Operations Management
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Lecture - 20
Location Evaluation Methods II

[FL] Friends, welcome to session 20 in our course on Operations Management. And currently we are in week 4 of our discussion on the course. And we have already finished our discussion for the first 3 weeks in week one we have covered the basic aspects of operations management scopes and functions of operations management, in week 2 we covered the product design and development in which we have covered the basic concepts of design for manufacturing design for assembly, we have covered value engineering, we have covered rapid prototyping, we have covered the basic aspects of ergonomics in week 3, we covered sales for we have covered sales forecasting in which, we have covered the qualitative and quantitative methods of sales forecasting and now we are incorrect week 4 we are discussing the plant location and how to decide that where we have to set up our plant.

This is a brief summary of the course till today and in this particular week we are now into the end of our discussion on plant location and this is a fifth session in week 4. And in fourth week we have covered the basics of plant location and layout in session 1, in session 2 we covered the factors governing the plant a the look facility location or the location and then we have seen the case study of the state of Uttarakhand that how Uttarakhand is promoting the industries. And in the fourth session we have covered the quantitative method that is location evaluation methods 1 and now today we are going to cover the location evaluation methods 2.

In location evaluation method one we have covered 2 method the first one was the cost volume analysis in which 3 inputs were required the fixed cost was required for a particular location, the variable cost for a particular location and then we required the volume of output or the production expected from that particular location. Based on that we plotted a curve or we plotted the data on x y plot x axis was showing the volume of production or the output annual output and on y axis we have plotted the total cost and

from there, we try to figure out that which location can give us the best results in terms of the minimize in terms of minimising the overall cost or the total cost of production.

And the second method that we have seen in the previous session was the factor rating method in which we have seen that first we have to identify the full stop factors that are going to governor our decision related to the selection of location and then we give certain ratings to these factors on a scale of 0 to 10 or 0 to 100 and finally, we multiply the weights assigned to these factors with the values or the rating that is assigned to the factors, for each particular location and then we multiply the weights and the scores and add up the scores for each location and then we compare the scores and try to select the best location for setting up of our plant.

This is what we have covered in week 4 related to plant location and today we will try to wind up will try to finish our discussion on plant location with 2 more methods that will help us to decide that where we have to set up our plant or facility. In next week our discussion will start on plant layout and once we know that where the location of our plant is going to be then with that location where which facility must be created for example, like IIT Roorkee we have specific areas for specific facilities maybe there is a specific location for hospital, specific location for hostels, specific academic area. So, within this location we have a layout of the various facilities.

So, from plant location and layout we try to understand that when we are trying to manufacturers something we have to identify where our factory is going to be located. So, from starting from the country to the state to the district to the town we have to 0 down on a location where the facility has to be created. And for that these are the tools and techniques that we are discussing in this week, which help us to make a judicious decision regarding the setting up of this facility.

And we have already covered 2 methods or 2 quantitative methods in session 4 and today we will cover 2 more methods which will help us to make this decision, but as I have told in the previous session also it is not only the mathematical values that will be used for making a decision, we will definitely take into account the other factors which we have already considered in our session 1 and session 2. And a combination of these to the qualitative and the quantitative information will be use for finalising the location, but currently today our focus has to be on the location evaluation methods and today we are

going to understand 2 more methods, which will mathematically help us to calculate the scores for different locations and this course in the meanwhile will be helping us to take a dis to take informed decisions about the location of a facility. The third method that we are going to cover in quantitative methods for identifying of locations or plant location is the centre of gravity method.

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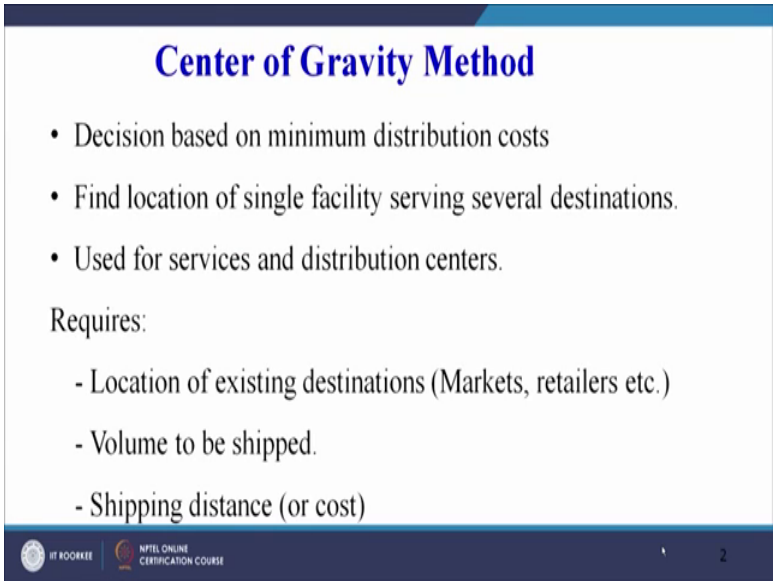

