Supply Chain Analytics
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Lecture-25
Location Decisions in Supply chain

So welcome and we are already discussing about decisions for the development of a network in our supply chain environment and we discussed in our last session a very conventional type of distribution network you have distribution centres of the vendor, then you have a complete setup of manufacturing and you have a warehouse within the plant, then you have distribution centre of the finished goods, owned by the organisation itself.

Then you have customer distribution centre and the customer stores. And there was a very serial network between all these facilities was there. Nowadays if you see the changes which are taking place over a period of time in the supply chain systems particularly with respect to development of facilities and their rules.

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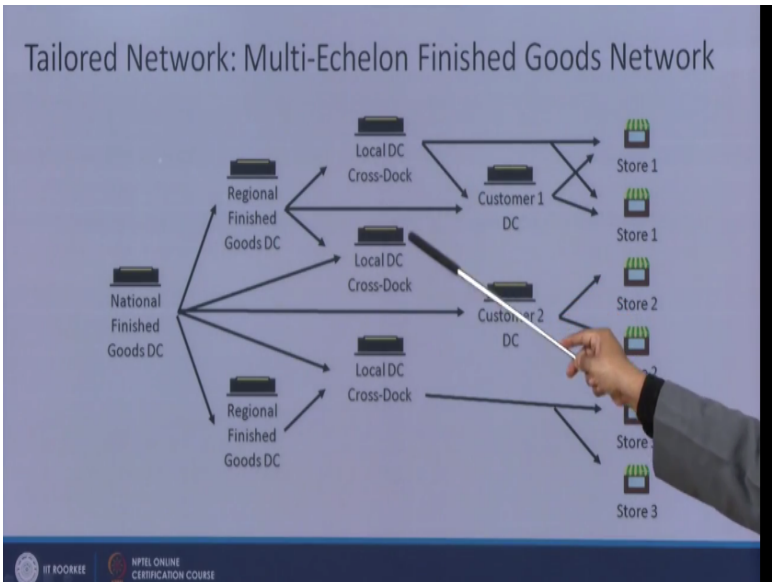

The current slide gives you an idea that in our latest systems we have in a global kind of supplies and environment you have one finished goods distribution centre at the national level, so this is a central facility within a particular country, then you have various regional finished goods distribution centre, so maybe if you take an example of India so within Central India somewhere maybe around Nagpur, Bhopal in that area you have a national finished goods distribution Center.

And then if you divide India in four major regions North, East, West and South for that you have for Regional distribution centre, goods distribution centre, finished goods and then you have local distribution centre in maybe State wise you can think of that you have 1 in UP, one in MP, 1 in Maharashtra, 1 in Gujarat, 1 in Tamil Nadu, one in Kerala like that. And hair you see this distribution centres are working on the principle of cross docking.

We have already discussed in detail in our earlier sessions that what is the meaning of cross dock?. The meaning of dog just to give you a fresh idea that where we do not keep physical inventory. These inventories are coming either directly from the national finished goods center or from the regional centre and these inventory or just repack, redistributed at the local distribution centres which are working on the principle of cross docking.

And then from these local distribution centres these products are going to customer distribution centre or directly to the customer store. So you are either using one label of description from this point to this point, where you involve this customer distribution centre or you can do direct distribution from this point to this point where you are by passing, you are not using the customer distribution center.

And directly these products are coming from this cross docking location to the customers store, so these are the changes which are taking place in our modern supply chain network which are working on the multi Echelon finished goods network. So these are multi Echelon either you can say in our area case you have only one finished good facility, 1, 2, 3 all these finish good facilities were known as simply finished goods of the company site.

But nowadays instead of having a single finished goods facility you are having 1, 2 and 3 installation for the finish good at the company site. So therefore this term multi Echelon has evolved and multi Echelon finished goods inventory is coming, before that whatever we have discussed that before this National finished goods distribution Centre you have the factory where you are having a warehouse within the plant.

And before that on the left side of that you have very offended distribution centre, so that system is already there but in this finish good side the right hand side of the supply chain we have now developed a multi Echelon system by these three stages which we have included in

the distribution system of the products. The very point why should we have the multi Echelon finished goods network.

