Decision Support System for Managers
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Week – 12
Module – 03
Lecture – 57
Decision Support Systems for Operations Management (Contd.)

Hi, welcome to our 3rd module of the last week on "Decision Support Systems"! We will be discussing today another multiple criteria decision making technique, as part of a modeling tool for DSS related to operations management.

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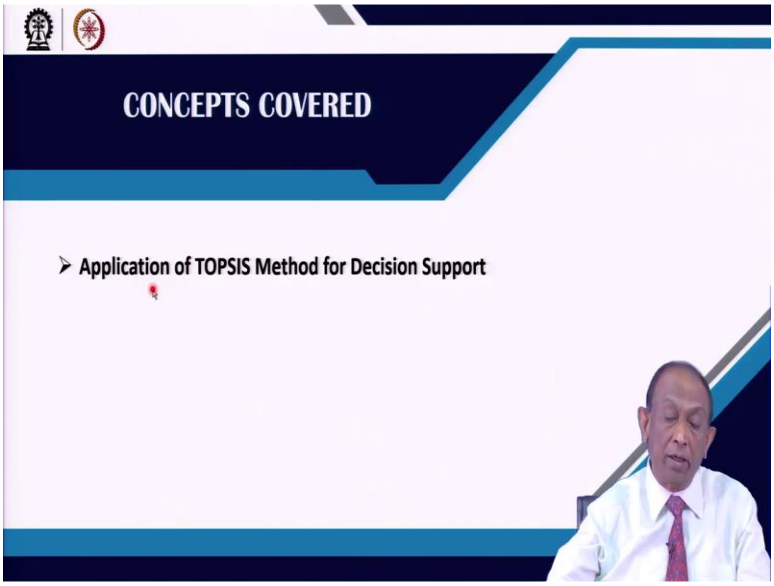

So, today we will be discussing about the application of TOPSIS method for decision support like AHP; TOPSIS is another very popular technique widely deployed in the area of multi criteria decision making.

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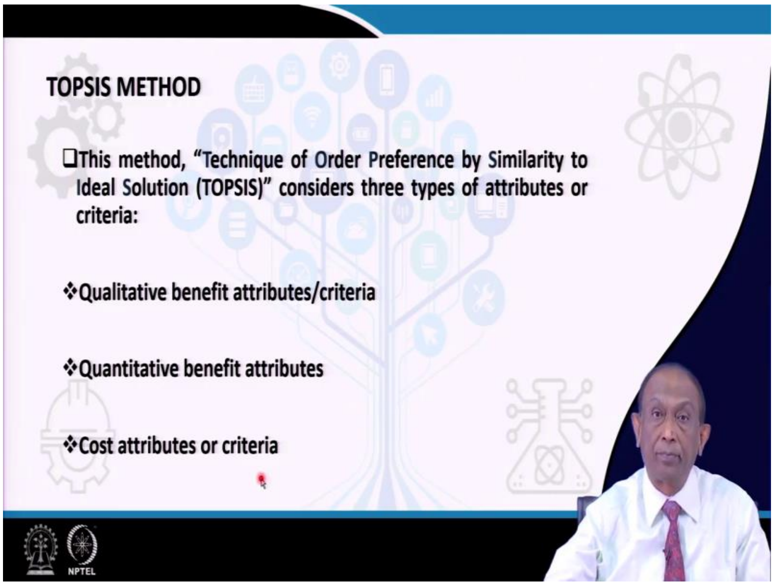

This method technique of order preference by similarity to ideal solution; that is TOPSIS considers three types of attributes or criteria. One qualitative benefit attributes; next quantitative benefit attributes and the third one cost attributes or criteria.

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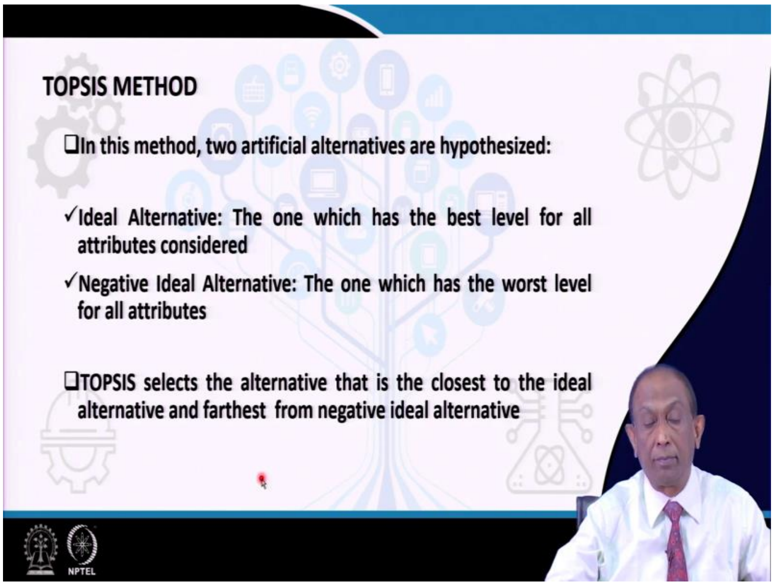

In this method, two artificial alternatives are hypothesized. What are those two artificial alternatives? One is the ideal alternative that is the one which has the best level for all attributes considered. That means, for each of the attributes we consider the best value and this we repeat for all the attributes and thereby, we form a set and each member of that set considers the best level for each of this criteria.

Then we have the negative ideal alternative and the other artificial alternative and what is this negative artificial alternative or negative ideal alternative? It is also another set in which each member has the worst level for that attribute; that means, negative ideal alternative is the one which has the worst level for all the attributes.

So, TOPSIS selects among the given alternatives one which is closest to the ideal alternative and farthest from the negative ideal alternative. So, that means, that particular alternative among the given ones which is closest to the ideal alternative and farthest from the negative alternative ideal alternative is the alternative which needs to be chosen or selected.

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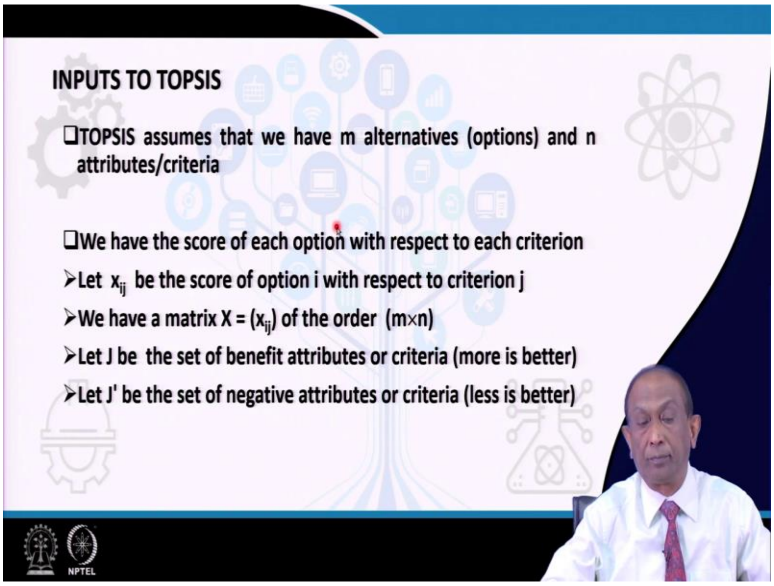

So, TOPSIS assumes that we have m alternatives or m options and n given attributes also known as criteria. So, n number of criterias, m number of alternatives and for each alternative with respect to each criteria we have to first get the score. So, let x ij be the score of option i; option i means alternative i with respect to criteria j.