Now, where the decision is based on the minimum distribution costs. So, if you remember the previous 2 method that we have seen we have in the first method that was cost volume analysis method what was our input our input was fixed cost variable cost volume of production.

So, that method was based on the fixed and variable cost or in nut shall we must say the total cost and the volume of production. Then the second method that we covered was the factor rating method that was based on the weights assigned to each factor and the rating given to each location based on those factors. And the third method that we are covering is a centre of gravity methods it is based on the minimum distribution cost. So, we will try to reduce the cost of distribution first. So, what we are trying to what is the objective of this method we are trying to find out a location of a single facility serving several destinations.

So, basically we are trying to figure out one particular central manufacturing facility which can cater to a number of demand centres. So, we can have 8 to 10 demand centers,

but we have only one manufacturing facility from where we have to satisfy all these demand centers.

So, this is used for services and distribution centers as you are well aware that while distributing or while identifying the logistics for managing the supply chain usually, the companies try to locate a central warehouse at a position from where they are able to serve a number of maybe Regional Centers or a number of State Center.

So, basically that where location of that warehouse for distributing the product to various demand centers is very very critical and it is based on minimization of the distribution cost, now how to figure out that where this warehouse aware this manufacturing facility may be created that is going to be found out using the center of gravity method. Now it requires now what are the inputs for each and every method we are trying to find out that what is the input required, now input here required is the location of the existing destinations.

So, we need to find out that what are the demand centers and the demand centers here we are calling as the markets or the retailers. So, why we need to find out that, what are the demands centers that we are trying to serve that this facility is going to serve or this manufacturing facility is going to cater 2.

So, that is one thing we require their location second is the volume or the quantity to be shipped is another input requirement finally, the shipping distance or maybe some cases the cost is very very important. So, we required the destinations, we required the volume to be shipped to each destination and finally, we required the shipping cost or distance.

So, maybe sometimes we may try to optimise or minimise the distance that the may maybe the material or the product has to travel from the source to the destination. Now the center of gravity method is based on finding out the x and y coordinates for all the destination or for the final destination of our facility.

So, we our main objective is to find out the x y coordinates of the facility that we want to create, but for that as we have already seen it is prerequisite that we know the x and y coordinates of all the destinations that are going to be served by this facility that we are creating centrally.

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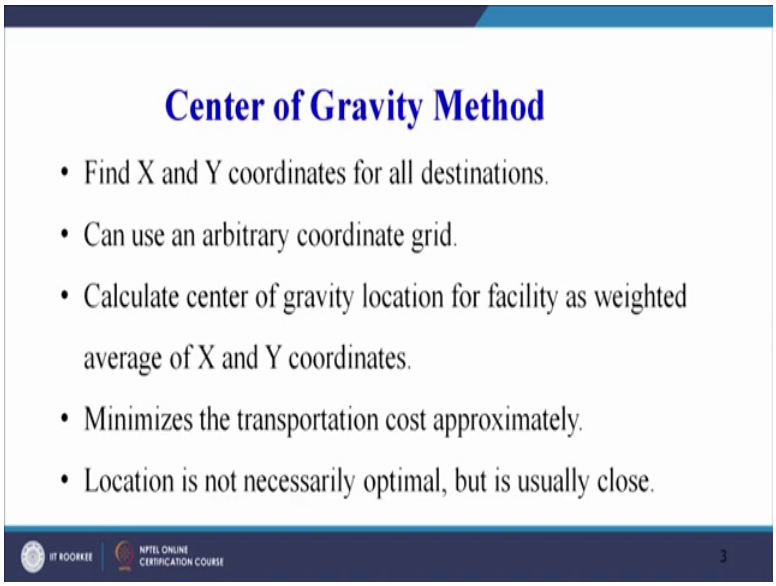

So, can use an arbitrary coordinate grid calculate center of gravity location for facility as weighted average of x and y coordinates that we will try to understand with the help of an example that, how we calculate, how we give the maybe final coordinates of the up location. It minimises the transportation cost approximately; approximately means the solution is an approximate solution it may not exactly be fitting into a exact solution, but the solution that we get because it may. So, happen that mathematically we are calculating x y coordinate, but the x y coordinate that we are getting may not be feasible form other stand point that it may be located in the hills or may be a reason which is a in habited. So, we cannot maybe which is in habitable maybe.