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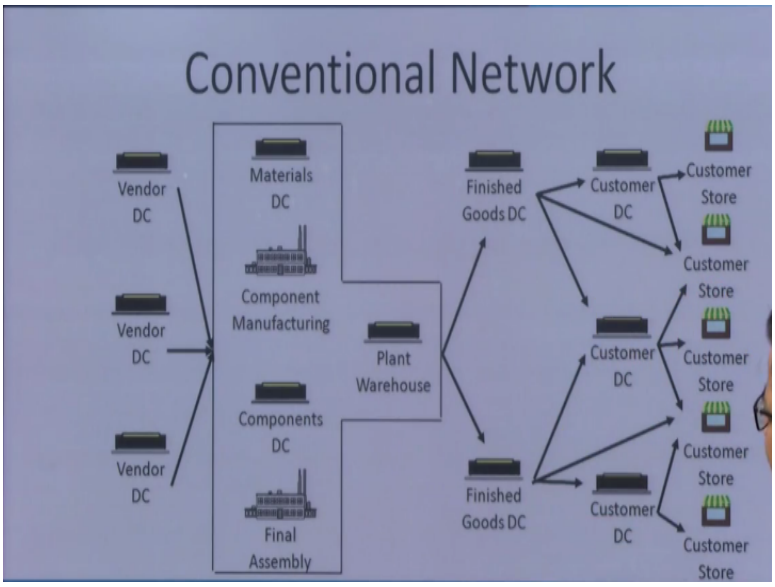

I give this question to you that you need to think a lot but why do we have earlier in the conventional system we were happy with a single type of if you see that we were having simply this finished goods distribution centre we were not naming this as a national, regional or local finished goods distribution center and now this finished goods distribution Centre or no changing into national facilities, regional facilities and local facilities.

And then this is the customer site which is already over there in the conventional distribution network also, so these changes are taking place because we want to fulfill the customers requirement with minimum possible time, so if we are serving a country like India with one single distribution centre, fresh distribution centre the response time will be very high, so therefore we want to reach to very close and even maintain that economy of scale.

And therefore with national we are going to regional and we are going finally to the local distribution centre, so this is a type of arrangement we are following in modern supply chain network. Now as discussed in the previous section, now we will discuss some of the methods for developing the location of these facilities.

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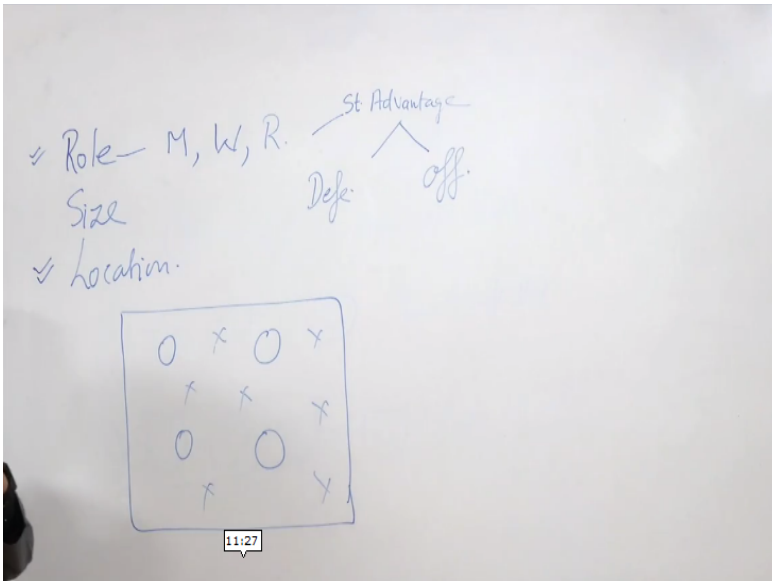

We discussing that we need to have 3 particular aspects, one is related to roll of the facilities, the second is related to size and third is related to location where to locate the facility and now for answering this particular question we have some of the common methods and I request all my participants that they should learn the uses of excel and we will solve this model with the help of excel and we will see that how this model is being sold.

So the issue of location can be handled by this gravity method, it is a very simple method like gravity method is to give you the background of the method, if we have this space where we want to locate our facilities and now these are the probable sites where we can locate our facilities, so and these are the locations of my customers, so in the gravity method with respect to all these sites which are represented by circles I will calculate the cost for moving cost of logistics from facilities to my different customers care facility.

Now whichever facility, whichever location gives me the minimum cost that will become my answer**.** So that we will discuss in this gravity method for location. Now before that one more issue we will like to answer that is the role of the facilities, well these discussed can be of 3 types manufacturing, warehouses and retail. But there is one more way to look for the roles, that role is what type of strategic advantage you want to have.

