Decision Support System for Managers
Prof. Kunal Kanti Ghosh
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur

Week – 12
Module – 01
Lecture – 55
Decision Support Systems for Operations Management

Hi! Welcome to our 1st module of the 12th week on "Decision Support Systems"! Today we are going to talk about 'Decision Support Systems for Operations Management'.

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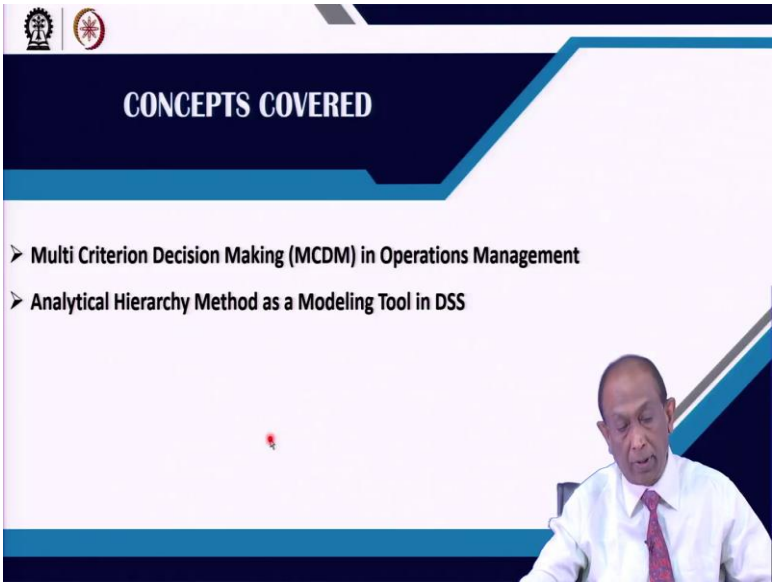

In particular in this particular session, we are going to deliberate upon multi criteria decision making in operations management and within that domain, we will be discussing about analytical hierarchy method as a modeling tool in decision support systems.

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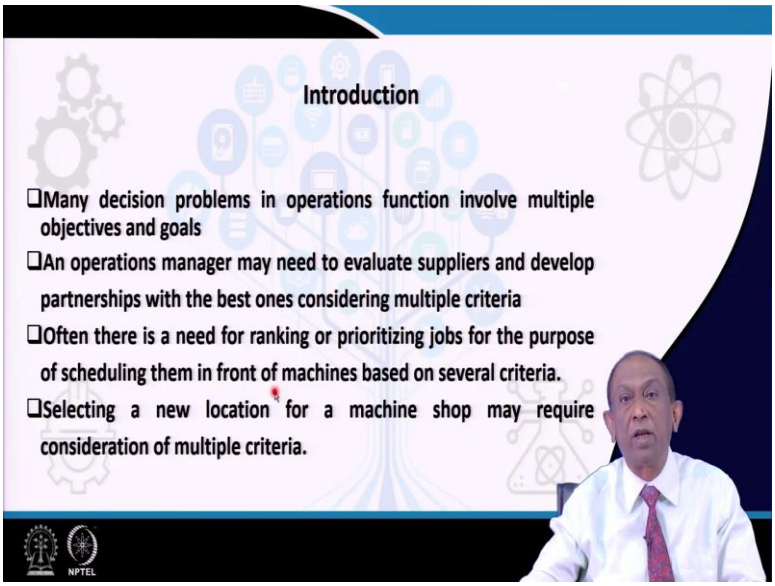

Many decision problems in operations function involve multiple objectives and goals, also known as multiple criteria. An operations manager may need to evolve and evaluate say suppliers, they have to select the best supplier among the many suppliers that have applied for supplying materials in their organization and develop partnerships for strategic items with the best ones considering different criteria.

Often there is a need for ranking or prioritizing various jobs for the purpose of scheduling them in front of machines based on several criteria, which jobs should be processed first, which one should be processed next. So, effective scheduling can be accomplished through such techniques when multiple criteria is there. Another interesting area operations manager always face is selection of a new location for a machine shop that might require consideration of multiple criteria.

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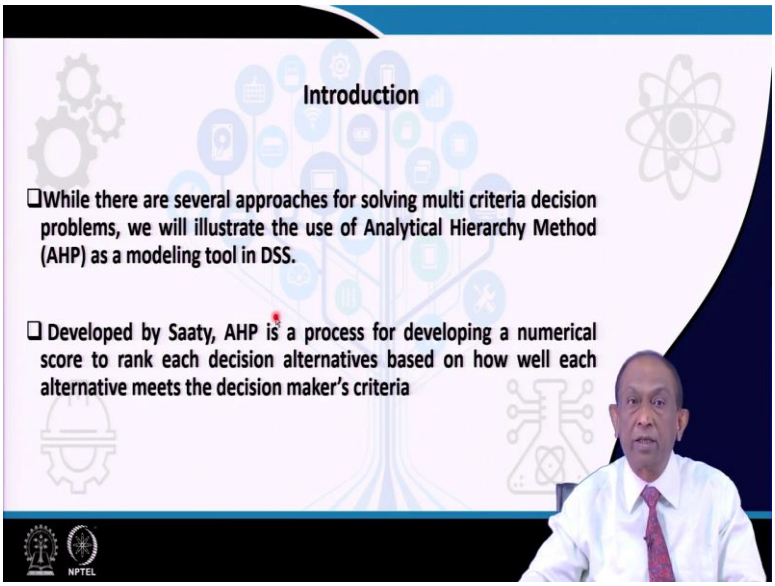

Now, while there are various approaches for solving multi criteria decision making problems, in this session we will illustrate the use of Analytical Hierarchy Method which is also known as AHP technique and its effectiveness as a modeling tool in decision support systems. Developed by Saaty, AHP is a process for developing a numerical score to rank each decision alternatives based on how well each alternative meets the decision maker's criteria.

