Modelling and Analytics for supply chain management
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Lecture 45
Forecasting: Simple and Weighted Average, Mean Square Error

Hello and welcome to Modelling and Analytics for Supply Chain Management. We are into week 9, lecture 45.

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Today we will discuss on forecasting in supply chain. Now, if you recall initially when Professor Kunal Gosh and myself gave you a brief orientation about the holistic way in which a supply chain operates, we had told you that forecasting is the first stage of supply chain. That means how will you design your supply chain when you do not know what will be your demand in the future.

Based on a futuristic demand, based on what will be your demand in future, you design your supply chain because the moment, where does the supply chain start? Your supply chain starts from raw material procurement. The moment you go to a supplier and ask that I need this much quantity of raw materials or I need raw materials the supplier will ask you two, three questions. Supplier will ask you how much quantity do you need, number one, how much quantity do you need at a time, number two, and how much quantity do you need at what. Got it?

So the supplier will ask you these few questions, now that how much quantity you need you will not be able to tell unless you have done a proper demand forecasting. So demand

forecasting is the starting point of Supply Chain Analytics or Mathematical Modelling in Supply Chain. Now this demand forecasting is very, very difficult rather phrase, easier said than done. Very easier said than done.

If you forecast more what will happen, the products will remain unsold that means lost money. If you forecast less, you sell less so what happens? Lost sale. Now that lost sale is very dangerous because lost sale does not only mean lost only revenue, lost profit but lost sale means lost market, that is very important. With so much of competition today, lost sale does not mean lost money, lost profit. Profit is there but lost sale means lost market and lost market is very, very difficult to recover from the competitor space. So forecasting becomes very difficult.

Now, there are different methods of forecasting. One is quantitative method, one is qualitative method which you normal see in books, etc. Let us take a simple example that will help you to understand how difficult it is to forecast, okay. You are trying to bring into the market a product which is very less costly, but if accepted the market is huge.

What is the product? The product is a children use pencils in school, in classroom. KG, one, two, three, four, they use pencil. And particularly the kids, the smaller ones in pre-nursery, nursery, KG they will lose pencils every day. They lose their pencils and next day they will say, they will come back home and tell you that no, my pencil he has taken, she has taken my pencil and that child will go back home and say, no, my pencil he has taken, she has taken.

So here is this company who comes up with an innovative product, an embossing machine. Embossing machine means just like your date stamp that embossing machine will be of that pattern, it will have your name's initials. Say your name is ABCD, so that initial ABCD will be there in that stamp and that will be there at the back of the pencil.

So if you emboss that ABCD then nobody can claim it is their pencil. So it is a product that children will love very much and the price of this product will not be anything because it is just a simple embossing machine. So if the market picks up, the demand is your entire country means from your entire country and the demand is your entire country.

So the issue is how much to manufacture? So for that you need forecasting but it is a new product, it is never come in the market, so how do you forecast? You have any previous data to tell you this will be my demand. So no previous data, so no quantitative data to prove. So you have to depend on some market hunch, market feedback, maybe some focus group everything.

So forecasting what I want to say is, it is very risky, challenging, difficult, everything because, simple reason as we mentioned earlier, excess stock is dangerous but lost sale is further more dangerous, okay. So let us now start off with how to, the basic elements of forecasting, how to model forecasting in supply chain okay.

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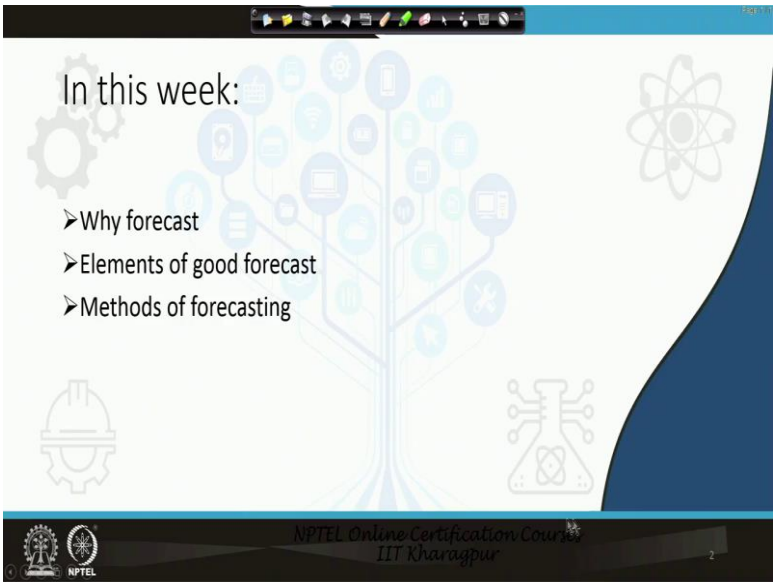

So we will cover why forecast, elements of good forecast, methods of forecasting, okay.