And this strategic advantage can be with respect to the type of role you expect from your facility advantage with respect to defensive or offensive. Now what do you mean by defensive and offensive role in case of a supply chain distribution network. Now defensive

role is that where I want to develop is supply chain based on conventional thoughts which we just discussed in the last session, that this type of conventional network is there.

And I want to use the same network for my product also so that is very defensive thoughts and I just want to reach to the maximum possible customer as per my supply chain strategy and I do not want to experiment the point which is important, I do not want to experiment in the case of 1 defensive approach in my defensive role of facilities, so whatever my competitors are using, whatever type of distribution network my competitors are using I will also go with the same type of distribution network in a defensive supply chain system.

In case of offensive supply chain system now it is a different ball game. I will not go with this conventional type of distribution network, I will not go with this type of routine finished goods distribution centre, routine customer distribution centre, routine customer store etc. I want to use my network for some kind of advantage and that is the offensive strategy of the distribution and in that case I use some very innovative locations.

So that I can get the status regarding. My other competitors are using A type of market for distributing the product but I will use B type of market for distributing the product, so it's a very different type it is always not sure that offensive type of approach will give you success, but at least you are not going on the conventional way of distributing the product, that is the idea behind this offensive distribution system.

The conventional distribution system gives you 3 defensive approach, competitors are doing that way, I will also do that way, so that I will at least match my competitors performance. Offensive can take you over to your competitors or maybe you maybe at the totally lost, so offensive strategy is a kind of innovative study in case of distribution where you are expecting that you are facilities will have a role which can provide you a strategic advantage.

That is why the offensive way of distribution. In our literature you will see some time when a manufacturer, when supply chain manager decides for offensive type of strategy and if it becomes successful then all other computers will start following the same strategy and over a period of time that offensive strategy will become defensive strategy, so you have examples where you started using ATMs.

So ATMs once upon a time was part of offensive study because normally you go to a bank, the physical branch of the bank and to withdraw or to deposit your money, but when ATM started coming so you can go to a ATM at any time to withdraw your money and then later on to deposit your money also. So this became an example of offensive distribution but over a period of time now it is almost impossible to think any bank without ATMs.

So now ATM is a very much part of defensive distribution system of the banking products. So all success initially we started with some E-portals in India for E-Commerce. At that time customers was hesitant weather this E-Commerce, E-portals will be successful or not. But over a period of time now we see almost every company, so initially it was offensive distribution.

We were very comfortable with bacon motor distribution system, you need to open a showroom, you need to open a shop etc. but this type of distribution using electronic mode was almost new focus and products like shoes, sweaters, jackets, mobile phones, laptops, all coming through this electronic mode of distribution. So it was initially the offensive way of distribution.

But nowadays it is almost impossible for a company to survive without this E-mode of distribution, electronic mode of distribution. Therefore it is very necessary that for initial advantage you think on the basis of offensive way of distribution and later on it can become a defensive way of distance. But we also have one example where offensive way of distribution did no need to defensive of distribution.

You may be knowing in name of company known as 3M. 3M is a very popular name and which is world leader in the market of adhesives. Now 3M once upon a time lost the product known as phenol, phenol all know is used for cleaning your floors etc. and phenol normally we all know is available through hardware shops, is available through general stores, maybe in some cases medical stores also.

So these are the places normally we all know or the shopping malls also, these are the places normally where you get the phenol as a product, but 3M because they were thinking of a offensive way of distribution, so 3M used a very different ways of distributing the product,

3M thought that let us use beauty parlours for distributing this phenol, now the beauty parlour for distributing the phenol is never seen before, so 3M use this beauty parlours.

Now in case of beauty parlour the idea was that normal phenol for the cleaning purpose is used by females in the families and females visit beauty parlour and they wanted to promote their product as it is safe for skin, it is safe for nails, it is safe for nail polish etc. etc. So they thought that latest promo, latest position this product as a beauty product for the cleaning purpose, but unfortunately this distribution idea of using the beauty parlours, beauty shops for distribution of phenyl did not work.

The reason is also very simple I think we all can understand that those who are visiting beauty parlours are not using phenyl for their household purposes, they can afford made etc. and those made do not visit the beauty parlour, so the idea did not click finally, but it became every classic example in literature that how to think of offensive way of distribution where you have totally innovative idea of distribution. So this is with respect to role of distribution facilities.