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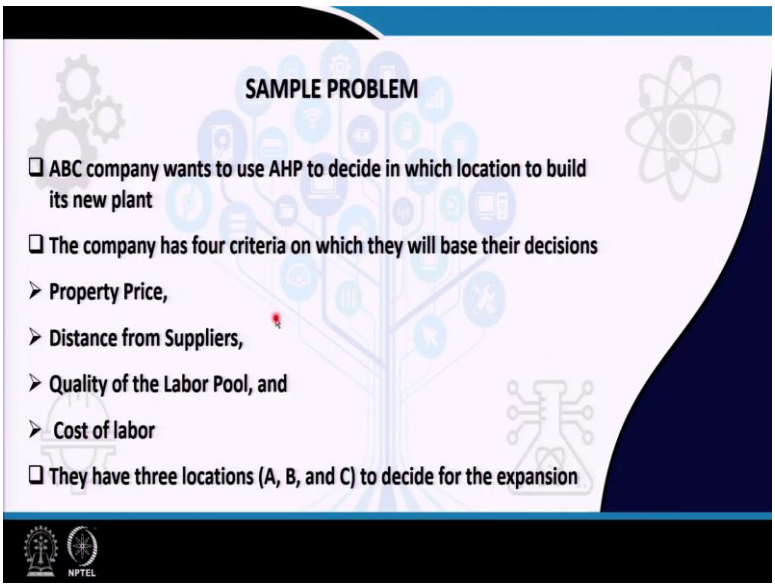

For example, look at the sample problem; ABC is a company and this company wants to use AHP technique to decide in which location they should build their new plant. The company

has four criteria on which they will base their decisions. What are those four criteria? One is property price; next distance of the plant from the prospective suppliers, the third criteria is the quality of the labor pool and the fourth criteria is the cost of labor.

Once again the four criteria on which they will base their decision to locate the new plant are one: property price, distance from the suppliers, quality of the labor pool, and cost of labor. And, they have three alternatives locations: A, B and C to decide whether they will locate their new plant for the purpose of expanding their organization.

So, that is the overall goal. Multiple criteria and the number of alternatives; so, we have to choose the best among the several alternatives considering all the different criteria, that we have just talked about.

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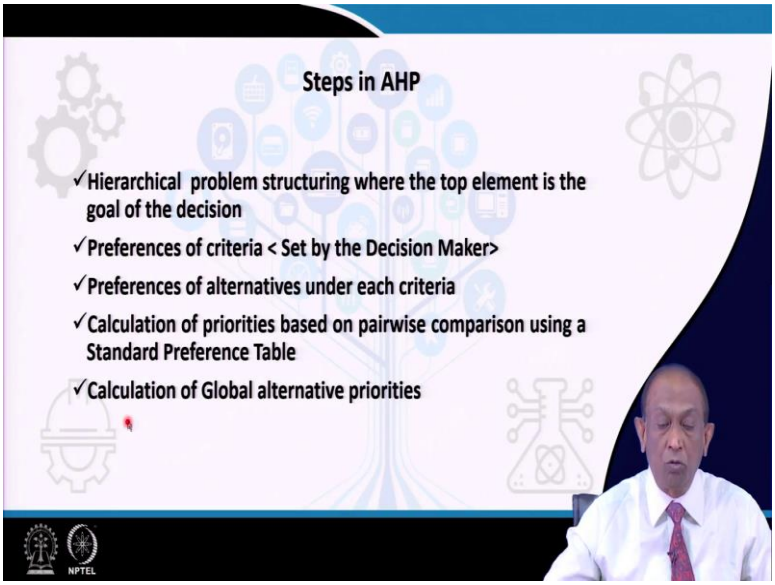

So, let us deliberate up on the steps in analytic hierarchy process. Here we have a hierarchical problem structuring, hierarchy some hierarchy is there. The top element is the ultimate goal of the decision. Next to the top level, we need to decide the preferences of the criteria which is set by the decision maker.

That means if you look at the previous slide, among all these criteria: property price, distance from suppliers, quality of the labor pool, and cost of labor, which one is most important? We have to rank these criteria in their order of importance. And where from we will get the input for ranking this criteria? We will choose say four, five decision makers; each of them we will rank this criteria as per their experience, judgment and intuition.

And finally, considering the opinion of all the decision makers, we have to rank or find the order of importance of the criteria; that is going to decide the priorities of the criteria through a preference matrix. So, that is preferences of criteria. Now, once we know the importance or the ranking of the criteria we have to take one criteria.

And, then within that criteria we have to rank the alternatives; that means, the relative priorities of the alternatives within a criteria have to be decided. And, this entire process has to be repeated for all the criteria; that means, we will take one by one the criteria and within that criteria, we have to prioritize or find the relative importance of the alternatives.

That is what we mean by preferences of alternatives under each criteria. And, for ranking either the alternatives within a criteria or even deciding the importance of the criteria themselves, we have to do a pairwise comparison using a standard preference table.

And once we complete all this, then we will calculate the global alternative priorities; that means, we will find out the best alternative satisfying all the criteria or considering all the criteria together. This entire thing will be clear, when we take one example.

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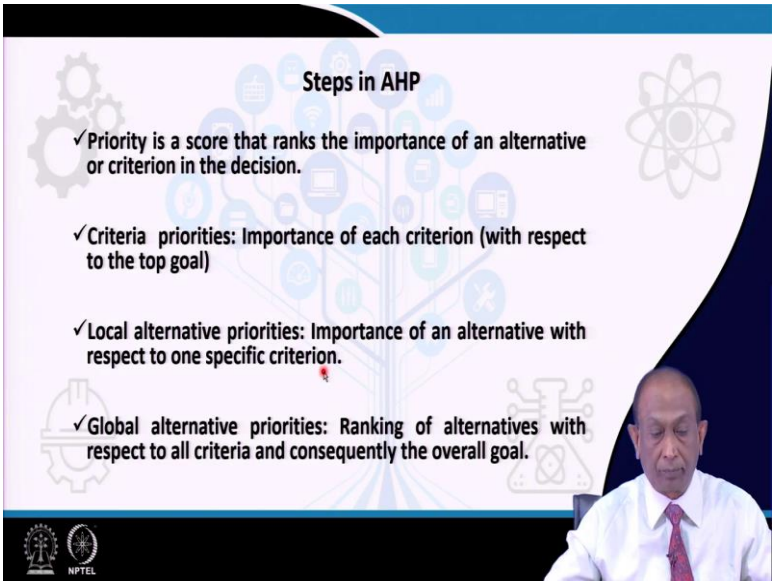

So, priority is a score that ranks the importance of an alternative or criteria in the decision. So, here we have to get ourselves familiarized with some terms. The first term is criteria priorities which means importance of each criteria with respect to the top goal.

