Modelling and Analytics for Supply Chain Management
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Lecture 24
Strategic Performance Improvement (Contd.)

Hello and welcome to modelling and analytics for supply chain management. We are into week 5 and if you remember in the previous week, we have started off with strategic performance improvement and we said a few things. Let us remember those few things in bullet points. One, supply chain is a cost centre. Number two, therefore, performance of the supply chain has to be very very effective, efficient in efficiency wise as well as cost wise because it is a cost centre. And number 3, it is very simply performance measure is equal to output by input. But in every industry output is not one output. Outputs maybe 2-3 types. Similarly, inputs are also not one input. Inputs maybe 2-3 types.

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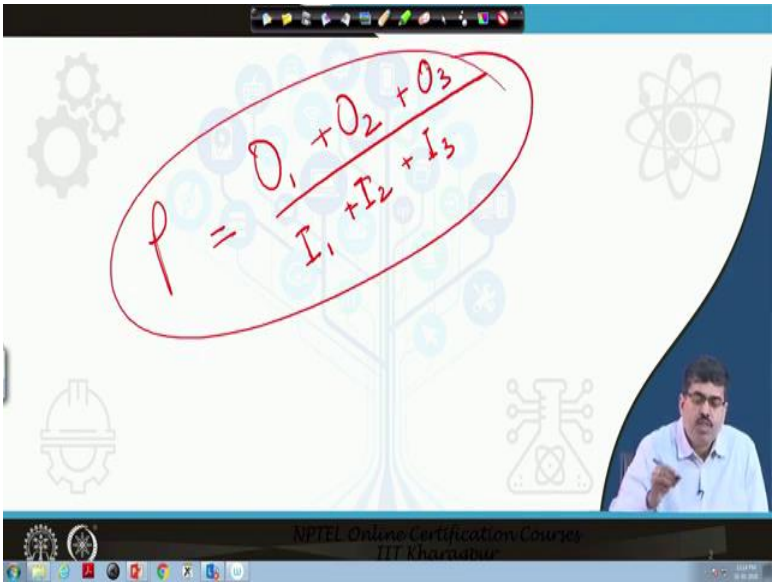

So basically in supply chain when we speak of performance measurement, we speak of that p, is equal to multiple outputs, output 1, output 2, output 3, output divided by input 1 input 2 input 3. And then you can give weightage to all these things. So very simply performance is equal to this. So in supply chain there will be multiple outputs and multiple inputs. s

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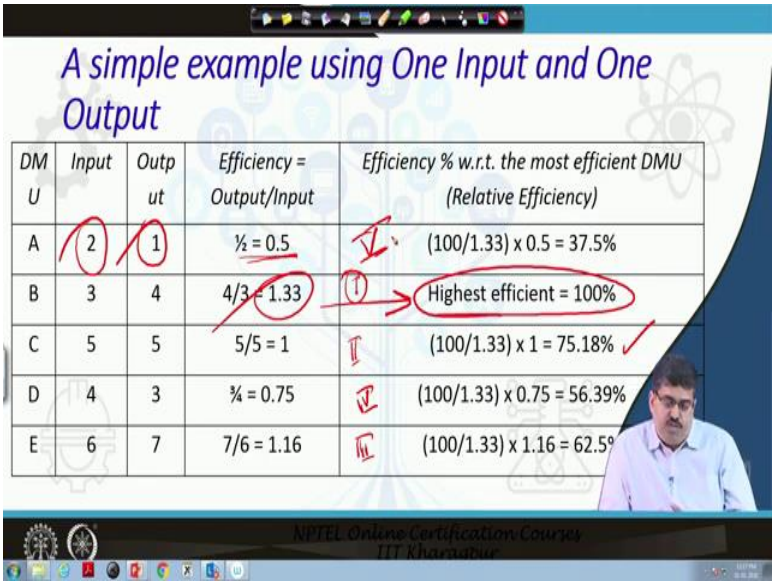

Now, and then what we did was, we took this very, very simple example. And we said that if you remember, this is what we ended with. We said that there are 5 units, 5 units A, B, C, D, E. Assume this is a warehouse company, a particular company has 5 warehouses in India at 5 locations, A, B, C, D, E. This with Delhi, Mumbai, Kolkata, Madras, Ahmedabad, Bangalore. So A, B, C, D, E, they have five DMUs or decision making units. Warehouse is a DMU, assume. Now, inputs, DMU A that is warehouse a uses two inputs. How much output does it generate? It generates 1 unit of output. So what is happening?

It has two inputs. How much output it is generating? 1. So what is my efficiency? 1 by 2, that is equal to 0.5, similarly A, B, C, D., all the all the units have inputs and outputs. Now, if you clearly look at this, which one is the most efficient unit? Now, this is where we ended and we start this week with this question, which of these units is the most efficient? Definitely B with 1.33

Now, so this will be considered as the highest efficient unit, all others are relative to this. All others are relative to this. Agreed? All others are relative to this. So the next highest efficient is C, third highest is E. So B is 1, this is 2, this is 3, 4, 5. So this is the ranking of your units. So we have answered the first question. What is the first question? The first question says, how do you measure the efficiency? So output by input.