So, we can say that no we that facility cannot be created there. So, we have to look for some other location nearby where we can we locate this facility or locate this manufacturing facility. So, the actual ideal solution means pointing out at a particular x y coordinate, but we are not able to acquire or set up the facility.

So, we are setting up at a nearby or in a best possible location nearby to the ideal x y coordinate therefore, we have tried. So, were at the word approximately now location is not necessarily optimal, but it is usually close to the ideal scenario. So, let us try to take an example centre of gravity method we will do the calculations based on these 2 formulas as given here.

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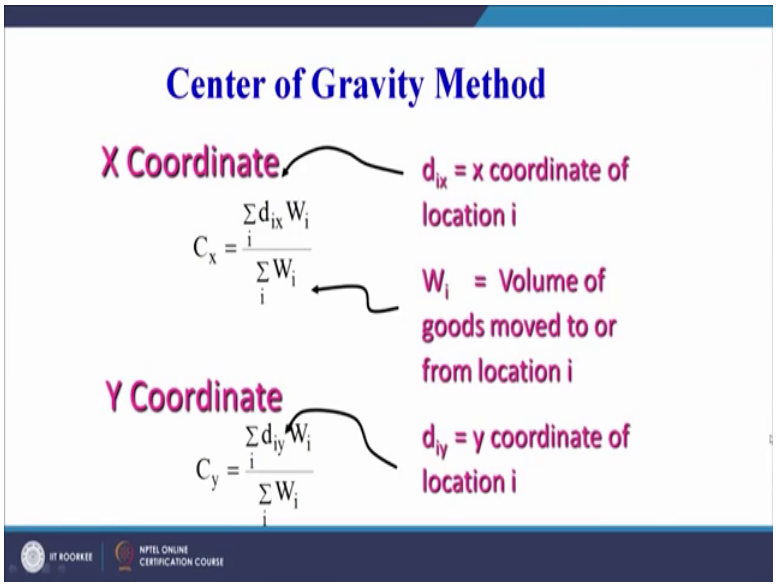

So, x coordinates for our facility will be calculated as C x and y coordinates C y the C x how we will calculate as we know what are the 2 inputs required here, that 2 inputs required here are the x and y coordinates of the destination. So, the d i x here is the x coordinate of location i and W i is the volume of goods moved to or from location I, this is the first thing in the numerator we require the x coordinate of location i.

Now, we can say we can have 5 or 6 or 7 or 8 different locations. So, I can go from 1 to maybe 8. So, this is the x coordinate of location i. Similarly W i is the volume shift that we have already seen let me go to the previous slide again and maybe this slide. So, what are the requirements here you can see the requirements we required the location of existing destination. Now existing destinations locations means we need their x and y coordinates and we required the volume to be shipped now here W i is the volume of the quantity to be shipped and sigma W i is the total quantity that we are shipping from over manufacturing facility.

So, this data will give us the x coordinate for our final destination or final objective. So, first we require the x coordinate for each location, which is to be served by this manufacturing facility we require the volume to be shipped to that particular destination that is destination i suppose we call our manufacturing facility as m. So, how much volume we need to shift from m to i that is location one that volume is known to us then how much volume of product we want to shift from m to location j that must also be

known how much volume we want to shift from m to location z that also must be known to us.

So, from this central location where we want to set up our facility how much volume we are shipping or we are sending to different locations that must be known to us. As well as we must know x y coordinates of location i x y coordinates of location, z x y coordinates of location x. So, all that must be known to us. So, here we can see once we know this data we can very easily calculate the x coordinate of our objective the objective is to locate a facility where we are where we want to establish our warehouse or where we want to establish our manufacturing plant.

