Decision Support System for Managers
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Module – 04
Lecture - 17
Decision Making for Warehouse Location (Contd.) Centre of gravity; Ardalan Heuristic and Transportation Cost Models

Hello and welcome to "Decision Support Systems for Managers"! We are into module-4, 'decision support systems for materials management' and lecture-2 of module-4. Now, at the beginning of this module that is in lecture-1, in the previous lecture, we have mentioned that earlier, this entire warehousing operations was segregated into two functions; one is the warehousing decision as such, and the second one was the function of the materials manager.

But today with tremendous advancement automation in the warehouses etcetera, one person is enough to carry out both the functional activities, and that person in some cases he is called as the warehouse manager, in some cases, he is called as the materials manager; ok. But materials manager is a very-very old term; it has been continuing since about 100 years. So, we sometimes go with it; ok. So, our today's activity or today's effort of this module is decision support systems for the materials managers; ok.

Now, the first decision that a materials manager or warehouse manager has to take is decision on warehouse location. In the previous lecture, we had mentioned that all over the world there is tremendous focus a tremendous stress on, can we do away with warehouses, number 1? If we cannot do away; if we cannot delete or eliminate a warehouse, can we reduce the size of the warehouse; ok?

So, all over the world these two things are going on and on, that is why there is a totally renewed look on forecasting, on transportation models, route optimization, so all of these activities new focus is aimed at whether we can reduce warehouse space or whether we can eliminate a warehouse altogether; ok.

You see take a simple example. If your demand is stable all throughout the year and if your production is also stable all throughout the year, we can to a great extent

synchronize the production with the demand. And if we can synchronize the production with the demand, then perhaps theoretically we might not require a warehouse.

We will require various, in reality; we will require lesser much-much lesser warehouse space, just to keep some buffer stock, to take care of some sudden discrepancies, emergencies, etcetera. But theoretically if we can synchronize the demand and the demand and the production, then there is no requirement of any warehouse.

When can you synchronize demand and production? When your demand is stable throughout this year and when your production is also stable. But you will say production can be stable?

No, production may not be stable. Certain raw materials are not available throughout the year it is available only in certain times of the year. So, production will have to happen during that period, and then it will be sold throughout the year. Certain products demand only in certain seasons, for example, winter garments ok, orange juice, all the juices ok, demand is only during certain times of the year.

So, you see so demand supply if they can be synchronized, there is theoretically no requirement of any warehouse. So, we had dealt with these in the previous lecture. And we had given you two structured what models of warehouse location ok. One was factor loading, second was the break even method of warehouse location; ok.

Now, factor loading was a purely structured decision that is what are the factors involved etcetera. To some extent, what part of this factor loading model was semi-structured, it was semi-structured in the sense that opinion, it was based on opinion of the people who are in this trade.

Then, we went into break even. Break even again was mostly structured, little bit semi-structured, because we wanted to know a range of outputs within which a particular warehouse system is feasible ok. Now, today we will do three more such warehouse location models. They are pretty simple one is centre of gravity, next is Ardalan heuristics and the third one is transportation cost models; ok. Let us proceed.

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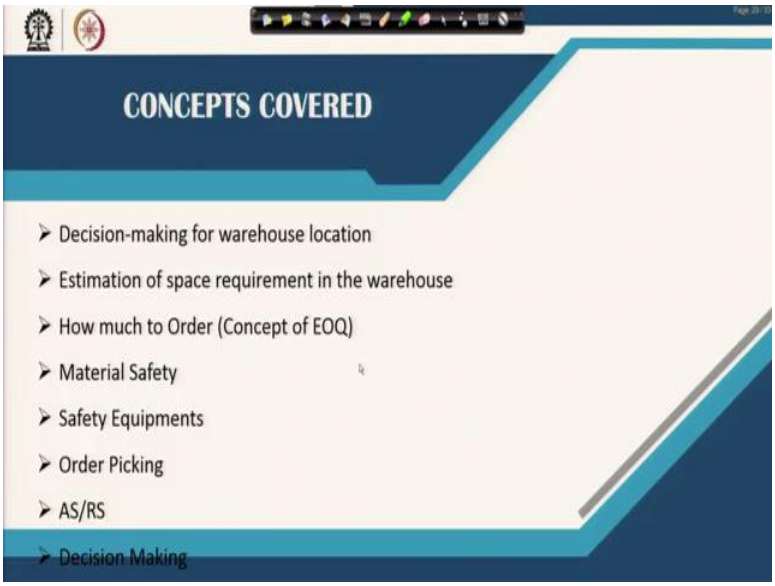

You see, this was the content that we plan to cover in this module.