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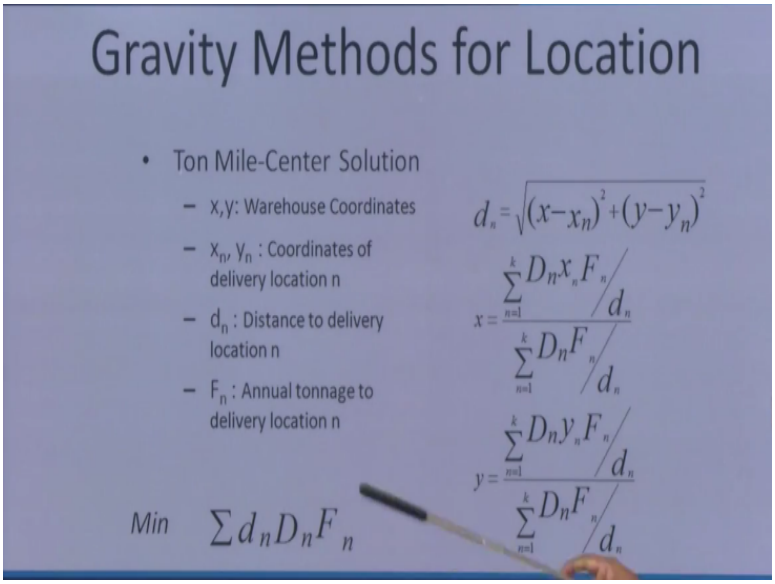

Now another important area is location, so we are now going to discuss the area that is gravity method of location to decide about the location how to decide that which facility with white should be selected. Now for that purpose the model which we are going to use can be this type of model where you have X and Y the coordinates of the warehouse. So these are the coordinates of these type of facilities which are the warehouse. So, I want to locate the

location of my warehouse, so these are represented by XY, then these xn and yn, these are the coordinates of delivery locations n.

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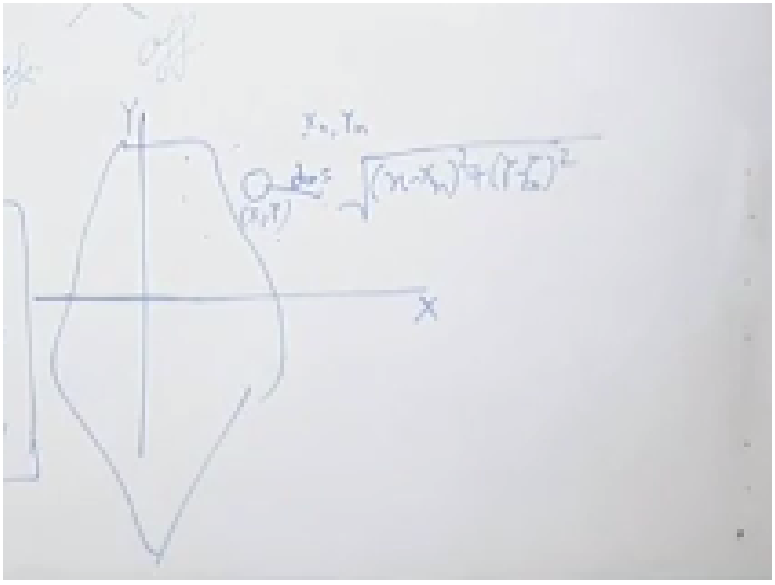

So if you see or a graphical access, so this is max this is why so these are my delivery locations the coordinates of these delivery locations are xn and yn and I have to select a site for my warehouse the coordinates of this are XY and dn is the distance to delivery location n, so dn is the distance of this warehouse site to this place, this is Dn, so for all these delivery locations I can have Dn with respect to that.

And Fn is the annual load which I want to deliver to a particular deliver location n, so that is the load with respect to a particular delivery location. Now this is the formula for Dn x that is this –xn this is +Y-yn and the square of these two terms, the under root will determine the distance of this distance is this - this location x-xn to whole square + Y-1 whole square and that is the formula for calculation of Dn,

Now I want to determine actually be coordinates of my warehouse x and y, and for that purpose I will see that how I will determine, so this is the formula for determining the location of X and Y. Here you see this is being Dn Xn Fn, Dn is the distance, Xn is the co-ordinate of the warehouse this delivery location and Fn is the total load which I am going to deliver to divided by this distance. And this is the sigma term, and same is for the Y, so this is how I will determine the coordinates of X and Y.