So, x coordinate can be calculated using this equation similarly y coordinate can also be calculated only thing that will change is y coordinate is that we have to use the y coordinate of our destinations. As I have taken an example of 3 different destinations we need to have the y coordinate of all the 3 different destinations. And then we can based on that we can calculate the y coordinate of our manufacturing facility. The volume as I have already told as in calculation of x coordinate we require the volume of products to be shipped to the various destinations from this facility that we are trying to create.

Now, I think some of the learners maybe little bit confused what I have explained till now I although I have tried to be very very simple in giving my explanation, but I think that things will become crystal clear if we see this example.

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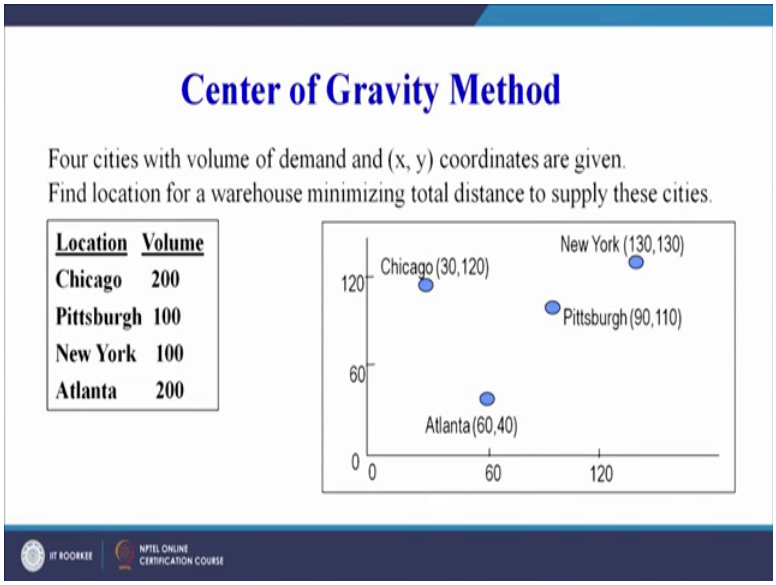

If we are attemptive and if you focus on this example the things will become absolutely clear. Now you can see we have taken an example where 4 cities there are 4 cities maybe in US, Chicago, Pittsburgh, New York and Atlanta. So, 4 cities with the volume of demand and x y coordinates are given. The volume of demand you can see here is given Chicago has a volume 200 requirement Pittsburgh 100 New York 100 Atlanta 2000. And on x y scale all the 4 coordinates are given the blue circles or ovals that we have on the screen are representing the locations.

So, we can see Chicago x is 30 x coordinate is thirty and y coordinate is 120 similarly Pittsburgh x coordinate is ninety and the y coordinate is 100 and 10. So, we have the x and y coordinates for all the 4 locations. Now find the location for a warehouse minimising the total distance to supply these cities. So, we have to minimise the total distance here we are not focusing on the cost involved here. So, we are seeing that we are of objective is to minimise the total distance and find out the optimal location which will minimise this total distance in order to supply to these 4 cities so now, how we will calculate.

So, what is our final answer going to be the final answer going to be is the x and y coordinates of that location, which will minimise the total distance to be travelled for serving these 4 different destinations?

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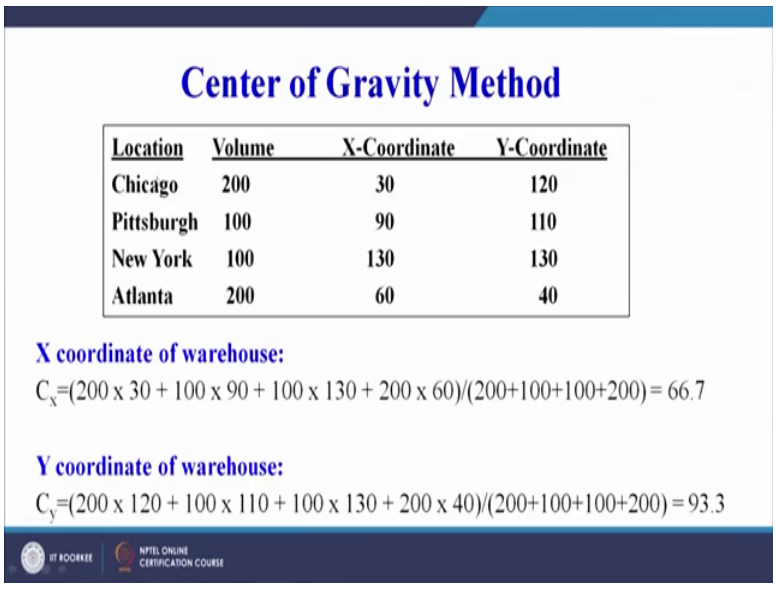

Know how we will do the calculation we can see x coordinate for Chicago is 30 y coordinate is 120 here we can see Chicago x coordinate 30 y coordinates 120. Similarly Pittsburgh, New York and Atlanta x and y coordinates are known to us volume also is given to us.