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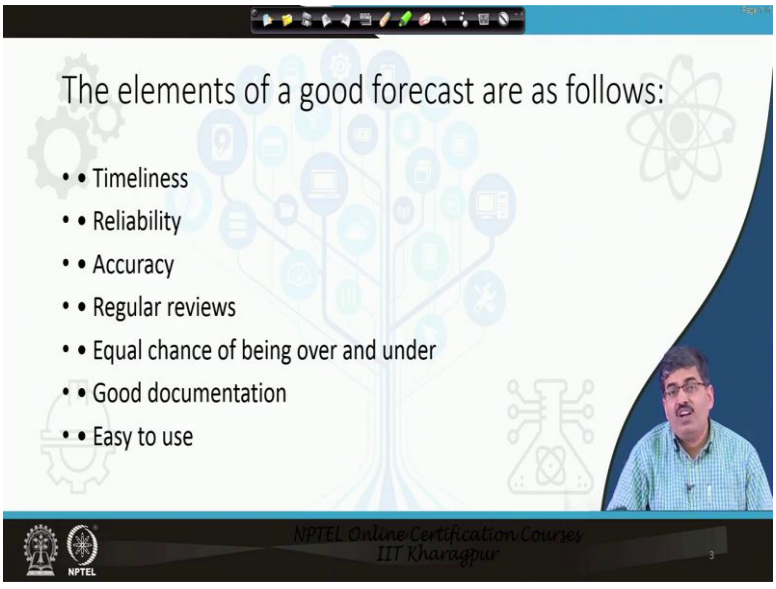

Let us now consider the elements of good forecasting. Elements of good forecasting is it should be timeliness. It should have a timeliness. It should be very timely. For example, I forecast that

sale will be in X quantity after six months, but I am not able to forecast what will be the sale tomorrow then it is of very little use.

Let us take a very pertinent example, all of us take these soft drinks during summer months. Hot summer, humid summer, dry climate, arid climate, etc. we try to take these cold drinks okay. Coke, Pepsi, Thumbs up, Mirinda, whatever, Seven Up, whatever.

So basically we take these cold drinks. Now the issue is these cold drink bottling units, that is the manufacturing company they also need to forecast. What do they need to forecast? How much will be the sale for tomorrow, day after tomorrow, day after tomorrow? Accordingly they will have to prepare their production plan and they will have to prepare their distribution plan, root planning.

You know why? Because the smallest retailer at this furthest corner, if that retailer does not get the Coke supply right on time, what will happen? If there is no supply so he will shift to Pepsi, he will shift to the competitor, okay. Same applies to ice cream also, so if you do not supply on time it shifts to your competitor, okay. The demand or the product shifts to your competitor.

So you have to have a very accurate forecast for these types of things particularly, during the summer. If a Coke or Pepsi is not in the shelf, it is a lost sale. Lost sale means some sort of a lost market. Now, see the issue. Coke and Pepsi has forecasted some quantity for the next two-three days demand, some demands. Accordingly they have done their root planning, they have done their production planning, root planning, delivery schedule, everything they have done.

Suddenly, tomorrow morning it is not sunny, it is a cloudy weather. So what has happened? Then tremendous scorching heat is not there, it is cloudy. What will happen to your demand of Coke for that day, for Coke and Pepsi for that day? Demand will fall, so your forecast is not accurate anymore, right.

So the timeliness, third bullet point accuracy these are very, very important in forecasting okay. Now reliability. How reliable is your market information, market data based on which you are forecasting for the next cycle? How reliable is your base data? If base data is not reliable then your forecast will also not be reliable.

You have asked some people to collect your perception of your product, about your product. You have asked some people to collect the market perception about your product based on

which you are trying to judge gauge how much will be the sale for the next week. So forecasting based on market perception. Whom have you employed?