Here we had one output, the output units and we had number of inputs. So efficiency is measured, but will this actually suffice in the real world? Answer is no. This will not suffice. What assumption and a very very tall assumption we have taken here. What assumption and I

must say, it is a very very tall assumption that we have taken here. We have taken here an assumption there it is a constant returns to scale, which in normal monopolistic situations, does not work.

So we assume a constant returns to scale. What does constant returns to scale mean? Constant returns to scale means that if one unit, constant returns to scale does not mean a 45 degree line through the origin. Constant returns to scale means if one unit is giving, one unit of input is giving two units of output. It should give me the same over years and years of time and no matter how many times you do this activity, it should give me the same level of output as the inputs.

It is not saying, constant returns to scale is not saying that 5 units of input should give me 5 units of output. No. 5 units of input should give me 5 units of output, it is not saying so. It is too large in assumption. But for CRS what constant returns to scale says is that if 5 units of input is giving 10 units of output now, it should give 10 units of output tomorrow, it should give 10 units of output on the next day, that is what is consistency. So constant returns to scale. So this is a tall assumption that this table is done this table is assume that there is constant it has to scale okay which is very difficult to achieve.

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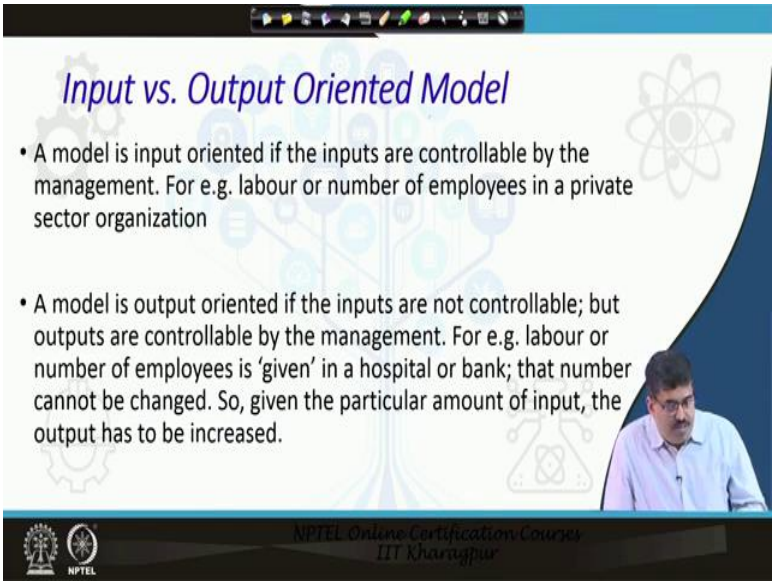

Now, the next thing that we want to say is that is input versus output oriented model, input model and an output model. Now, see these are the building blocks for measuring performance., these are the building blocks. Input model, what is an input model? In

performance measurement, there are two models, input and output. Input model is when you, you means the business owner, when you have control over the inputs, it is an input model.

When you have control over the output, it is an output model. When you have no control or equal control over both inputs and outputs then look at the cost of these models, implementing these models and then you go ahead. Now, can you give an example of an input model? Input model is what if you have control over the input it is an input model. If you have control over the output it is an output model.

Now, let us say let us take an example. Performance measurement of banks. Is it an input model or is it an output model? Now, for your understanding, we must say that there is nothing called it can be both. It either has to be this side or that side. Now performance measurement of banks, is it an input model or output model? If you think very carefully, it is an output model. Why?

Because what are the inputs of a bank? Inputs of a bank are deposits for which you have no control, because you are not the controller of the economy. Economy more money (generation), more income generation. So people go to the banks to deposit. But you have no control in developing the developing what the farmers should do. So you have no control over your inputs, that is the deposits. You have no control.

Do you have control over another input that is called employees? No. You have no control. But if you look at output deposits generated, maybe with some extra effort you can generate some more deposits. So banks is an output oriented model. So model is input oriented if the inputs are controllable by the management, the model is output oriented if the inputs are not controllable by the management.

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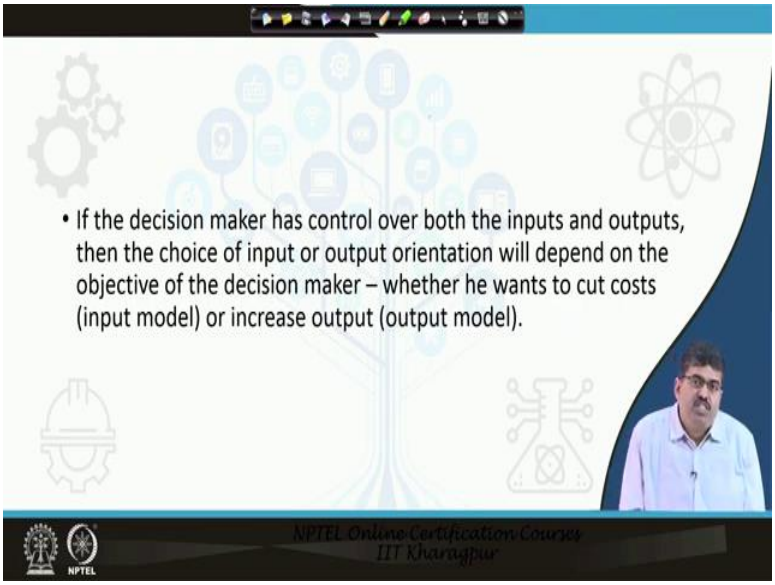

If the decision maker has control over both inputs and outputs then the choice of input or output orientation will depend on the object of the decision maker, whether you want to cut costs or increase the output. Cutting cost is a cost model. Increasing output is the output model.

