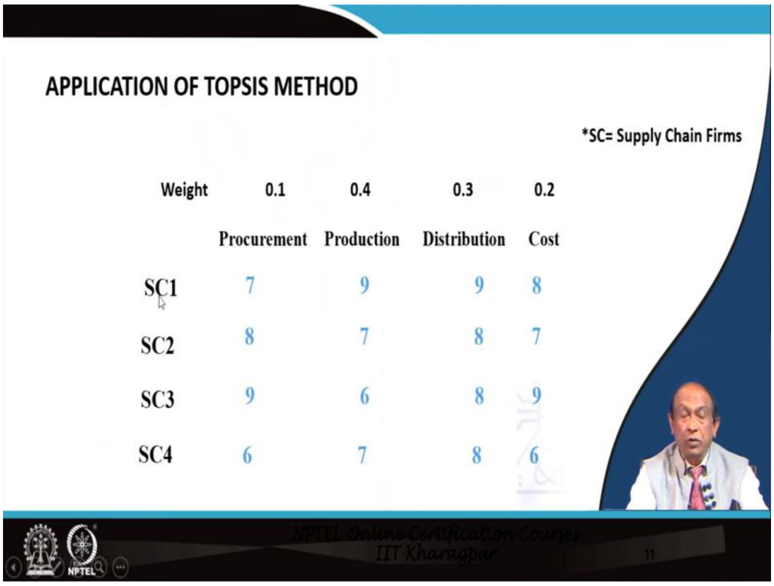

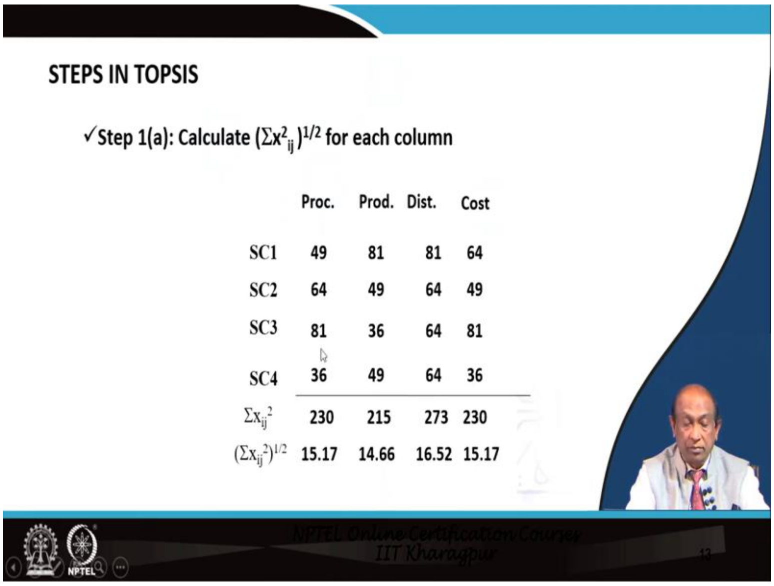

What we do in here is that we first square each of the elements of this matrix, okay. So this particular matrix if you look at it, if you square it up, you will find that we get these values. Next, you compute this column's sum. This column's sum is nothing but sum of the squared elements in this column, which is denoted by sigma of xij square. And then what you do, you extract the square root of this column's sum, which is nothing but root over of sigma xij square. So this value that you arrive at are 15.17, 14.66, 16.52, 15.17.