Since there are n number of criterias and m number of alternatives, we will have a matrix of the order m into n where x ij will be the score of alternative i with respect to criteria j. Now, another thing that we must keep in mind that let J be the set of benefit attributes or benefit criteria; in this case the more is the better. And, let J prime be the set of negative attributes or criteria in which case the less is the value of the criteria that is the better.

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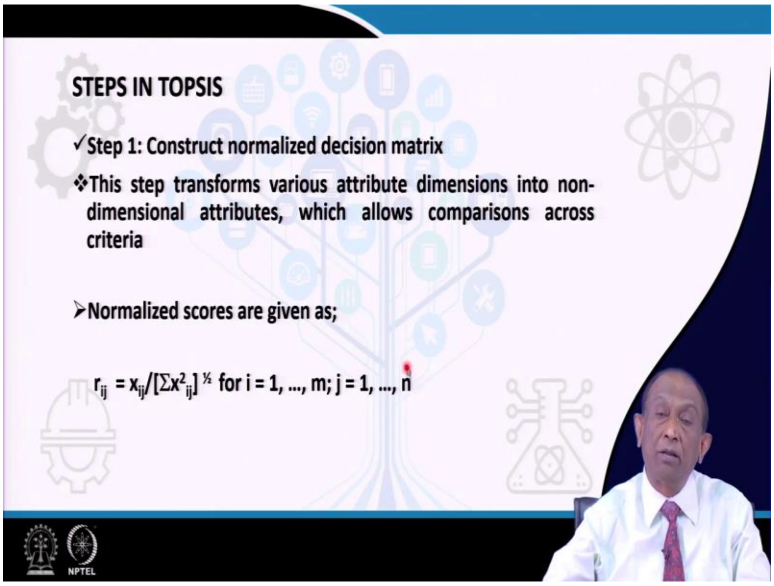

So, first after getting that matrix we have to construct a normalized decision matrix. Why normalization is required? Because each one of this n attributes may have different units. So, until and unless we normalize those matrix to make it unit less the comparison does not make any sense.

So, when we are constructing a normalized decision matrix we are basically transforming various attribute dimensions into non-dimensional attributes that allows comparisons across criteria. So, how do I get the normalized scores? The x ij entries will get replaced by a new entry which is r ij where r ij is x ij divided by the square root of the sum of squared values of x ij's as given by this expression. Now, when we take an example, it will be much more clear.

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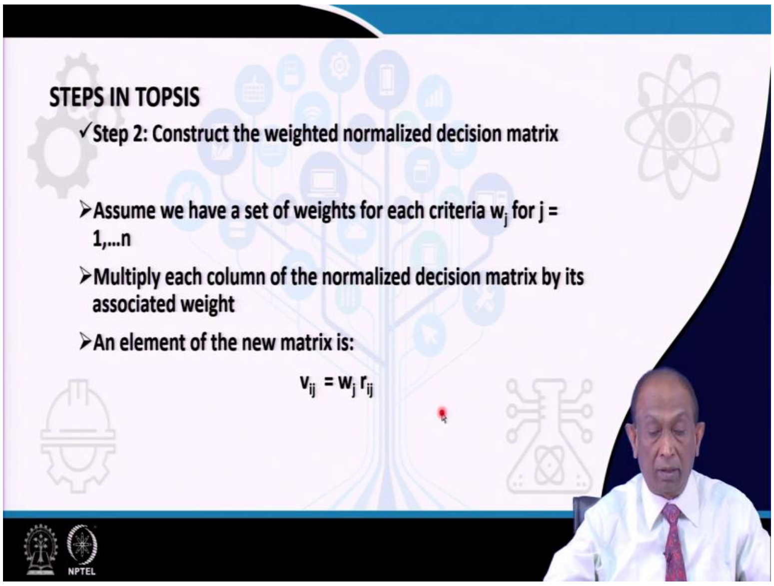

Once we get that normalized decision matrix we have to construct a weighted normalized decision matrix. For that we have to first get the relative importance of each criteria in terms of some weightages applied to each criteria. So, assume we have a set of weights for each criteria w j for j equal to 1 to n; that means, w 1 is the importance or the weight associated with criteria 1; w 2 is the importance or weightage given to the criteria 2 like this for n criteria's we will get n different weights and that will comprise a set.

And, we have the already got the normalized decision matrix. So, multiply each column of the normalized decision matrix by it is associated weight. So, the new element v ij is nothing, but the weight of the criteria j that is w j multiplied by r ij and that will comprise or that will basically form another new matrix which is called weighted normalized decision matrix.

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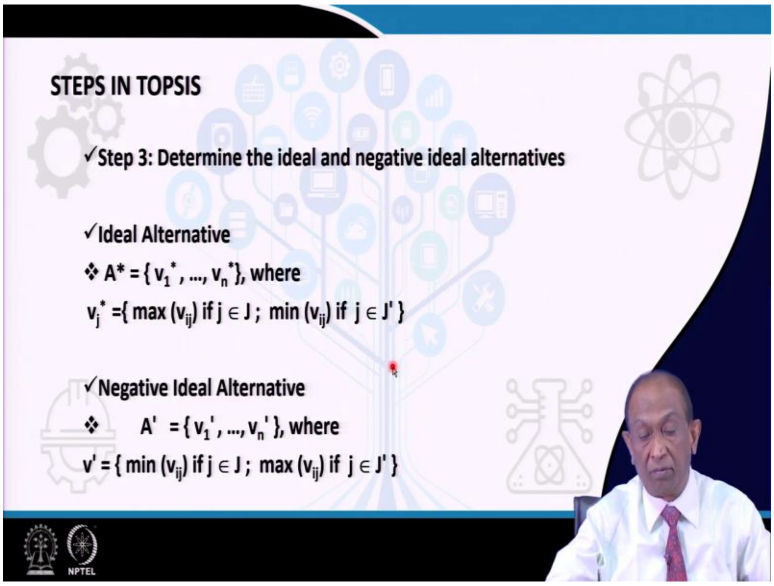

Then from the weighted normalized decision matrix we will form the ideal alternative which is also a set expressed by A star. A star will comprise of elements which are expressed as v 1 star, v 2 star, upto v n star. If we generalized any element here is v j star if that j is a benefit criteria, then this v j star will get the maximum value because we have already said that for benefit criteria the more is the better.

And, if it is a cost criteria, then minimum is the better that way these elements are framed that is the v 1 star, v 2 star, v n star they ideally represent the best possible level for the criteria. Like say for the first criteria v one star is the best possible level. Similarly, we create the negative ideal alternative and denote it by A prime or A dash whatever it may be in here each of these elements they represent the worst possible level for the criteria in question.