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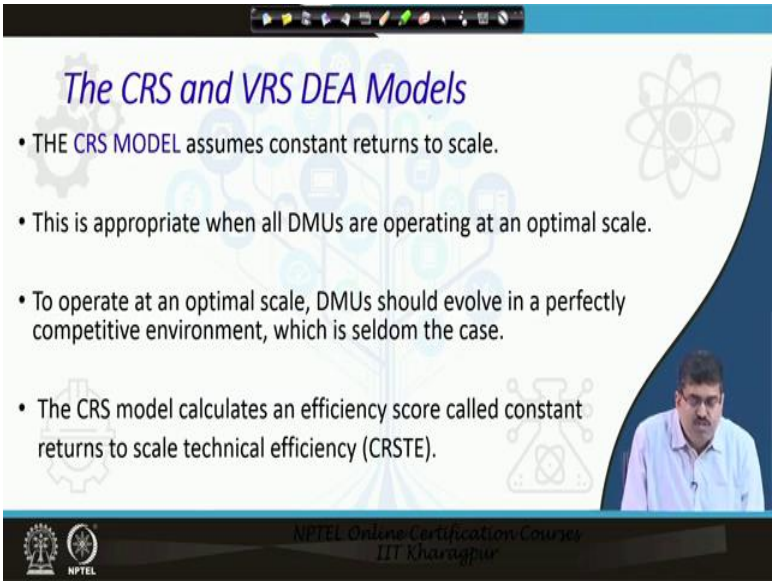

Now, here is what we were talking about using the table. The constant returns to scale and variable returns to scale. As we mentioned constant returns to scale does not mean that 5 units of input has to give 5 units of output, 3 units of input has to give 3 units of output, 2 units of input has to give 2 units of output. In that case, the line is a 45 degree line, straight line, 45 degree line. That CRS does not tell.

CRS tells that if you have used one unit of input to manufacture two units of output in the morning, you should use the same units and get the same outputs in the evening and the same units and the same output at night. That is constant. As if you are not constant then the mathematical tools cannot be applied, so that is what is called as constant. Variable returns to scale, we know that the market is imperfect and accordingly the returns will also be imperfect. That is variable returns to scale. This is what we have just mentioned.

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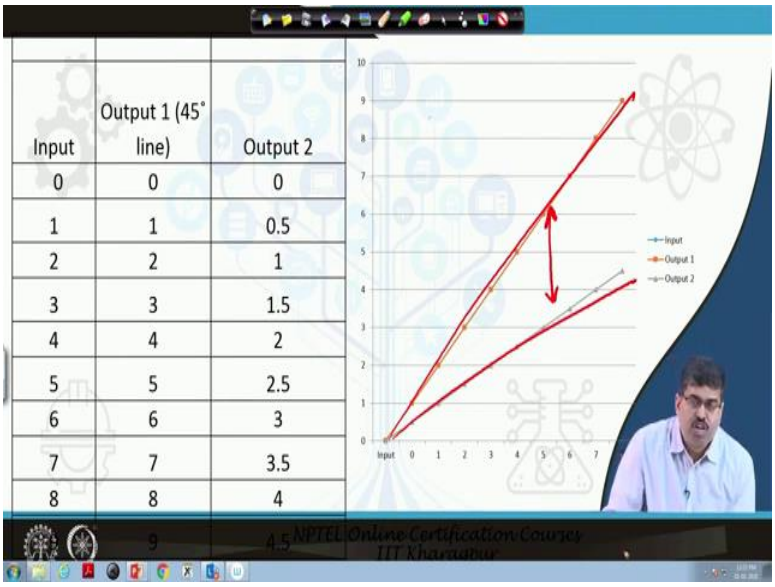

So basically this is what we wanted to say actually. That is if it was actually a theoretically constant, it has to scale output is equal to input, this was your 45 degree line, but here what we are saying? That it is consistent, not output is equal to input So it is consistent given by the straight line but it is at a much much much lesser level., right, then the 45 degree line.