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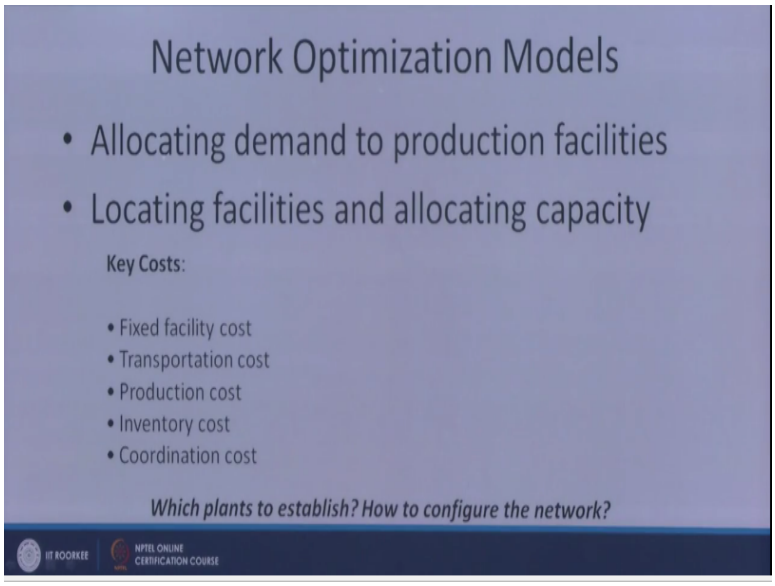

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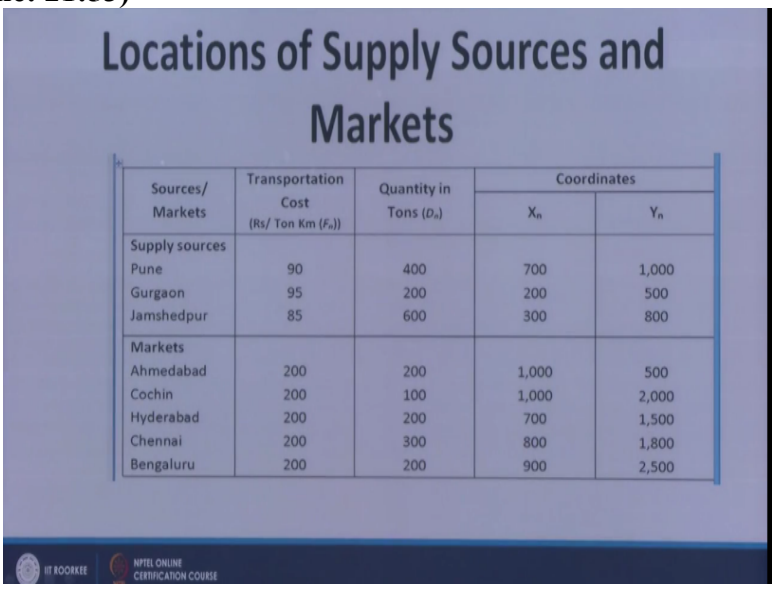

Sources/ Markets	Transportation Cost (Rs/ Ton Km (F_n))	Quantity in Tons (D_n)	Coordinates	
			X_n	Y_n
Supply sources				
Pune	90	400	700	1,000
Gurgaon	95	200	200	500
Jamshedpur	85	600	300	800
Markets				
Ahmedabad	200	200	1,000	500
Cochin	200	100	1,000	2,000
Hyderabad	200	200	700	1,500
Chennai	200	300	800	1,800
Bengaluru	200	200	900	2,500

Now once I determine this X and Y done with the help of this example you can come that how can we use for the purpose of determining the location of our warehouse, we have these different sources and these are the market so I have to take a decision where to establish my source facility, so these are Pune, Gurgaon, and Jamshedpur. These three areas are the sourcing facility, this is for some kind of automobile problem.

And the markets are available in Ahmedabad, Cochin, Hyderabad, Chennai and Bangalore. The transportation cost that is rupees per ton per kilometre is 90, 95, 85, from these supply sources and to these different markets sources. Now quantity in terms from the supply sources are available 400, 200 and 600 and in the demand for the different markets are this is the date. Non this graphical source the coordinates of supply sources can be 700,000.

