Operations Management
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Lecture - 19
Location Evaluation Methods I

[FL] friends, welcome to session 19 in our course on operations management. So, just to have a brief review of what we are covering in the last maybe 2 or 3 weeks. So, we have covered the fundamental aspects of operations management, then we have covered the product design and development, then we have covered sales forecasting or demand forecasting and currently our focus is on the selection of a location where we want to start our operations or our enterprise or our factory. By, now we have the answers to few questions that are very important in operations management, that is what a company must produce and the answer comes from product design and development.

Then how much the company must produce? The answer comes from design forecast, demand forecasting or sales forecasting and then where the company must produce? We are trying to find out the answer in our discussion on layout or facilities, planning and layout. We have covered that, we have to take a decision that in on in the globe in which country we have to set up our location, within the country we have to design decide the region, within the region we have to decide that which particular location and this depends upon a large number of parameters and if you remember we have seen 3 sessions in plant location only and we have covered different types or factors that are important while deciding that where the facility must be created, where the factory must be put up, where the enterprise must be situated.

To we have to try to find out highlight the factors that are responsible or that are important for our consideration in deciding or selecting the plant location and if you remember in the last session, we have covered a case study of state of Uttarakhand and I have given a list of facilities or may be list of facilitation activities that the government of Uttarakhand has planned for industry and why industrialist, why entrepreneurs are more interested to put up their facilities in the state of Uttarakhand or to set up their factories in the state of Uttarakhand. Today, we are going to find out that what are the

location evaluation methods mathematically also, logically also, scientifically we can find out that where we must locate our facility.

So, basically there can be 2 types of decision making 1 decision making can be based on the different factors, different policies, the political situation and the other social cultural, so many parameters we consider, so many factors we take into account, when we have to decide on the location of our factories. All these can be clubbed under the qualitative parameters are qualitative method or the factors which cannot be quantified too much into mathematics or in to numbers.

So, we take a decision based on these factors, which are qualitative helps us in taking a decision. Then, there can be method, which are quantitative in nature, where we have some data, we have some information, we have some number, a mathematical equation, we can have a mathematical table, which can help us to take a judicious decision that where we must set up our plant. So, maybe I have revised in totality what we have covered in operations management, I have tried to revise that what we have covered in plant location and in the next week maybe we will focus our attention on plant layout.

So, currently we are deciding where to put up the factory, we are trying to find out the answer to this questions that where our factory must be located, where our organisation must be located and to find out that answer we have 2 types of techniques or maybe methods 1 can be based on the factors we can make a judicious decision without involving much calculations and the other method as I have just highlighted are the mathematical tools that help us to make this decision. In the last 2 sessions, we will be focusing on this location evaluation methods only and we will try to find out that how mathematically we can calculate that where our position must be, where our factory must be located.

So, let us start the discussion for today, about the location evaluation methods.

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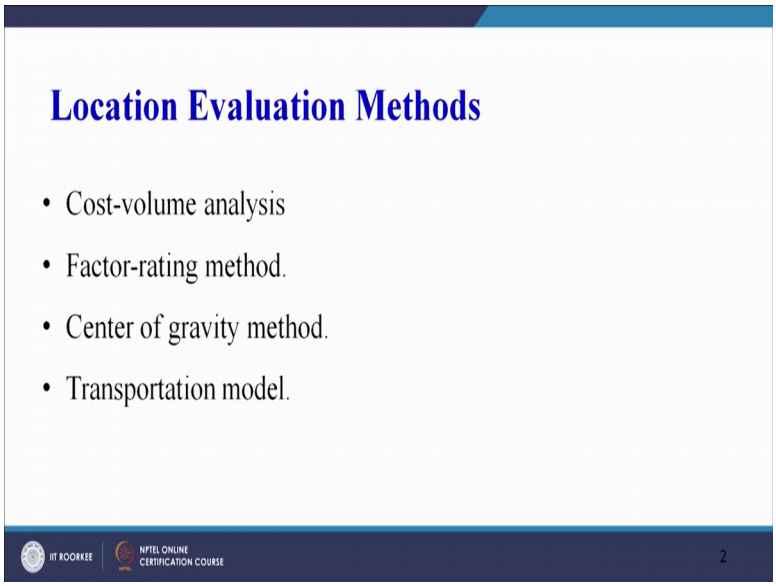