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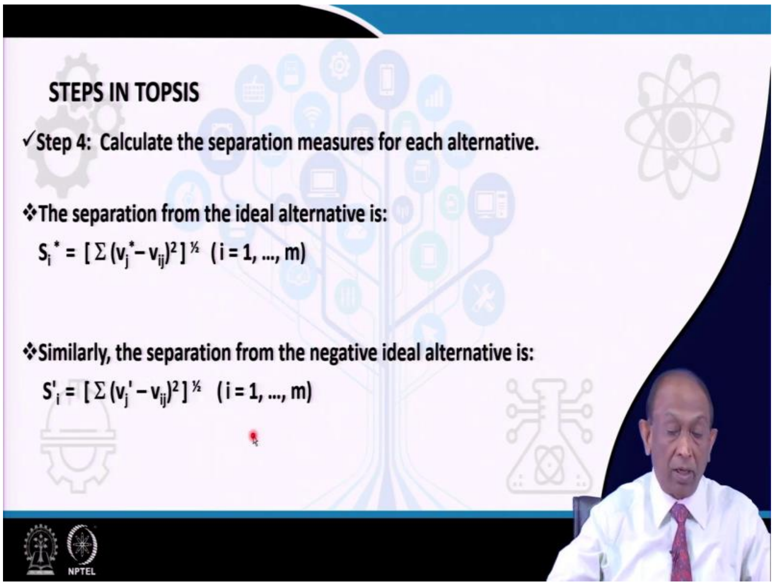

Now, this thing will be very clear when we take one example and once we get this ideal alternative and negative ideal alternative then we calculate the separation measures for each alternative by computing some Euclidian distances. The separation from the ideal alternative is given by this notation S i star where v j star minus v ij whole square this basically is a Euclidian distance expression. Similarly, the separation from the negative ideal alternative is given by S i star S i prime.

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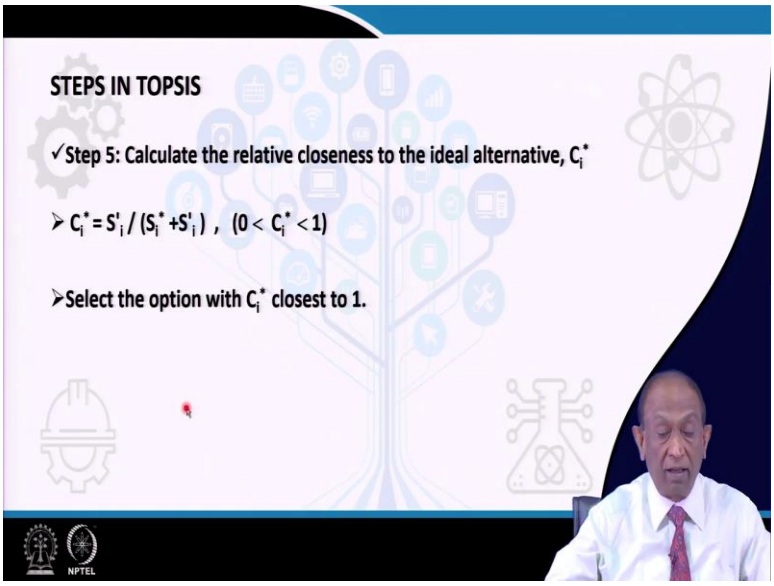

And, once we get this distances then we calculate the relative closeness to the ideal alternative by finding a ratio which is S i prime by S i star plus S i prime and we have to select the option which is closest to 1. Let us take one example otherwise it will become too abstract for you.

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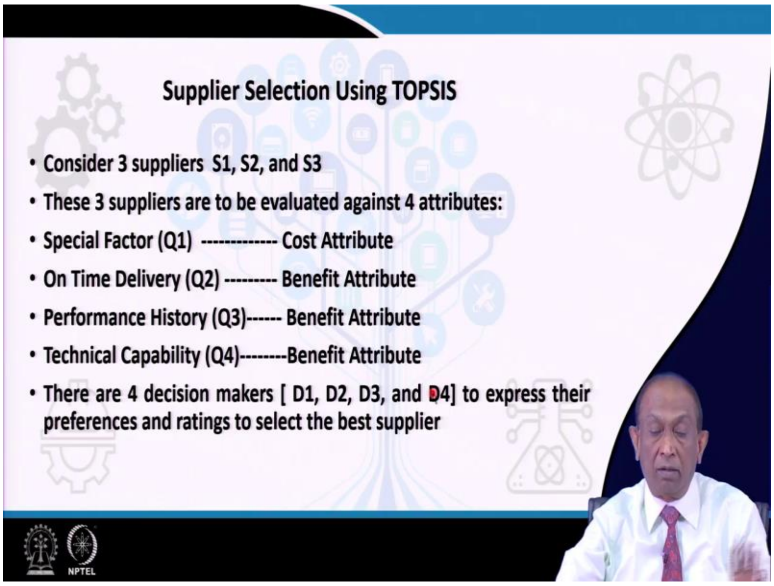

Consider 3 suppliers S1, S2 and S3. These 3 suppliers are to be evaluated against 4 attributes. The first one is a special factor which is basically a cost attribute and the remaining three attributes are the benefit attributes. For example, on time delivery, the overall performance history and the technical capability of the supplier; that means, out of the four attributes the first one is the cost attribute and the remaining three are the benefit attributes.

There are 4 decision makers D1, D2, D3 and D4 to express their preferences and ratings to select the best supplier and there are 3 suppliers S1, S2 and S3. So, that means, like three different alternatives and these are 4 criterias. In this case they are called attributes. Out of these 4 attributes the first one is a cost attribute the remaining 3 one remaining 3 are the benefit attributes and there are 4 decision makers D1, D2, D3 and D4 they will express their preferences and ratings to select the best supplier.

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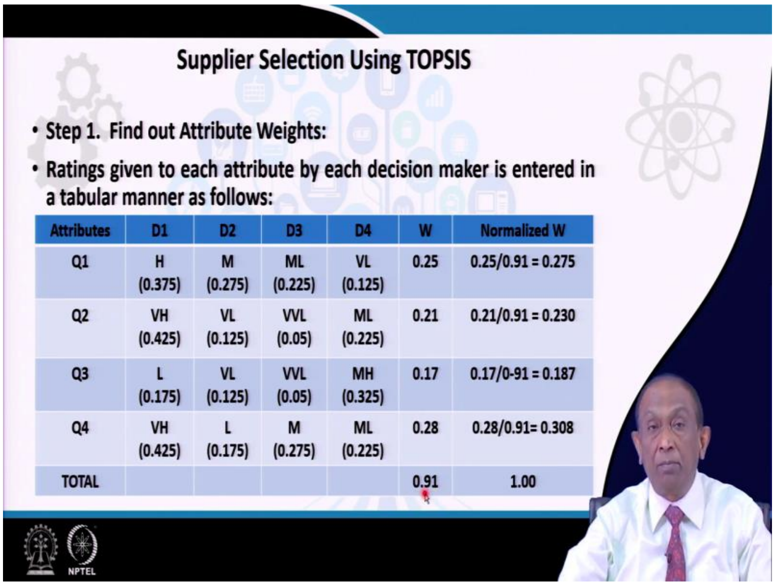

Now, the problem is very easy we have to find out attribute weights; that means, among these four attributes which one is more important. We will get determined by finding weights corresponding to these attributes find out attribute weights to determine their relative importance. There are four decision makers D1, D2, D3, D4 and they have given their opinion in terms of certain languages – high, medium, medium low, very low, very high, very low like this they have given their opinion in terms of languages.