So if I see this is, if I want to have India on this map, so the coordinates of Pune, coordinates of Gurgaon, coordinates of Jamshedpur, so you can get the idea of the coordinates, now will go to the calculation, the model with we just discussed, this is how now you can also start using the Excel on your computer and this is how we will develop the input data for our gravity location model.

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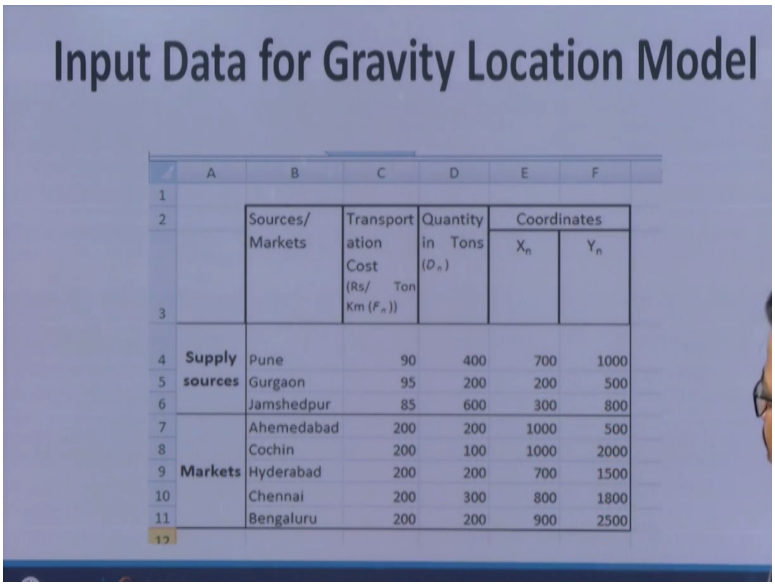

		Sources/ Markets	Transportation Cost (Rs/ Ton Km (F_n))	Quantity in Tons (D_n)	Coordinates X_n	Coordinates Y_n
4	Supply sources	Pune	90	400	700	1000
5		Gurgaon	95	200	200	500
6		Jamshedpur	85	600	300	800
7	Markets	Ahemedabad	200	200	1000	500
8		Cochin	200	100	1000	2000
9		Hyderabad	200	200	700	1500
10		Chennai	200	300	800	1800
11		Bengaluru	200	200	900	2500

You can use almost the same table this is the portion of the table is spreadsheet which I will like to show you that from column B to column F. This is how you will input the data, these are the sources, these are the markets you also please try simultaneously with me Pune, Gurgaon, Jamshedpur, Ahmedabad, Cochin, Hyderabad, Chennai, Bangalore, so you use this data, the transportation cost data, quantity, which are available at these place.

And which are required at this place, this is the source, these are the destination and the coordinates, so this is the input data in fact this is exactly the last table which was given to us in the simple format and I have just copied same table in this Excel spreadsheet and I think you also start using from B to F and from row number 2 to 11. So that you can follow while doing the calculation at your end with the help of formulas which we will be developing and you can see that how these results are coming there.

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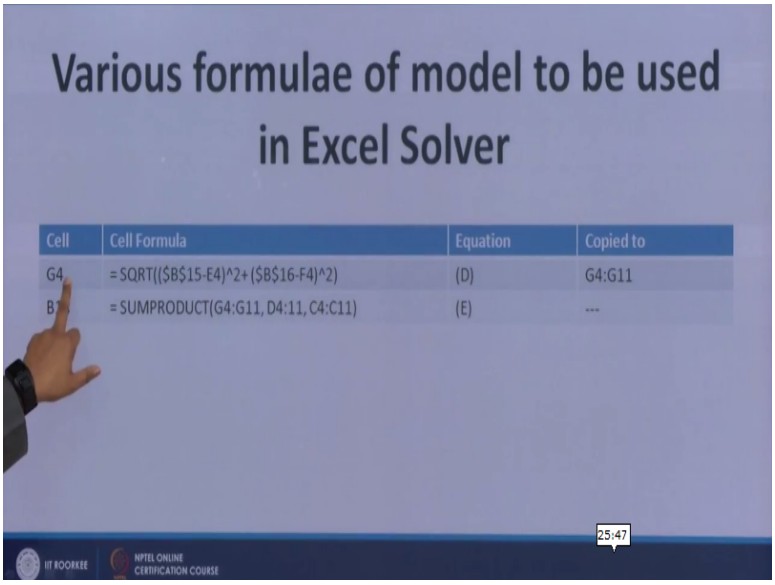