Next we should know: what do we mean by local alternative priorities; that means importance of an alternative with respect to one specific criterion. And what do we mean by global alternative priorities? That is ranking of alternatives with respect to all criteria and consequently the overall goal.

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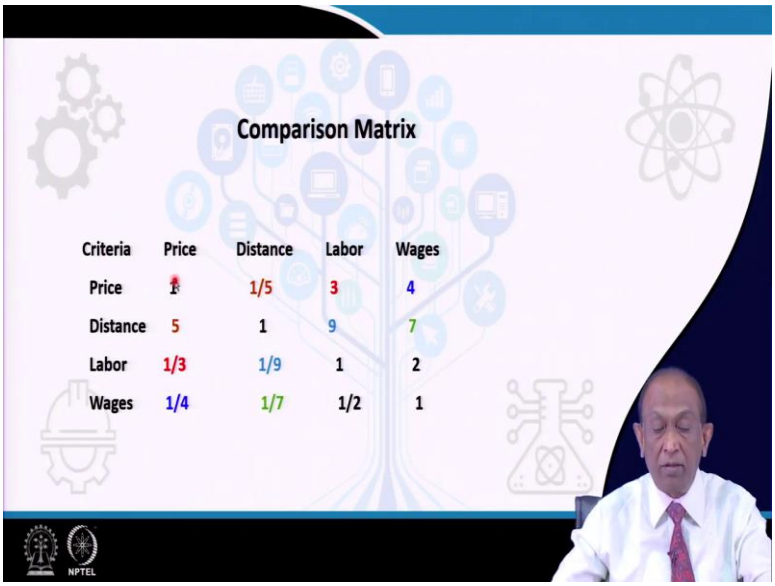

For example, when I am going to rank the priorities as per their order of importance, I get a comparison matrix. This comparison matrix is based on a pairwise comparison as per some given scale. For example, if you look at this matrix, here price is 3 times more important compared to labor cost; price is 4 times more important compared to the wages that needs to be paid; distance is 5 times more important compared to price.

So, if this is 5 times more important than price; obviously, the relationship between price and distance in terms of pairwise comparison will create an entry of 1 by 5 in this comparison matrix. Distance is 9 times more important compared to the labor cost. As a result, what will happen that when you are looking at this relationship between the labor and distance; since this is 9, this is 1 by 9.

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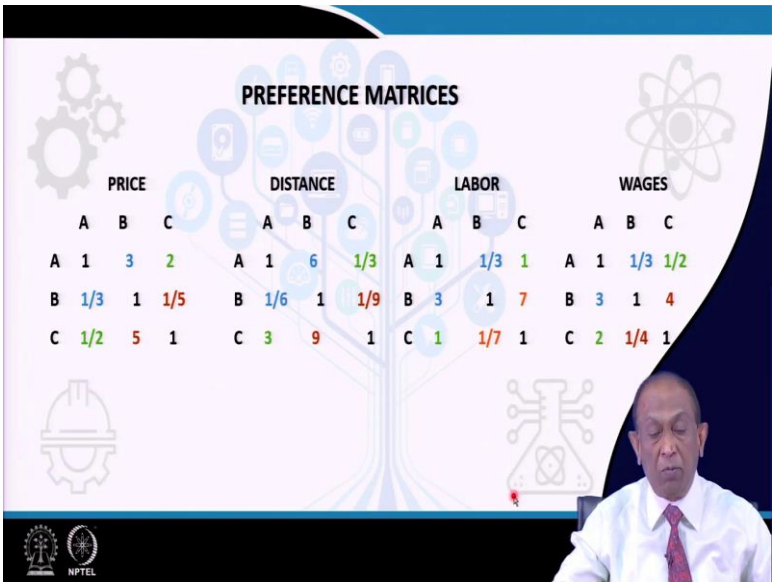

And, these are called preference matrix, preference matrices under different criteria; that means, within the criteria price; when I am ranking the alternatives we get these matrices. For example, in this case with respect to price alternative A is 3 times more important compared to B and 2 times more important compared to C. When you look at B, since A is 3 times more important compared to B, B is one-third of A in terms of importance.

Like this, this matrix is getting formed and similar is the case here, but the criteria is different. Within the criteria distance, we have ranked the alternatives; within the criteria of labor, we have ranked the alternatives; within the wages, we have ranked this alternative. So, we have got four different matrices which are known as preference matrices.

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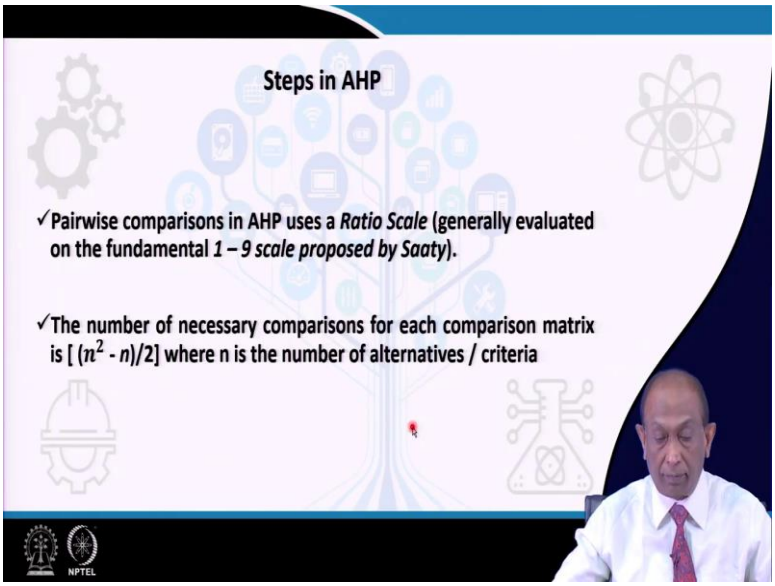

So, you see these pairwise comparisons in AHP uses a ratio scale generally evaluated on the fundamental 1 to 9 scale proposed by Saaty. And, that you have just seen that these are the measures obtained from a ratio scale. The number of necessary comparisons for each comparison matrix is n into n minus 1 by 2 which is n square minus n by 2, where n is the number of alternatives or criteria.