So, on your screen you can see, there are 4 different methods that are listed, 1 is cost volume analysis, factor rating method, center of gravity method and transportation models which are usually taught as a course or as a topic in operations research. So, we are trying to look at these methods try to solve a problem or 2 based on these methods and try to see that how these methods operate? What is the data that is required for using this method? What is the type of output that we derive out of using this method? And, how these methods will help us to identify a location where we want to set up our plant? So, let us go 1 by 1, in today's session we will cover the first 2 methods, that is the cost volume analysis methods and the factor rating method and in the last session of this week we will cover the centre of gravity method and the transportation model for finding out the best location.

So, we have divided our overall discussion of the week into 5 sessions and just to have a brief review of these 5 sessions, in the very first session we discussed about plant location and layout and facility location and layout whatever you want to call it, so it was basic fundamental lecture only. In the second lecture we focused on the factors governing our decisions regarding the selection of a location, in third session we focused on a case study of Uttarakhand, that why companies are focusing on states where they get certain benefits, financial benefits, technical benefits as well as there are schemes that helps these companies which in their pursuit of excellence.

So, 3 lectures or 3 sessions we have already taken, related to the location, identification and now we will be focusing on quantitative methods of finding out a solution to this problem of location of a factory or plant or a enterprise. As I have already told, 4 methods are there on your screen, it is really important to fix or to locate that what we are studying, we need to relate that particular topic to the overall picture that we are creating.

So, the overall picture is operations management and within that we are trying to find out where our operations must be done? Where our factory must be located? And in that also we have covered all the factors now we are focusing on the quantitative method. So, I think I have given a very long introduction today. Let us quickly go to the cost volume analysis.

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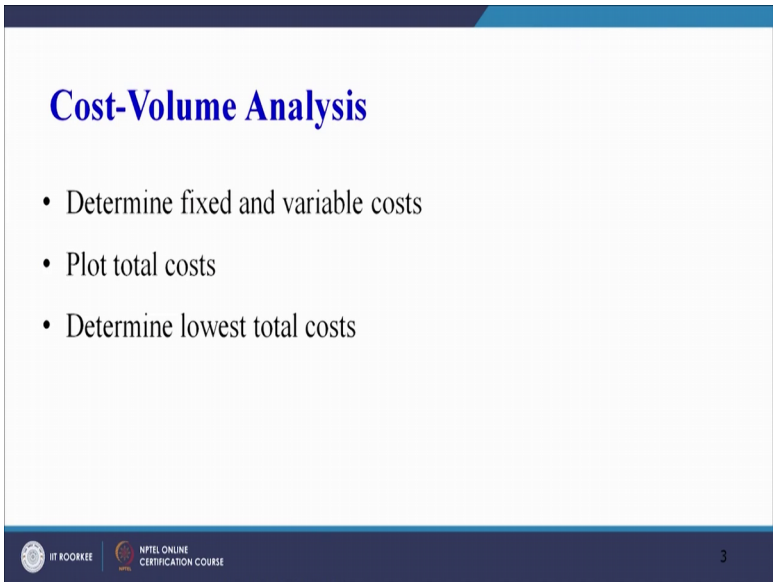

Now, in cost volume analysis we require the fixed and the variable costs associated with that particular location, we have to plot the total cost, all of us know that the total cost is the summation of the fix cost and variable cost little bit of economics is involved here. Then, we have to determine that which particular location is offering us the lowest overall cost. So, overall cost is the total cost.