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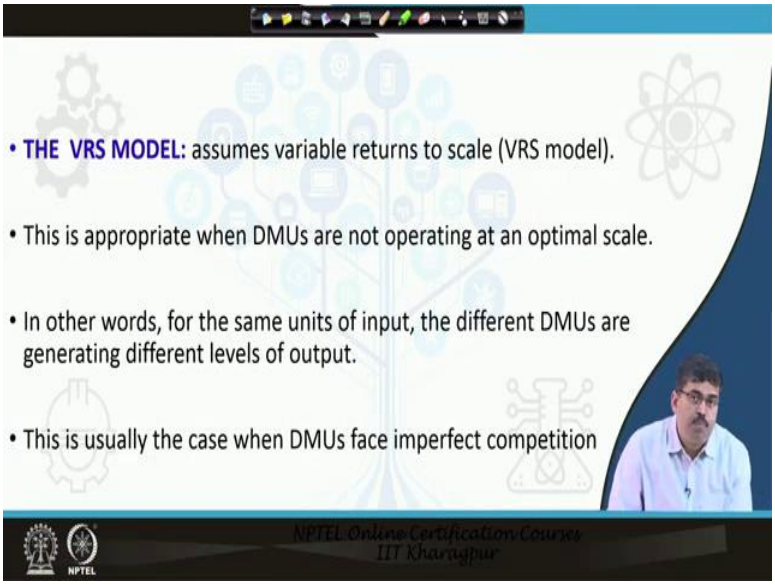

Variable returns to scale, assume variable returns. This is appropriate when DMUs are generating different levels of output. This is usually the case when DMU is facing perfect competition.

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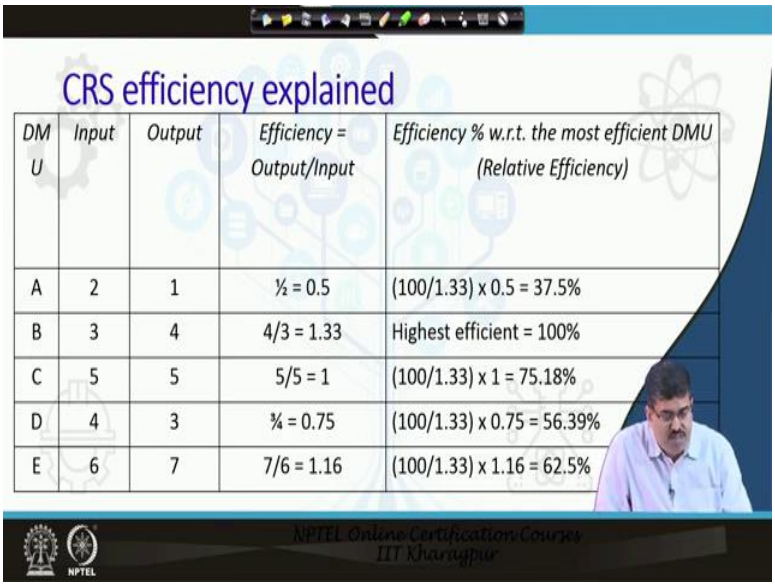

And this is the same table using a variable returns to scale.

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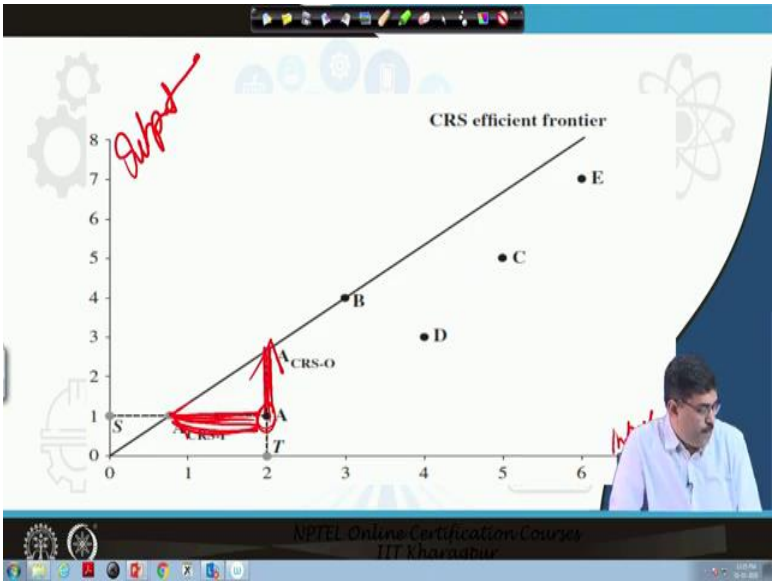

Let us explain the CRS again here. Now you see B was the most efficient, B was the most efficient. So this was B straight line. Where was A? A's efficiency was, let us go back, A's efficiency is 0.5. So in this diagram, he is here. So either this is what? This is your input and this is your output. So A is here, either A has to reduce the input up to this point, either A has to reduce the input up to this point or A has to increase the output up to this point. So either reduce the input, reduce the output to move up to B,

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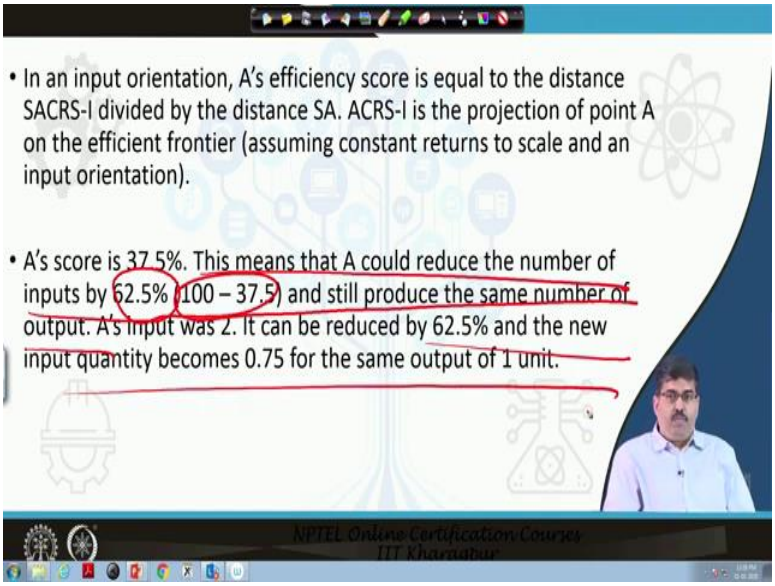

