Modelling And Analytics For Supply Chain Management
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Lecture - 10
Supplier Selection Analytics (Contd.)

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Welcome to modelling and analytics for supply chain management, we are in week 2 module 4. We started off with what are the modelling techniques by which we can select suppliers. Now, we discussed that when we are calling a tender, then many suppliers are bidding. Now, while bidding, we are asking suppliers to give certain information, like what price they are quoting, what is their defects parts million, what is their CPK value, how much maybe, maybe also how much is the distance of their factory from our production base.

So, we are asking suppliers to furnish certain information. And based on those information, we are ranking the suppliers or we are prioritizing or preparing a list of prioritized suppliers. And then we will select suppliers. And in that manner we learnt LP method, we learnt rating method and we learnt ranking method. We also learnt that these three methods can give us three different types of supplier selection priorities. Like, one method may give supplier 1 as the best supplier, another method may give supplier 2 as the best supplier.

Now, why is this happening? Because the criteria we applied for supplier selection are differing. In LP method, we are using equal weights for the criteria, in rating method, we are giving them some rating on a scale of 1 to 10, in ranking method we are not able to give a rating to the suppliers because the suppliers may be new, we have never worked with them

earlier, so we cannot give them a score. So, what we are saying? We are only saying, the supplier A is better than supplier B, supplier B is better than supplier C.

So, definitely my rating or my prioritization might differ. So, we have to be very careful as to which method we are applying for supplier selection, it will vary from situation to situation. Now, we left you with a problem and that problem was, assume that there are 10 suppliers who are good enough, means we have prioritized them, we have put them in serially, in order of their merit and S1, S2, S3, S4 up to S10 we have 10 suppliers. Now, what we want to do?

We are saying that look my organization requires so many products, every time we cannot go and do this exercise, so, what we will do? All the suppliers who are good enough, we will group them, we will group them into Group A, Group B, Group C. Group A, we will buy costly products from them, Group B, we will buy the medium price products from them and Group C, we will buy the less costly products like the pens, pencils and office stationery and office equipments from them.

So, we will have groups of suppliers, some suppliers in Group A, some in Group B and some in Group C. And then when the time comes to purchase we can pick up any supplier from that particular group and ask them for product, ask them for the supply of the materials. So, how to do that?

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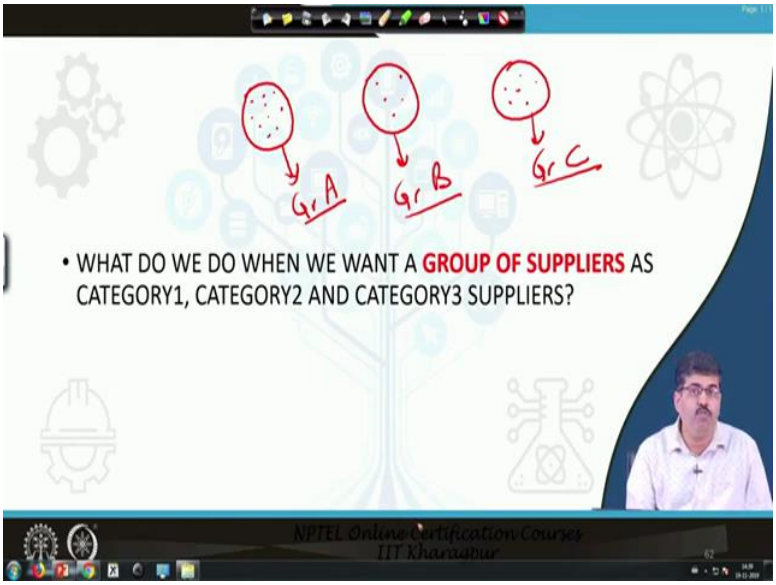

So, basically what I was saying is that you have to find out like this, say this is a group, there are some suppliers, this is another group, there are few suppliers and this is another group, where there are again few suppliers. What we are saying is, how to group the suppliers, that is

my question. So that and this is Group A, this is Group B and this is Group C. So, how to group suppliers and then whenever order comes I will ask one-one group to, or suppliers from one group to give me the product. So, earlier methods was ranking single suppliers, now we are saying, let them be put under groups. So, how to do this? So, let us now move.

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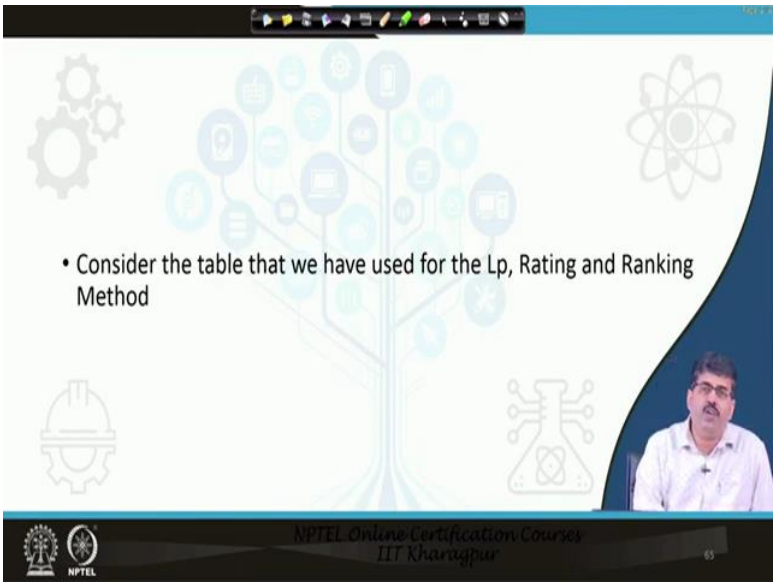

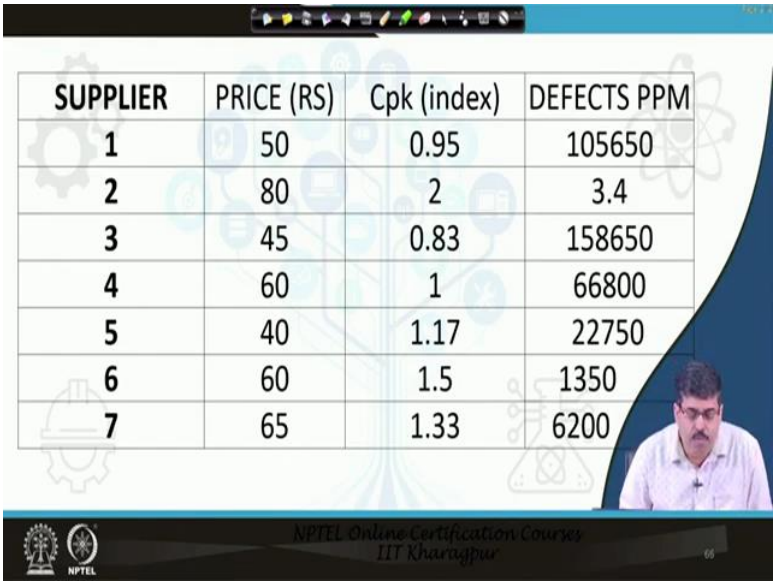

Consider the table that we have used for linear point rating and ranking method. Okay. For your quick recap, this was the table that we used. Seven suppliers have quoted, that is the prices that they have quoted, the CPK index value, the defects parts per million, this is what their quotation was.