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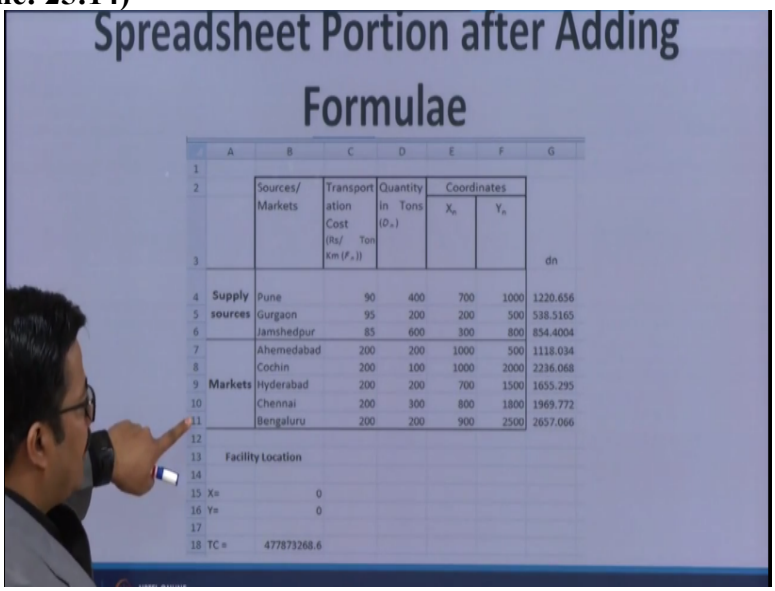

Now for that purpose the formula which we need to use, you see this we put this much spreadsheet from B2 to B11 we already have, this much spreadsheet we already have, now we need to develop some formula which we will build in this spreadsheet and what will be those formula that we can see here, in cell number G4, so which is that G4, G4 is this cell and in this we want to determine this distance Dn.

We want to determine this distance Dn, so we will build the formula for Dn here and the formula for Dn as you know X-Xn to the whole square +Y-Yn to the whole square the whole under root, so that formula is written this cell and that is the square root of B15-E4. B15 this is B15-E4, this is B15 and E4, this is the final coordination of the facility we want to locate x, this is the Xn, so x-Xn to the whole square + B16-F4 -F4 this, so B16-F4 to the whole square.

So this is the symbol for square and under root the square root of the whole bracket, so what we have written in that algebric for the same is written here in the form of Excel formula builder, so square root double brackets B15-E4, E4 I am giving as absolute value and B15 the dollar symbol here, these are for the relativity, because as I am moving from this fourth root to fifth, sixth, seventh, eighth, ninth, tenth, eleventh, I need to change the values of Xn.

The values of Xny are constant, these are B15 and B16, so I need not to change these values but I need to change E values, E4 and F4, so E4 and F4 will change and B15 and B16 will not change because of this dollar symbol. So these are fixed and then I will copy this formula which I will be developing initially for G4 I will be coming this formula from G 4 to G11, so I will copy this formula from G4 to 11.

So far this entire column I have copied the same formula, so when I am copied the same formula with this type of equation so in each of these cells B15 and B16 will remain common and E4 and F4 E4 will become here, E5 here, it will become E6, E7 and so on, here it will become E11. F4 will become F5, F6 and at F11 in each of these respective cells, so much formula will change as per the different values of cells.

And since the initial values of X and Y I have kept 00, so these are the calculated values with the help of that formula. Now coming to second formula that is for cell number B18. In B18 we are putting the total cost**,** so total cost as you know is the sum product of these three values, if you remember the formula which we discuss in the slide of initial slide of gravitational model.

So this formula where you have multiplication of G4, D4, C4, G4 this value, D4 is the total supply available, G4, D4 and C4, this is the transportation cost, so C4, D4, G4, so this is one product, similarly C5, D5, and G5 this is another and so on you will have up to C11, D11, and G11. The sum product of all these is written like this, in Excel it is written like that from G4 to G11, we will like to multiply D4 to D11 and also C4-C11.

So G4 will be multiplied with D4, will be multiplied with the C4, G5 with D5, with C5 and so on G11 with D11 and C11 and the sum product of that is coming in the B18 column, B18 cell. So this is the value here with the help of this. Now I want to optimise and for that

purpose I will use this cell, this spreadsheet portion is getting after you have the location of X and Y.