So, basically what we need to do. Suppose, we have to compare 4 or 5 different locations, for each location we will see that what will be the fixed cost of setting up a plant there? What will be the variable cost maybe a monthly cost that is associated with a

particular location? So, for example, we have 4 locations A B C and D. So, for location A, what is the variable cost? What is the fixed cost? Similarly, for locate B and location C and based on that we calculate the total cost for that location and then we try to have as you see in the title it is cost volume analysis. So, we have to see the volume also, that how much volume we are producing because as the volume will change the variable cost will change and as the variable cost will change the total cost will also change. So, we have to do a cost volume analysis to figure out that which is the most optimal lowest cost location for setting up of our plant.

We will try to understand this with the help of an example and I think after the example everything will be absolutely clear to all of you. This is much similar to decision making, using the break even analysis and I think most of the engineers are most of the managers usually have a basic understanding of the break even analysis.

There also we plot the total revenue and the total cost and try to figure out that when the break even is going to happen and here also we are plotting the total cost and we are trying to figure out that which alternative is going to give us the lowest total cost, so that we can fix up our plant at that particular location. So, what can be the inputs required here for making this decision that out of the 4 alternative location, where we must fix up our plant. So, the location can be it can be New Delhi, it can be Mumbai, it can be Chennai, it can be Kolkata, so we have 4 different locations.

Now, we have to find out that where we have to put up our plant? So, what is the basic information or data required for this type of decision making? The data required is the variable cost associated with that location and the total cost associated with that location plus we require how much volume we are producing at a particular location and then we can calculate the total cost and compare based on the total cost. Now, let us quickly take an example before going to the problem let us try to see what are the assumptions involved in the cost volume analysis.

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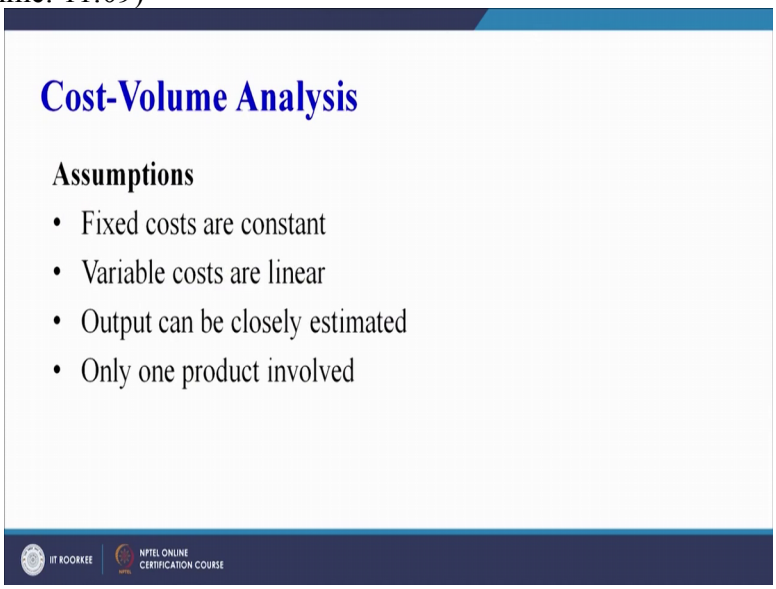

Now, the assumptions involved are the fixed costs are assumed to be constant, the variable costs are assumed to be linear. So, there is a linear variation not the quadratic or a polynomial variation in the variable cost, the output can be closely estimated and only 1 product is involved. So, the product mix is not involved. So, we are doing this calculation for a single product only.

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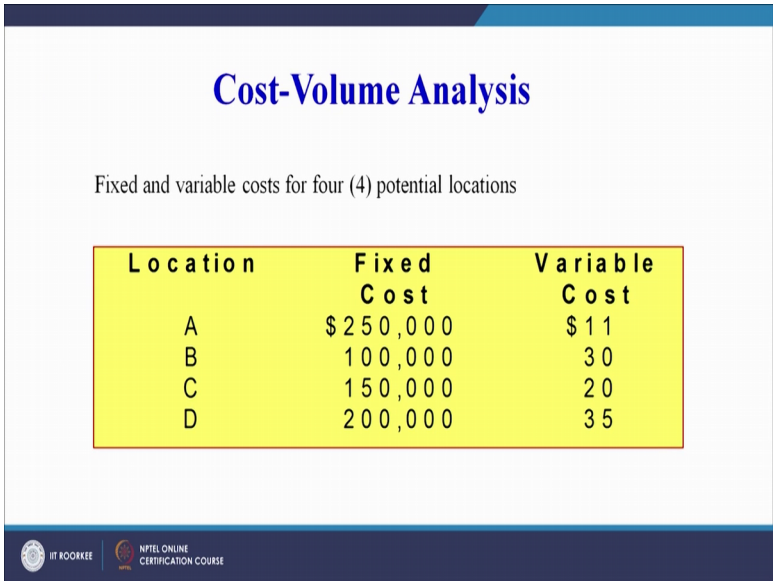