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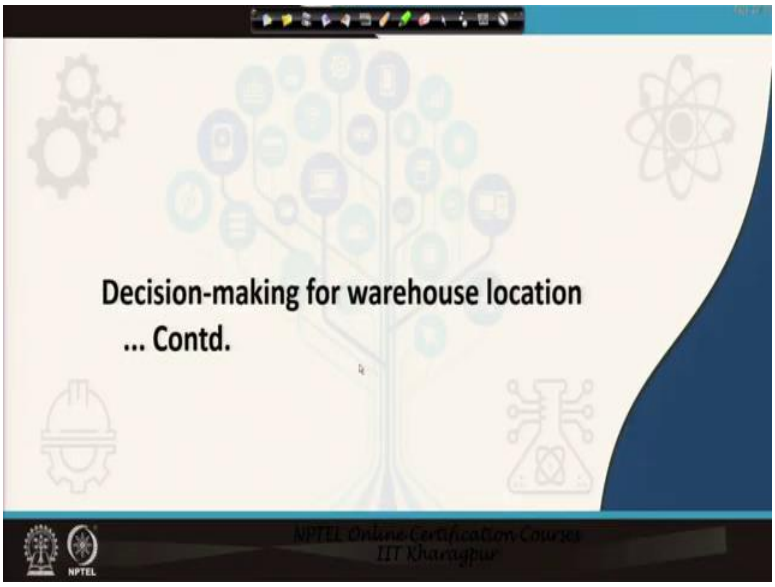

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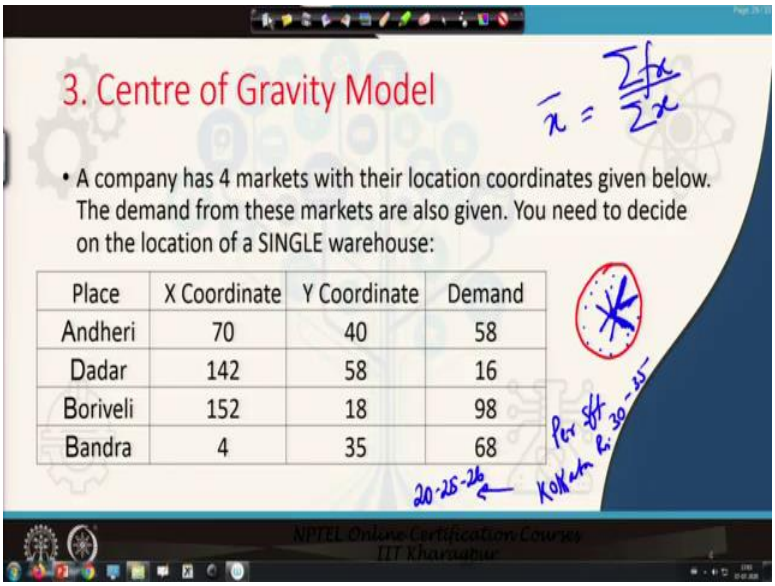

And the first model in this is centre of gravity model ok. Centre of gravity by the very name of this, you have understood the very name of this is a pretty old model. The very name, by the very name of this, you know that if this is your total area, this is the centre ok. So, centre of gravity model is just this.

Again I repeat, what does it mean? That if so now let us bring it down to the models of warehouse location that means, these are the demand points; these are the demand points. Assume these are the small this is a big city Delhi, Mumbai, Kolkata, Madras, and these are the demand points within the city, but you want to have only one warehouse in the city. You cannot have so many warehouses in the city that is costly.

As of today cost per square feet of a warehouse in Kolkata within the city; within the city is about rupees 30 to 35 per square feet. And if you are in the highway, it will go up to 20 to 25 to 26 rupees per square feet ok. So, it is very costly.

So, imagine you are having a very-very small warehouse, just a two room apartment type of a space 1000 square feet. So, now, you multiply by 30, you are paying rupees 30,000 rents per month for warehousing ok. So, it is very-very costly fare. So, you do not want to have so much of warehouse space within the city. So, you want to have only one warehouse space. So, this will be somewhat, what is the basis of having this warehouse space?

This basis of having this warehouse space is distance multiplied by the demand, or the load into distance something like your frequency calculations that you have done in school summation f x divided by summation x, and you got a mean right, so summation f x by summation f something like that. So, it takes care of how many what is the demand and what is the distance bit from a particular point to the this particular demand point ok. So, this is what is centre of gravity.

We will do one problem and you will understand ok. What does it say? A company has 4 markets with their location coordinates given below. The demand from these markets are also given. You need to decide on the location of a single warehouse ok. So, you have been given 4 market points; you have been given 4 market points; if you see they are Andheri, Dadar, Boriveli and Bandra, you have been given 4 market points.

And the location coordinates that is the X and Y coordinates are 70, 40 ok, these are the location coordinates. And these are the demand from Andheri, from Dadar, from Boriveli, from Bandra ok. So, these are the demand points. Now, so what is our objective? Our objective is to have one single warehouse location which can cater to these.

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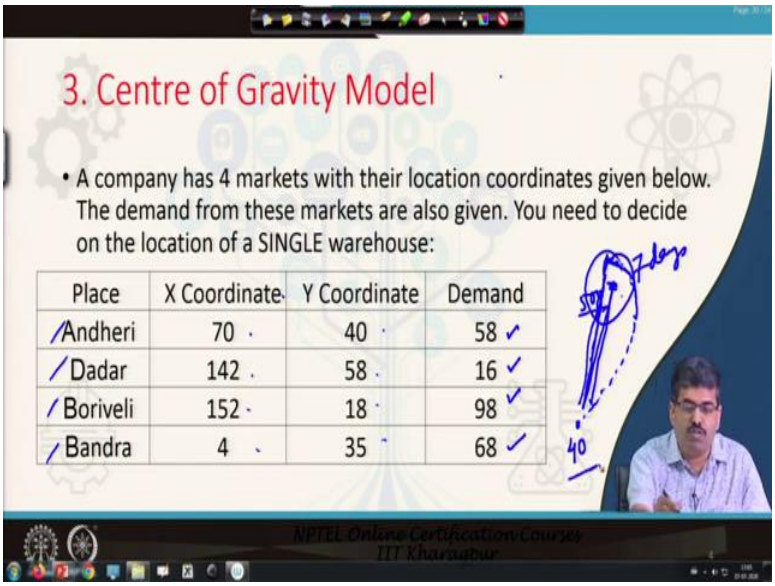

Now, if you see; now, if you see; something that here the; if this is your demand point, these are your demand points; ok. This one at this point you have 500 units of demand, these are your demand points ok, and at this point you have only 40units of demand.