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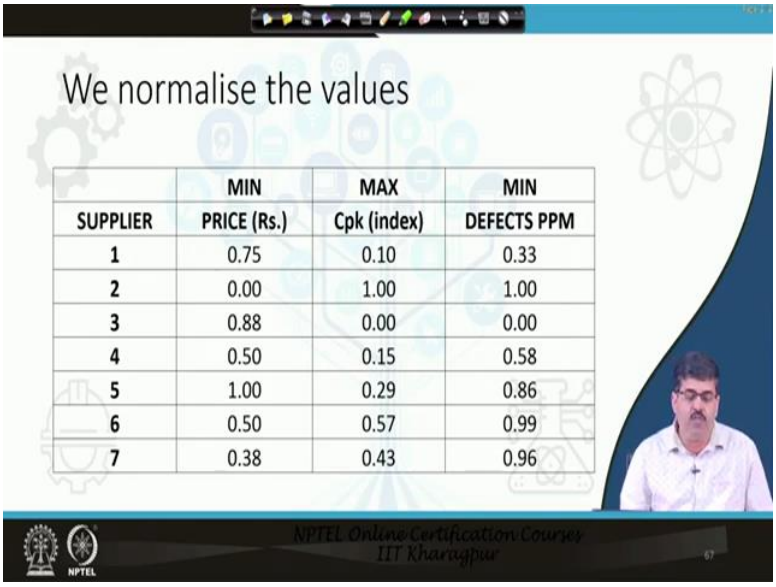

And if you remember that we had normalized the values also. What was the criteria that we used if you remember, if the criteria was, if the objective was min, objective maybe max, maximization objective, objective maybe minimization. So, based on that we have used the formulas like min, if the criteria is min, then h j minus Fij divided by rj. If the criteria was max then Fij minus Lj divided by range. So, these were the formulas that we had used.

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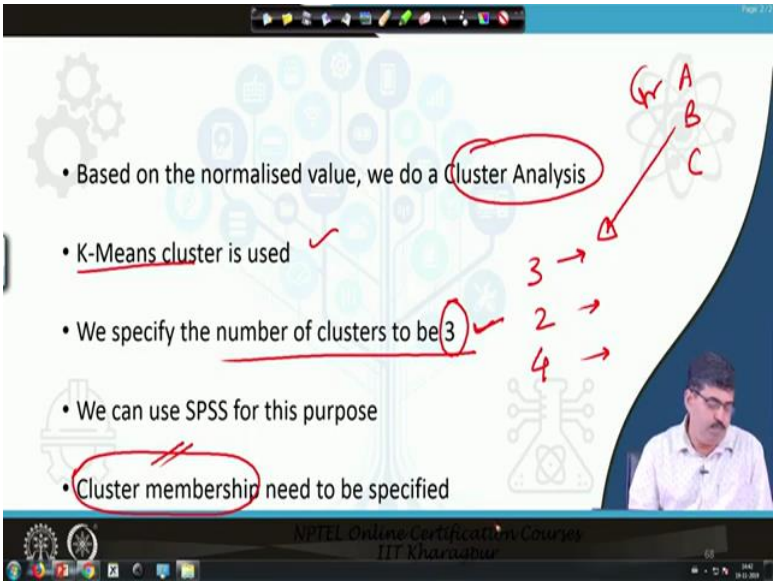

Now, so, after getting the normalized values from this matrix, this, up to this we have been regularly doing, LP method, rating method, ranking method we have been doing. So, once we have got this, now, what we do is, we do a cluster analysis, we do a cluster analysis. What is

cluster analysis? It groups the values together based on the homogeneity, based on the Euclidean distance. Now, what cluster we will use? We will use K-Means clustering.

In K-Means clustering, we can specifically tell that we want three clusters, we want two clusters, we want four clusters. What are clusters? Groups. Here, for this problem, we had mentioned that we want to group the suppliers into Group A, Group B and Group C. So, how many clusters are we looking at? We are looking at three clusters. So, we are looking at three clusters.

So, we do a K-Means clustering, we specify the number of clusters to be three, and what software we can use SPSS which is again a very, very popular statistical software package. We can use SPSS for this purpose. Now, so, we will specify in SPSS that use K-Means clustering. Now, the moment we specify in SPSS, that use K-Means clustering, it will ask me how many clusters I want. So, I will specify that I need three clusters.

If your organization wants to group suppliers into Group A, B, C and D, then how many clusters will you specify? You will specify four clusters. So, we will, we will ask the, we will ask the system to specify the number of clusters. Now, once we have specified the number of clusters, we will also give a command to mention the cluster membership. What is this cluster membership, we will come in a bit later. So, what did we say? In SPSS, we will go, we will do K-Means clustering, we will specify the number of clusters to be 3 and we will also specify to mention the cluster membership.

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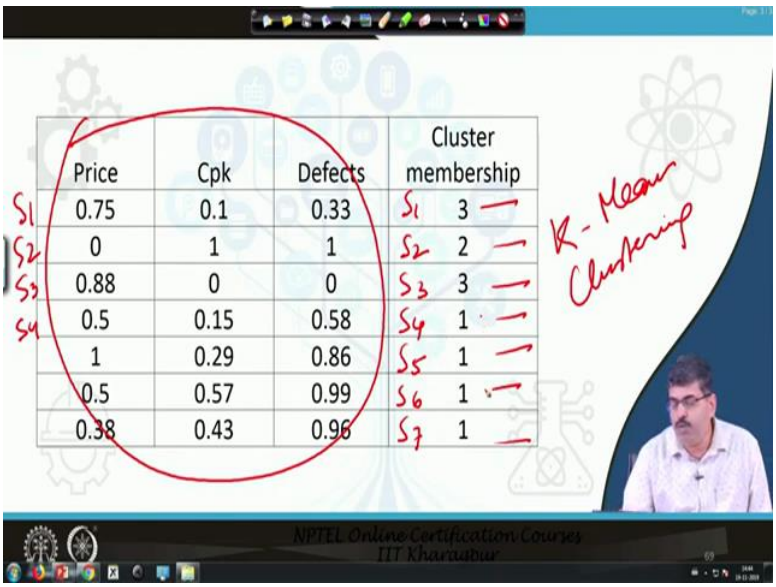

Once we do this, this was my original normalized matrix, based on K-Means, based on K-Means clustering, based on K-Means clustering, this is the cluster membership that I get. What does this mean? That supplier 1 is in cluster mem, is in cluster 3, supplier 2 is in cluster 2, supplier 3 is in cluster 3 again, supplier 4 is in cluster 1, supplier 5 cluster 1, supplier 6 cluster 1, supplier 7 cluster 1. So, this is S1, S2, S3, S4, S5, S6, S7.

So, what are we saying? That supplier 1 is in cluster 3, supplier 2 is in cluster 2, supplier 3 is in cluster 3, supplier 4 in 1, 5 in 1, 6 in 1, 7 in 1. So, what we are seeing, that we, if you, if now we can do it now beside this then what you will see is that, let me erase this and then I will show you.