Now, let us take an example the cost volume analysis example. So, fixed and variable cost for 4 potential locations are given on your screen. So, you can see the locations we

are identifying as A B C and D and the fixed costs are given in dollars. So, we have 250000 dollars for location A. So, the fixed cost for location D is 200000 dollars.

Similarly, the variable cost for location A is dollar 11 and the variable cost for location C is dollar 20, so this way we have a table, we have the information available. Now, what is missing here, for making a decision you see the name of the, or the title of the slide that is cost volume analysis. So, we have fixed cost, we have variable cost, now what is missing? The missing part is the demand or the volume, so the volume is missing. So, we will do the total cost calculation based on a fixed volume only.

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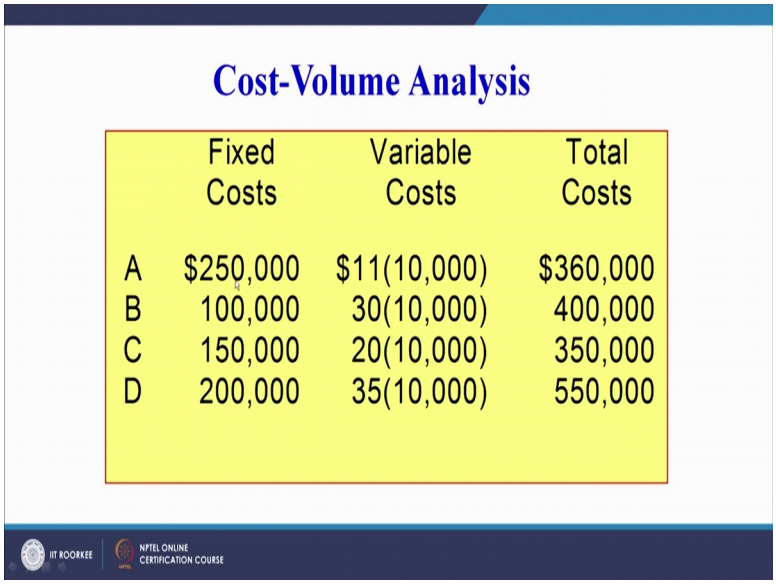

So, here you can see the fixed cost is dollar 250000 for location A, variable cost as was given in the previous table was dollar 11, but we are assuming for comparison purpose the demand as 10000 or the volume of production as 10000. So, this is a volume of production or volume 10000, 10000, 10000 and 10000 and we are calculating the total cost. So, here we can see that location C is giving us the overall minimum cost.

So, we can say that if we have to produce 10000 products, therefore, that the location C is most advisable, why? Because the overall cost or the total cost for location C is minimum, but there is a condition that 10000 products have to be produced. So, we can see that when the volume will change, the costs will also change because it is being multiplied with the variable cost and if the cost will change our decisions may change.

So, we have a plotted the variation of the cost with the variation of the volume. So, we have taken volume on x axis and the total cost on the y axis.

So, we are not plotting the fixed and the variable cost, but we are plotting the total cost on the y axis and on x axis we are taking the volume and then we are trying to see that what is the maybe break even volume beyond which may our location may change, may be up to a particular volume may be as in this case 10000. So, if 10000 volume location C is giving us the best total cost or the minimum total cost, but if we change the volume the location may also change or let us try to see the effect of location.

