Principle of Industrial Engineering
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Lecture 49
Forecasting: Method 2

Hello, I welcome you all in this presentation related to the subject Principles of Industrial Engineering and you know we are talking about the forecasting. So in this presentation, basically I will be talking about the quantitative methods of forecasting. We have seen that based on the averages there are 3 approaches.

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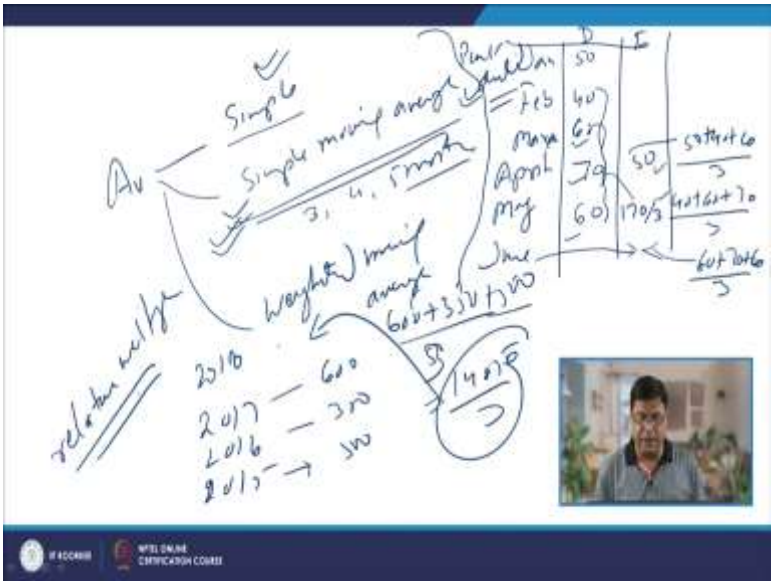

One was like simple average, which uses the average of certain past periods. Then there is a simple moving average. In this case the average will keep on moving while considering, so far determining the average, we use the certain past periods and that becomes the forecast for the next period. Say for the January it is 50, for February it is 40 and then for March it is 60.

So if we have the past demand data for 3 months, then our April forecast based on the past 3 months demand becomes equal to, like say forecast here will be putting, so 50 plus 40 plus 60 by 3. So it becomes 50, 50 becomes the forecast for April and say, if the April demand is 70, then we will be considering for May again these 3 months period.

So forecast of the May becomes equal to the 40 plus 60 plus 70 by 3. So 170 divided by 3 becomes the forecast for May. Say again we get the 60 the demand for the May and this is our forecast for the May. So what we will be doing, now we will be considering the demand of the 3 most recent periods 60, 70 and 60.

So here the June forecast becomes equal to the demand average of the past 3 periods, demand say 60, 70, 60, divided by 3. So here our average for determining the forecast, the forecast is based on the average of last 3 months periods. So for determining the simple moving average, what we can do, we can consider 3 months, 4 months, 5 months as per the availability and suitability of the forecast.

But more is the number of the past periods are considered that is smoothens the forecast, means that neutralizes the effect of fluctuation in actual demand on determining the forecast. Then third method is weighted moving average. So we have seen that in all these 3 methods basically past demand data is used and forecast is not being considered.

In simple average, this is the static in nature, in a simple moving average here we consider the demands of certain periods, maybe 3, 4, 5 as per the availability but here equal importance is given to all the periods. It does not give any, it does not differentiate the most recent demands with the other past demands.

So to consider the greater effect of the recent demands, like say, 2017, 2016 and 2015 demand data is available, say 500 units, 350 units, and 600 units. If this is the kind of the demand data, then in case of the simple moving average considering the 3 periods, then the forecast for 2018 comes out to be 600 plus 350 plus 500 divide by 3 for 3 periods. So here it becomes like 1450 divided by 3 that becomes the forecast for 2018.

So if we see the demand for here we are giving the equal weightage to each of the periods. But if we are interested really how the recent demands will be affecting the forecast, so to consider the effect of the recent demands on forecast, we can give the different relative weightage to the different demand periods. So what is done in that case?