You have employed people on a daily basis, means you are giving them daily salary, what is the reliability of such data? What is the guarantee that that data will be reliable, because these people who are collecting data for you they do not know whether they will have a job tomorrow or not. So what will be their sincerity level? They all will be searching for a new job, so reliability of the data is also a big question mark.

And you have to regularly review them. Is the method correct? Is the sample correct? Has the sample been selected correctly? So regularly review. Equal chance of being over and under means you have forecasted hundred units as your sale. Equal chance of over forecasting or under forecasting, right. Equal chance of over forecasting and under forecasting.

It is not that I will keep on over forecasting, over forecasting, over forecasting or I will keep on under, under, under, under forecasting. No, equal chance. That means if it is equal that means it averages out, it evens out if it is equal chance. That means your forecasting is pretty accurate. That little bit of over and above, over and under the normal expected demand, that is the chance error, so you are correct. Your forecasting method is correct, okay. Clear?

And good documentation. Very, very important. How have you collected data, what is the method, have you documented it, what has did people said, what were people's feeling about your product? Based on that you are forecasting, so good documentation. And the last one but most important, easy to use. Unless your data is easy to use there is no benefit of forecasting.

That is what in this course we have repeatedly told you. Use complex methods, no problem but make it simple and understandable to your employees, so that an employee can use it without fear of getting it wrong, so ease of use, easy to use. These are elements of good forecasting.

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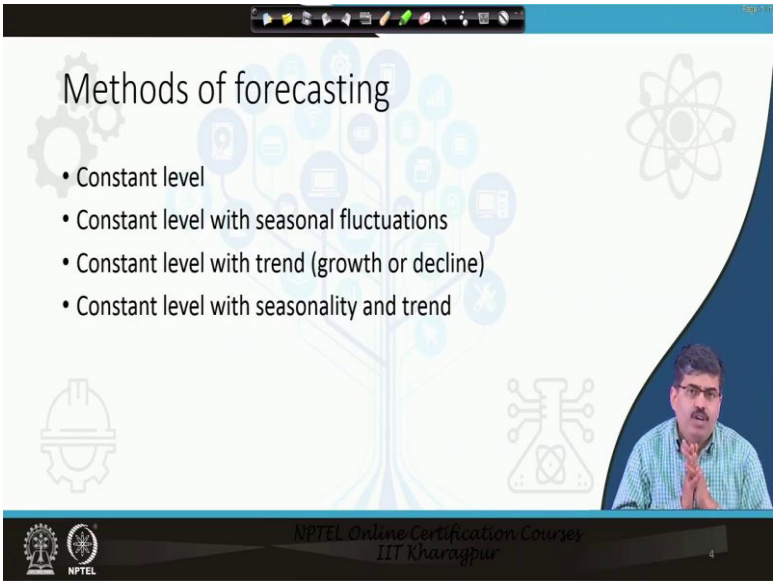

Now, next question is what are the methods of forecasting? See we have these, constant level, constant level with seasonal, constant level with trend, constant level with seasonality and trend. What are these? Can you give an example of a constant level forecasting? See the shirt I am wearing, this shirt, the demand for this shirt is an example of a constant level forecasting, okay. It will not change. Be it summer, be it winter, this demand for normal ordinary shirts will remain more or less stable okay.

What will change? During marriage seasons some people buy the sherwanis, and the suits, and the new sarees, etc. That demand is what? That demand is for a particular season. The marriage season some people will buy more, either because there is marriage in the family or you will have to attend the marriage, etc. So that is, the demand is constant but during certain times there is a seasonality. Okay, clear. Constant level is maintaining but with ups and downs. So constant level is this shirt, demand for bridal wear, seasonality. Similarly winter garments, jackets, example of seasonality okay. We will explain them but this just to give you a brief of these, okay.