For example, in this case you see number of alternatives is 3. So, how many comparisons will be required? n 3 into n minus 1, that is 2 by 3. So, you see how many, say actually see in this how many comparisons you have made? n into n minus 1 by 2. In this case how many comparisons? 4 into 3 by 2, 6 comparisons are required.

And, that comes from the either upper triangular matrix upper triangle or the lower triangle. Here we have made one comparison; 1, 2, 3, 4, 5, 6 clear. It is a square matrix; so, the number of pairwise comparisons required is n into n minus 1 by 2.

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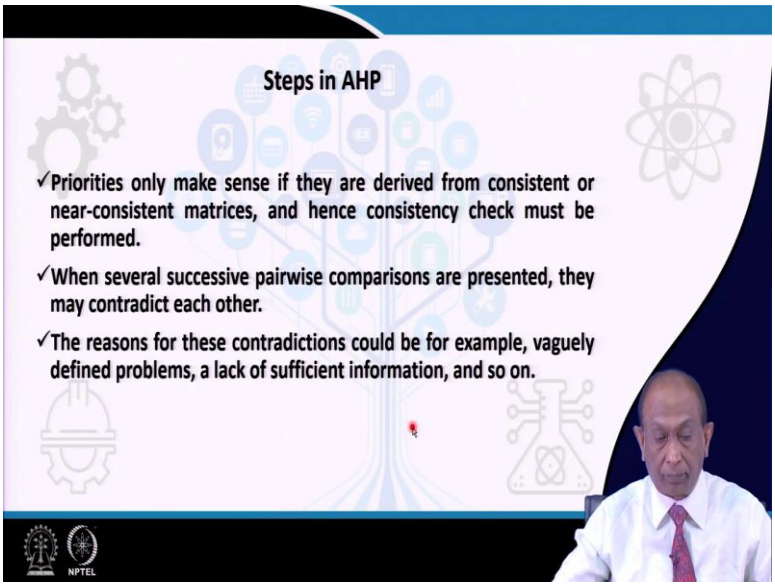

Now, priorities only make sense if they are derived from consistent or near consistent matrices, and hence consistency check must be performed. Because, when several successive pairwise comparisons are presented, they may contradict each other. And, the reasons for these contradictions could be for example, the problem may be vaguely defined or there may be lack of sufficient information, and so on.

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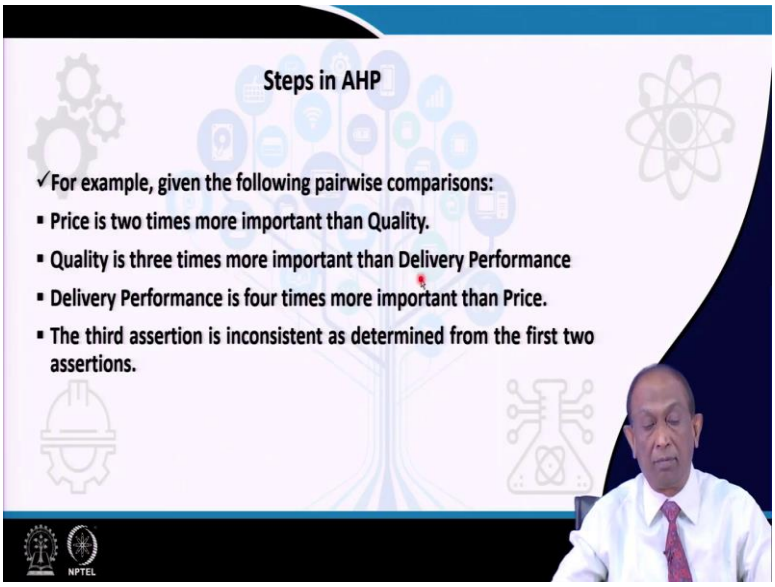

For example, given the following pairwise comparisons based on interaction with the decision makers, suppose we have got their version as price is two times more important than quality. Then they are saying quality is three times more important than delivery and then

somebody is saying that delivery performance is four times more important than price. So, this is case you see, the third assertion is inconsistent as determined from the first two assertions.

Because, here you are saying price is two times more important than quality and quality is three times more important than delivery performance and again in here you are saying that delivery is four times more important than price. So, these are all inconsistent assertions and if I go ahead with this, then we will be nowhere. And, hence a consistency check has to be performed first for each comparison matrices that we form.