So, logically as a simple lay person simple, but lay person this point has 500 units of demand; every 7 days this point has 500 units of demand and every 7 days this point has 40 units of demand, so where will you locate the warehouse? Logically you should locate the warehouse very near to this place because otherwise every 7 days you will have to keep on transporting your goods to this distance, again the vehicle comes back; again go again come back, etc.; right; ok.

So, ideally it should be closer to this point that part that location part is taken care of this X coordinate, Y coordinate and the demand part is basically as we are mentioning 500 units of demand and 40 units of demand. So, how do you; so how do you solve this problem? Right. As we mentioned that there are 4 places; Andheri, Dadar, Boriveli and bandra, X coordinate and Y coordinate, and the demand; right.

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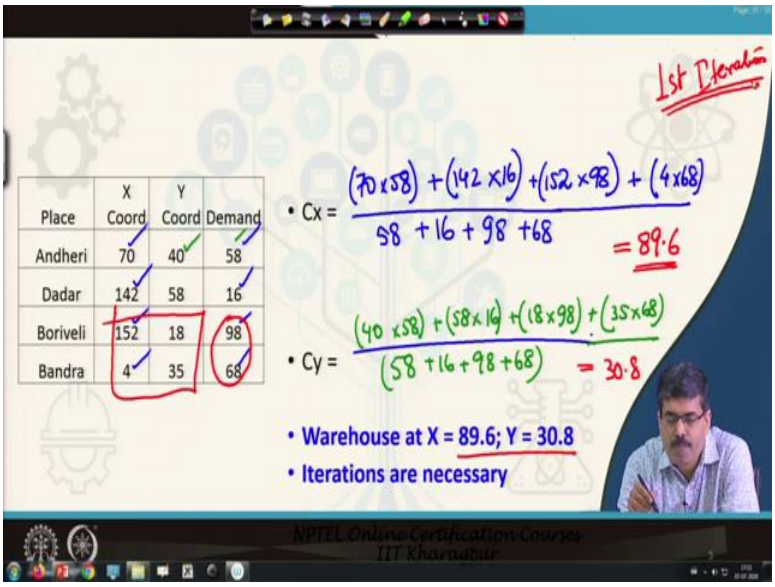

This is the same problem we have just miniaturized it, check up at the left hand side the same table is produced; ok. How do we solve this problem? We want to get as we mentioned right at the beginning; we want to get this was my location; we want to get a central point.

Now, this central point may not be at the centre exactly as we mentioned right now. It will be more shifted towards the place where there is more demand agreed, it will be more shifted towards the place where there is more demand right; ok. So, it will be

somewhere here or somewhere here, etc; it is not necessarily at the centre that is what we mean; ok.

So, what did we say centre of gravity model it is summation f x by summation f right ok, what did I write in the previous slide, I forgot let us go back sorry, there was an error here. Summation f x by summation f right, right yeah; I was thinking of something else sorry yeah, so now. So, here what do we do 70 into 58, let us write it down 70 into 58 plus 142 into 16 plus 152 into 98 plus 4 into 68 right divided by ok, yeah, so that stands corrected, because I maybe I was just looking at something else. So, summation f x by summation f; right; ok; so yeah.

So, this is this is my formula, this is my formula just by looking at it yeah ok. So, as we mentioned it is 7 70 into 58 plus 142 into 16; 152 into 98 and 4 into 68 whole divided by 58 plus 16 plus 98 plus 68. What you will get, you will get an answer that is that is 89.6. Now, what is Y? Let us go back to Y, Y is what let us use a different colour yeah. Y is 40 into 58, so Y coordinate 40 into 58 plus 58 into 16 plus 18 into 98 plus 35 into 68, this whole divided by again same 58 plus 16 plus 98 plus 68, ok. What is the solution? The Y coordinate becomes 30.8; ok.

Now, if you see; if you see what did we mentioned right at the beginning, what did we mentioned we mentioned that this the location will be somewhat near to the demand point. So, if you see 89.6 and 30.8, 18 what is my highest demand point? My highest demand point is these two right. So, 89 and 30 if you look at it, it is somewhere closer to these two points ok, clear. So, this is the way we do the centre of gravity method of warehouse location.

Now, remember just a word of caution this is the first iteration with these values of 89.6 and 30.8 we move to the next iteration ok, but this is the first iteration. Normally, for a decent medium scale warehouse we can go for further refinement, but otherwise first iteration is enough.