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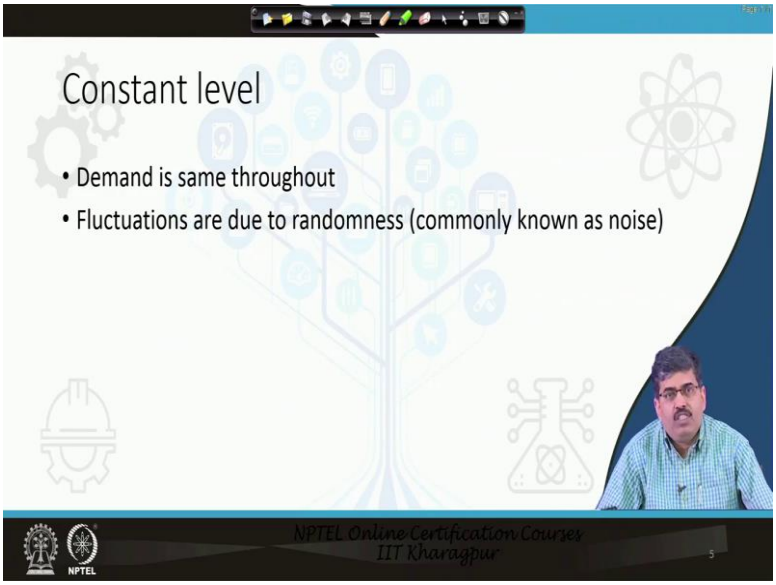

As we were saying constant level demand is same throughout. Fluctuations are due to randomness commonly known as noise. What is this? Every day you take bus or a tram or a train to reach your institute for studying. right. Those of you who are staying in hostels may take the bicycle from your hostel to the department to attend the classes, but can you say that I will reach there exactly at 9 not at 8:59 neither 9:01? No, right. Some days you will reach at 8:59 using the same mode of transport, be it bicycle, be it the metro rail, be it the tram, be it the bus, etc.

So every day you will take same mode of transport but one day you will reach at 8:59, one day you will reach at 9:01, one day you will reach at 9. So these are what? These are fluctuations due to randomness, noise. We commonly call it as noise. It is not planned. It is just like that. It will just happen because human hand is involved, it is just like that. So demand is same throughout. Every day you will reach at 9 but then the randomness, 8:59, 9:01 that will remain okay. That are fluctuations. This is called a constant level okay.

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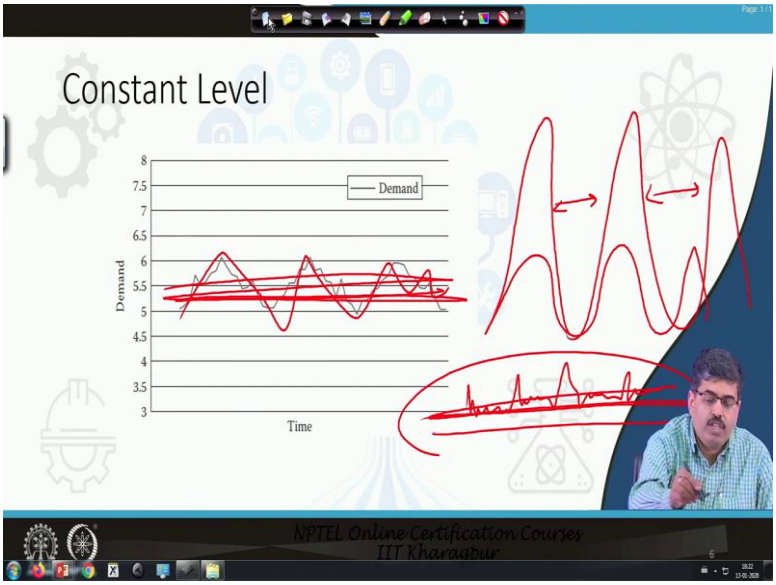

This is an example of constant level one. If you see the middle, the demand is same, right. If you see, the demand is same. If you see this is your demand, okay. This is your randomness okay. Now you will say, no sir it is looking like seasonality. No, sir. Seasonality is very prompt, okay and there is a major distance between these two gappings. Major distance between these two gappings. Major distance between these two highs and the lows but randomness is what? Randomness is this. Somedays it is like this, just like a normal human heart beat, that is randomness okay. It follows a particular pattern little bit up and little bit down okay, so that is what is called as a constant level right. Okay.