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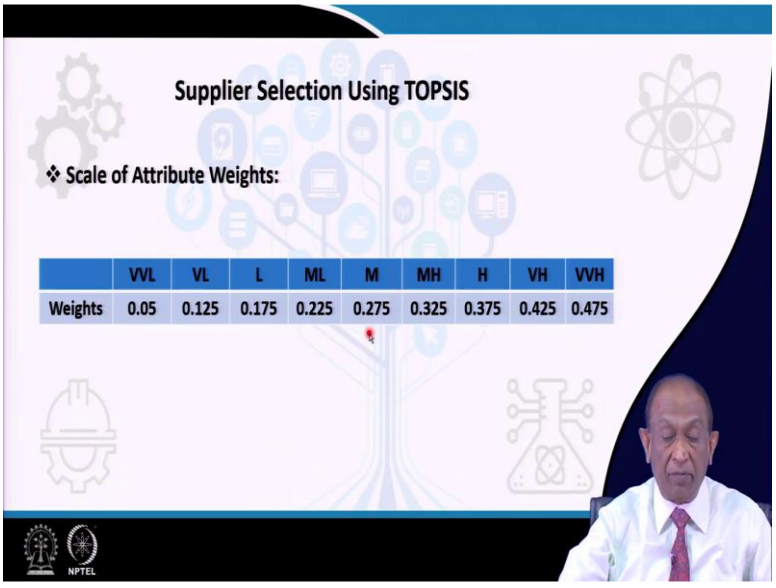

And, we have a rating scale like when somebody is saying that medium low, the rating is the weight is 0.225. High is getting a rating of high 0.375. So, when the decision makers they are saying that with these are the these are my preferences in terms of languages with the help of that scale that I have shown you we get the quantitative measures of their opinion and then what we do? For the first attribute we add this to this to this to this and then divide by 4 to get the average weightage.

So, average weightage; that means, row averages corresponding to each of these attributes are first computed and then this column sum is obtained. Once we get the column sum, we divide each of these weightages by this column sum to get a normalized weight for these attributes; because these normalization is necessary to make it dimensionless.

The cost attribute is expressed in one particular unit, quality attribute may be expressed in another unit. So, we need to make them dimensionless. So, we get this normalized weights and we have to ensure that the sum is 1. This is the scale of attribute weights.

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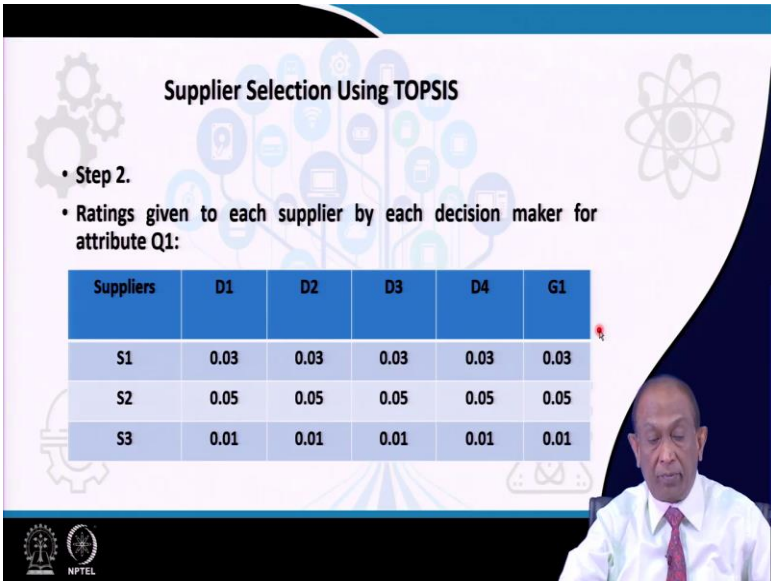

Suppliers	D1	D2	D3	D4	G1
S1	0.03	0.03	0.03	0.03	0.03
S2	0.05	0.05	0.05	0.05	0.05
S3	0.01	0.01	0.01	0.01	0.01

Step 2 ratings given to each supplier by each decision maker for attribute Q1 with respect to each suppliers the ratings are given like this. In this case all the decision makers have given the same rating. Hence the average rating which is expressed by this column is more or less the same. So, we have to get this ratings for all the attributes. This is for the first attribute.

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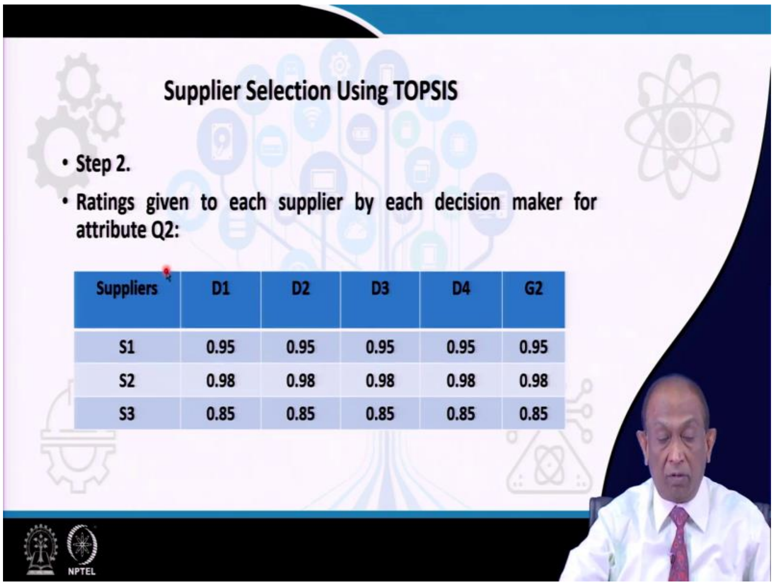

Similarly, for the second attribute these are the average weightages or average ratings.

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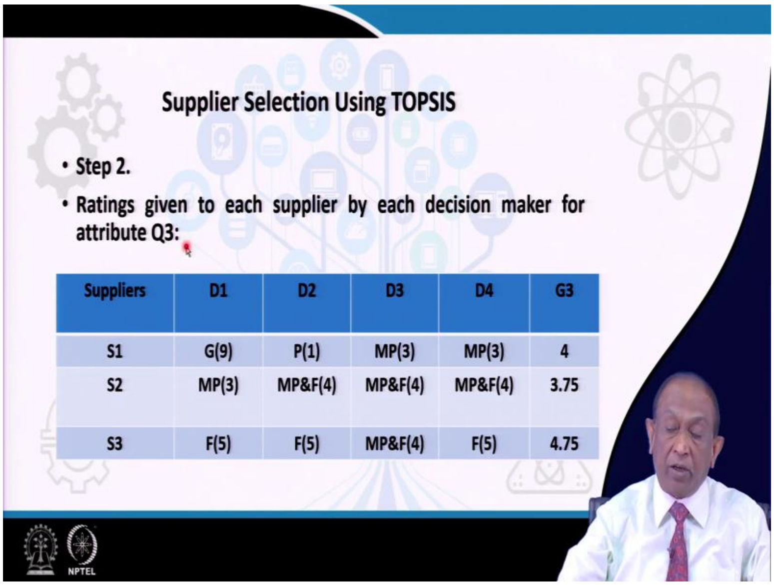

For the third attribute, this is the average rating. In case of third attribute the decision makers had initially given their opinion in terms of a descriptive rating scale which by using one guide line we have transformed it to quantitative measures.