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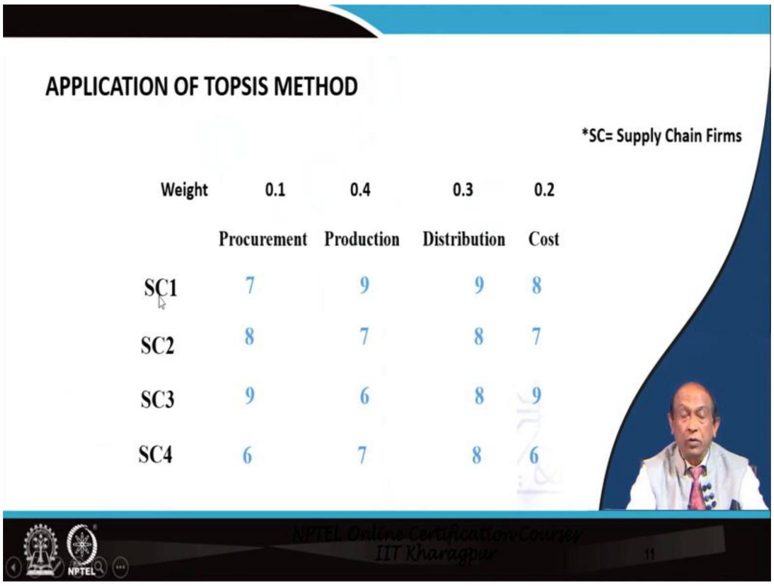

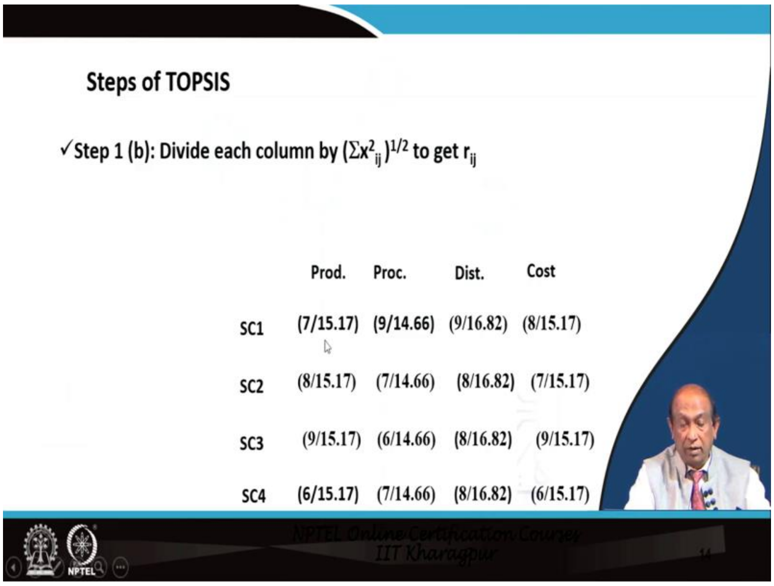

Having done this, when you are going to normalise this matrix, you take each element of this matrix and divide each element by the square root of sigma xij square. So the first element will be 7 divided by 15.17, which is like this. The second element will become 8 by 15.17, the third element will be 9 by 15.17. Like this, after dividing by these values, square root of this sigma xij square, each element of the normalised matrix we denote by rij.

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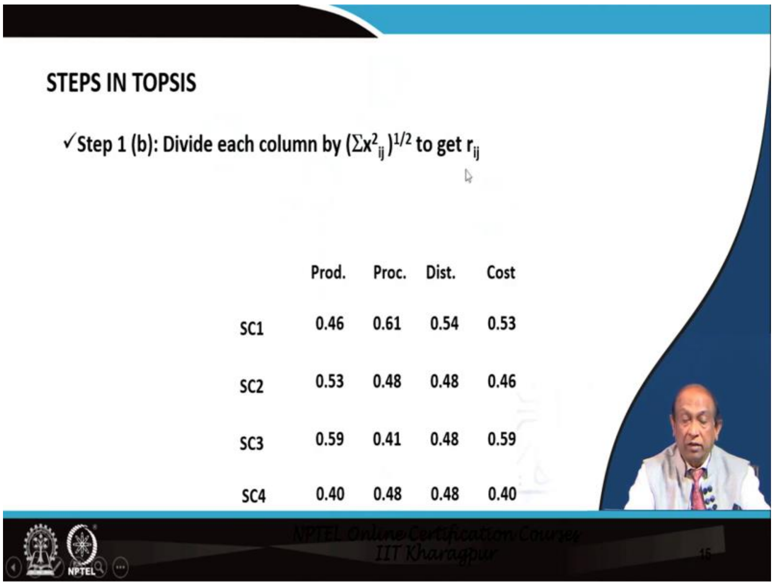

So this rij matrix, this particular matrix, consists of elements, which we denote by rijs, okay. Then what we do is that, we multiply each of these elements in the column by the corresponding weights assigned to those columns.