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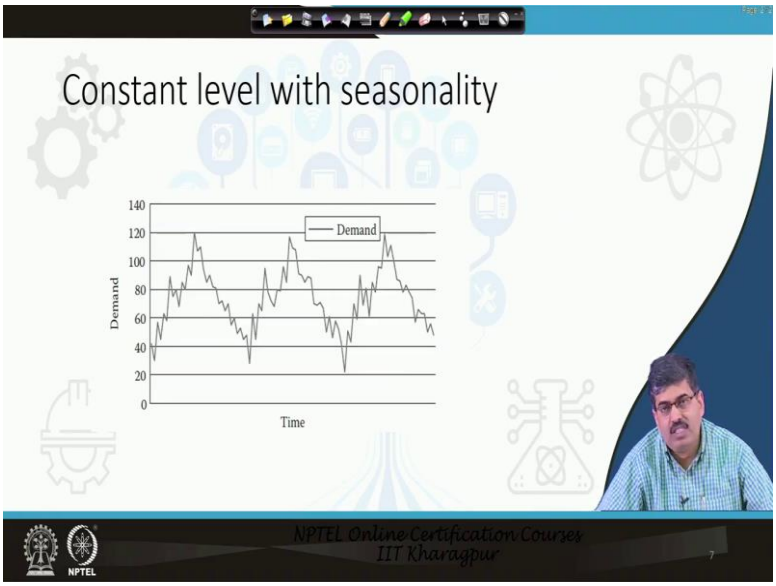

Next is, as we said, constant level with seasonality. Clearly you can see the difference between this diagram and this diagram, this is seasonality okay.

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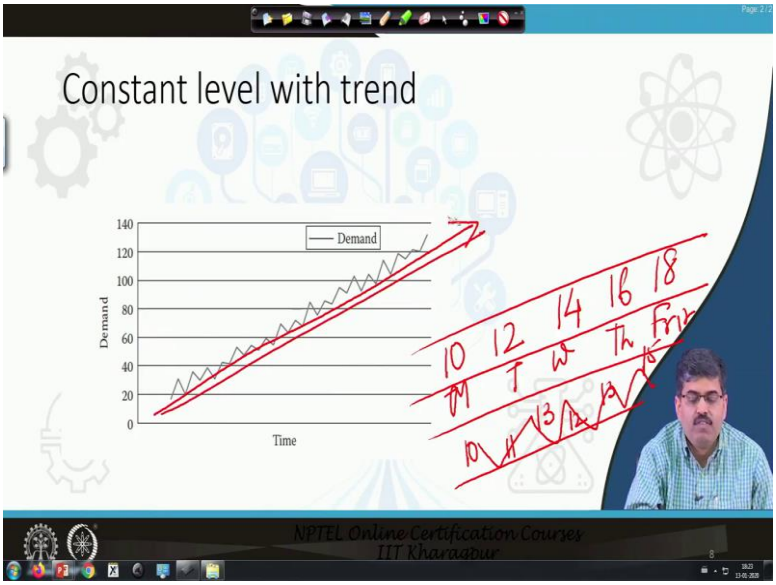

The next one is constant level with trend, that means it is an increasing line. The sales are showing me an increasing trend but within that this minor fluctuations are there. On Monday the sale is, as the summer is increasing Monday, Tuesday, Wednesday, Thursday, Friday assume that the temperature is also increasing Monday, Tuesday, Wednesday, Thursday, Friday.

So Monday 10 bought, 10 ice bags have been sold, Tuesday 12, Wednesday, 10, 12, 14, 16 and 18. Monday, Tuesday, Wednesday, Thursday and Friday. Now, so this is it right. So the trend is there. Now that minor fluctuations will be there. Monday it may be 10, Tuesday may be 11, Wednesday maybe 13 then 12, then 13, then 15, then 17. So that small zig-zag is there, are you getting the point? So this is what constant level with trend, okay.