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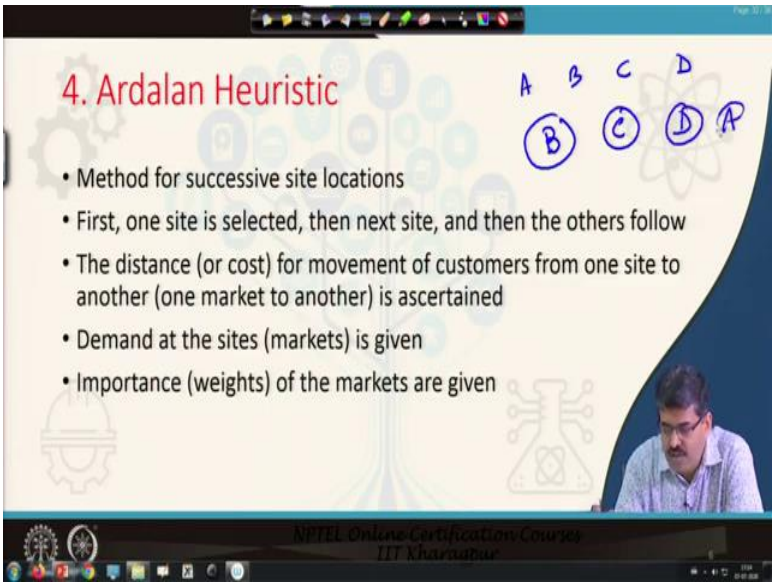

Let us go to the next warehouse location model. Now, the next warehouse location model is again is a semi-structured model it is not that much structured one ok. It is a heuristic, now Ardalan heuristic mentions this is a model that is taken care of when you have to take a decision that there are 4, 5 units that you want to set up, but you do not want to set them up all at the same time ok. Which one will you set up first, which one will you set up next, next, next, next, next?

Now, remember what are we saying; we are saying that we want to set up let say 4 units, we want to set up 4 warehouses ok. We want to set up 4 warehouses, we are not finding out the location of the warehouses that we will set up, we are not finding out the location of the warehouses; ok.

We are just trying to that location of the warehouses that location has been found out mathematically by centre of gravity, factor, rating, then your break even or any other method; total cost model, location of the warehouses is already identified, just remember let us make it very clear.

Location of the warehouses is already identified, what we are looking at in Ardalan heuristics is you have you want to have 4 warehouses location has identified, but you do not have the money or you are not sure whether your business will succeed in that area. So, you do not want to set up all the 4 warehouses at the same time; you want to space it, first one warehouse, then warehouse 2, then 3, then 3, then 4, then 5 in this way; ok. So,

you want to set it up warehouse 1, 2, 3, 4, 5 you have to set up 5 warehouses or 4 warehouses, but you do not want to set them up all together.

Location of the warehouse is it not is not done by this method, this method tells you which warehouse should come in first; this method tells you which warehouse should come in first; ok.

So, Ardalan heuristics is a method by which it tells us the sequence in which warehouses should come in. So, just let us again just tell, it tells us the sequence; ok. We have identified that we will set up warehouse A B C and D, this has come in by some mathematical way; locations are also identified.

Now, we are saying, but first you set up warehouse B, then you set up warehouse C, then you set up warehouse D, and then you set up warehouse A. Just let us go back, here what did we find that we found that my warehouse was at 89.6 and Y 30.

Now, assume that we want to set up warehouses at all these places; you want to set up warehouses at all these places. It will tell you all these, it will tell you that Boriveli, you set it up first; then go to the other, then go to Andheri, and then go to Bandra; ok.

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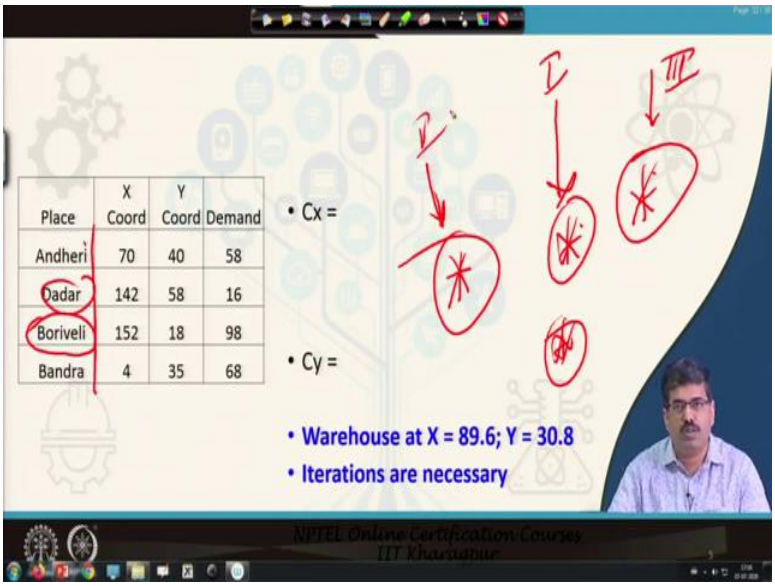

So, so what is the basic difference, here we found out the location where I will set up the warehouse? In Ardalan it is telling me that; ok, you have it is a big country, huge big country; you have identified that in the in India, you will have 4 warehouses. In India

you will have 4 warehouses, but right now you are not sure whether how much business it will pick up. So, you want to set up only 1 warehouse fr the for the time being.