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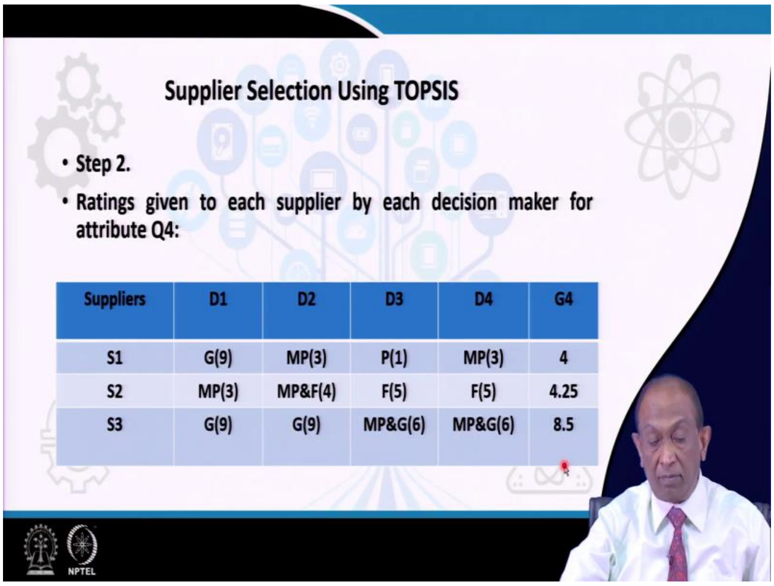

Similarly, with respect to attribute 4, the suppliers have been rated and the average ratings are of each of these suppliers are given by this.

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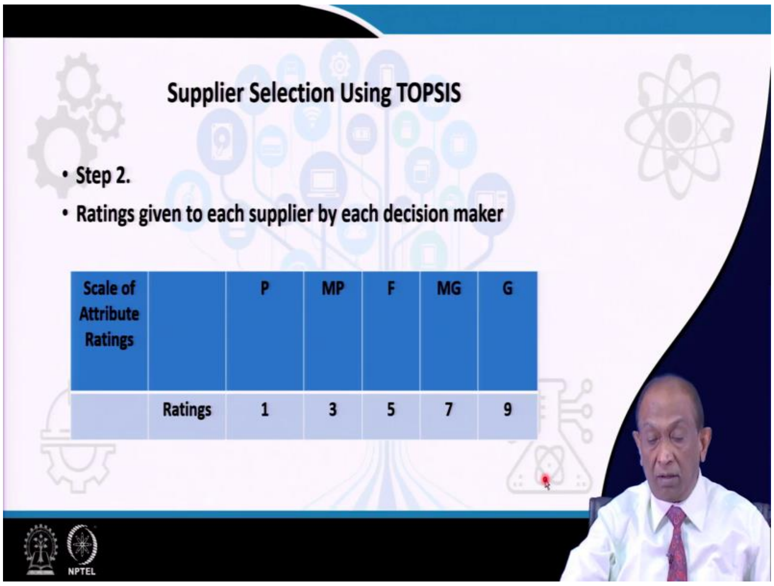

Since the decision makers express their ratings in terms of descriptive language poor, medium poor, fair, medium good, good – we have devised a scale for getting a quantitative measure of the relative importance and we have used this scale to develop this kind of matrices, a medium poor is 3, poor is 1 like this.

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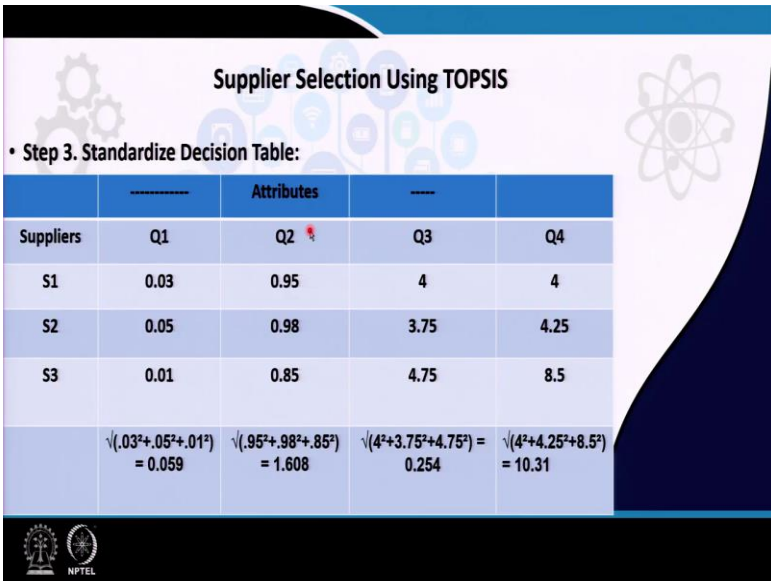

Now, once we do that; that means, we have ranked the suppliers with respect to each of these criteria's we have constructed this particular matrix which is basically called a decision table. Once the decision table is constructed, we standardize that particular decision table. How do we standardize each of these entries? We first square them, then add them and take the square root that is what we expressed as these are all x ij square this plus this plus this.

So, this expression is sum of x ij square and then we have taken the root of that. So, for this column this is the value, for this column this is the value, for this column this is the value, for this column this is the value. Once we get that we will divide each of these entries with this particular value.

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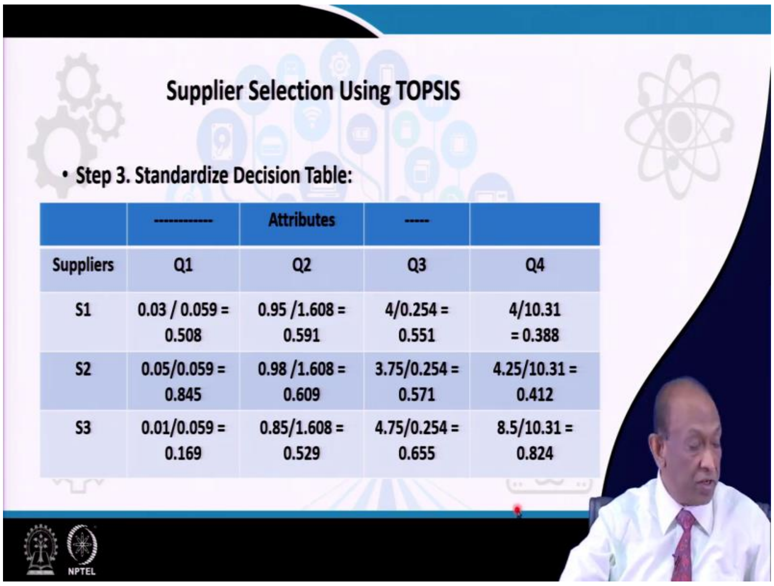

So, this is after division by the column sum these are the values.

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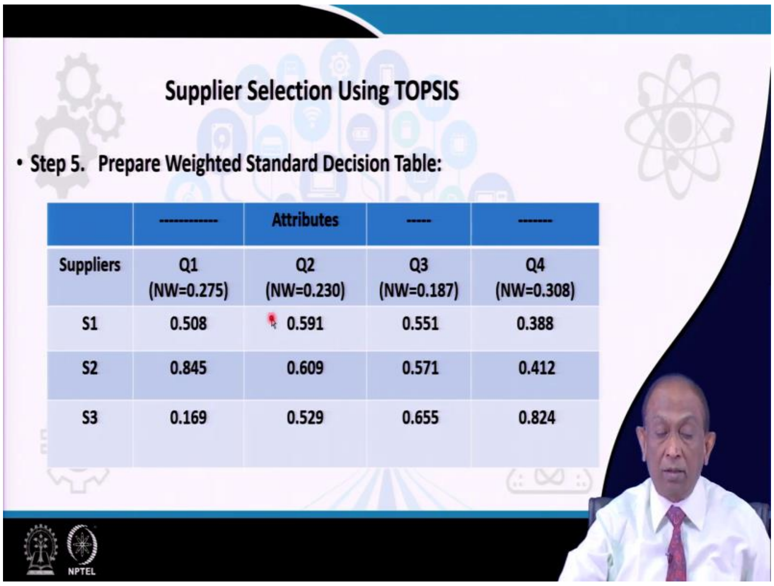

So, the standard decision table works out to be like this this is called standard decision table. Now, we have to prepare weighted standard decision table we have already obtained the normalized weights for each of these attributes.