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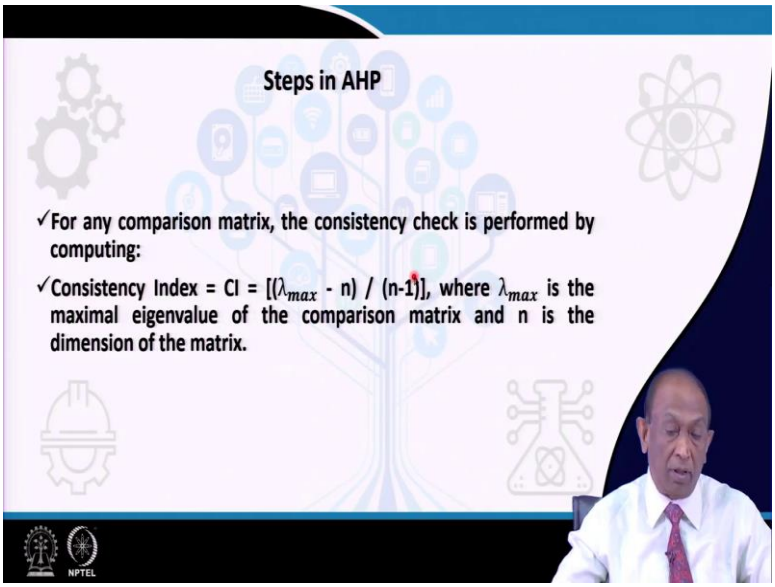

So, for any comparison matrix, the consistency check is performed by computing a consistency index. Consistency index is defined by lambda max minus n divided by n minus 1, where lambda max is the maximum Eigen value of the comparison matrix and n is the dimension of the matrix.

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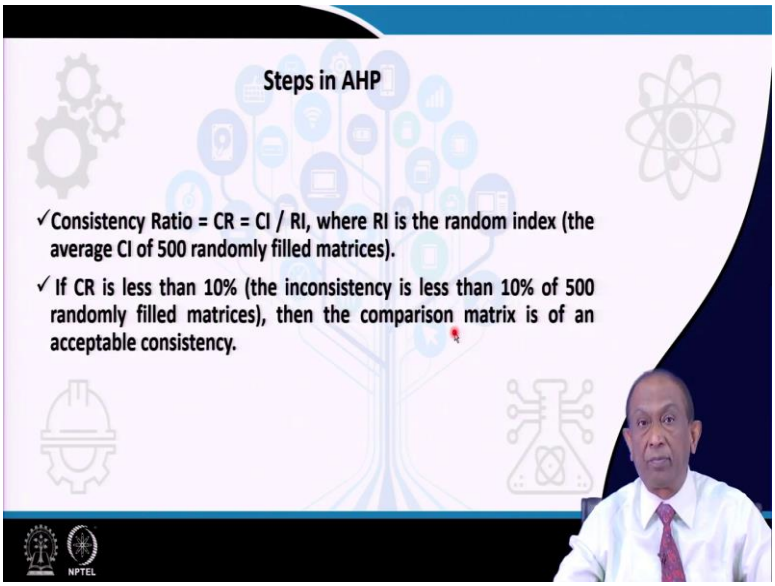

Then, after we compute the consistency index, we have to compute consistency ratio which is consistency index CI divided by RI, where RI is the random index. What is this random index? Random index is the average of consistency index of 500 randomly filled matrices.

And, if consistency ratio is less than 10 percent which means the inconsistency is less than 10 percent of 500 randomly filled matrices, then the comparison matrix is of an acceptable consistency. And for where from we will get the value of this random index?

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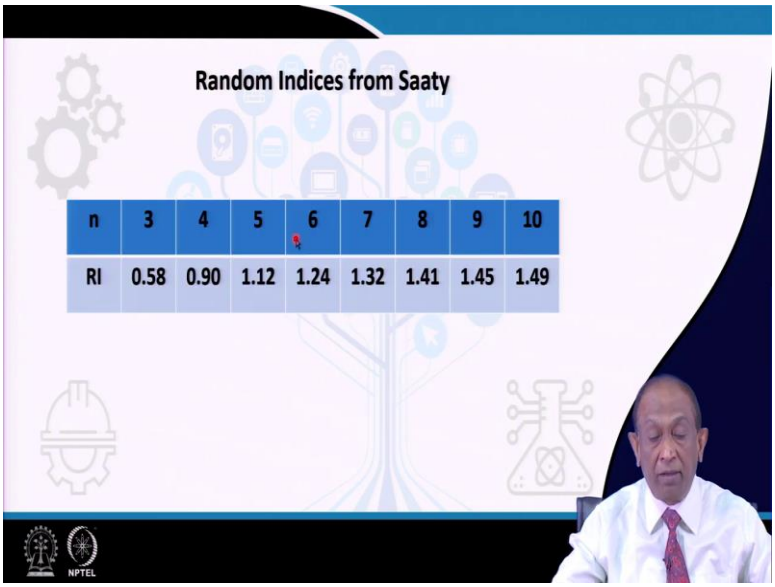

There is a table, depending on the dimension of the matrices we will pick up the random indices from here. And we have already computed the consistency index, we will divide the consistency index for a comparison matrix by the RI value, depending on the order of the matrix. And, then compute the consistency ratio CR and if that is less than 10 percent, then we can say the comparison matrix is consistent and we can go ahead.

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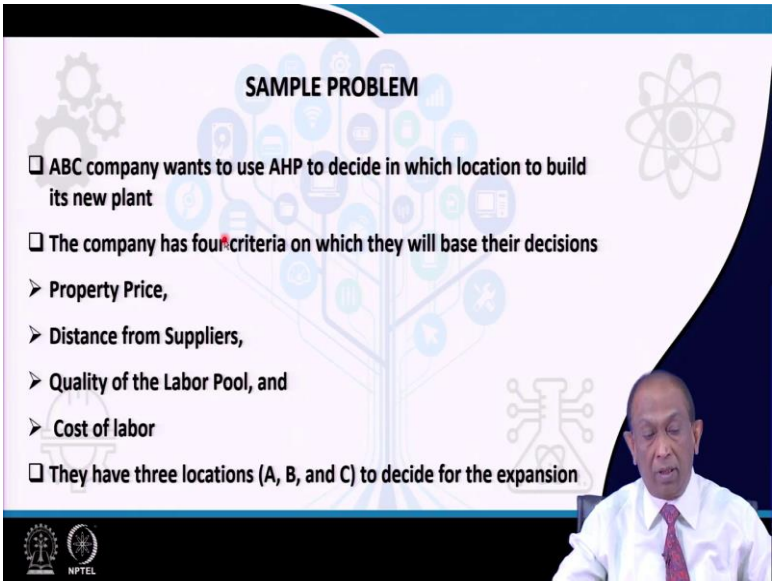

Now, let us look at that sample problem: how do we solve it through AHP. We have said that company has four criteria: property price, distance from suppliers, quality of the labor pool, and cost of labor. And we have three locations: A, B and C to decide for the expansion.