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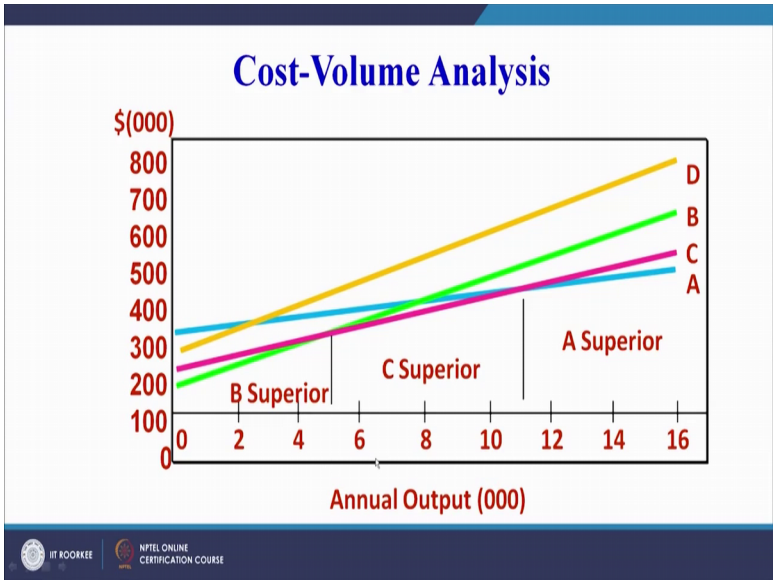

So, on your screen you can see the annual output or the volume of production is given in 1000. So, this is 10000, so we have seen in 10000 approximately that pink colour line you see, pink colour line is representing C. So, the pink colour line representing C at 10000 is giving us the minimum total cost. So, on y axis we have the total cost and on x axis we have the volume.

So, cost volume analysis if we do, so for C we are getting the minimum cost, as you can see in the table also and A is also near about the same only it was 350000 if I am correct. So, it is 350000 and A is 360000, so we can see A and C are very close if we are producing 10000 products. So, the annual output is 10000. So, prior to that, if it is less than 10000 C is superior, but less than maybe 5000 products we can say B is superior.

So, if we do this cost volume analysis and we can forecast from where do we get this number because we have to take a decision that where we must locate our facility and that is not dependent upon the volume or the products that we are going to produce. So, from where we will get this number that how much will be the sales? We have already covered that, we have seen the qualitative methods and the quantitative methods of demand forecasting.

So, we can make a forecast we can calculate that what is going to be the output and based on that output then using that number we can do our calculation, but sometimes the forecast also may not be accurate and therefore, a combination has to be used we have to see the other factors affecting the plant location also that we already covered in lecture or session 2, as a session 2 of this week I am talking about and in session 3 of this week where we have see why, what are the facilities being offered by the government of Uttarakhand, for setting up a facilities and setting up factories in the state of Uttarakhand. So, we have to make a combined decision based on the factors as well as the calculations and then we have to take a final decision that where our facility must be created.

I think cost volume analysis is clear to all the learners that we need 3 input data sets. So, this 3 input data sets are, the first data is the total the fixed cost for a particular location, the variable cost for a particular location and the volume that we are trying to produce in that particular location. So, if we have these 3 quantities we can plot the total cost curve as it varies with the volume of production or the annual output and based on that we can take a decision that which location is more suitable for making or setting up a our plant or setting up of our factory.