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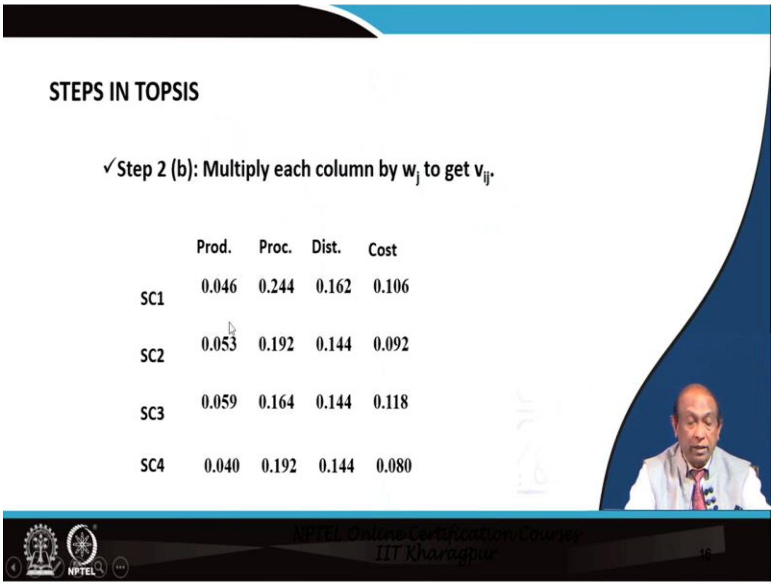

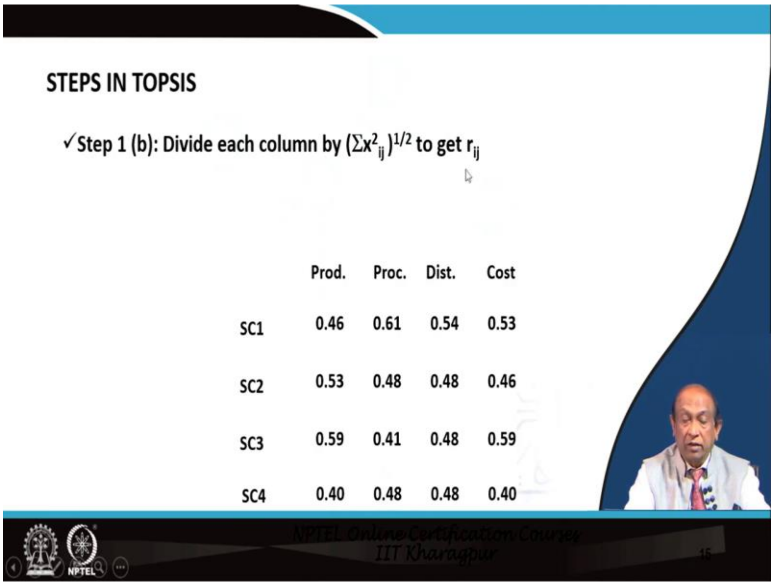

So if you do that, you get this particular matrix. The elements of this matrix we denote by vij. For example, the first element, 0.046 is arrived at by multiplying 0.46 with the corresponding weight of this particular criteria production, which is 0.1 that gives you 0.046. Like this go to this element, how did we get this element? 0.53 multiplied by 0.1 gives you the second element 0.053.

Having done that, now you have to construct the two hypothesised sets that I had told you right at the beginning. One is the ideal alternative set, which we have denoted by J and the other one is negative ideal set. So first, let us see how do we construct the ideal alternative set.