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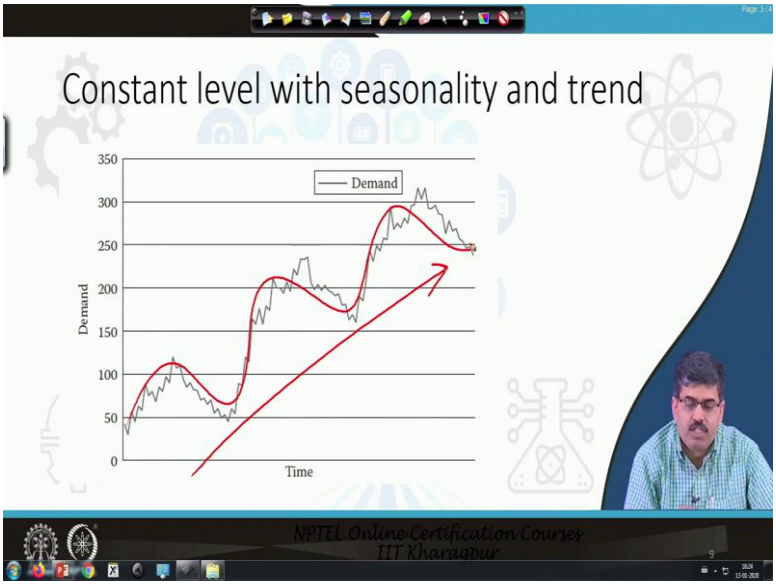

Next is constant level with seasonality and trend. Now you see the difference? This was your constant level with trend, the simple one and this is your, it is increasing but ups and downs. It is still increasing but it has a seasonality aspect rate, right? Are you noticing it? So this is constant level with seasonality and trend.

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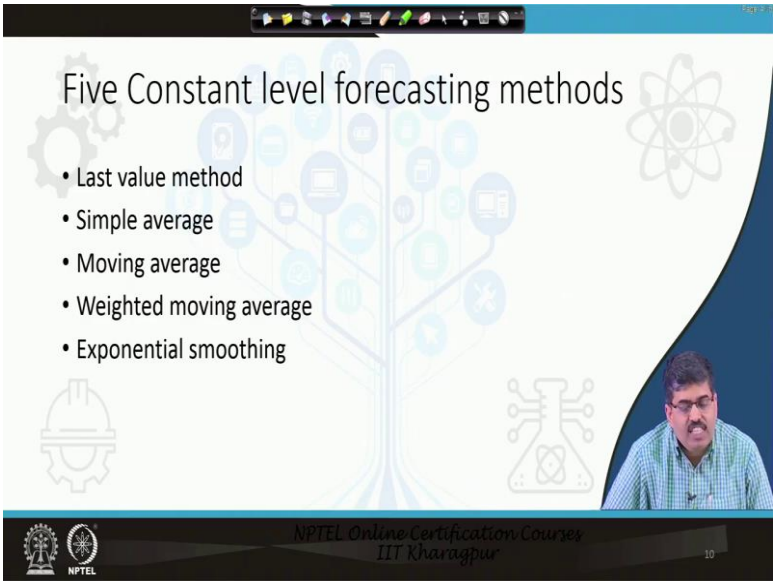

Now we have five constant level forecasting methods. Last value, simple average, moving average, weighted moving and exponential smoothing. Now let us take a brief on it.

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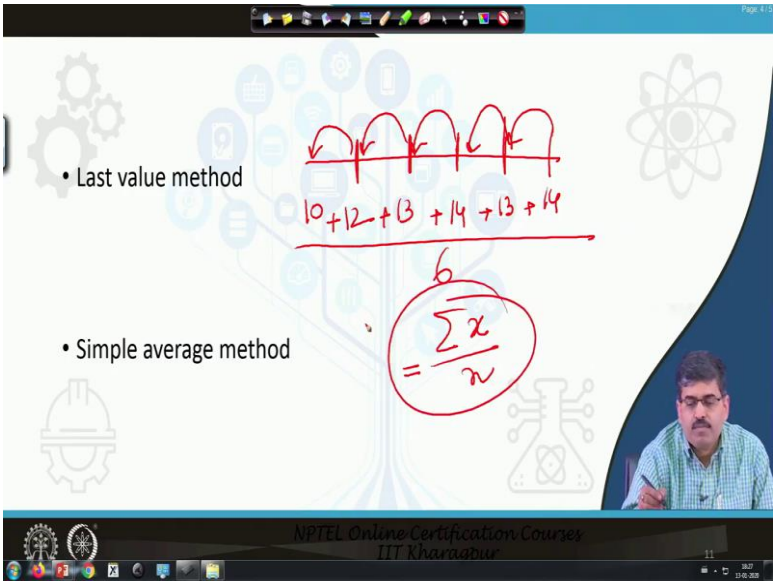

Last value. Last value method is very simple. Last value method is the method is whatever was your sale in the previous month the same will be here in this month. Minor fluctuations, one or two this side is due to random error or noise. When do you use last value method or where do you use last value method? The local shop just beside your house selling bread, eggs, rice, daal. There is no change in sale, why? Because it is serving a particular geographical locality, geographical location.