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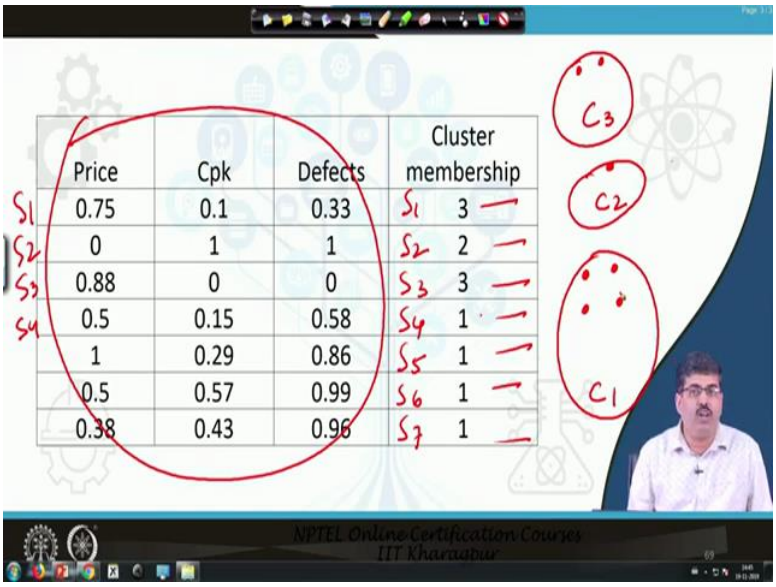

So, what we are seeing is we have got, this is cluster 3, how many suppliers? S1 and S3, two suppliers. This is cluster 2, how many suppliers? Only one supplier. This is your cluster 1, how many suppliers? 1, 2, 3, 4, this is what we get now, agreed? Cluster 3 has 2 suppliers in them, cluster 2 has 1 supplier and cluster 1 has 4 suppliers. So, we have got our clusters. But the question is which cluster is A category, which cluster is B category and which cluster is C category.

That means, which cluster we will buy the costly items, which cluster we will buy the medium priced items and which cluster we will buy the less priced items, that we have not obtained from this table. We have only obtained which supplier falls in which cluster, but which cluster is better than the other, that we have not obtained. So, up to this is clear? So,

what we did? We normalized the supplier scores like previous ones, then we just applied K-Means clustering and gave the machine their order to have three clusters.

And we now have the mapping which supplier is falling in which cluster. And we have just shown that using the diagrams, which cluster, which supplier. But the question remains which cluster is good, which is better and which is best in terms of the, for decision making purpose.

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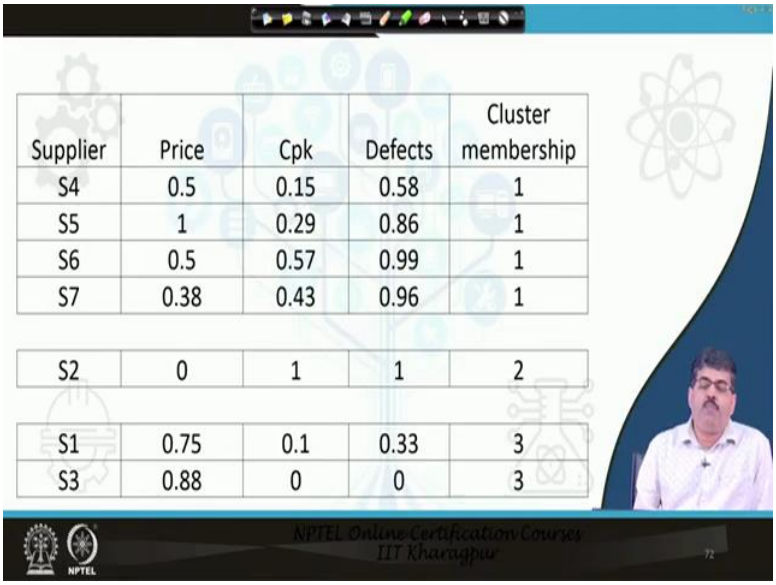

If you see we have just arranged the table, all the suppliers under cluster one we have put them together, all the suppliers under cluster two we have put them together and all the suppliers under cluster three we have put them together. So, basically we have rearranged the table, nothing else. It is the diagram that I drew, this is just the same representation in a table format.

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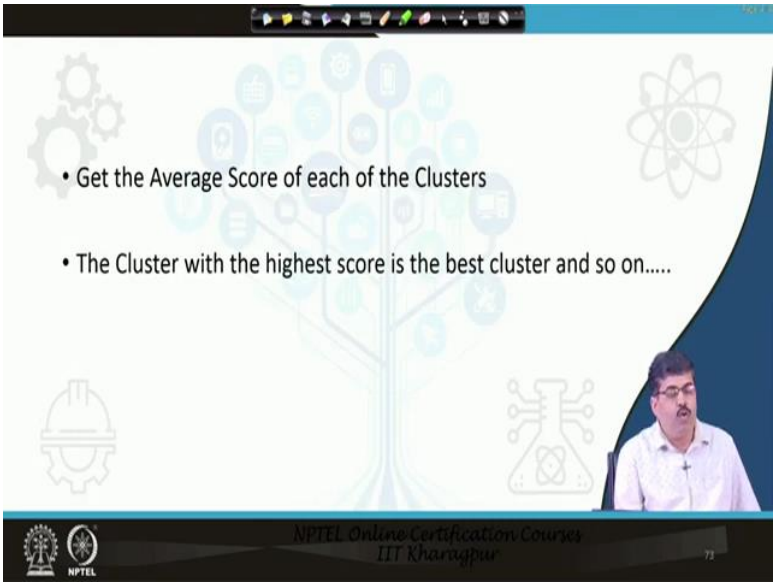

Now, what we need to do is get the average score of each of the clusters and the cluster with the highest score is the best cluster. Repeat, get the average score of each of the clusters and the cluster with the highest score is the best cluster.

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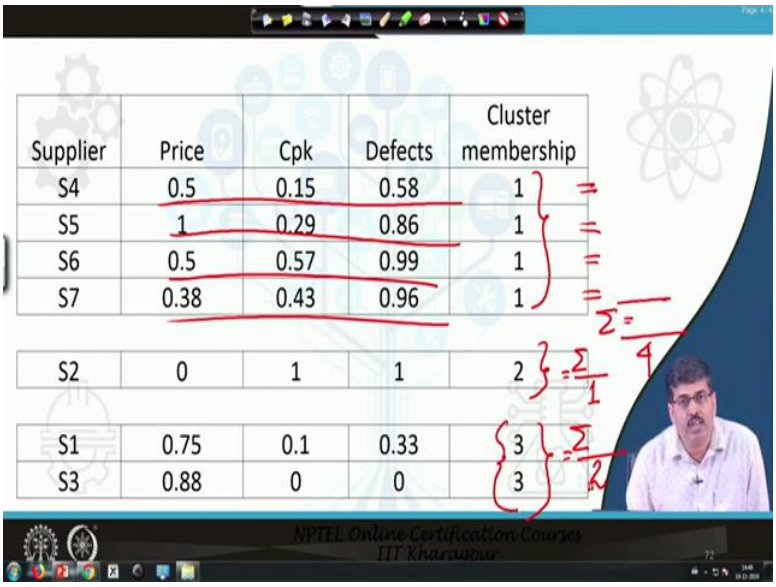

So, what do you mean by that? So, this is my cluster, get the average score of this cluster, get the average score of this cluster and get the average score of this cluster. The cluster with the highest average score is the best cluster. So, how do we get the average? We total the rows, we total the rows and then whatever summation value we are getting, find and that is to be divided by four. Here whatever value we are getting summation, that is to be divided by 1 because only 1 value is there.

Here whatever we are getting summation value, that has to be divided by not 3, 2 members are there in the cluster, so 2. How many members? Average, average is simple, total divided by 4, this divided by 1 and these two members are there, so divided by 2. So, this will give us the average value.