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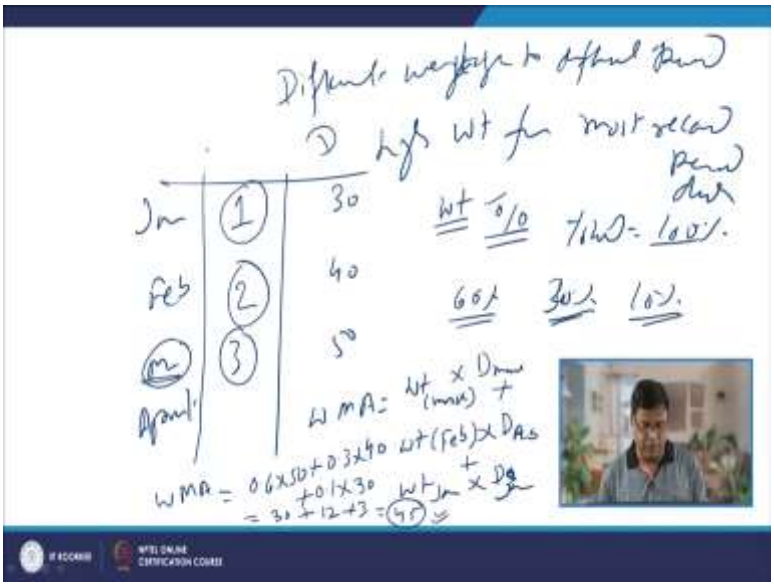

We give them different weightage to the different periods, normally high weight for most recent period data. So let us say if, and this is expressed in 2 ways. I will show both, like say, the period 1, 2, 3 for which demand is available like 30, 40 and 50, so this is the most like say January, February and March.

So if we want to determine the forecast for April according to the weighted average method, so what we will be doing, we will be giving the more weightage to the most recent demand data. This is the demand data, past demand data. So we will be giving the more weightage to the March demand or period, third period demand, somewhat less to the second most recent and third most recent demand data is given the least importance and likewise we determine.

So there are 2 ways. Say the weight is expressed in 2 ways. One is like simple weight percentage; weight is given in terms of percentage, like the total weight percentage is 100. So how many weight is being given, how much weight is given to the most recent data? Like say 60 percentage weightage is given to the most recent data, then for 30 percentage weightage is given to the second most recent data and 10 percentage weightage is given to the third most recent data.

So assuming that like say according to the weighted moving average method, since the highest weightage is being given to the most recent demand, so the weightage, weight for March month

into the demand plus weight for, weightage being given for February month into the demand, this March demand, February demand and plus the weight being given for January into the demand of the January month.

So since here we know all these things. Weightage for March is say 60 percentage, so 0.6 into the demand for March is 50 plus weight is being given to the February is 30 percentage, so 0.3 into the demand for February is 40 and then for January weight is being given just 10 percent, so 0.1 into 30.

So what we do basically we determine the, we just solve it for the weighted moving average like this and we, what we do, now say 30 plus 12 plus 3. So this is how we will be getting the weighted moving average, which will be the forecast for April 45.

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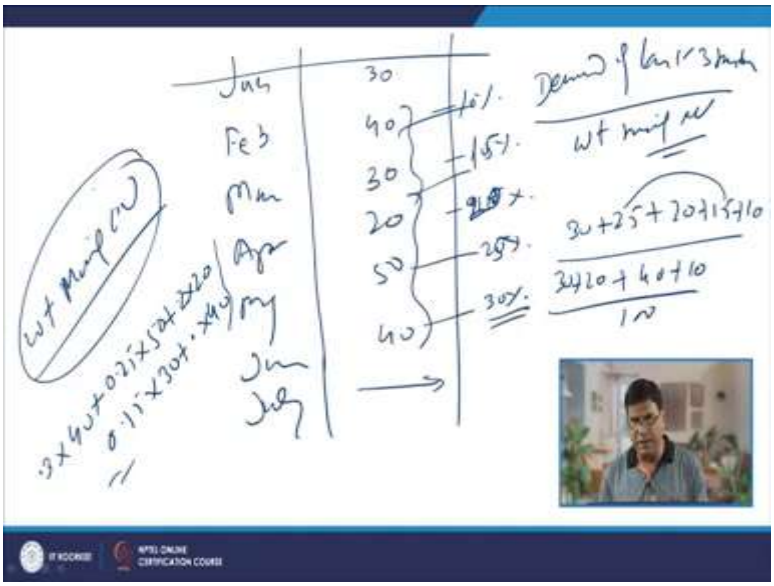

Now if again we have the some other period, like say January, February, March, April, May like this, June, July and the demand data is like say 30, 40, 30, 20, 50 and then say 40. And if you are interested in determining the July demand, so assuming or considering the demand of the last 3 months only using the weighted moving average.

So what we will be doing, the last 3 months demand will be considered here or we can consider the last 5 months demand and accordingly the weightage for the different periods will be given of the different types.

So say if we consider like say (20 percent) 30 percent weightage to this June demand, 20 percent weightage to the May demand and say 15 percent weightage to the April demand, 10 percent weighted to the March demand. So 30, 50, or 75 like say now we can change this data say 25, then 20 weightage and then 15. So here the 40 and 50 say now, so the 10 percent weightage being given to the February month demand data.

So here, 30 plus 25 plus 20 plus 15 plus 10, this should be a 100. So here what we have basically 40 plus 10 that is 50 and 30 plus 20, so it is a 100. Now if you have to calculate the weighted moving average considering the 5 periods, then this weightage will be given accordingly.