His customers will only be from that area and locality, so the total number of family members is also fixed, so the total eating capacity of that locality is also fixed so that the total selling also, forecast is also fixed, so that is last value. Whatever the sale was yesterday, of the total number of bread loaves and eggs same thing will happen today.

Minor fluctuations will be there, what minor fluctuations? Somebody may not be home, so one egg will sold less. So that minor fluctuation will be there but otherwise it is same, last value. Got it? So wherever your, the nature of the product is such that its demand will not fluctuate, it is a stable product there last value method is very, very good.

Then is simple average method. Simple average method says okay, last value method we are saying that it is taking, last value method is doing this. This today's forecast is based on yesterday's forecast, tomorrow's forecast is based on today okay and this is fixed. Simple average says that no, but the sales maybe 14, 13, 14, 13, 12, 10.

Simple average says take an average. Take an average. Simple average says no, do not take the last value rather definitely take care of the fluctuations and do a average. So what we do?

We take the average demand of all the things divided by the total number of observations and we get a simple average, okay. So something like summation of X divided by total number of observations okay. So that is my simple average, right.

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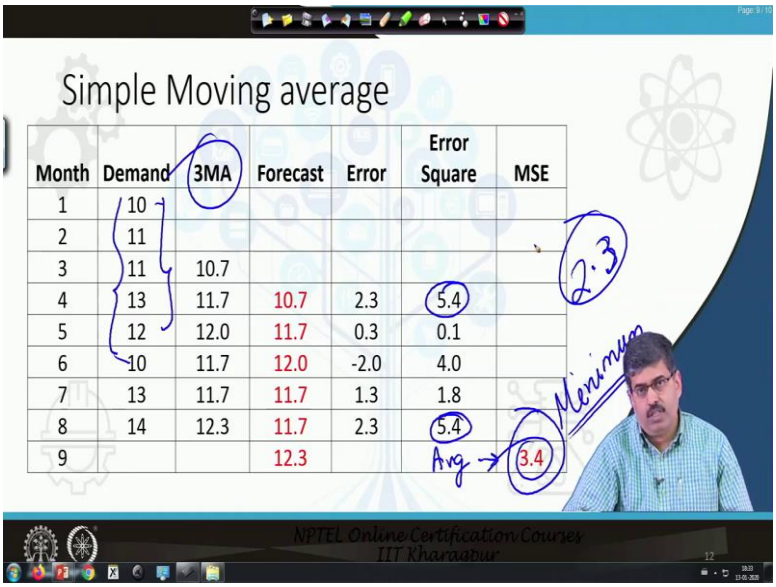

So what is simple moving average? Simple moving average as we say is very simple. It is very simple. Simple moving average, what is this? Let us look at the data in front of you. These are your months, okay. one, two, three, four, five, six, seven, eight, January, February, March, April, May, June, July, August. These are the actual demands in these months, okay. Months, these are the actual demands faced by the company. What is your job? Based on this demand you have to forecast the demand for month nine, that is September. Okay, clear? So let us clean it.

Yes, you have to forecast this. So what do we do? We take a moving average. What is moving average? 3MA. 3MA means three months, look here. 3MA means three months moving average. What does that mean, three months moving average? We will take average of first three months, that is January, February, March. Next we will take what? The average of February, March, April. Next what will you take? March, April, May then April, May, June; May, June, July; June, July, August; July, August, September in this way. So we are deleting one and moving to the next. As we are moving, we are removing the earlier month out of my calculation system okay.

So what are we saying? These three months we take and do an average. What is the average of these three months, that is 10.7. This is the average of January, February, March

remember. Average of January, February, March so that is my forecast for April. Average of January, February, March is the forecast for April. Next month what will happen? February, March, April this is the average and that is the forecast for May. Next month what will happen? March, April, May, this is the average and that is the forecast for June okay. So in this way we get the forecast for the month of September.

But that looks very simple but have we done any error? Have we committed any error? So what is the error? The error is basically, here what was my forecast? 10.7. What was the actual demand? 13. So demand 13, forecast 10.7 so I have manufactured 10.7. My demand was 13, I have manufactured 10.7 based on the forecast so what is my error? 2.3 lost sale. I just square it. This is called as error square. Why we do this error square? I will tell you later on.