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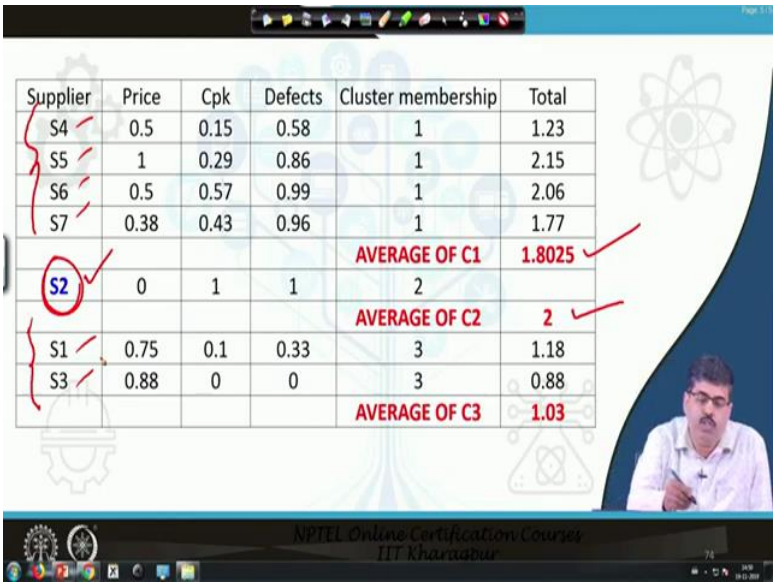

This is my average score, average score of C1 1.8 average of cluster 2 is 2 and average of cluster 3 is 1. So, who is my best cluster? My best cluster is S2, my best cluster. So, cluster A or best cluster is only one supplier is lying in that cluster, that is supplier 2. The next best cluster is this one with 4 suppliers with an average score of 1.8. So, the best cluster, cluster A is cluster 2 with only one member. The next best cluster is cluster 1 with 4 members or with 4 suppliers and the third best is cluster 3 with 2 members.

So, for important items, for costly items, we will go to supplier 2, for the next ones we can go to any of these 4 and for the office necessities, daily use items pen, pencil, paper, office stationery, ink, cartridge, etc. we will go to these suppliers, we will go to these suppliers. So, now is it clear? So, what is the difference? The earlier methods were telling me for individual ranking and here we have got a group ranking, a cluster wise ranking. So, this is another method, so when we want a group, we will go for this method. This is another method.

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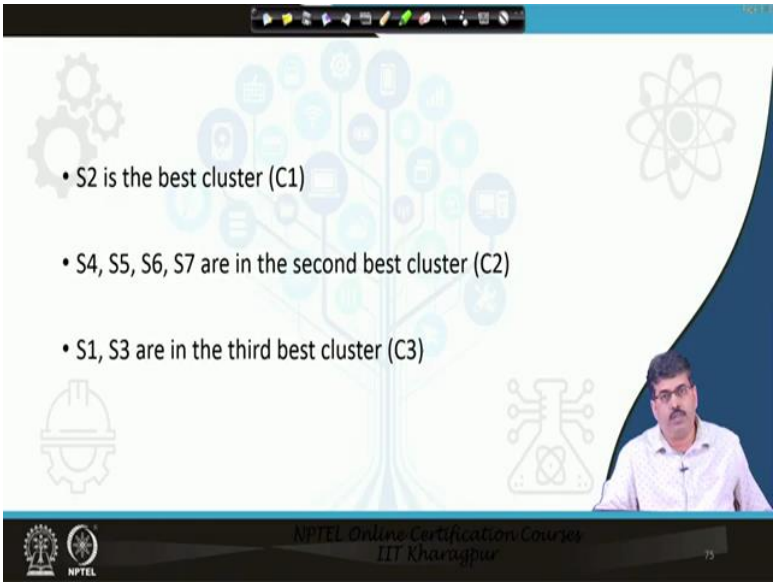

This is what we have written down.

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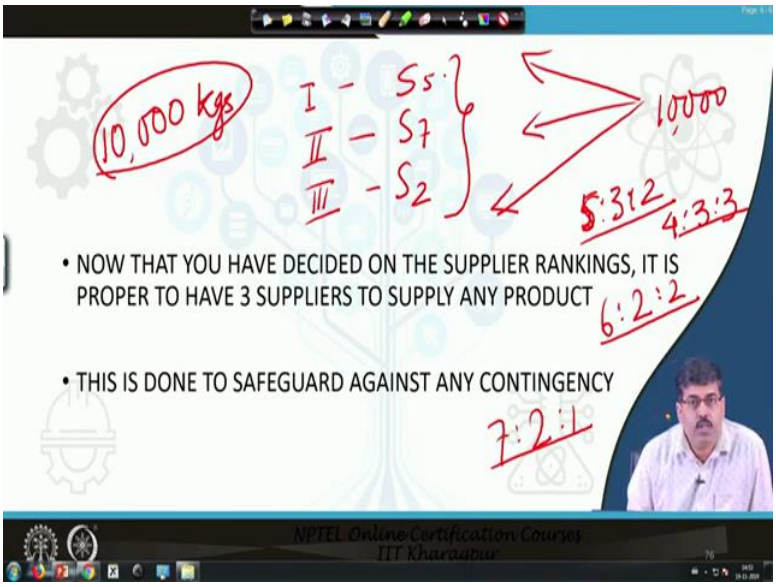

Now, we have a point, now that we have decided on the supplier rankings, it is proper to have three suppliers as we have mentioned this is done to safeguard against. The question now is a bit different, that is the second phase we are coming to for supplier selection analytics. What we are saying, what we are saying is that let us say we have got S5 as the best supplier, S7 as the second best supplier and S2 as the third best supplier.

So, best supplier, second best supplier and the third best supplier. Who am I? I am the factory, I am the manufacturer. How much of raw materials do I need? I need 10,000 kgs of

raw materials. Supply Chain logic says that I should distribute this 10,000 kgs of raw material among these three suppliers because I will have to retain them. Because tomorrow if I buy everything from supplier 5 and tomorrow supplier 5 for any reason is not able to supply me, then supplier 7 and supplier 2 will not supply me, because I do not have any business relationship with them.

So, I should buy certain quantity from 5, certain quantity from 7 and certain quantity from supplier 2. And my total requirement is 10,000 kg. The question is, the question is, how do I distribute this 10,000 kgs among these three suppliers, that is my question. Have you understood? Now, you will say it is very simple. Make a ratio of 5 is to 3 is to 2, somebody will say why 5 is to 3 is to 2? Why not 4 is to 3 is to 3? Somebody will say why not 6 is to 2 is to 2? Somebody will say why not 7 is to 2 is to 1?

So, there are a lot of questions and you as an analyst will have to be very very justified in how and why you are doing, whatever you are doing. So, have you understood my question? I have ranked the suppliers, I have 10,000 units of raw materials to buy from, how will I distribute that 10,000 units among A, B and C. Is that clear?

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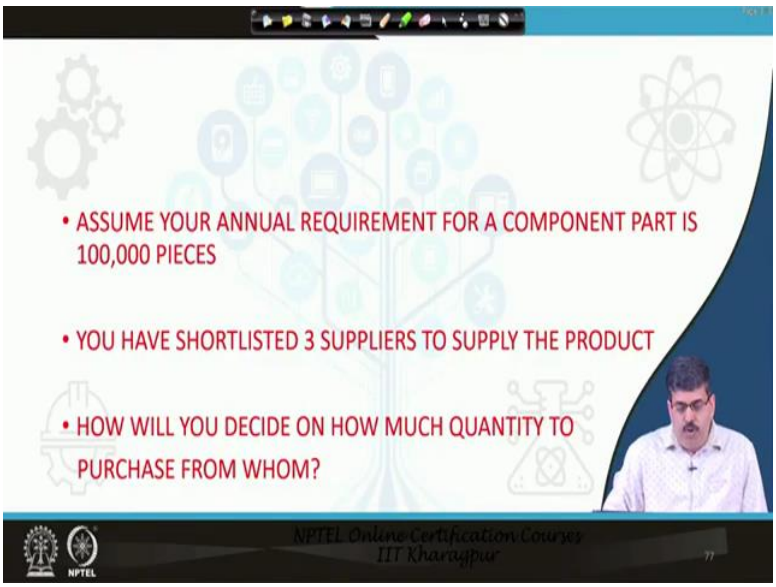

Now, let us bring in certain criteria. Assume your annual requirement for a company part is 100,000 pieces, you have shortlisted 3 suppliers to supply the product, how will you decide on how much quantity to purchase and from whom? This was the problem, this is what we started off with.