Problem solution is very simple, we first develop these preference matrices within each criteria; price, distance and labor and wages. We take the opinion of the decision makers and formulate the importance of each these alternatives, under each these criteria.

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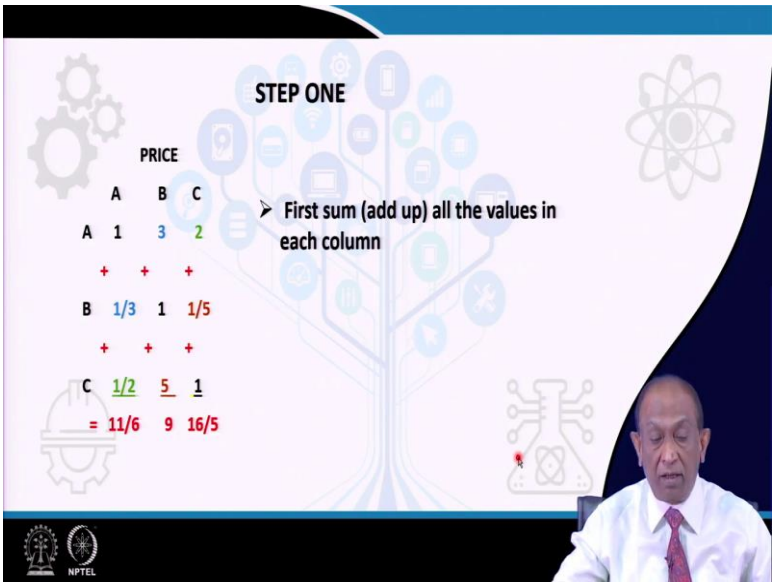

Once the preference matrices are done, then we will take one by one; first we take this criteria price, within price we have obtain the preference matrix. So, first we will sum or add up all the values in each column; 1 plus 1 by 3 plus 1 by 2 is 11 by 6, 3 plus 1 plus 5 9, 2 plus 1 by 5 plus 1 16 by 5.

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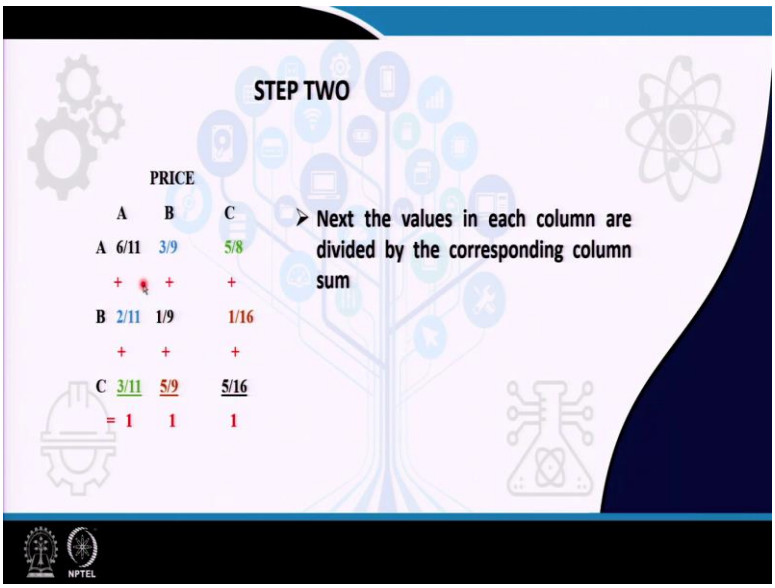

Once we add up all the values in each column, then the values in each column are divided by the corresponding column sum; that means, we get this matrix ok. This particular value 11 by 6 is taken and with this we divide all the elements in this matrix. So, we get this matrix.

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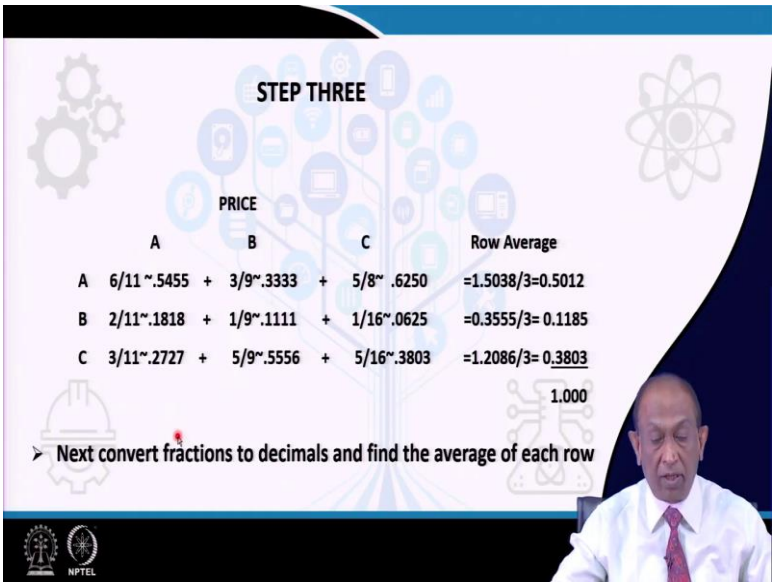

Once we get this matrix, then what we do? We convert this fractional elements to decimals.5455,.1818,.2727 like this and then we compute the row average. So, row average for this first row is first we add this plus this plus this and then divide by 3, we get this row average. And, it is adjusted in such a way that the sum is 1.000. So, this is a these are the row averages, find the average of each row.