Now, when you are trying to construct the ideal alternative set with respect to benefit criteria, you have to choose the maximum values and because we said the more the better, and with respect to cost criteria you have to select the ones with the least cost. So corresponding to this first column, first benefit attribute we get 0.059 as the first element of that hypothesised set which is the ideal alternative. The second element of that set will be 0.244. The third element will be 0.144. And with respect to this cost criteria, what is the least value? 0.080.

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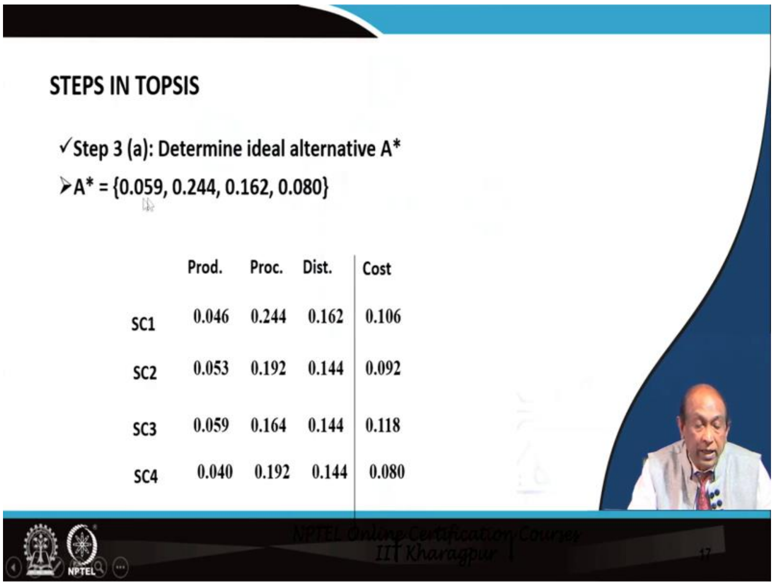

So you see the ideal alternative set is 0.059, 0.244, 0.162 and 0.080. For all the benefit criteria, the maximum values, for example, in this column this one is the maximum, this goes here. For this column this is the maximum, this goes here, for this column, this is the maximum value, this goes here, and for the cost criteria, this is the least value, this goes in here. You have constructed A star as the ideal positive alternative set.

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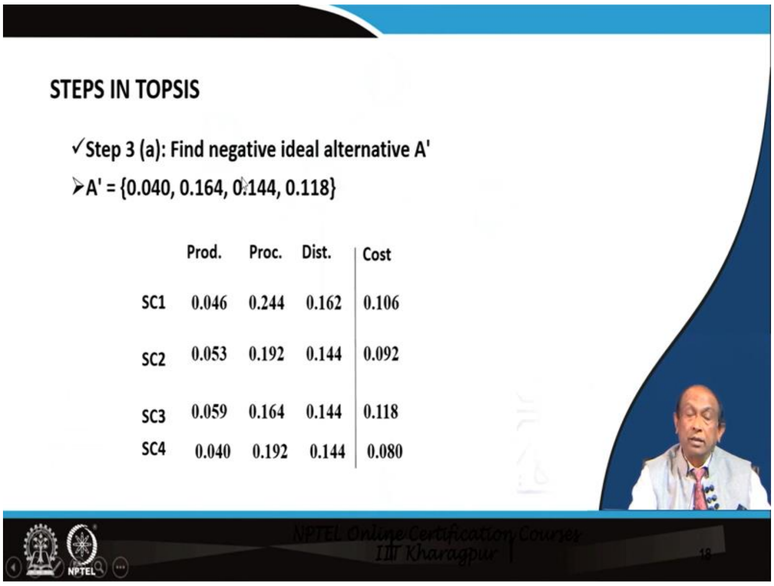

Next, you have to determine the negative ideal alternative then the worst-case solution. And for negative ideal alternative or the worst-case solution, for all those benefit criteria you choose the worst possible value with respect to each of these columns. For example, out of all these values 0.040 is the least in the first column, so the first element of the negative ideal alternative set will be 0.040.