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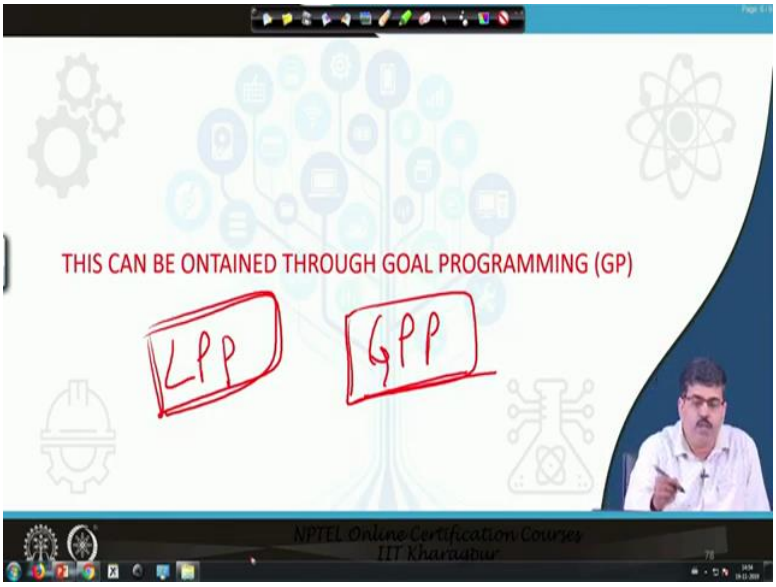

This can be obtained through goal programming, commonly known as a goal programming problem or a GBP. The previous problem with which we started was a linear programming problem or an LPP. This is my goal programming problem or GPP.

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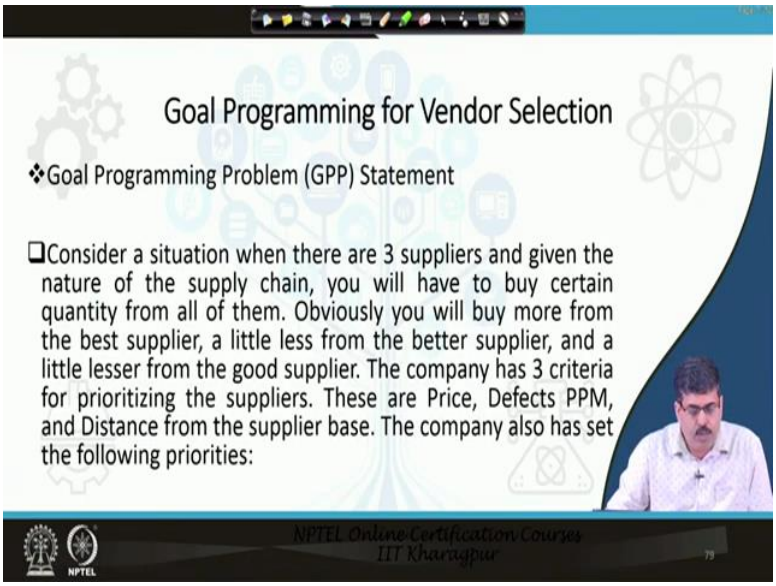

Now, consider a situation when there are three suppliers and given the nature of the supply chain, you will have to buy a certain quantity from all of them, this we just now mentioned. Obviously, you will buy more from the best supplier, a little less from the better supplier and a little lesser from the good supplier, so, good, better, best. The company, now this is what is important. So, how do you do it? The company has 3 criteria for prioritizing the suppliers.

These are price, defects PPM and latter these are two, these two are from the earlier ones these are price, defects PPM and distance from the supplier base. The comp, and now okay, so, we are putting in 3 criteria price, defects and distance. Now, the company has set the following priorities, the company has set the following priorities.

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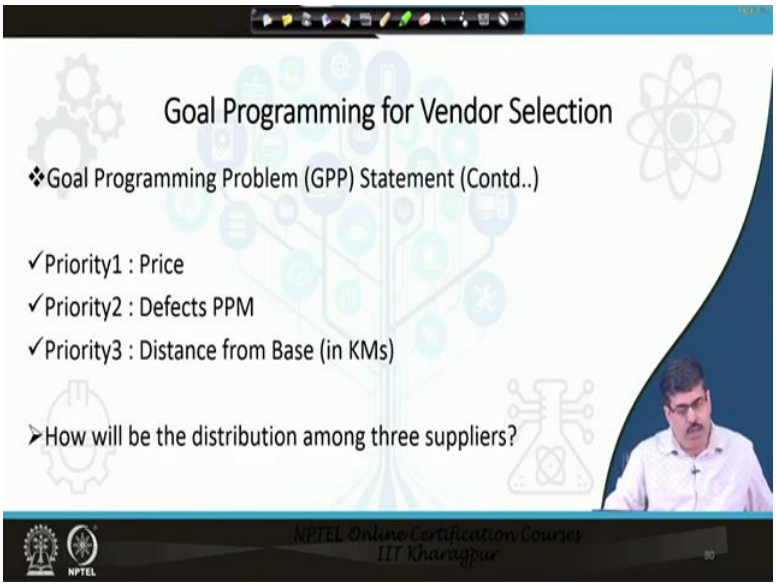

What are these priorities? Price is my first priority, defects second important and distance from the base is third important or third priority.

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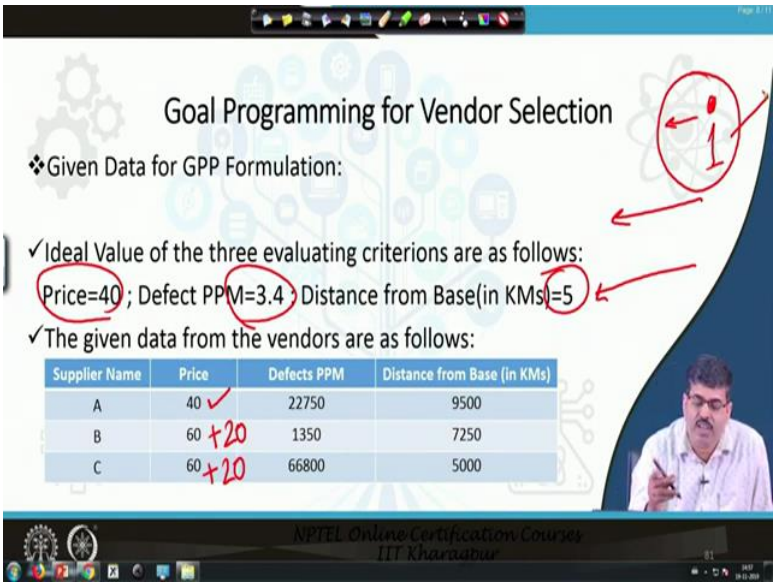

Now, as we had asked, the suppliers have furnished us some information, and if you notice supplier A's price quotation is 40, defects is this, supplier B's price quotation is 60, defects are

very less, that is why they are charging a higher price. Now, the company has its own ideal values. Company says, ideal price should be rupees 40, ideal defects should be only 3.4, Six Sigma and I do not want a supplier who is very very far away, then uncertainties in delivery increases. So, distance from my base should be 5, this is ideal.