Where should you set up that warehouse? Given the existing demand and other things ok. So, now so Ardalan tells you this should be set up first, this should be set up second sorry, we have put third, this should be set up second ok; so in this way right, this is what is all Ardalan is about right ok, so this is Ardalan right.

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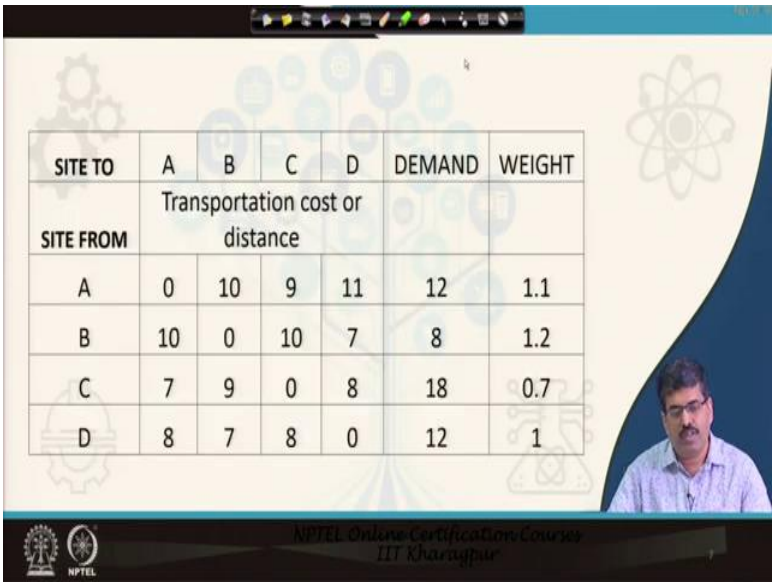

What are the how do you go about it method? First, one site is selected, then next site; first one site is selected, then next, and then the others follow. The distance or cost of movement of customers from one side to another is ascertained, so ascertain the distance; and if distance in is per unit cost is given, then that is ok.

Demand at the sites is given and the weights of the market are given. So, distance, demand and the weight very simple, but this is a you know earlier times when mathematical models were the rule, now it is a demand based actually, but that is it is for post offices and bank branches. Post office branches and bank branches, they are set up following this Ardalan model; ok; ok.

So, so this is the model assume that we have identified 4 warehouses, 4 locations; A sorry, assume we have identified 4 warehouses that is 4 locations; A, B, C and D ok; A, B, C and D we have identified. What it saying, it is saying the transportation cost or the

distance transportation cost or the distance from A to A - 0, A to B is 10 units; either 10 rupees or 10 kilometres.

Similarly, this is this is my transportation cost or distance matrix ok. This is my transportation cost or distance matrix from one warehouse to another or one market to another anything ok, anything. The demand at these locations is given and the importance of these locations is also given, ok. If this is a warehouse site the demand adjoining that warehouse or the demand that this warehouse can cater to that is given and the weights is given, so how to proceed ok; very simple, let us move; ok.

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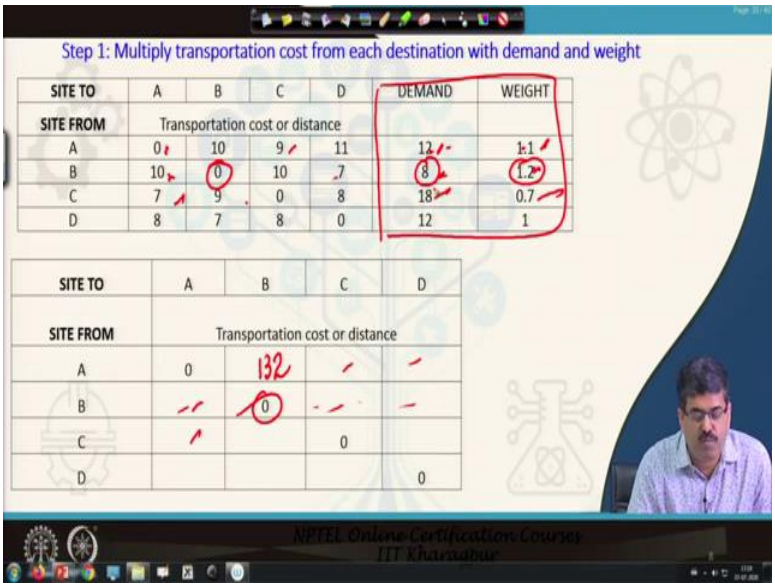

So, multiply the transportation cost from each destination with demand and weight; multiply the transportation cost of each destination with demand and weight. So, this is the transportation cost, this is the demand and this is the weight; so 0 into 12 into 11, what is the product, 0 ok. Then 10 into 12 is 120; 120 into 1.1 ok, 120 into 1.1 how much? 131 or 132 ok, just check up I am very poor at numbers calculation; ok; into yeah.

So, in this way then 9 into 12 into 11 ok; then 10 into 8 into 1.2 something will come; 7 into 18 into 0.7 ok. Then see 0 into 8 into 1.2 is 0, so fill up this matrix in this manner ok; this is the block take each cost multiplied by these two, take each cost multiplied by these two, take each cost and multiply by these two; ok; clear?