For the next column, procurement, you see 0.164 is the least amount in all these entries so that becomes the second element of the negative ideal alternative. For the third one 0.144 but when you are considering a cost criteria in that case you have to select the maximum value, okay, that is 0.118. Thereby we get the negative ideal alternative set.

Now in TOPSIS, what we do that with respect to each of these set, the scores assigned to supplier 1, supplier 2, supplier 3, supplier 4, each one of them is a set. You have to find out the Euclidian distance of each of the sets from the ideal alternative as well as from the negative ideal alternative. So that Euclidian distance computation is very simple. In coordinate geometry you have learned that way, so what we do?

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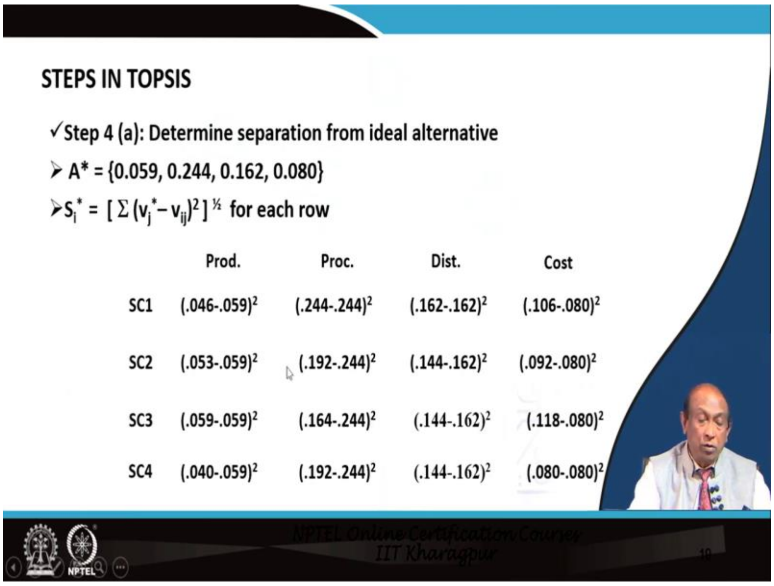

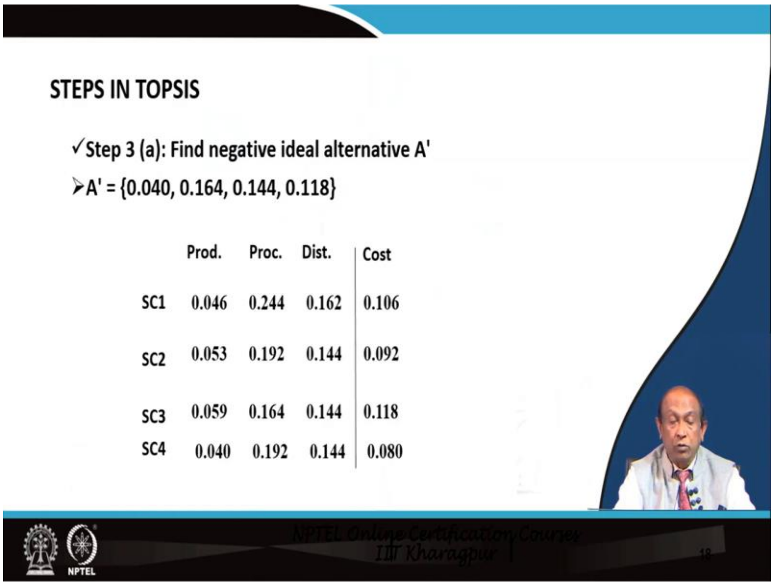

We have to determine the distance or separation from ideal alternative. Elements in the ideal alternative set we denote it by vj star. For example, these are the elements in ideal alternative set, and the vij matrix is already given here. So calculate first the square of the difference between each of these elements vij from the corresponding element in the ideal alternative set.