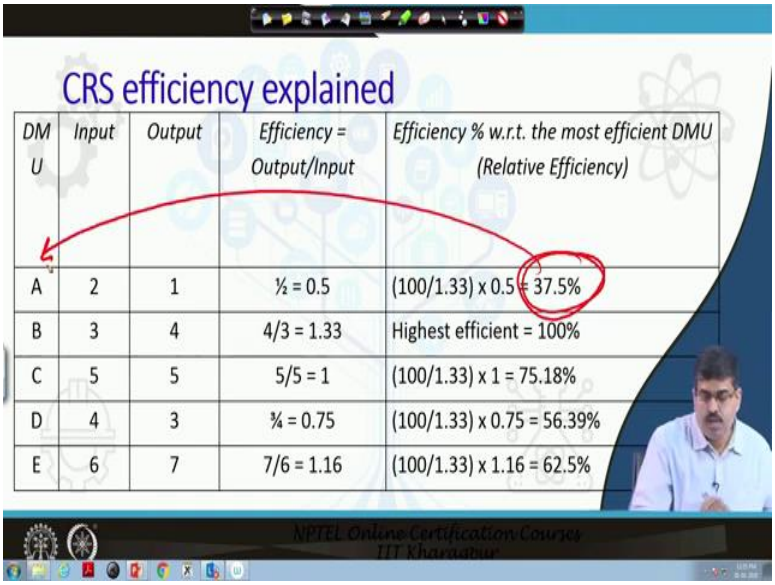

This is explained here, just go back to the table. A's score is 37.5 percent. A's score was, this means that A could reduce the number of inputs by 62.5 and still produce the same number of outputs. It can be reduced by 62.5 percent and the new input quantity becomes 0.75 for the same number of units. So definitely DA helps.

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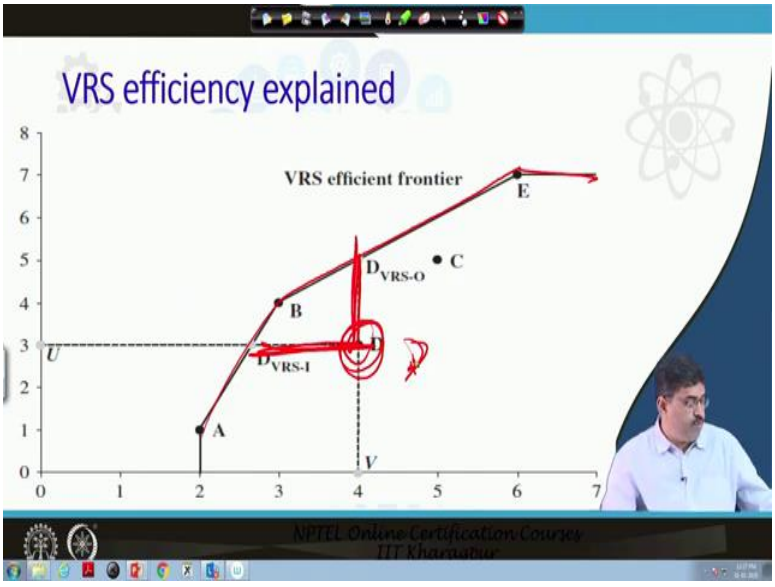

We have given some explanation. This is your VRS or the variable returns to scale graph. So what we do is we just connect the extremes. We connect the extremes and naturally all will fall below this line. So D has to reduce inputs or increase output, has to reduce inputs or increase output. This is what is your DEA.

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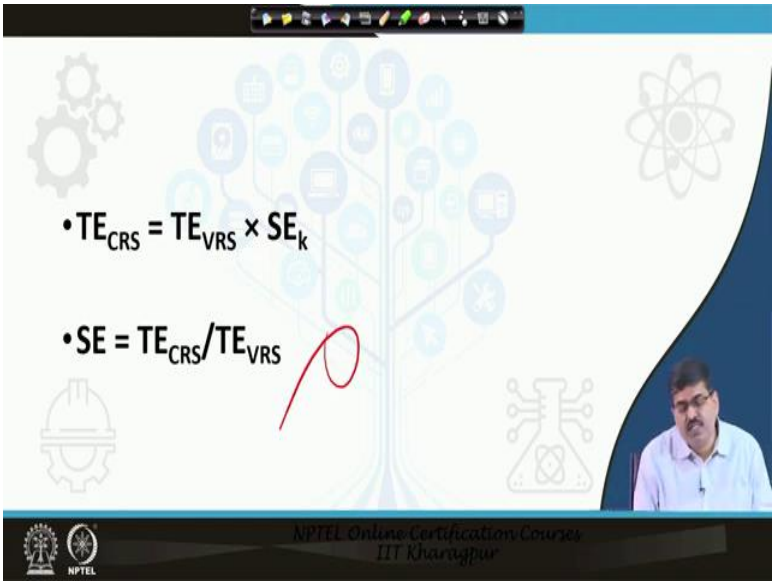

And now if we plot both the graphs together, this is what B is at the centre of this. Now situations may come when these two may not match. This is the formula for efficiency. Technical efficiency is equal to TECRS is equal to VRS into standard error.