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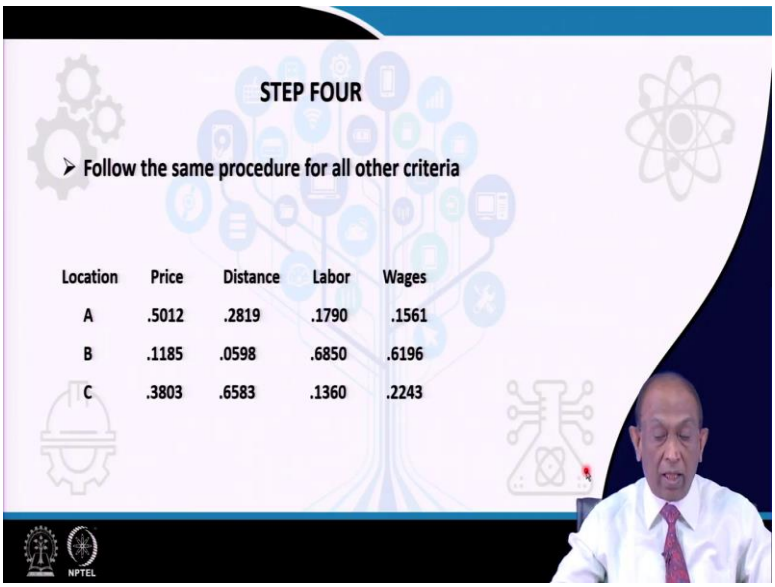

We have to follow the same procedure for all the other criteria. So, within price the row averages are like this, within distance the row averages are like this, within labor and within

wages. These average values will reflect the importance of an alternative within that criteria. So; that means, within price alternative when we talk look at the property price only; with respect to property price alternative A is the most important or the best location.

Next comes the location C and then the location B. When you look at the distance criteria, distance from the supplier with respect to distance from the supplier alternative C is the best location. With respect to cost of labor pool alternative B is the best location and with respect to wages cost alternative B is also the best location.

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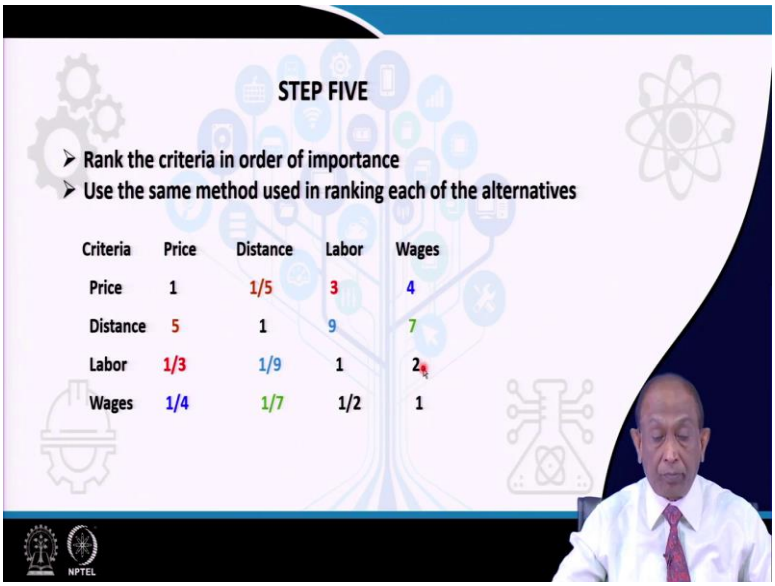

Now, we have to rank first the criteria in order of importance. So, we have seen this matrix earlier. So, we apply the same procedure with respect to the comparison matrix, pairwise comparison matrix that we have formed taking all the criteria's.

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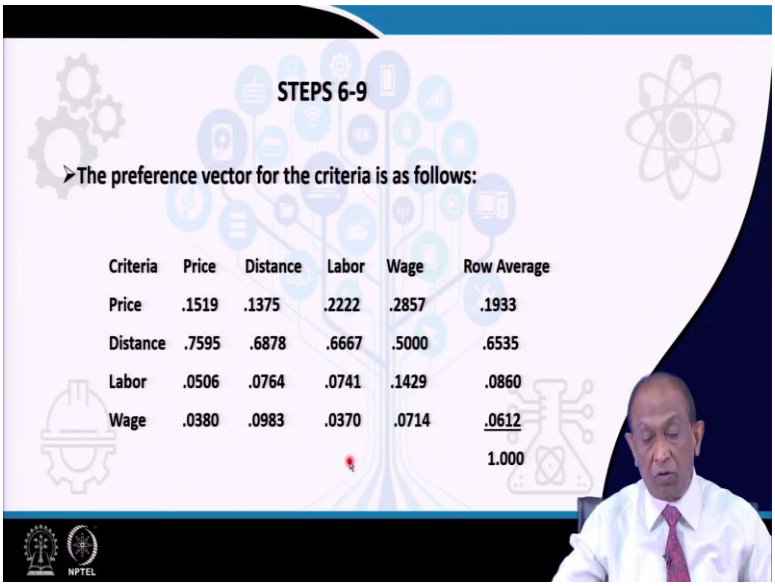

So, if we do that, the preference vector for the criteria turns out to be like this; the same procedure. If you look at these row average values with respect to the criteria you see, the distance from the supplier is the most important criteria, then comes the property price and so on.

Now, given the importance rank rating of the criteria and given the importance ranking of the alternatives within each criteria, we have to decide which alternative is best when we consider all the criteria together.