So, x coordinate of the warehouse or the manufacturing facility can be very easily calculated in the equation as we have seen that we have to multiply the x coordinate with the volume. Similarly and this has to be a summation has to be done for all the 4 locations here we can see again that I is the location i is the location here and summation i. So, in our case we have 4 locations. So, we go we say i goes from one to 4 and here also we wills add the demand for all the 4 locations.

So, here 200 is the demand and it is multiplied by the x coordinate plus then x coordinate for Pittsburgh is 90 the demand is 100 then the x coordinate for New York is 130 demand is 100. Similarly 60 and 200 and then it is divided by the overall demands overall demand is 200 plus 100 plus 100 plus 200 comes out to be 600. So, then we get the x coordinate of our warehouse or the manufacturing plant.

Similarly we can calculate the y coordinate here the y coordinate will be multiplied by the volumes of 120 into 200 120 into 200 110 into 200 1 the 10 into 100 and then summation divided by the overall demand. So, the overall demand is again the same and we get the y coordinate. So, we can plot this x and y coordinate on x y scale and try to find out that whether this is going to give us the minimum distance that is our objective. So, here you can see when we plot this 67.7 and 93.3 this is the location.

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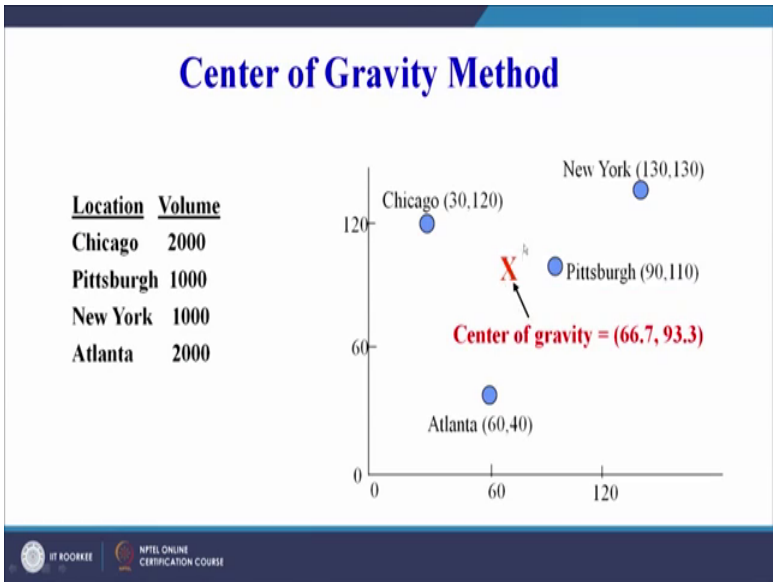

So, this is the location which will optimizer minimise the distance travelled from one place to another.

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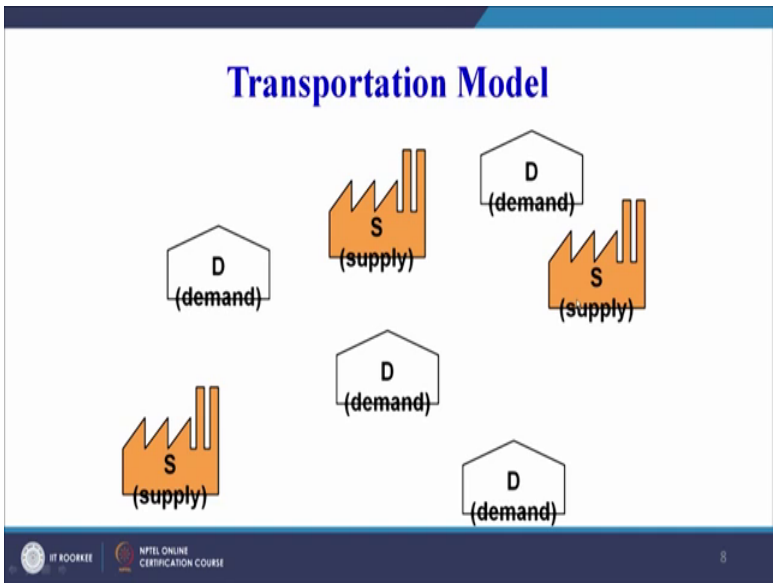