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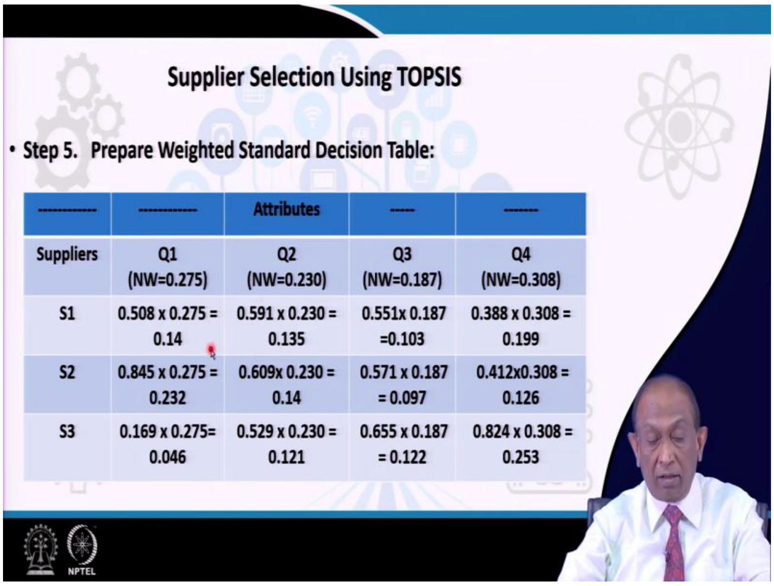

------------	------------	Attributes	-----	-------
Suppliers	Q1 (NW=0.275)	Q2 (NW=0.230)	Q3 (NW=0.187)	Q4 (NW=0.308)
S1	0.508 x 0.275 = 0.14	0.591 x 0.230 = 0.135	0.551x 0.187 =0.103	0.388 x 0.308 = 0.199
S2	0.845 x 0.275 = 0.232	0.609x 0.230 = 0.14	0.571 x 0.187 = 0.097	0.412x0.308 = 0.126
S3	0.169 x 0.275= 0.046	0.529 x 0.230 = 0.121	0.655 x 0.187 = 0.122	0.824 x 0.308 = 0.253

Once we do that, we multiply with those normalized weights the entries in the standard decision table to get this matrix which is weighted standard decision table.

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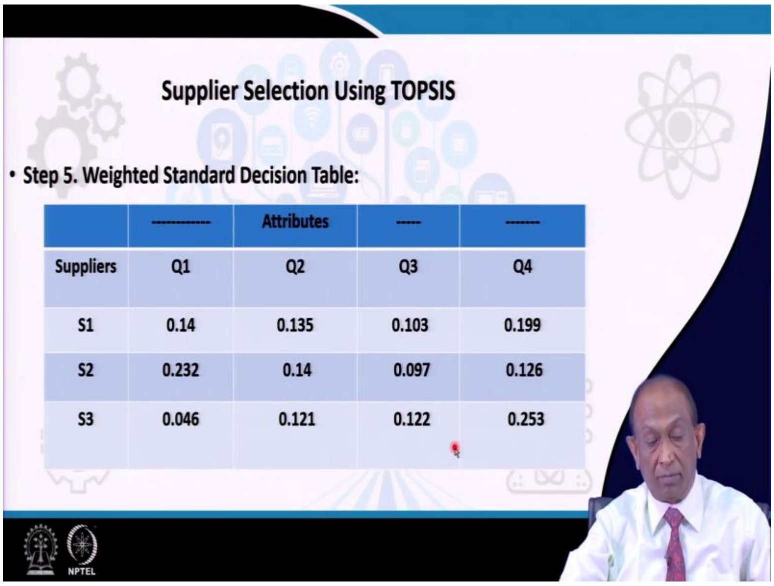

	------------	Attributes	-----	-------
Suppliers	Q1	Q2	Q3	Q4
S1	0.14	0.135	0.103	0.199
S2	0.232	0.14	0.097	0.126
S3	0.046	0.121	0.122	0.253

So, finally, we have got this weighted standard decision table.

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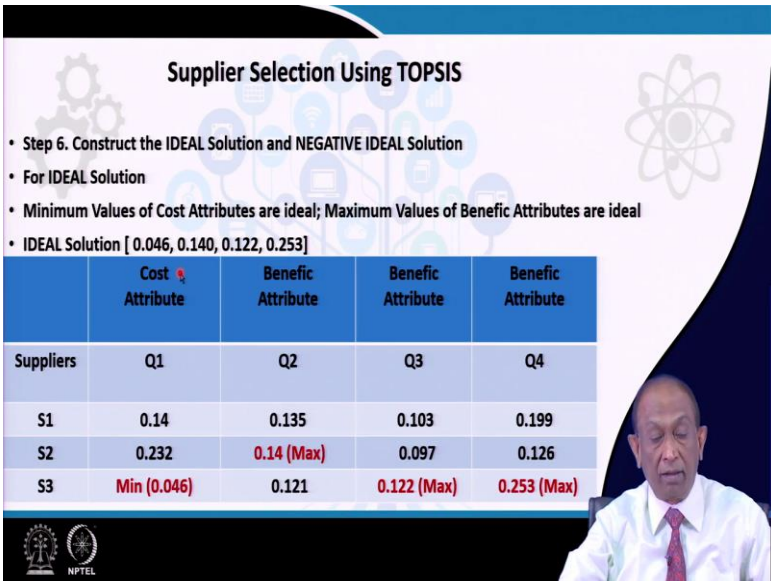

And, once we get that then we have to construct the IDEAL solution and the NEGATIVE IDEAL solution from that weighted standard decision table. Now, what will be the members of the IDEAL solution? You see among these three entries related to cost attributes the minimum values is 0.046 which becomes the first member of the IDEAL solution because this is a cost attribute.

So, minimum value is the best level. For all these three benefit attributes Q2, Q3 and Q4 we have to look at the respective columns and choose their maximum values which represent the best possible level for that particular attribute. Hence the members of the ideal solution set are 0.046 with respect to cost attribute 0.140 with respect to attribute Q2 which is the benefit attribute and so on.

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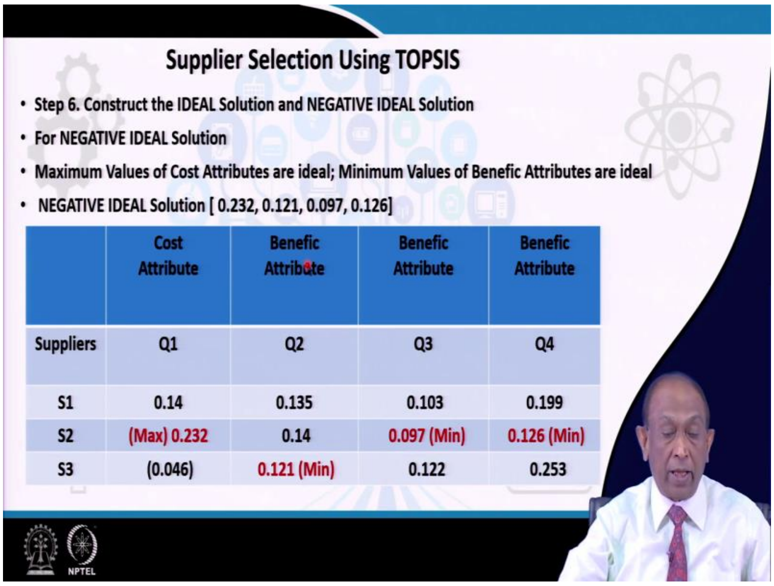

Then for the NEGATIVE IDEAL solution which will possibly with the worst level for the all attributes. So, for the benefit attributes we will choose the corresponding minimum values and 0.126 in this case and for the cost attribute the worst level is the maximum value. So, we choose 0.232.