But are the suppliers quoting the ideal value? Supplier A is quoting a price of 40, supplier B is quoting 20 rupees more than the ideal value and supplier C is also quoting 20 rupees more than the ideal value. So, it is and this is what will happen in reality. In reality it is not theory, whatever we propose will not happen in the same manner as we are proposing. So, in reality whatever you want, your market dimensions and dynamics will take you away from ideal.

If you remember the LP method of supplier selection, what was there? The ideal point was there with one value and we were seeing how far they are from the ideal. And the one which is nearest to the ideal, we selected that as the best supplier, the same thing is there. So, ideal value will remain, only thing is that you will, you can nev, you there will be deviations from the idea value, there will be deviations from the idea value.

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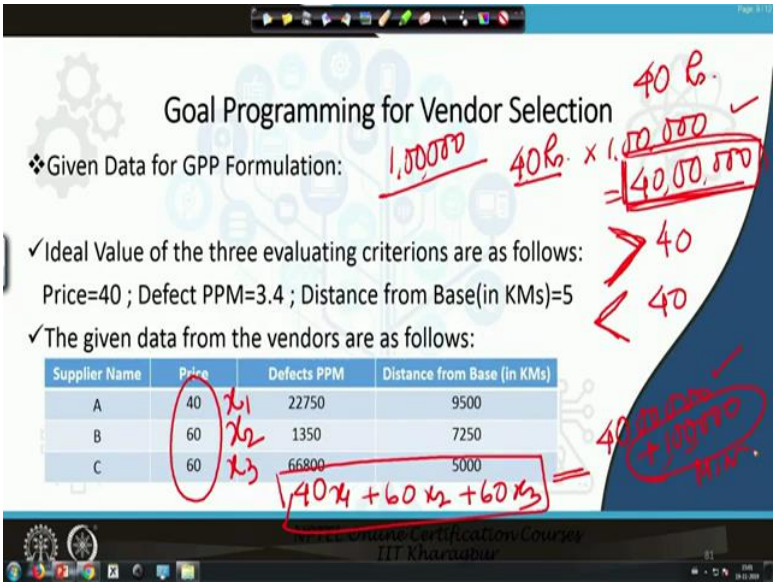

Now, let us take this situation, my ideal price is 40 rupees. How much is my annual requirement? 100,000 pieces, or hundred thousand pieces of material. So, what is my ideal budget? My ideal budget is 40 rupees into. So, this is my ideal budget, what will happen? This amount is my budget but the suppliers are quoting me 40, 60 and 60. So, what will happen?

The price that I pay, the price that I pay maybe more than 40,00,000, more than 40,00,000 or the price that I actually pay for buying from these suppliers will be less than 40 lakhs. I am repeating again. What is happening? My ideal price that I wish can buy at is 40 rupees, how much do I require? 1,00,000 pieces . So, what is my total budget, ideal budget, 40,00,000 rupees. But, how much am I actually paying?

40 rupees if I buy from supplier 1, how much quantity am I buying? X1. 60 rupees if I buy from supplier 2, how much quantity I am buying? X2. And another 60 rupees if I buy from supplier 3, how much quantity am I buying? X3. So, if you look at it, this 40, my total spend, my total spend is 40 X1 plus 60 X2 plus 60 X3. Now, this total spend, this total spend maybe more than 40,00,000 or this total spend maybe less than40,00,000. So, it cannot be equal.

To make it equal, what am I saying?40,00,000, if it is more than 40,00,000 by P 1 quantity, if this is more, if this is more than40,00,000, if this is more than 40,00,000, let us say it is 41,00,000, let us say this is 41,00,000. So, this 40 plus 1,00,000, this 40 plus 1,00,000. So, what is my objective? I have to minimize this extra that I am paying. Have I been able to explain? My total spend, actual spend will be 40 X1 plus 60 X2 plus 60 X3, X3 is the quantity purchased. My ideal spend is40,00,000.

So, this total spend might be more than my ideal budgetary spending. Assume that I have spent 41,00,000 rupees. So, 40,00,000 is my ideal budgetary spend and 1,00,000 rupees is extra that I am spending. So, what is my objective? My objective is to minimize this extra spending, this minimize 1,00,000 that is my objective, clear? Now, if I am spending less that can also happen. Let us look at it now.

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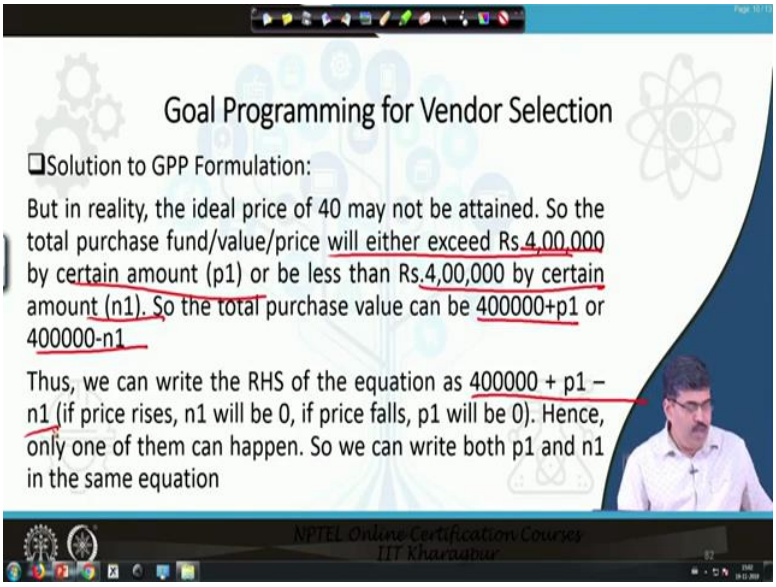

Let us go through it, in reality the ideal price of 40 may not be attained. So, the total purchase fund will either exceed 4,00,000, so 10,000, by certain amount P1, by certain amount P1 or be less than rupees 4,00,000 by a certain amount n1. So, the total purchase value can be 4,00,000 plus p1 or 4,00,000 minus n1. Thus, we can write the right hand side of the equation as 4,00,000 plus p1 minus n1. Now, p1 and n1 can never happen together. So, this is my right hand side of the equation.