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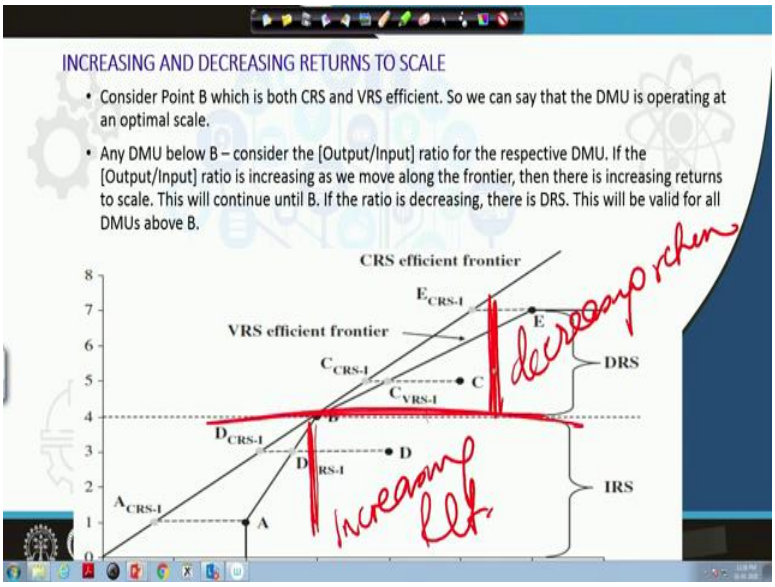

Now increasing and decreasing returns to scale. Any DMU below this, any DMU below this is considered as to be an increasing return. Any DMU above this is a decreasing returns. Any DMU below this is increasing returns. I am not going into these in detail because you have learned these in economics.

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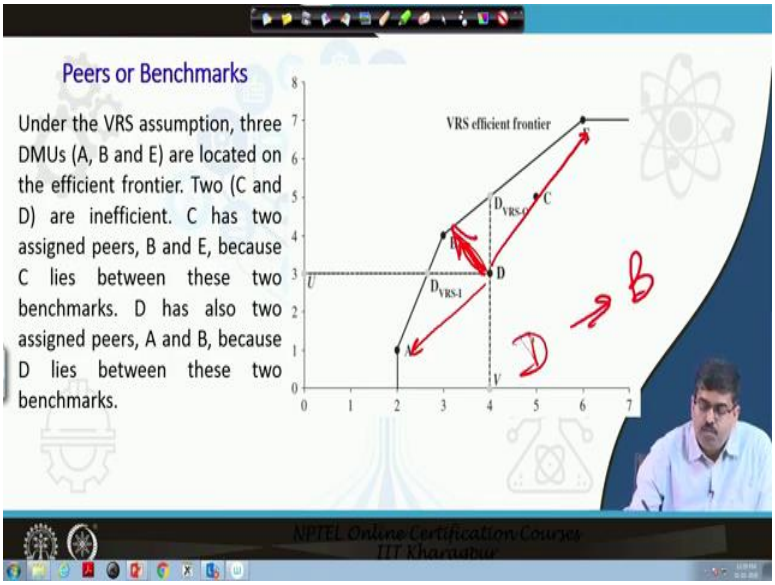

What are the peers or benchmarks? Here if you see whom should D benchmark against? Look at this graph. Who should D benchmark against? D should benchmark against either A or B or E. Now, which is the easiest one to implement? Naturally B. So D should benchmark against B.

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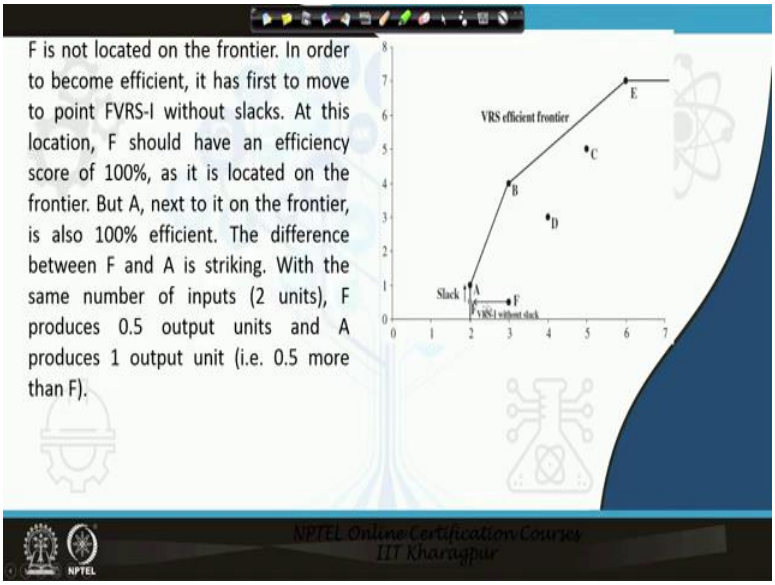