Now the next method that we are going to use is the transportation model. So, we are not going to solve any problem using the transportation model, but we are going to find out that what are the different methods that can be used to serve this type of a problem, if you remember in the previous method that we have seen it was one source only, we have located one warehouse or 1 manufacturing plant from where we are serving 4 different

demand centre or 4 different destinations. So, 1 source 4 destinations the problem was solved for minimising the distance to be covered by finding out the x and y coordinates of our warehouse.

But in many situations in many multinational companies we may have a different problem. we may have 3 or 4 sources 5 or 6 destinations and then we have to find out the optimal location of this sources that they are able to serve the destination with minimum possible cost. So, here we can see on your screen there are 3 supply centers or 3 manufacturing facilities S S and S and there are 4 demand centre this is one demand centre another demand centre third and fourth.

So, there we try to use the transportation model that is usually taught in the course on operations research as I have already highlighted this point maybe in today's session or in the beginning of the previous session. So, basically we try to figure out that what can be the most optimal solution to this transportation problem for minimising the overall cost. So, we can see that what are the inputs required for solving the problem using transportation model.

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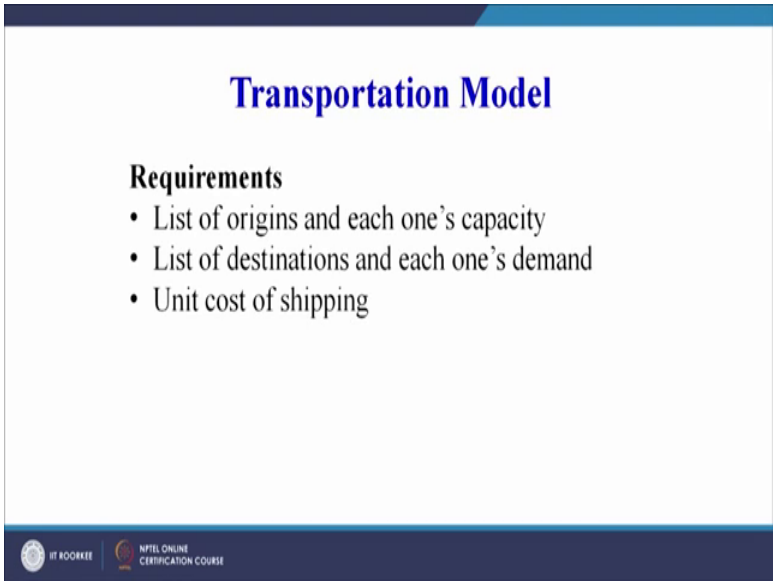

The requirements here are list of origins and each once capacity. Now origins are the sources or the manufacturing plants, which are producing the product, we must know that what are the locations? From where we are going to serve the various demand centers.

So, we need to identify their locations maybe again x and y coordinates are required. Similarly we must know what is the capacity what is the production maybe capability? Capability of a particular source that is one input that is required for solving a problem.

Second input is the list of destinations we must know that; what are the various demand points that have to be served by these sources or this manufacturing plants. So, we need to identify the manufacturing plants we need to identify the markets or the demands centres and location of each one of these as x and y coordinates must be known to us then we must know that what is the demand of each destination.

So, that we must know the capability and the demand otherwise what can happen there can be a mismatch. So, we need to know; what is the total availability of products at the various sources. What is the overall demand at the various demand centers. So, these are the 2 things that are required to solve this transportation problems and then the third thing that we must know is the unit cost of shipping and which has to remain constant.

So, if we are changing the unit cost of shipping for each and each demand and each destination sorry each demand and each source. That from source a to destination b the shipping cost is suppose one and from source b to destinations supposed d the cost is 2 or maybe is the cost is changing that the problem becomes very very complicated. For usually it is advisable that when we are solving a problem using transportation model the cost must remain constant between thus various sources and the destination, because that is the basic purpose with that is basic objective of our decision making the solution is found out which minimises the total cost of this problem.