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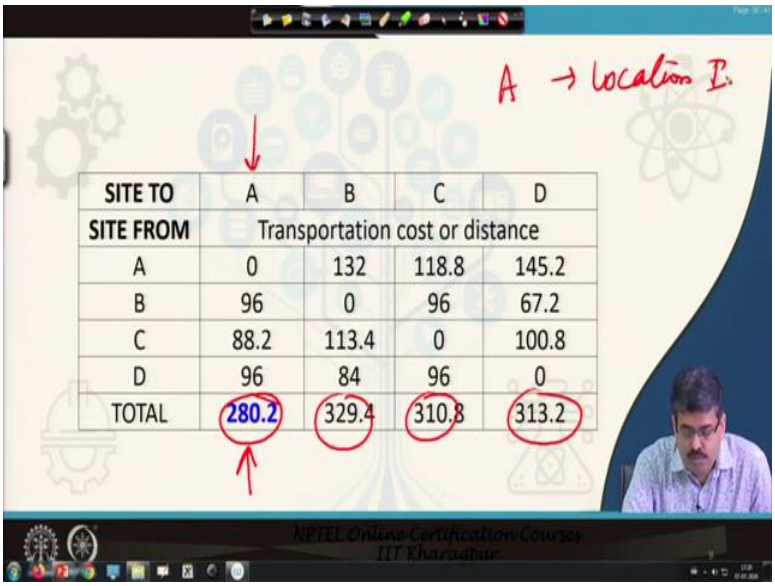

So, what matrix do we get? This is the cost matrix that you get by multiplying ok; this is the cost matrix that you get by multiplying right ok. Now, add up the columns this is the total cost of this column; total cost of this column, total cost of this column total, total, total. Which is the lowest cost? A right, so A is my location I ok, A is my location I. Now, rule A is my location I; let us proceed, then rule is already written here.

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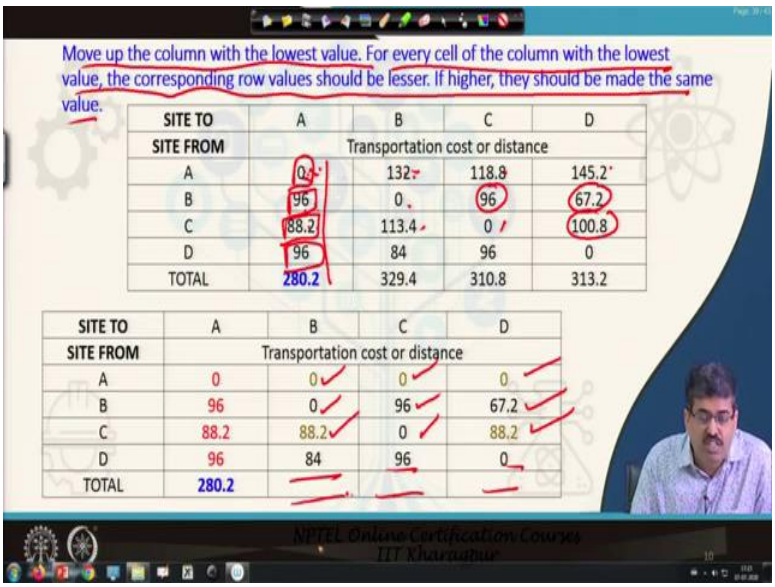

Move up the column; move up the column; move up the column; sorry; yeah move up the column with the lowest value. For every cell of the column with the lowest value, the

corresponding row values should be lesser. If higher, they should be made the same value. So, move up the column with the lowest value; 280 was the lowest value move up the column, these cells move up the row. If a row value is lesser than this value, leave it as it is; if a row value is lesser than this value, leave it as it is. If it is higher, make this cell value equal to this value.

I repeating; if a cell value is lower than this value, keep it as it is. If a cell value is higher or equal to this value lower or equal to keep it as it is; if a cell value is higher than this value, make it equal to this value. So, here 0 is the lowest cost, 132 is higher, so make it 0. 118 higher than 0, make it 0; 145 - 0. This is 96; this is 0; so it is lower than 96 keep it as it is. This is 96, this is 96 keep it as it is. 67.2 lesser than 96, keep it 67.2.

So, anything is lesser keep it; if it is higher, then make it less. 88.2, this is 113.4. So, what should we make? We should make it 88.2. 0, make it 0, it is less; 100.8 make it 88.2 ok. So, in this way, prepare this matrix, then again do a summation ok. What will you do after doing the summation?

The one with the lowest value is the second best choice. First choice was a one with the low, A is now done taken care of ok; A is now done complete. So, the other three the one with the lowest summation that is my next choice for location; ok; let us go and see what it is happening; ok.