So for the first, for the supplier 1 for the first element it will be 0.046 because here the value is 0.046 that you subtract from 0.059, make the square. Do it for the second element. Second element in the ideal alternative set, it is 0.244 and in here the value is also 0.244, so what do you do? 0.244 minus 0.244 whole square.

Similarly, for the third column, which is 0.162, okay, that also you determine from minus 0.144. Like this, you determine the, this value will be 0.144, it’s a printing mistake. And no, not this one, this is okay. So this one is 0.162 just let me see. 0.162, yeah, its alright. 0.162 minus 0.162 whole square and for the cost element its 0.106. The difference is from 0.080, you do this. This you do for all the elements with respect to all the suppliers, and then the Euclidian distance is nothing but you add all the squared elements and take the square root.

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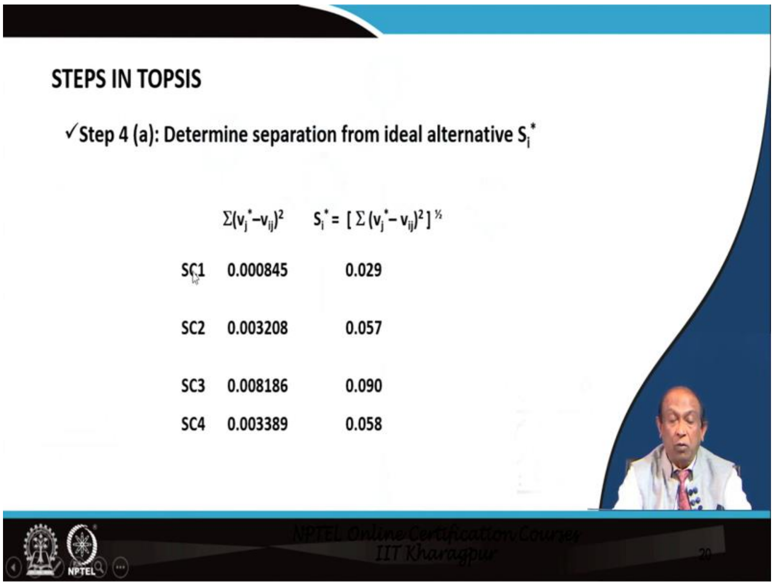

So for the first supplier SC1, the distance from the ideal alternative that is S1 star becomes 0.029. For the second supplier, it becomes 0.57, for the third supplier it becomes 0.090 and for the fourth supplier is 0.058. That is the corresponding distances from the ideal alternative set okay, Euclidian distance.

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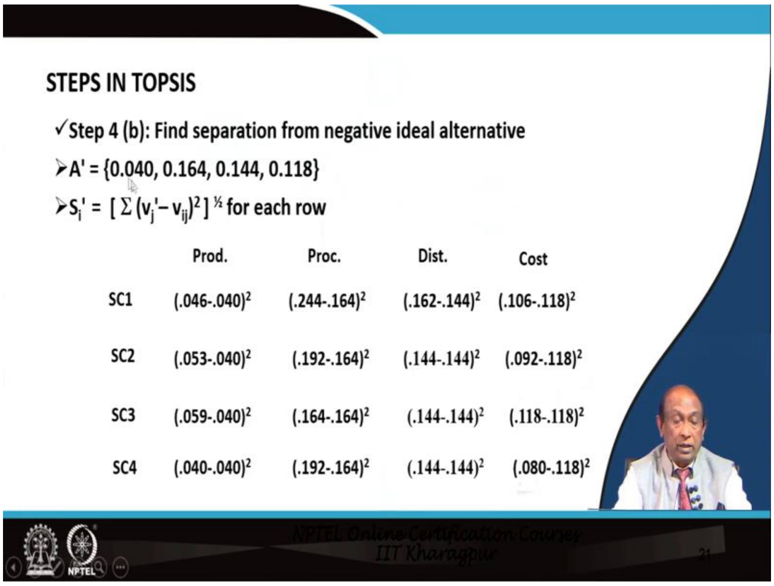

The same thing you have to do it for the negative ideal alternative set and that if we do again, this is the negative ideal alternative set, which we have computed earlier, we take each element and find out the square from the corresponding elements in the negative ideal set.