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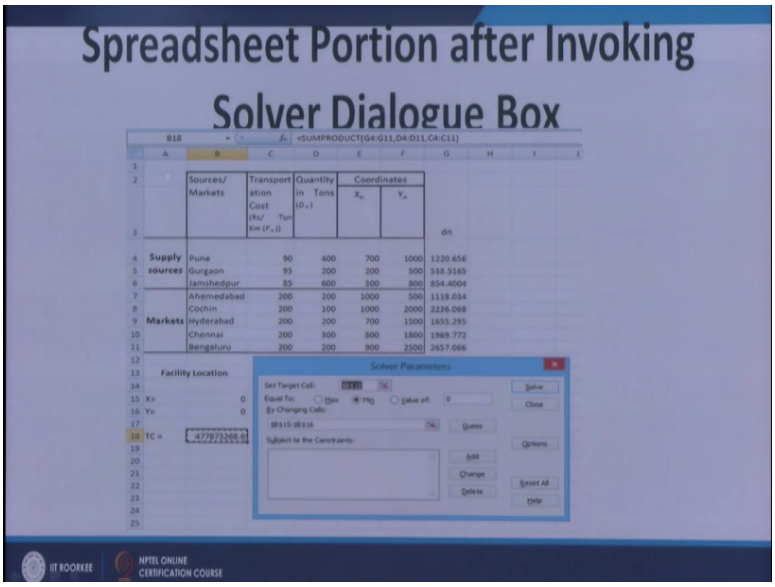

If I go with this data the location of X and Y is at the centre, at the origin because X and Y is given 00. Now my job is to reduce this total cost as much as possible and for that purpose I will invoke the solver and solver will say that if you invoke the solver, so this type of solver parameter will come, this type of dialogue box will come and here my target cell is B18, this you will write here B18. So this will be your target cell.

I want to minimise this, so equal to these options will come, so I will select this box minimise, in some cases will go for the maximize also but here we want to minimise the total cost so we'll go for the minimum value of the total cost, now minimum value of total cost will be achieved by changing the values of B15 and B16, so by changing the size of the decision variables, if you have the knowledge of linear programming.

So we can say that B15 and B16 represent my decision variable, so these are the changing cells and with the help of this now I will start solving this.

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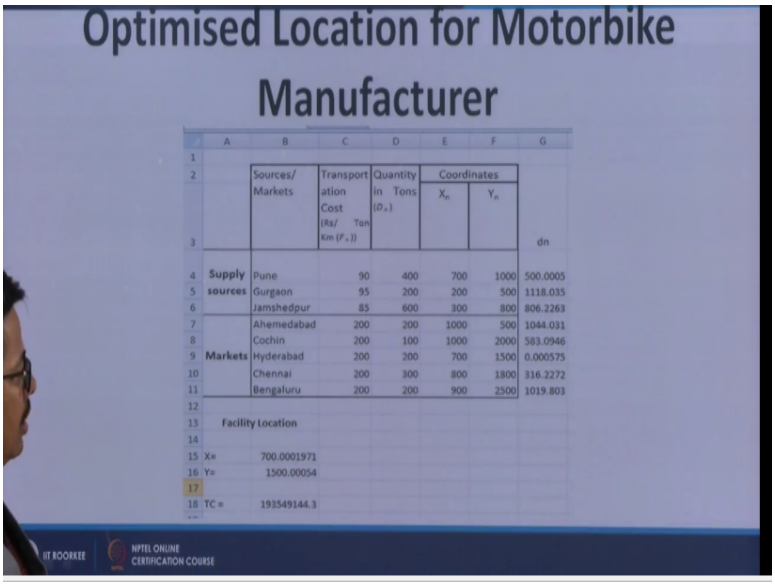

And once we start following this the values will be 700 and 1500 approximately, because once you have done this then you put the cursor on the solve, click this button and this solver will give you this type of optimise result, where are now you see your values of all these 1220, 538, 854 are changed , these are 500 1118, 806 and so on and now the values of x and y are 700 and 1500,.

And the total transportation cost is no reduce tremendously from this value which was 477873268, now it is 193549144 and the location of warehouse is 700 and 1500, so you can see this 700, 1500 is very close to this Hyderabad, 700, 1500 is almost Hyderabad, so you will decide that the warehouse should be at Hyderabad. So we are stopping at this point and will see further that what other models are available for getting our optimise location of the facility. Thank you very much.