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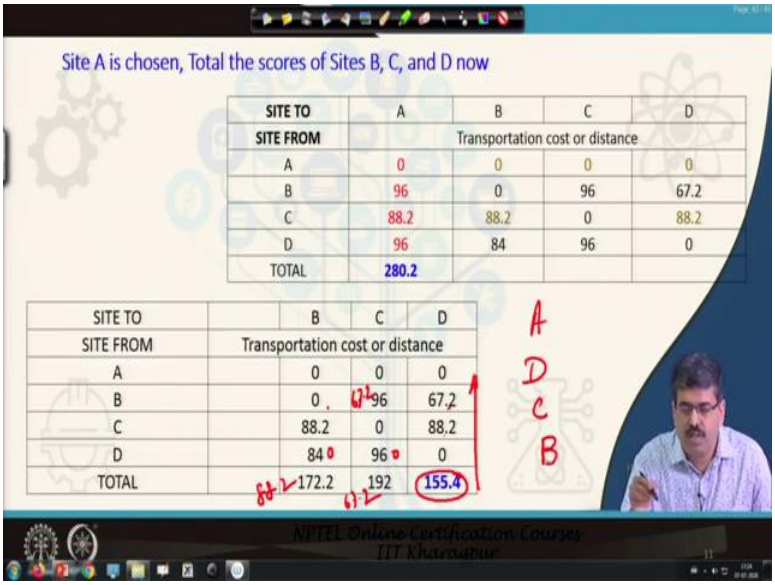

So, see now we have done the summation see here at the bottom see here at the bottom, the lowest was 155.4, so my first location was A, now is D. Then again repeat the same exercise, go up this column 67.2; what lesser, what should this now become 67.2; 88, 88 same 0, this should become 0, this should become 0 ok. So, the total for this column now becomes 88.2 this one, because this becomes 0; this one becomes 67.2; ok.

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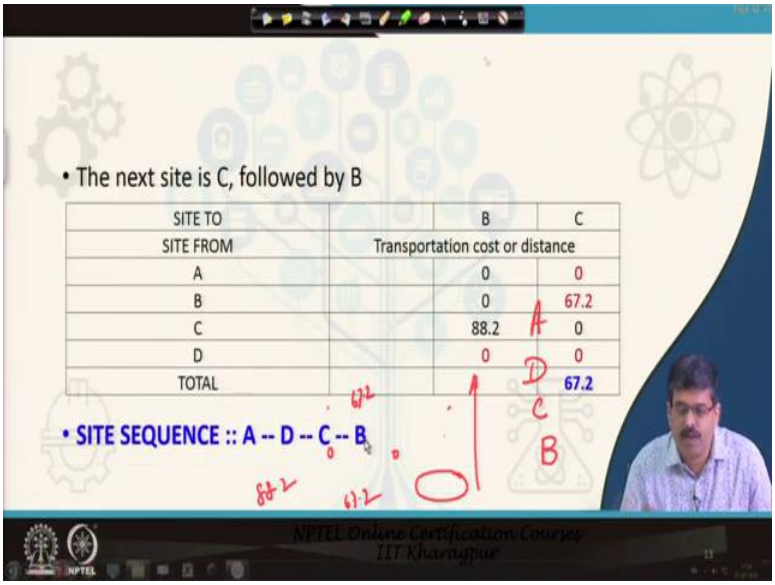

So, what is the next location? C and then is B, ok. Let us see C and then B ok, 67 and the last one is this right, so this is the Ardalan heuristics; ok.

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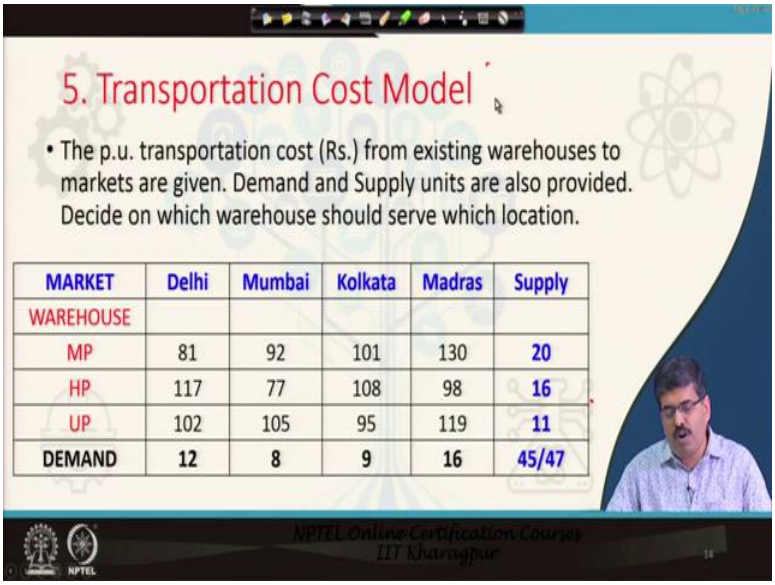

Now, the next model is transportation cost model ok. Now, I will not go through it, because we have already done linear programming in week-2. What you do is you try to solve this on your own;, ok.

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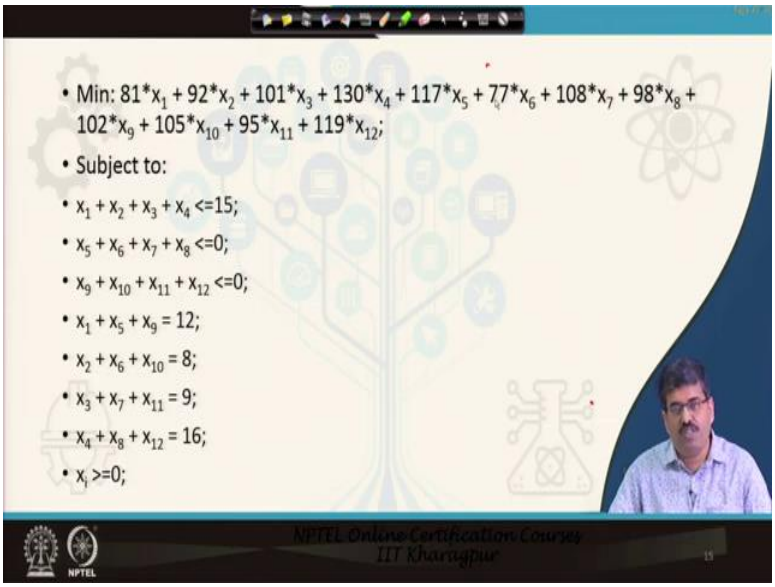