So, as I have already told the transportation model is based on certain assumptions as one of the assumptions, I have already highlighted that is a the shipping cost for unit is the same that we have to ensure.

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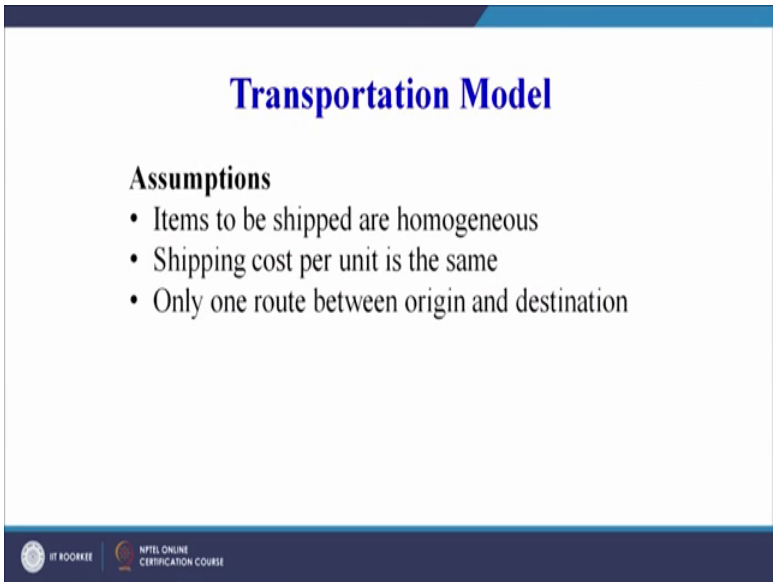

Secondly, the items to be shipped are homogeneous similar type of items and only one root is available between the origin and the destination. So, we cannot have multiple routes between one origin and one destination only one route is there between the origin and the destination.

Now, the transportation model is based on this is a generic transportation model that we are trying to understand today, we can have a specific transportation model also like here in generic model we have m number of sources m number of factories I can say, n number of destination maybe n number of warehouses from where the warehouse is where the product is going after being manufactured in the manufacturing facilities or manufacturing plants.

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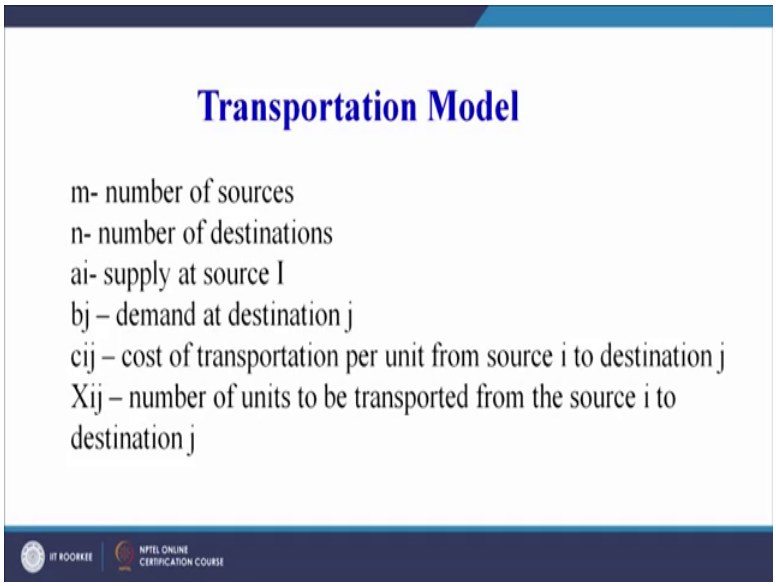

So, we have m number of manufacturing plants, we have a number of warehouses we have a I as the supply at source I, then b j is the demand at destination j. So, now, b j is the demand that destination j. Now suppose j can go from 1 to 5 so, we can have 5 destinations and supply at source I means that we can have 4 sources.

So, it can go from I goes from 1 to 4 j can go from one to 5. So, we have 5 destination 4 sources as a specific transportation problem then we have c i j cost of transportation per unit from source I to destination j. So, we require the cost data for each transportation from source I to source j and x i j is the number of units to be transported from the source I to destination j.