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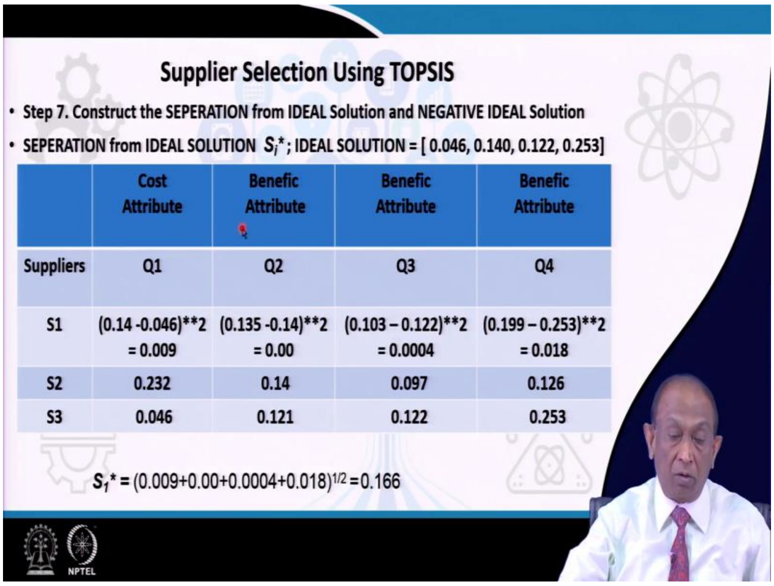

So, once we construct the IDEAL solution set and the NEGATIVE IDEAL solution set, then we for each alternative or suppliers we find out the distance from the IDEAL SOLUTION by computing the utility and distance. So, what we do? For this column for these attribute the maximum value or the best value is this, a minimum value is this. So, this is the best level.

So, we take value of each of these attribute with respect to this supplier minus this, then we square them. We do this for this particular supplier with respect to each of this attributes then we add them and then take the square root. So, that gives me S 1 star.

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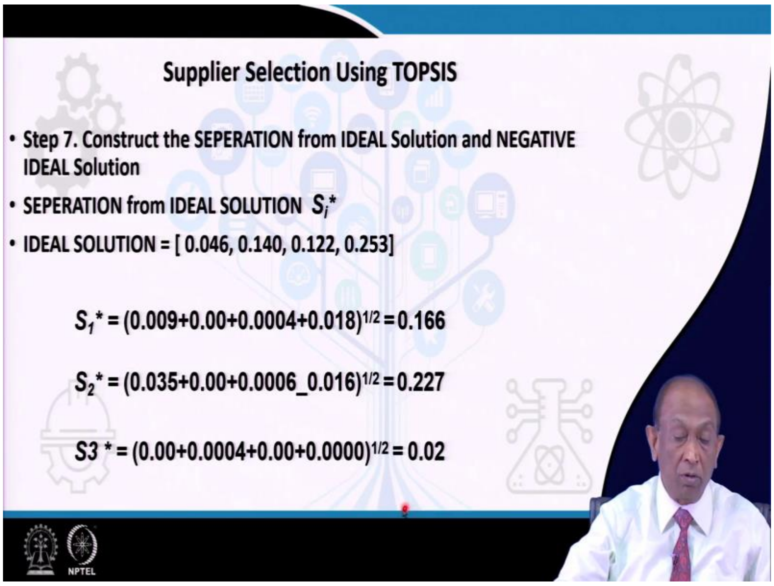

Similarly, we have to find out the S 2 star and the S 3 star. This is basically plus sign.

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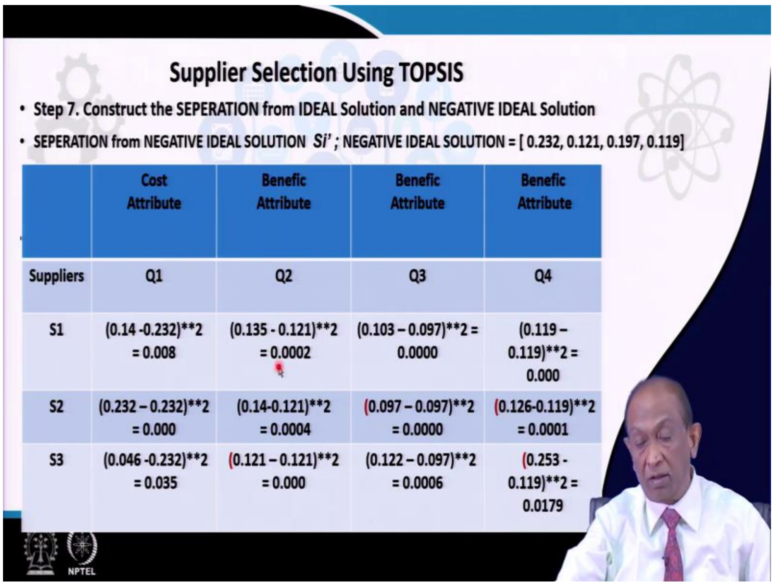

	Cost Attribute	Benefic Attribute	Benefic Attribute	Benefic Attribute
Suppliers	Q1	Q2	Q3	Q4
S1	(0.14 -0.232)**2 = 0.008	(0.135 - 0.121)**2 = 0.0002	(0.103 – 0.097)**2 = 0.0000	(0.119 – 0.119)**2 = 0.000
S2	(0.232 – 0.232)**2 = 0.000	(0.14-0.121)**2 = 0.0004	(0.097 – 0.097)**2 = 0.0000	(0.126-0.119)**2 = 0.0001
S3	(0.046 -0.232)**2 = 0.035	(0.121 – 0.121)**2 = 0.000	(0.122 – 0.097)**2 = 0.0006	(0.253 - 0.119)**2 = 0.0179

Similarly, the distances from the NEGATIVE IDEAL solution which is this one needs to be computed. Same manner, but it is computing the Euclidian distance basically.

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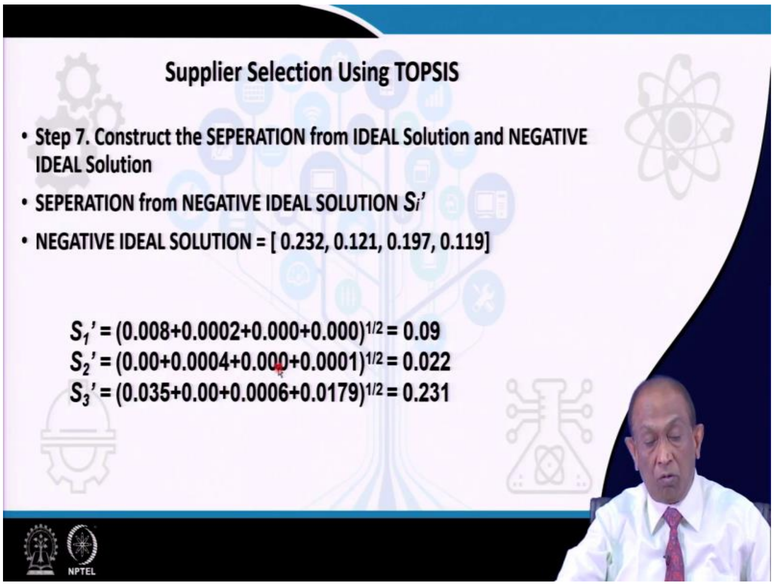

So, the distances from the NEGATIVE IDEAL solutions are computed and these are the values.