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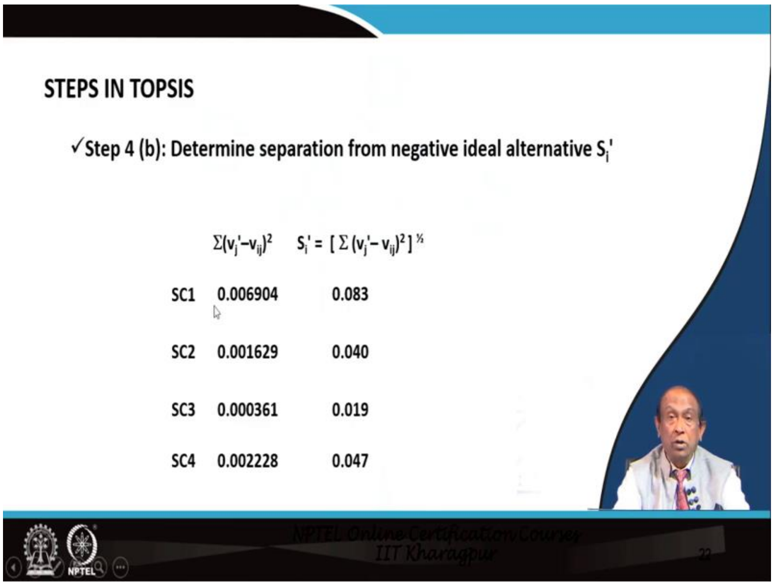

And then similarly, we compute the distance from the negative ideal solutions which is for this is S1 star is 0.083, S2 star is 0.040, S3 star is 0.019 and S4 star is 0.047.

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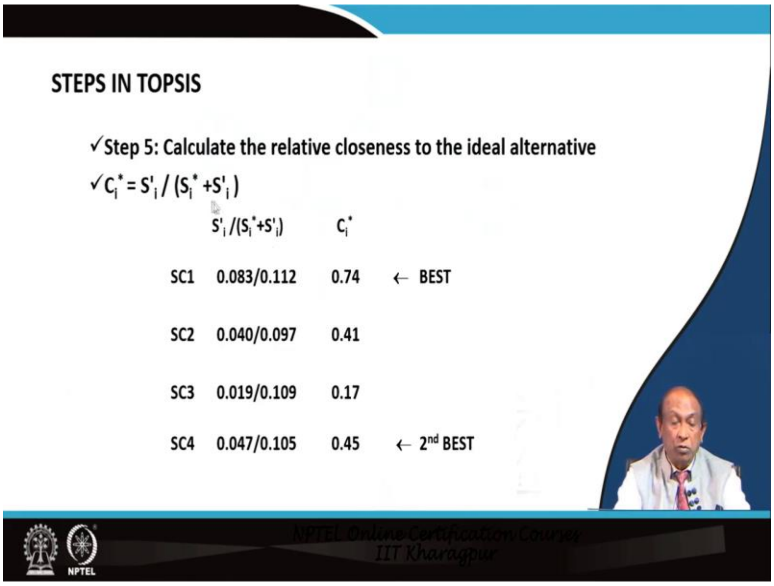