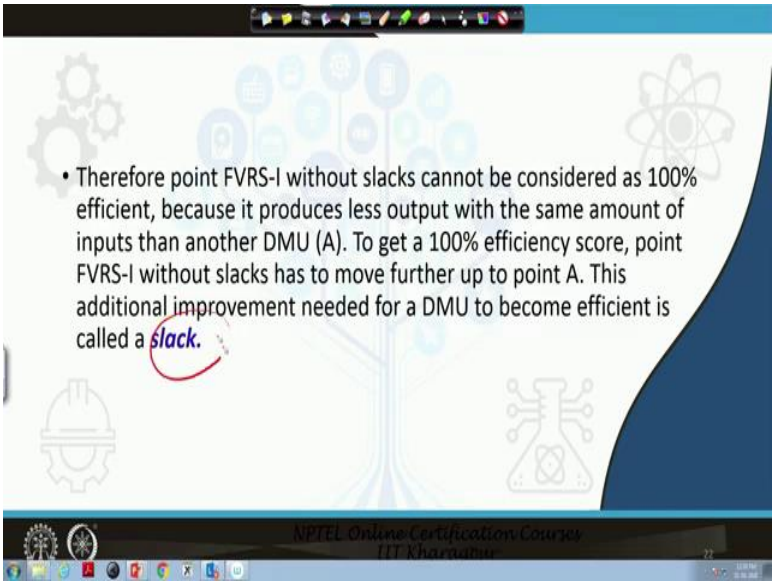

This is something is there. So this part is called as the slack variable, this part is called the slack.

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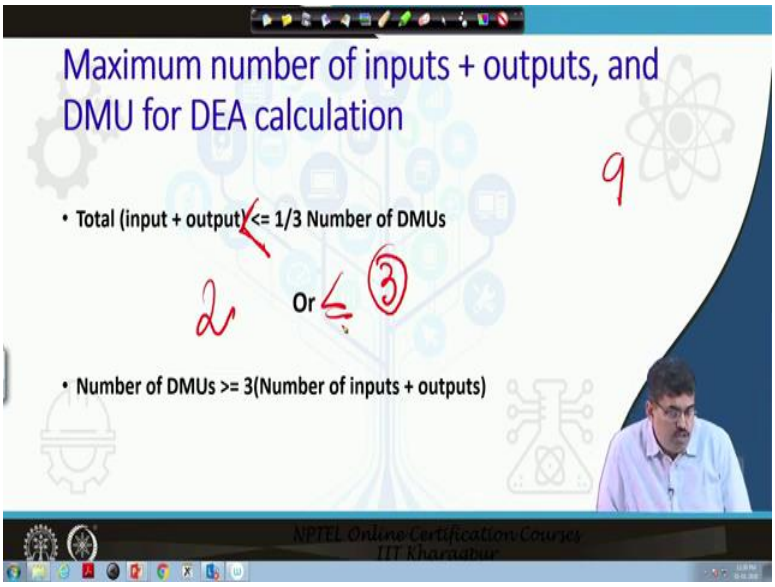

What is the maximum number of inputs and outputs for and DMU for DEA calculation? Normally it is total inputs plus outputs is equal to one third number of DMUs. Input plus output should be lesser than one third number of DMUs. So if you have 9 DMUs your number of, one third the number of DMUs is 3 and the input plus output should be lesser than equal to number of DMUs. So if your total number of decision making units are 3, the total input and output can only be 2.

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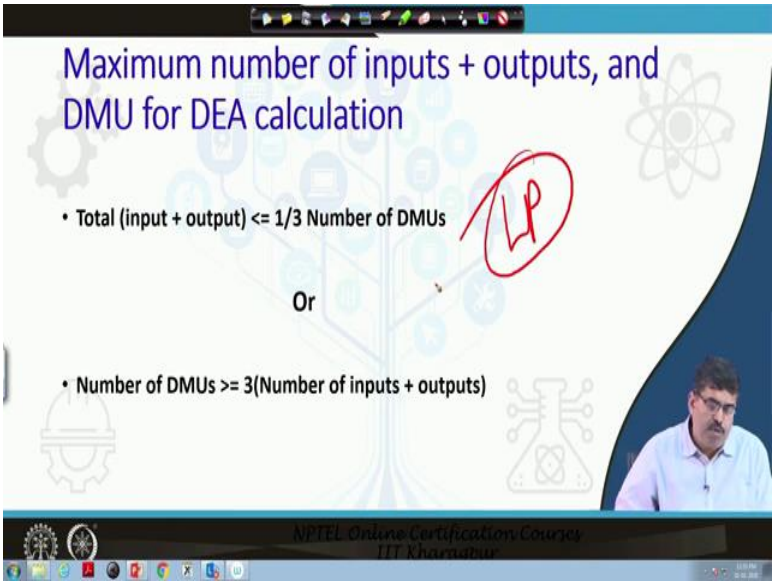

Now, this much is this. What are we left with? The traditional model was linear programming. Traditional model was linear programming. DEA can use linear programming also to solve the problem. Let us listen very carefully. This is the normal model. DEA can use linear programming to solve this model. But take a situation when there are 20 DMUs. So for 20 decision making units you will have to write 20 equations, 20 constraints.