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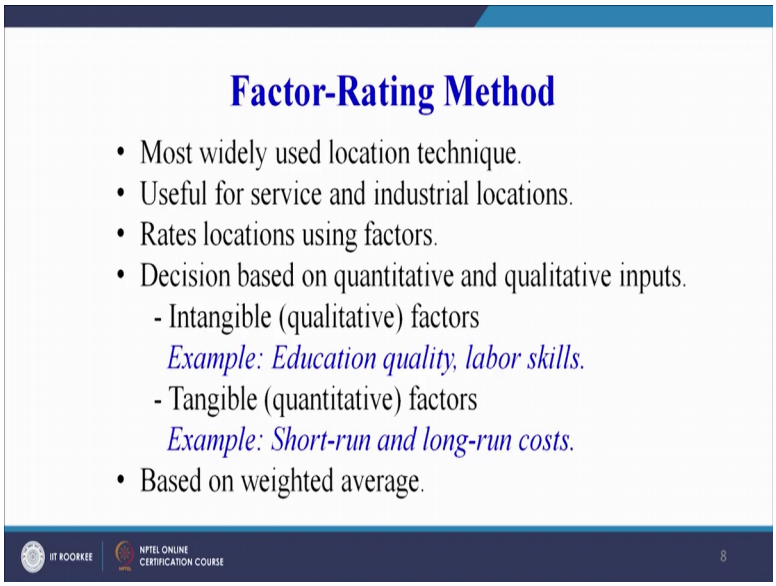

Now, the second method as we can say is a factor rating method. Here, we identify the factors that are going to governor decision and then we assign weights to these factors and then we give may be numbers to a particular factor and then multiply the weight and the number or the assigned number to the or the assigned rating must say because factor rating method the terminology is very, very clear.

There will be few factors and the factors will be weighed as per their relative significance and then a rating will be given for example, maybe suppose you are travelling by train you have to rate the quality of your travel many times, when I travel on train I get a call from the call centre and they ask me to rate the quality of food served and the quality of timing of the train on a scale of 1 to 5.

Similarly, we do the rating sometimes we feel certain scales from 0 to 10 or 0 to 100 or 0 to 5. So, that is basically the rating that we give and the factors, are the factors that we identify based on which we are going to make our decision. So, factor rating method 2 words I think I have tried to explain what is factor and what is rating?

Now, in this method how we are going to use this method for selecting a location let us quickly go through that. So, most widely used location technique, useful for service and industrial location is just a background, rates locations using factors, now decisions based quantitative and qualitative inputs both type of inputs can be incorporated, intangible is qualitative factor for example, education quality, labour skills, the labours

skills we can rate we in the questionnaires that from 0 to 5, how do you rate the labours skills available in our particular location?

I may do my calculation may be on my judgement, I may a feel that yes this is a place where there are so many number of school, so many number of colleges, so people would be more or less literate, that their basic education level will be up to this level. So, based on that I will give a rating; the skill set maybe between 3 and 4, if I am asked to rate between 0 and 5.

So, there is a qualitative education quality or labour skills can be a quality can be a qualitative parameter, but it can be rated I can give a rating based on my own judgement and then there can be quantitative parameters for example, short term and long term cost. So, cost we can quantify that what is expected expenditure in 3 months time? What is the expected expenditure in 3 years term? So, that is short term long term cost can be quantified very easily.

So, this method is based on the weighted average, so that we will try to understand with the help of an example. So, primarily there are 2 words here, there will be a list of factors which are influenced, which are going to influence our decision and then we have to provide a rating to these factors and then this rating will be multiplied by the weight assigned to a factor and we will do the summation for each location and figure out that which location is going to give us the best location for setting up of our facility.

Let us, try to understand this, because speaking so many things qualitatively may not be understood in that well manner, but if we see the data and the mathematics involved it is easy to understand. So, let us now see how we do this method, first of all we have to list the relevant factors.

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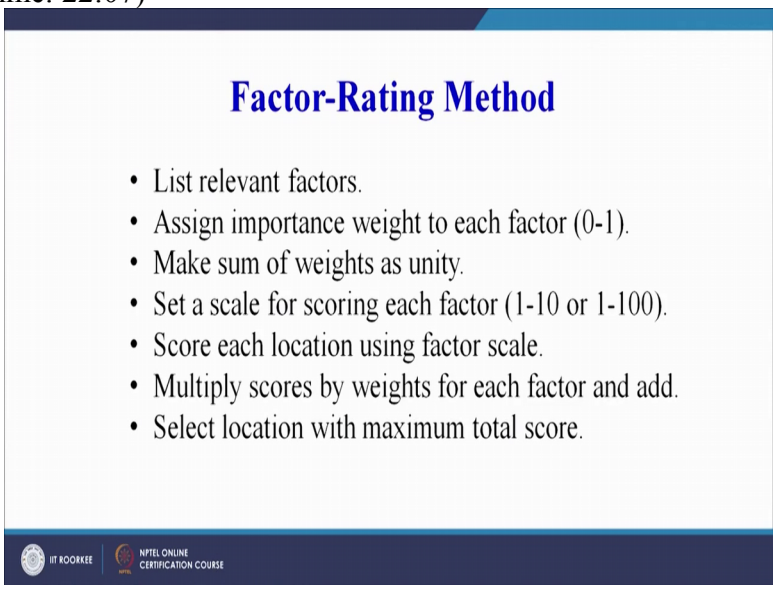