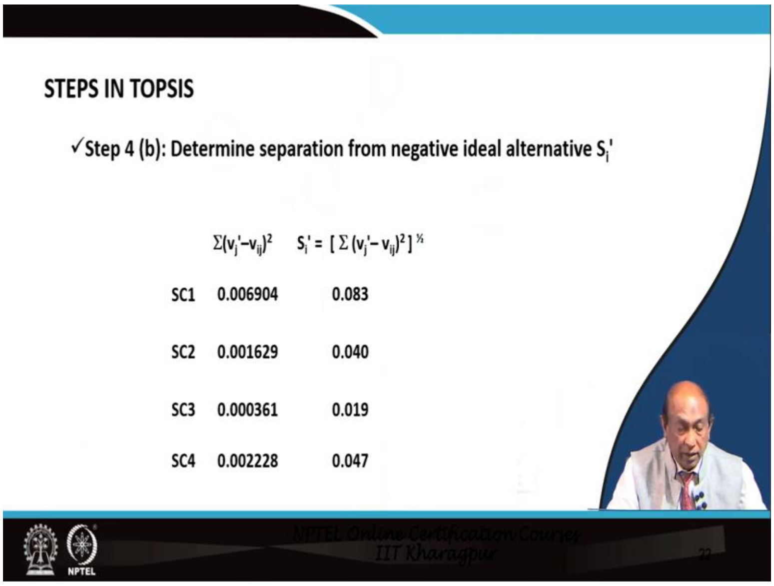

Having computed the Euclidian distances the rest is very simple, what we need to do, we want to compute a ratio, which is Si, this is 0.083 which one that is Si star, okay. That divided by Si star plus Si prime and this we denote it by Ci star. So what are these values? These values represent the relative closeness to the ideal alternative. Why? Because this ratio gives you the farthest distance from the negative ideal alternative, relatively.

The farthest from the negative ideal, you are the closest to the ideal alternative, and this value for the first supplier is 0.74. So the first supplier in this context is the best supplier, this is the next best. This is the third one and this is the fourth one. That means this ratio value will determine which one is the best, the maximum is the better because higher value of this ratio indicates farther the distance from the negative idea, which with a, that it is basically closeness, relative closeness to the ideal alternative.

So this is the technique or underlying essence behind application of TOPSIS method. It has also got lot of applications in industries for selecting the supplier given multiple criteria for selecting the best product, given multiple criteria and similar such applications and in the literature, academic literature you will find various combinations of AHP, TOPSIS which is an hybrid technique. And in real-life the decision makers, they find it not much comfortable when they are asked to do a pair-wise comparison giving precise values.

So there the application of fuzzy set theory has been widely used which gave birth to lot of literature like Fuzzy AHP, Fuzzy TOPSIS, hybrid of Fuzzy AHP-TOPSIS which are somewhat advanced, but for genuine industrial applications this simple technique can give you much better results in terms of cost savings, profitability and things like that.

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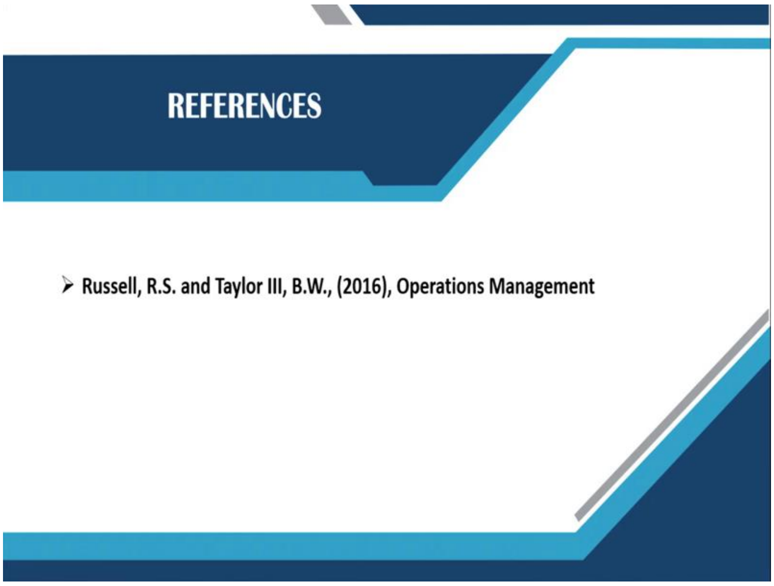

We have again used this particular book as a reference. Thank you, all.