If there are every variable is a constraint, so 20 equations, at least 30 constraints and that you will have to repeat for every DMU. For every DMU, you will have to repeat that. For every DMU you will have to repeat. The same equation and same number of constraints, so only thing is that the signs will change. So imagine a situation when you have been given a job, job means an assignment to measure efficiency of all the dealers and distributors for Nirma in India.

So how many linear programming equations will you have? You must be having at least 10,000 dealers for Nirma. So will you have 10,000 linear programming equations to measure each one's efficiency? No. Answer is no. Nowadays you can model this in excel, in solver, in other places and there you will see only model, the numbers once and the rest the results will come out.

So you can use linear programming. There are some readymade linear programming softwares that are now available. So you do not need to write or type the equations, just type in the numbers and the results will come out. So that is that. Now let us let us look at one more issue for just a few minutes that is we have measured the performance. What is the next

step? The next step is redeployment of people. Some places you will have to reduce people, reduce machines; some places you will have 2 increase the output. Depending on the input model, output model, the results will be such. Question is, is there softwares available to do this? See ready-made softwares, only software that is available is linear programming softwares. That you can do in Excel also.

So every time you just need to change the numbers and the software will generate some particular output. But more than that, and you can definitely program it with modern other mathematical software and more than that there is nothing. What is important is we need to know how many units we can reduce, how many inputs you can increase. That can be done in Excel, that can be done using some other advanced softwares.

This is the second question. So how to model it? Modelling is nothing, you can use a simple linear programming format and you can model it. Now, the next question is what will the company do after measuring? After measuring, the company has to take a decision on redeployment of the resources. As simple as that. After measuring, the company has to take a decision on the redeployment of resources.

If there is a resistance, company has to think otherwise. So this is what is very important, that is decision making units. Now, having said that, we have just mentioned about what we discussed up to now is the performance measurement of the supply chain. Now, if you look at any standard supply chain books you will find a list of, whole list of performance measures, for warehouses, for transportation, everything, everything, everything, but you know, it basically the performance of the supply chain, only one measure also if you can take, you should take truck turnaround time.

That is an all pervasive measure. If your organization does not use trucks, if they use small vehicles, then that, turnaround time of that. That is the one measure encompasses all measures in supply chain, that is truck turnaround time. So you will have to look into that. What about the other measures in supply chain? How will you measure overall supply chain performance?

Lead time, this, this, that but then as we said truck turnaround time is an overall, over encompassing measure of performance in supply chain and you need to know how to model this. Now, having said that, let us let us just say something to you, we are now into week 5. So week 1, 2, 3, 4, I think all of you have gone through them very, very meticulously and

parallelly what we will tell is, what we will suggest is you parallelly, you read different books, different materials, different developments across supply chain, just reading the newspaper also helps.

So different materials, different changes across supply chain and the types of models etcetera that are used in supply chain, that also you practice using the slides and the templates that we are providing. Supply chain is a vast area, modelling is also very vast area but then if you start early you should be able to do it properly, do it nicely. So you better start working on it. That is what we wanted to say. We have finished off enough lectures. So it is a high time that you start working on it sincerely.

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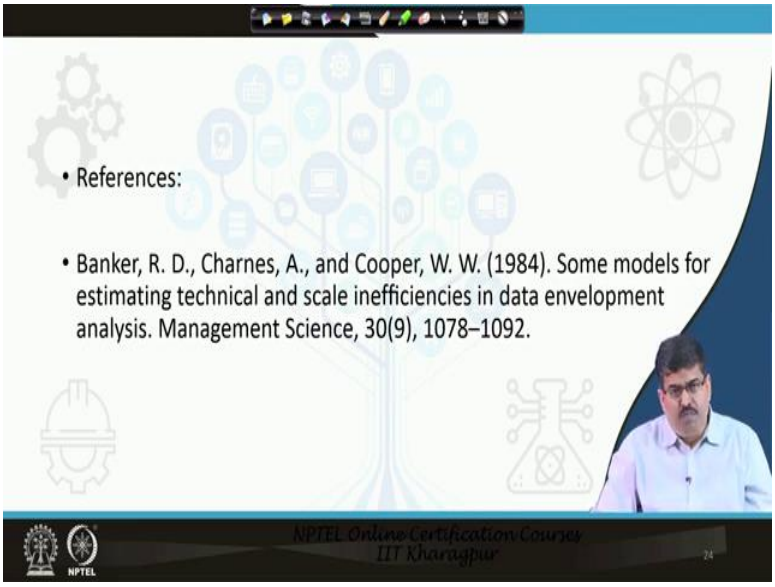

Now this is one paper that we have as reference. This is an all pervasive paper. Charnes, Cooper and Rhodes are considered the fathers of modern thinking on data envelopment analysis. There are many papers that you can get by the author Charnes. So you can go through them. I think this gives you a pretty much focus, pretty much idea about how and why, where and when should we measure performance of a supply chain. Thank you.