Now, you can see that with this generic problem we can convert to a specific problem and then we can solve it using the various methods that have been used by various researchers and scientists in as well as engineers in solving this type of problems. Now transportation problem maybe can be summarised in a way that we require that how many sources are there or how many factories are there, how many demands centers or warehouses are there, then we need to understand that what is the demand at each warehouse or demand centre, what is the capability of each source, what is the unit cost of shipping from each source to each destination. So, all these data can be clubbed and put into a tabular from like these.

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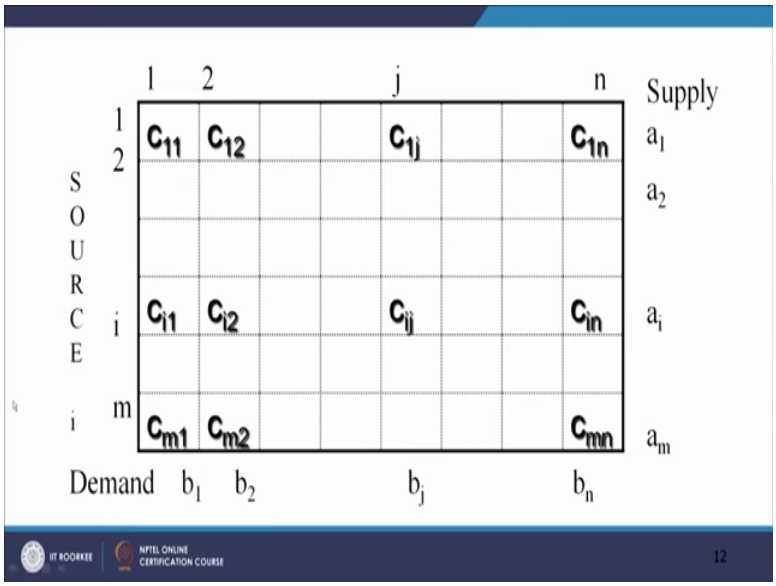

So, we can have sources as we can have generic 1 2 m sources then we can have number of destinations from 1 2 n then we have supply a i as we have seen that what is the capability of each source and b 1 is the demand at each destination.

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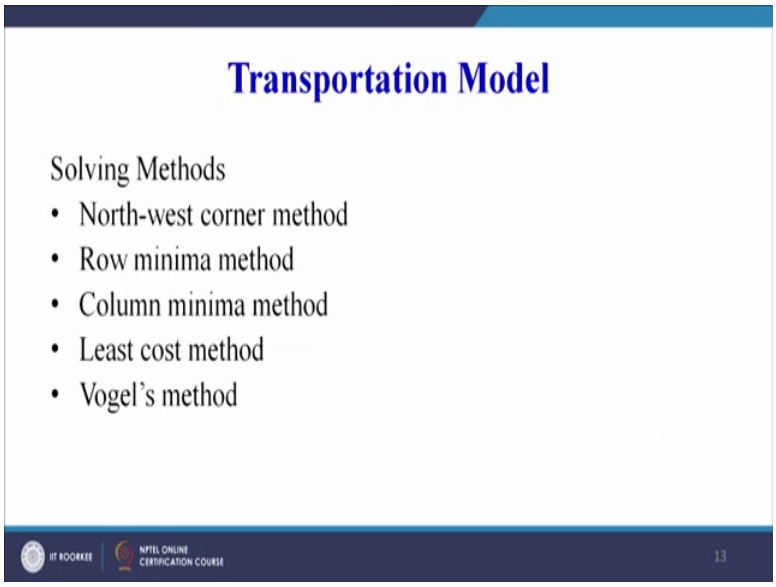

So, we can fill these values and finally, the problem can be solved using number of different techniques. To name some of them row minima method is 1 column minima method is another technique least cost method Vogel's approximation method is there then nor northwest corner method is there.

So, there are number of methods because of the positive of time we are not covering in detail, because we had 5 session of half an hour each for this maybe topic of plant location and today we are winding up this week's discussion. So, I will advise each one of you each of the learners to at least learn one method of out of these 4 or 5 method and try to solve a problem using the transportation model for finding out the best location for our manufacturing facility.

So, with this I conclude today's session as well as the discussion for this week on plant location. In next week our discussion will be on the plant layout and we try to we will try to see that what are the different types of plant layout, what are the different types of sequence or the flow diagrams and how or what type of layout can be used for which type of manufacturing activity.

Thank you.