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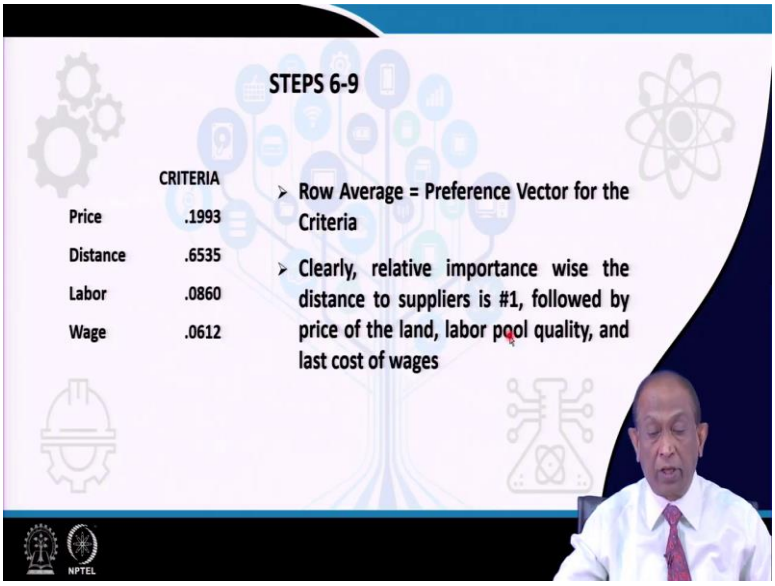

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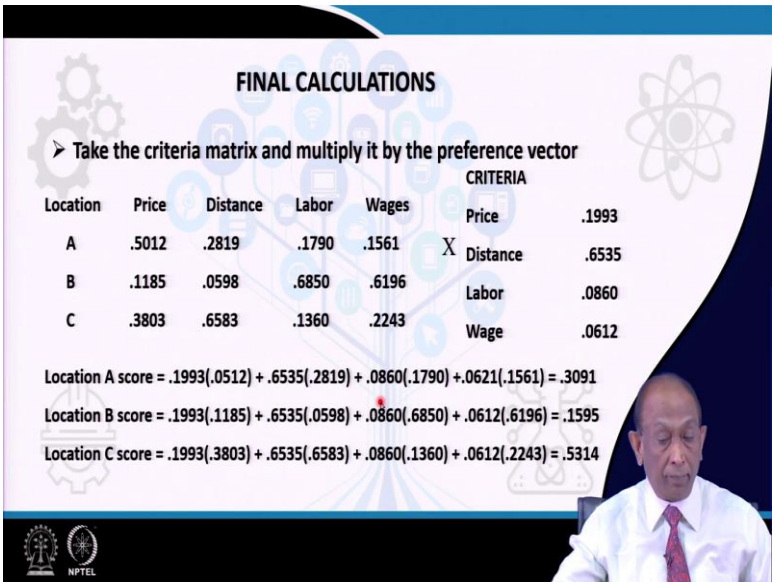

So, for this what we do that we take the criteria matrix and multiply it by the preference vector. So; that means, this matrix is getting multiplied by the criteria matrix. So, location A then gets a score of.3091, location B gets a score of.1595 and location C gets a score of.5314.

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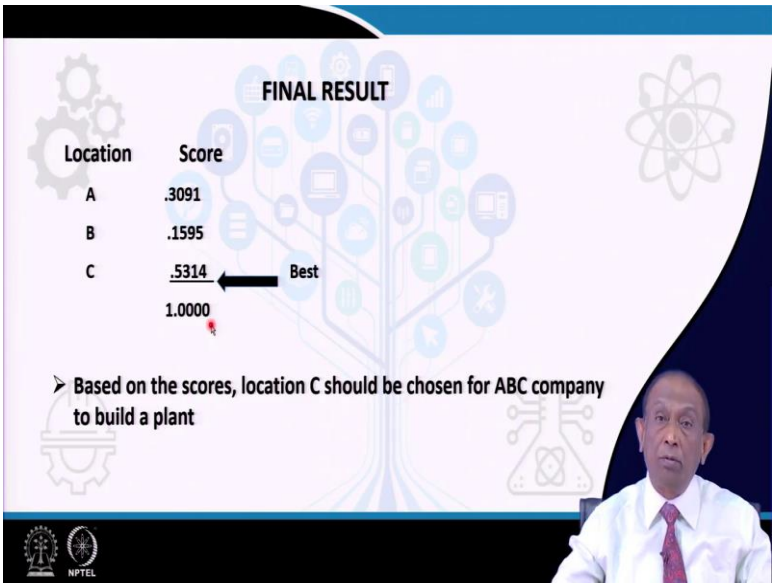

So, given all the criteria and also with the knowledge of relative importance of the criteria, we find that location C is the best location among all the other alternatives. So, based on the scores, location C should be chosen for ABC Company to build a plant.

In the next session, we will illustrate another example of AHP, where AHP technique had been used for selection of the best supplier and which is a very common problem that needs to be solved in an industrial situation for the operations function.

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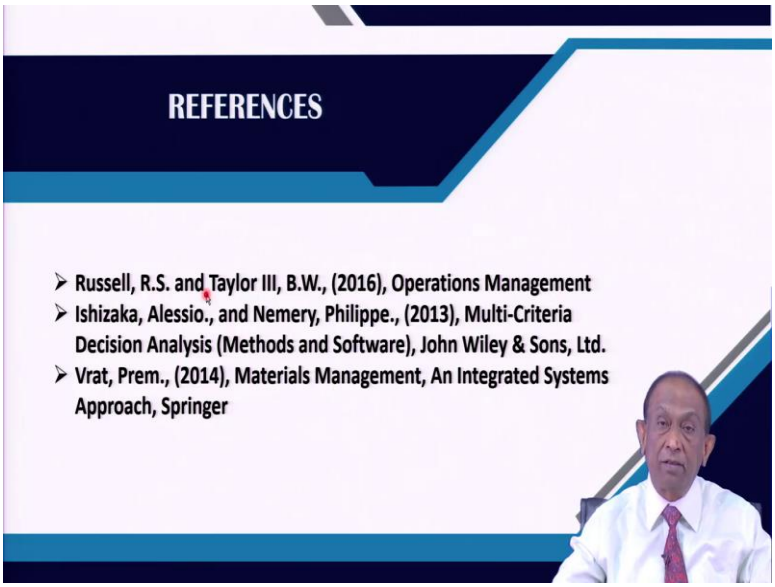

These are the references that I have used for this particular session. Among this, this is the book I will recommend that you should refer to when you are trying to solve some problems, which requires multi criteria decision analysis, is written by these three authors.

Thank you all for your patience!