Now, relevant factors can be the nearness to the source or the nearness to the raw material or the nearness to the market, so that can be 1 factor, then the cost involved in transportation can be another factor. So, these are first we have to list the relevant factors based on which we are going to make our decision, then assign importance weight to each factor. So, that can lie between 0 to 1 and then make some of weights as unity.

Now, suppose I am taking 3 factors and I feel that this is the most significant factor. So, I can assign a 50 percent weight to that factor, so I will assign a value of 0.50 to that factor, then little less significant factor I can assign a weight of 0.3 and then the remaining 0.2 to the 3rd factor. So, 0.5 plus 0.3 plus 0.2 will come out to be 1.0, that I have to ensure.

Set a scale for scoring each factor that is the rating that we have to give. The scale can be from 1 to 10 or 0 to 10 or it can be from 0 to 100 or 1 to 100 maybe 1 to 50, that we have to decide set a scale, score each location using the factor scale. Now, for each location we have to give some values based on that, for example, nearness to market, so we if we are setting up of a, if there is a location which is very near to the market. So, we can give that nearness to market this particular factor location D is the most suitable. So, on a rating scale from 0 to 10 I will give a value of 9 to this particular location, then there can be another location on the contrary is too far from the market. So, instead of given a value of 9, I may give a value of 2 to that or a rating of 2 to that particular location.

So, we have to give ratings to each and every location. Multiply score by weights for each factor and add, so we have given we know the weights as I have already told suppose there are 3 factors each factor we have to assign the weight, then for each location we have to give the values on the scale of 0 to 10 or 0 to 100 and finally, we have to multiply the weight and the rating and then add this for a particular location. Now, select the location with maximum total score. So, let us try to see this with the help of an example, you can see the factor rating method 3 locations there are A B and C.

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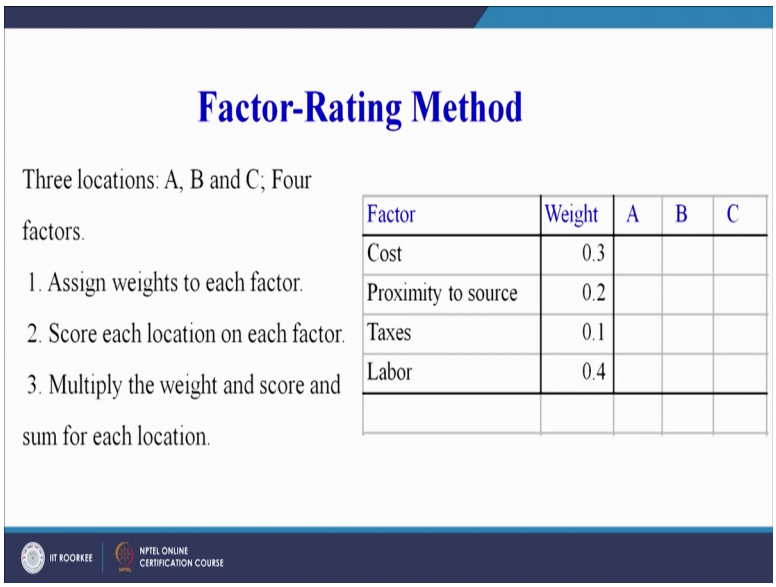

There are 3 location, the factors have been identified as the cost, proximity to the source, taxes and labour. Maximum weightage is given to labour that is 0.4 or 40 percent, then minimum weightage is given to the taxes that is 0.1.