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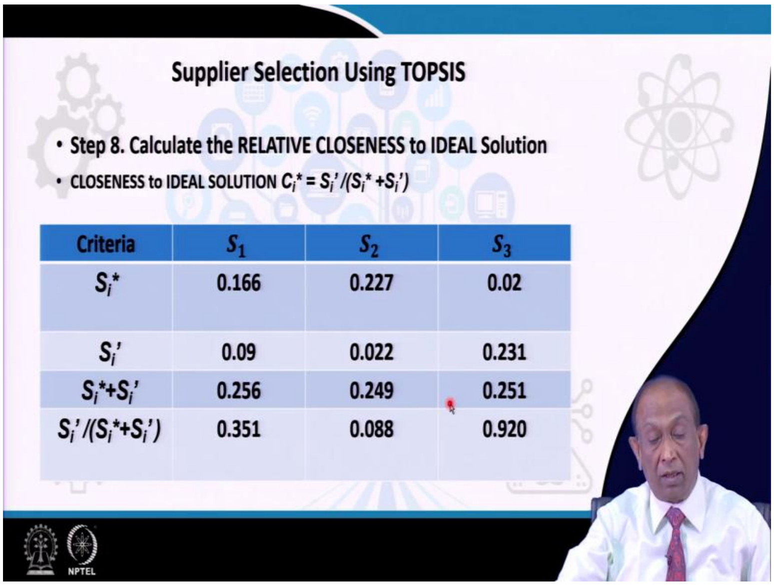

Once you do that then we compute this ratio which basically gives us the relative closeness to the ideal solution based on this ratio of S i dash divided by S i star plus S i star dash this ratio.

So, this table gives the value of this ratio of C i star for all these suppliers and we had said right in the beginning that particular value which is close to 1 or closest to 1 will be the best possible alternative; because that alternative will be relatively closer or closest to the ideal and it will be farthest from the negative ideal.

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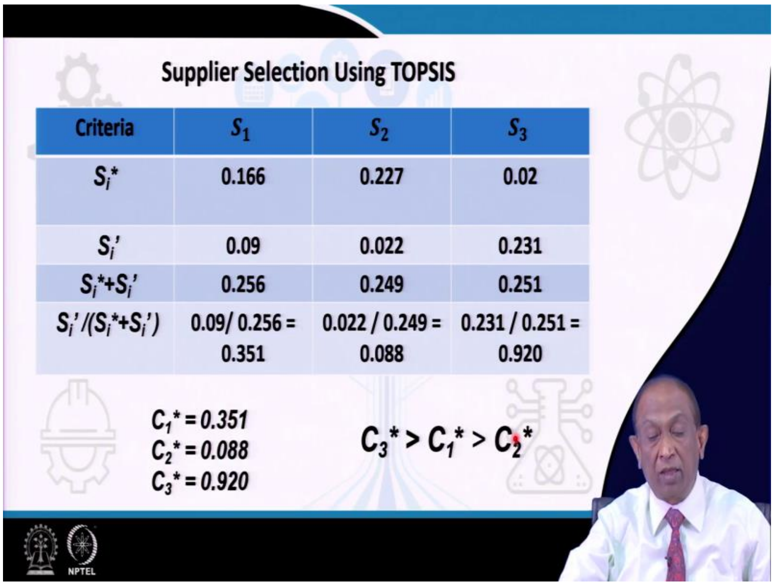

So, in this case among the three suppliers, supplier C is the best possible one.

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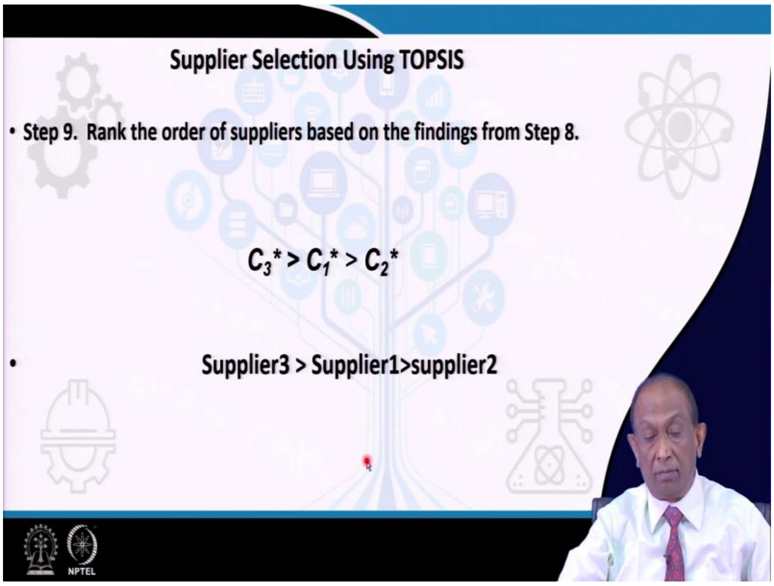

So, if we rank the order of suppliers based on our findings, we find that supplier 3 is better than supplier 1 who is better than supplier 2. So, this is an example of how you can use

TOPSIS to select the best supplier. So, vendor rating; so, this is another example of how you can use MCDM techniques for ranking suppliers which is an interesting area in the domain of operations management.

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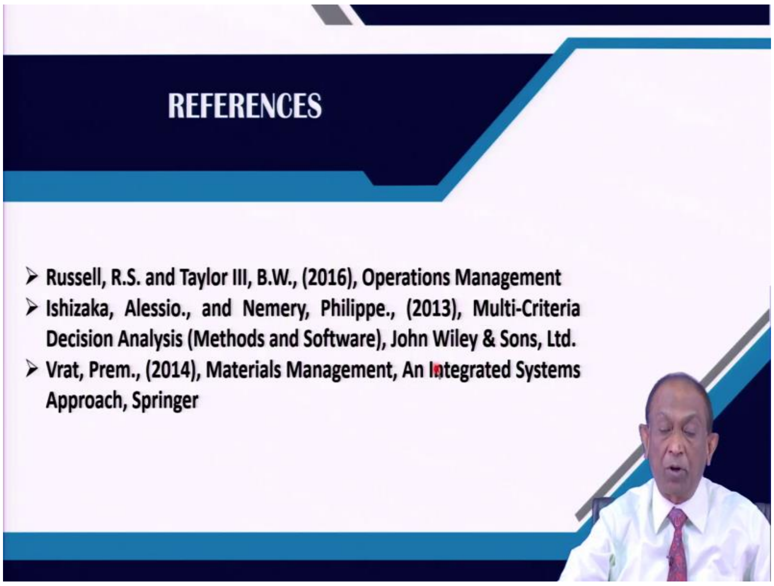

Again, the references are the same, same books we have used.

And thank you for your patience!