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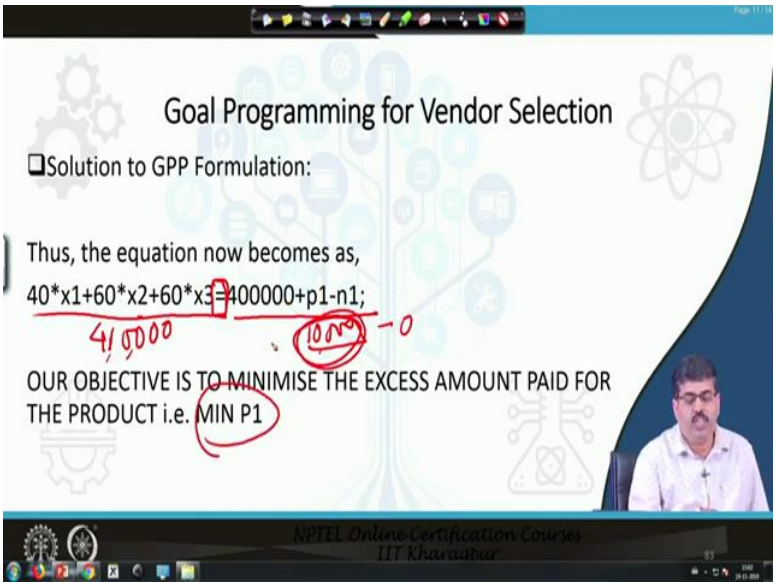

So, as we were mentioning 40 X1 plus 60 X2 plus is equal to, if you are putting that equal to sign, it should be 4,00,000 plus p1 minus n1. So, if side is41,00,000, so say this one is

4,10,000, this p1 is actually 10,000 and n1 is 0. Our objective is to minimize this extra spending, our objective is to minimize this extra spending. So, minimize p1.

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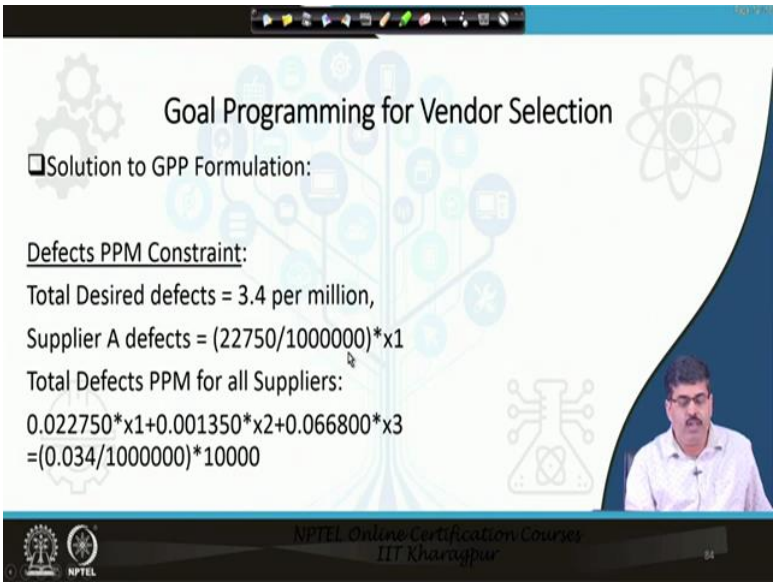

Same thing applies here defects 3.4 defects per million, supplier A's defects 22750 divided by per million into X1 and supplier B this, supplier C this.

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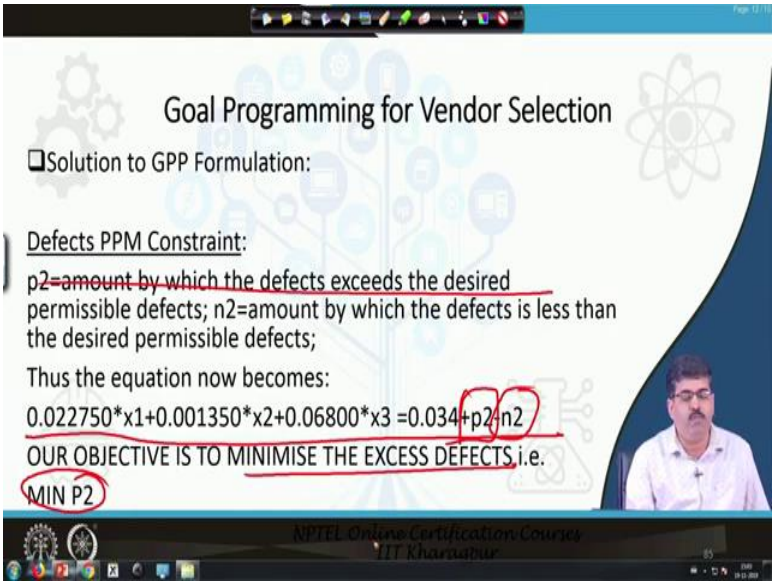

So, basically again here if you see that this is my equation. The defects may be more or the defects may be less. Our objective is to minimize the excess defects, so minimise p2. p2 is the amount by which the defects exceed the desired permissible defects.

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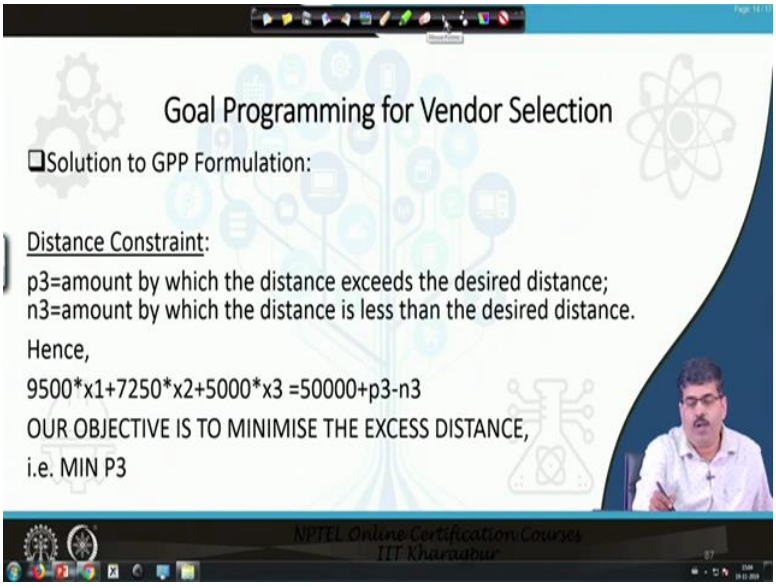

Similarly, for distance, same thing, it may exceed and it may be lesser than my desired minimum distance. So again, we have to reduce the excess distance. So, my objective is again minimize p3.

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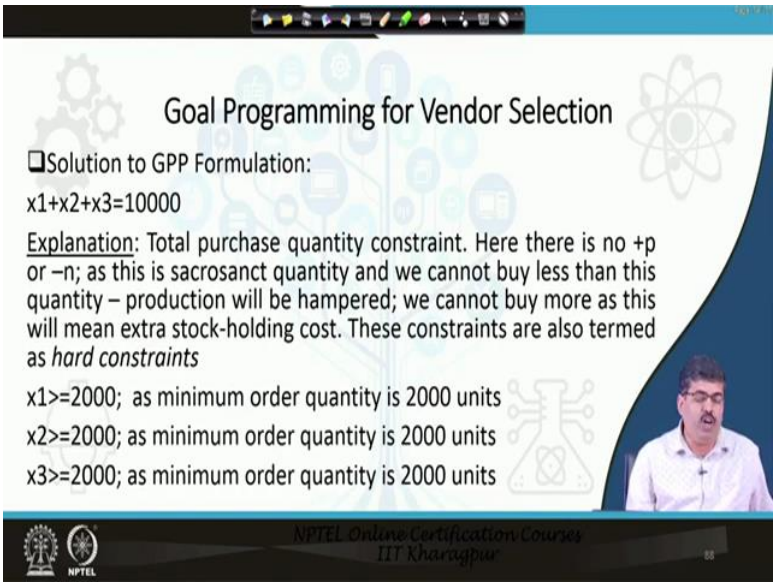

And we have to give a minimum order quantity to all the suppliers. So, each one should get a minimum order quantity of 2000 units, that is given here minimum order quantity of 2000 units. So, X1 greater than equal to 2000, X2 greater than equal 2000 and X3 greater than or equal to 2000.