So, first we have to do assigned weights to each factor, but prior to that we have to list the factors that we are going to consider. So, we have considered 4 factors here and then we have assigned weights to these factors based on our judgement, based on the brain storming, based on the company policy, based on the state policy, their weights are assigned.

Now, score each location on each factor. We have to set up a scale, now scale can be from 0 to 10 it can be from 1 to 100. So, based on that scale, values will be given. For example, for location A what is the score for cost? For location B what is the score for

taxes? So that, particular values we have to fill and then multiply the weight and the score and sum for each location. So, let us know see.

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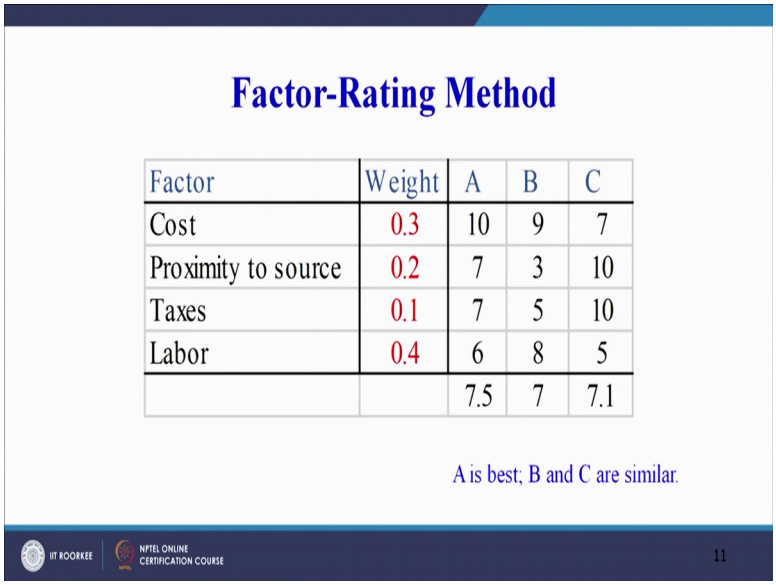

Now, here the rating is given on a scale of 1 to 10. So, we can see the weight assigned is 0.3, 0.2, 0.1 and 0.4 and the factors have been rated as 10, 9 and 7 on the basis of cost. So, from the cost point of view location A is giving a score of 10. So, which means that it can be a cost effective when we are selecting the maximum values, the maximum value is coming out to be 7.5.

So, which means when we are maximizing the thing, so from cost point of view we can say it is cost effective, from proximity to source it is close to the source and then from taxes point of view also we are saying that less taxes low cost production, so maximum profit, similarly the labour also. So, we can see this is just an example, from labour point of view labour cost can be a different factor and labour skills can be a different factor, this is just to explain that how do we do the calculations.

So, we list down the factors, we assign weights to the factors, then we see how many locations we want to compare location A B C here we are comparing 3 only, then we set a scale based on that scale we give the values like here for taxes the maximum score is given to location C and for proximity to score maximum score is again given to location C, but from cost point of view maximum score is given to location A. Then, we multiply

this like how the value 7.5 is arrived, 10 into 0.3 plus 7 into 0.2 plus 7 into 0.1 plus 6 into 0.4. So, we get this value of 7.5. So, if we compare these 3, the maximum value is for A.

So, the scale that we have set is 10 is the best and 1 is the worst. So, from 10 is the best score we have done this calculation and based on that location A is the best location and B are C are similar only. So, once we have to take a decision, based on the factor rating method we will say that location A scores may be better as compared to B and C, but it does not mean that we will select location A only based on this mathematics, we will definitely look at the other factors that we have already considered in our previous sessions and then finally, take a call that which location is going to be selected for setting up of the plant location.

So, with this we come to the conclusion of today's session, in next session we will try to figure out another method for finding out the best location for setting up of the plant facility.

Thank you.