Like say the weighted moving average for 5 months. So 30 is being given, so 0.3 into the June month demand, that is 40. Then we have the 0.25 into 50 plus 0.2 for 20 then 0.15 for 30 and 0.1 for 40. So this is how the weightage is given to the different months and the weightage for the past demands keep on decreasing and this is how we calculate what are the value we get that will be giving the weight, a weighted moving average for past 5 months.

So this is one of the methods based on the, so there is a simple average, simple moving average and weighted moving average method.

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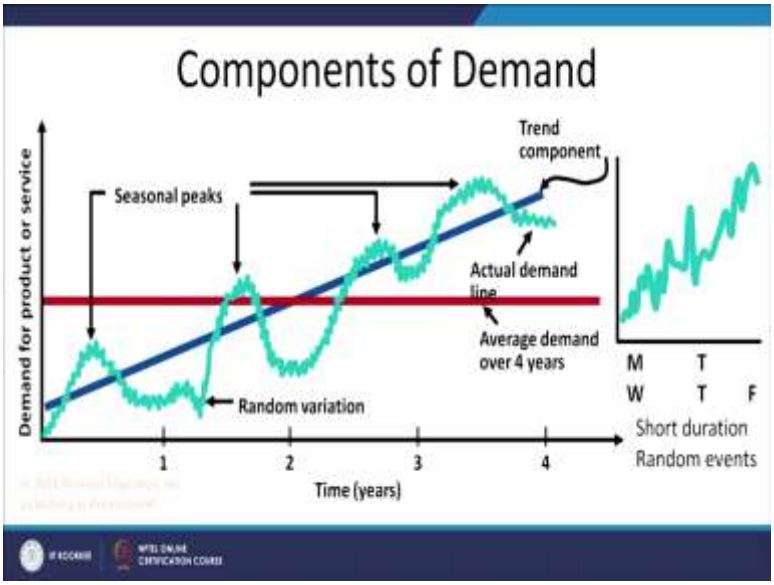

So we know that commonly the kind of the demands, the type of the demand, which we see that the data is actual data is, changing like this. So here the data is changing represented through this

green line like this and here what it shows, if you see a very narrow time period, then there is a random variation. The data is random. That is what we can see this diagram as well. So here what it shows that there is a fluctuation in the demand is showing number of things.

For example, the demand is a fluctuating in a particular way. There is a increase and then decrease is showing in a very cyclic manner. So this is showing the seasonality in that demand then that the demand is increasing also, so that is the trend component and if we see there are certain, at certain time there is a peak in the demand and if we see, if we determine the average of the certain periods, then we get simply horizontal line.

So this horizontal line actually, if we just determine the average of certain periods, then that will be giving the average forecast only but that will not reflect that demand in any way. So to be precise, it is important that we observe or we check the kind of trend which is there, whether there is increasing or decreasing trend or the kind of the fluctuation which is showing a particular pattern of increase or decrease in the demand that should be considered. So in quantitative methods considers all these the possibilities.

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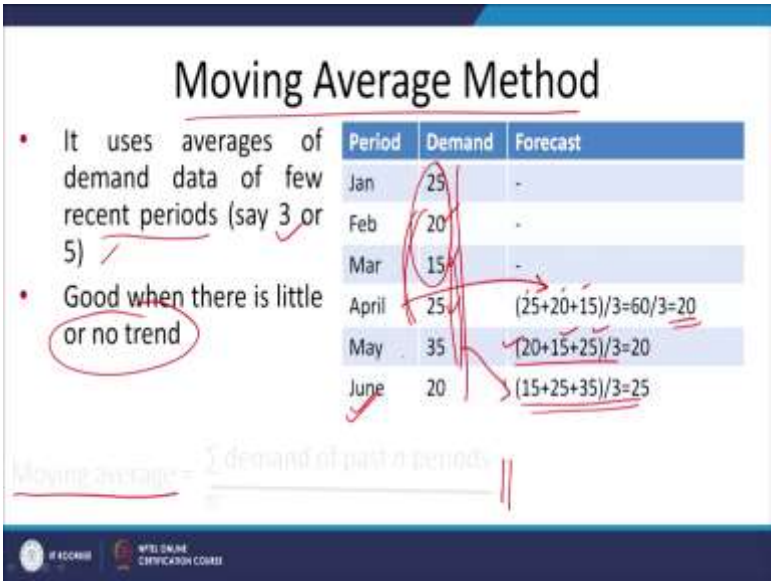

As I have explained just now, the moving average method, moving average method uses the average of that demand data for certain past periods. So it may be 3 or 5 but this method is found

to be good when there is no trend or very little variation. If that is the case, then will be very close to the kind of the actual demand, the forecast will be closer to the actual demand.