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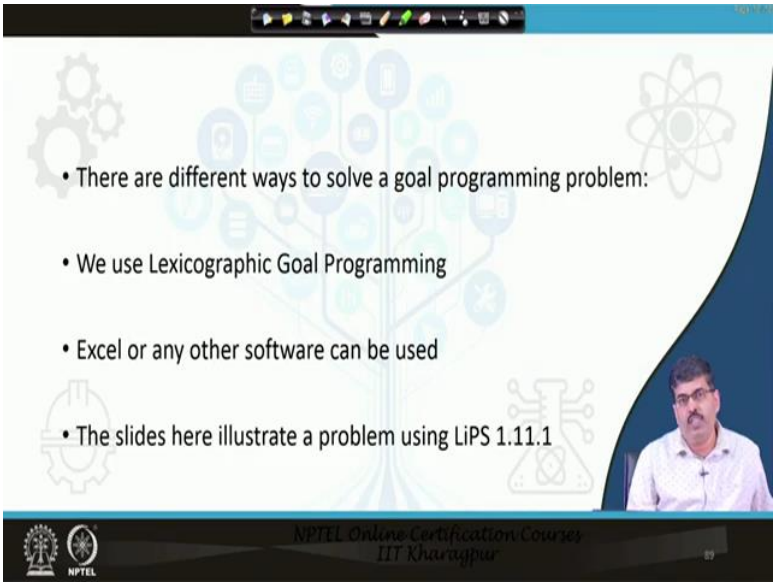

We will use Lexicographic goal programming, Excel or any other software can be used. We use a software called LiPS 1.11.1 this is easily available. It is some sort of an open source software, some sort I mentioned because it is still under construction.

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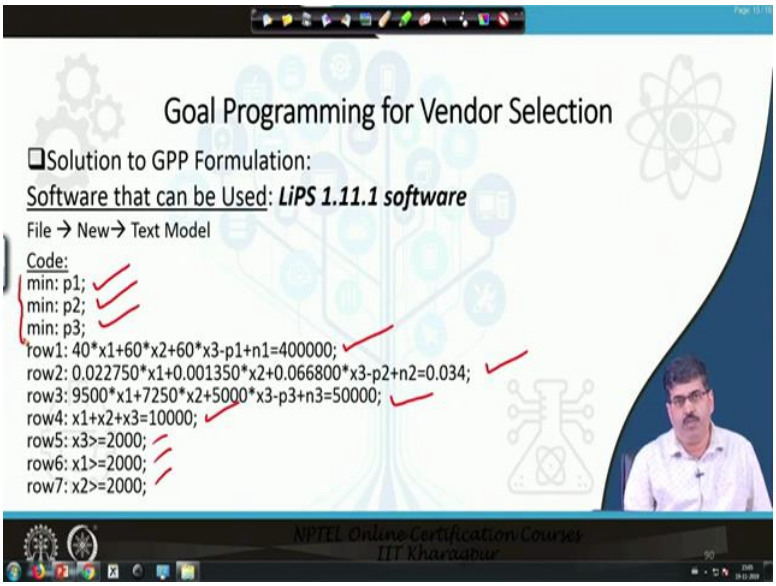

So, now if you see this is my goal programming formula. We have three objectives, given the priorities minimize p1, p2 and p3. And this is the budget constraint, this is the defects constraint and this is the distance constraint. Total demand is 10,000 units and each supplier should get a minimum of 2000 units, greater than equal to 2000. And since this is lexicographic we will have to write the model in this manner, minimize p1, p2, p3.

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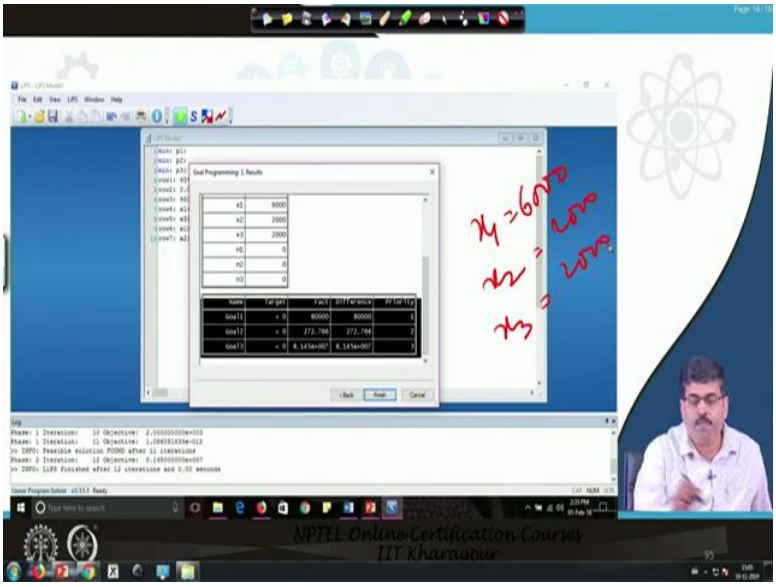

We use the software same, just write a simple linear programming equation and then we prioritize and what we see in this matrix is that X1 that is we will see supplier that is X1 6000, we see X1 6000, X2 2000 and X3 2000.

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So, basically, supplier 1 will supply 6000 units, supplier 2 will supply 2000 and supplier 3 will supply 2000 units. Now, what we want to, so, basically what we want to say is this goal programming will tell us exactly how to distribute my entire demand among the suppliers. So, tomorrow no one can question me, why I have given supplier 1 more number of units, why have given supplier 2 lesser number of orders. This is particularly useful when the raw materials that you are purchasing are very, very costly or have to be imported or very little

are available in lesser quantities in the market. Then the slightest order quantity change can make a supplier very rich or can make a supplier a little less rich.

So, unnecessarily you do not want to take their responsibility of making a supplier rich. So, nobody should ask you any question as to why you have given more order quantities, what is the basis of giving a supplier a particular order quantity. So, goal programming will help you to mathematically derive that order quantity level, which you should give to the suppliers.

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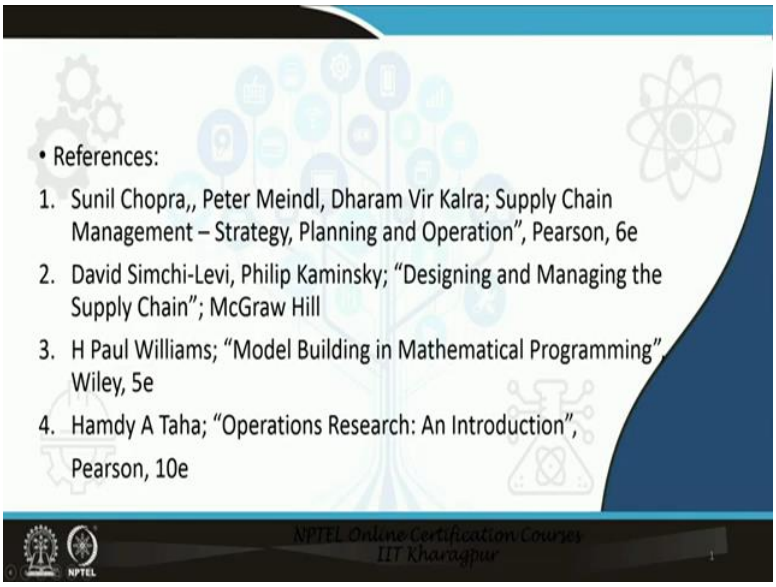

With this we end this week's session. Thank you.