So at every stage the forecast and the demand we deduct and we get the error and the error square. Error, error square. Error, error square. So it is the actual minus the forecast we get the error. Now, this mean square error. MSE, mean square, this square error. This error square we have got, the average of this is the mean square error okay. Remember this, why? I will later on. So average of this is mean square error okay, MSE.

Now why we did error square? Why we took error square? See, looking at the error. Why we did error square? So this is average error square. Now why we took error square, see look at the error 2.3, it does not look much. Look at the error, 0.3, looks very negligible but the moment you square it, it looks very big. Okay. Moment you square it, it looks very, very big. That is the sole purpose of doing a square error, nothing else. It is to magnify the error so that the organization understands and take cognizance of it, nothing else. So mean square erroe is this.

Now, what is the purpose of doing an average square error? See, today we are doing three months moving average. Tomorrow somebody might say why three months? Let us take moving average of four months moving average, let us 4MA. Somebody will say why four months, we should take five months moving average because the product that we sell the demand does not change too much. Demand is more or less stable, so let us take five months moving average. So three, four, five, somebody will say six months moving average. The issue is, the question is then how many months moving average should we take?

The answer is we should take that many months moving average for whom my mean square error will be the lowest. For whom the mean square error will be the lowest, minimum. Okay. If I was doing a 4MA, four months moving average and assume my mean square erroe was 2.3 then I should have taken four months moving average however, taking into view so many other things. So that is the purpose of average mean square error okay. So this is my one way of forecasting using the simple moving average, right. Simple moving average say, for the month of September the forecast is 12.3, okay.

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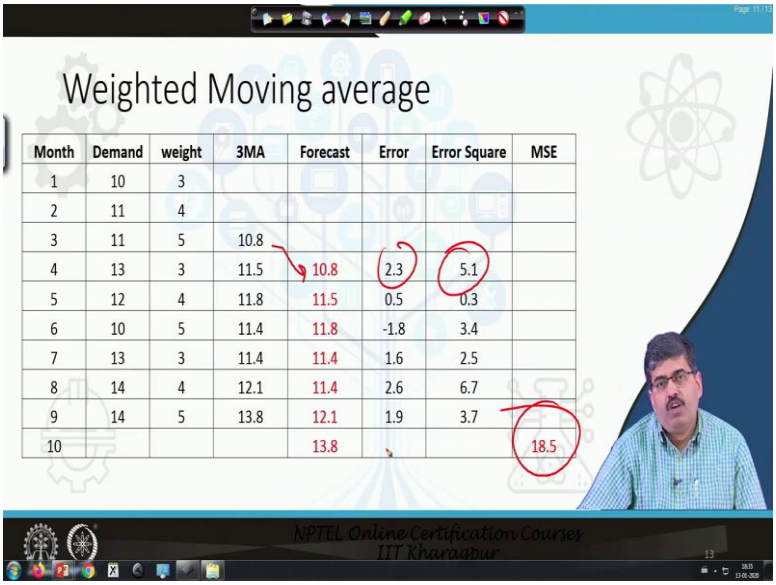

Now other method is just an addition to it, just a extension to it rather, weighted moving average okay. Same thing, demand is same okay and we just only give more weightage to the recent ones. 5, 4, 3, as we move beyond the weightage comes down and your moving average is just a weighted average. See, earlier one was a simple average okay 10, 11, 11 divided by 3. 10 plus 11 plus 11 divided by 3. Here what is happening? 10 into 3 plus 11 into 4 plus 11 into 5 whole divided by twelve, that is the summation of the weights, okay.

So this way we will do the three months moving average. The forecast is same. Same thing, same way we are forecasting, error, error square and we get the main square error. And definitely a mean square error will be more because this is, we are adding the weights, okay. So these are the two methods of forecasting that we planned to study in this week and we have learned that the moving average method, simple average and the weighted moving average method of forecasting, okay.

Here so we learned the simple, weighted and moving average method of forecasting. This is the simplest method of forecasting where we know that there is a constant level and we can move ahead with that, okay. So thank you. Next week we will continue with this forecasting technique and we will learn another method, which is called as the exponential smoothing method, okay. Thank you.