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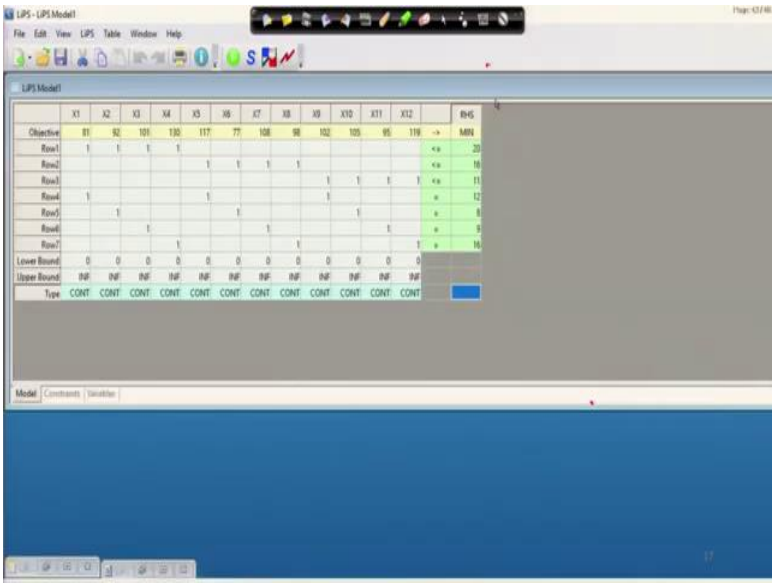

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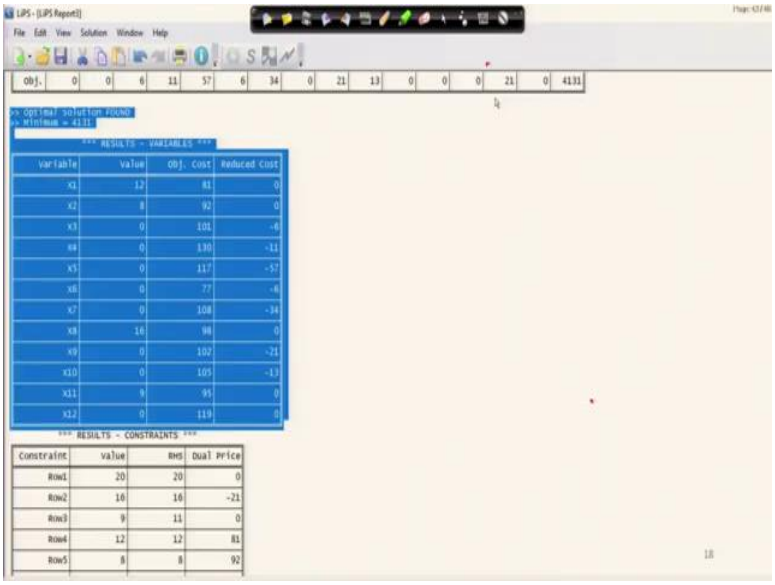

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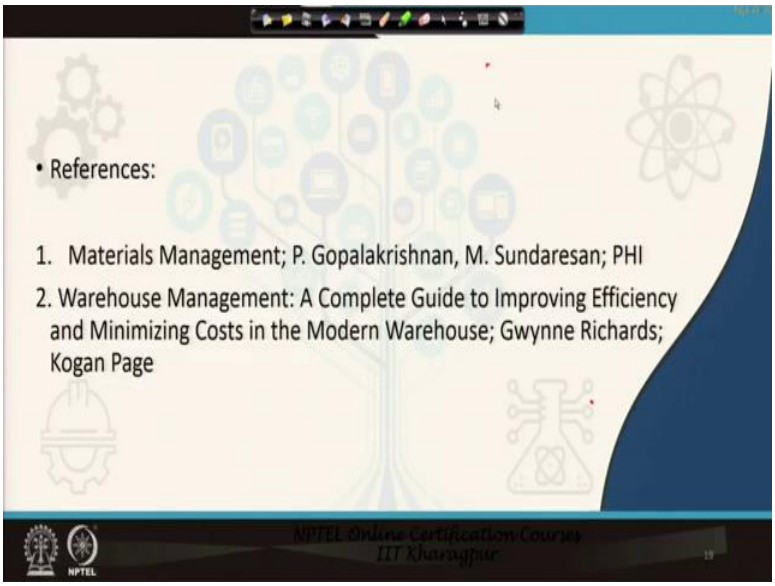

Then, I have given the solution also, I have put in the model in list, etcetera. You see the solution is already there, what you do is you try to solve it. In case you are not able to solve, you will get similar application of this problem in the product mix problem ok. There we will solve multi product multi location problems; there we will solve this problem; ok. So, this is the location pattern. These are the references; ok.

So, thank you!