So another example, this is the expression, which is their like moving average is obtained through the, average of the demand of the certain, sum of the demand of the certain past period divided by the number of those past periods.

So say this is the kind of the demand data for January, February, March, April, May and June. So if the data is available for 3 months, then the forecast of April we can determine by simply adding these 3 months period like 25, 20, 15 and average of this will be giving 20. Similarly for the next step, May demand will be obtained through the average of the another most 3 recent periods.

So the sum of the 25, 15 and 20 will be considered for May demand. So 20, 15 and 25 will be considered for determining the May forecast and then June forecast will be identified through the another most recent demand periods, a demand of the 3 most recent periods, like 15, 25 and 35. So that average of these 3 will be giving us forecast of the June periods. So this is how the moving average helps, a moving average method is used to predict the demand.

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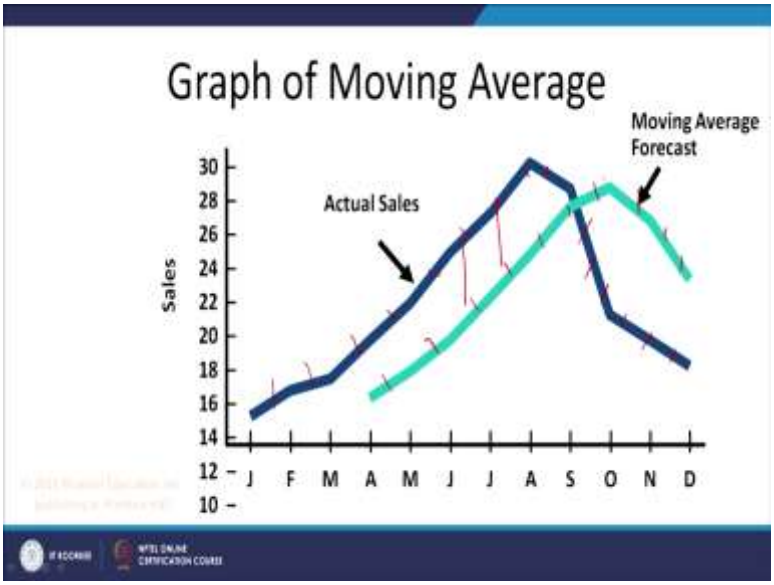

So if we see the actual sale data, for any period, if you see the actual demand and the demand forecast identified through the moving average method, there is always some gap and this gap is

used to determine the forecast. It is not very close to but it also shows a similar kind of the pattern. So we always try to come that these 2 lines are close to each other.

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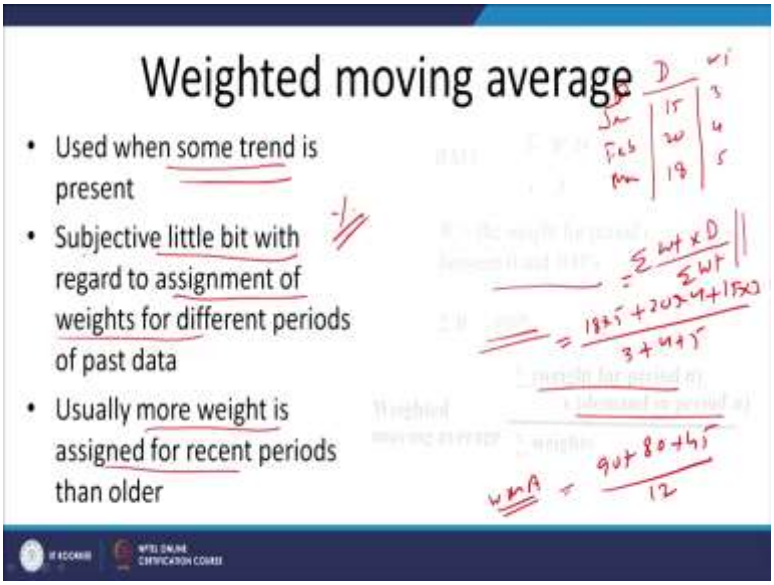

As I have explained, the weighted moving average method, in the weighted moving average method, this method is good when some kind of the trend is present in that data, so that we can give the more weightage to the recent. So when we give the more weightage to the recent data, it helps in predicting the forecast more accurately.

However the weightage being given is a subjective, because subjectivities involve with regard to the kind of the weightage is being given. So subjective little bit with regard to the assignment of the weights which are being given, like how much weightage should be given to the most recent data and then reducing weight to the data of the further past demand, the demand data of the further past periods.

Usually more weight is given or assigned to the most recent periods than that older one. So one as I have said that one simple method is this, where the weight percentage is being assigned to a particular demand data that is identified and sum of, and this weight percentage can vary from 0 to a 100 and sum of all these weights is equal to a 100.

There is another way, like we identified like the weight for certain period into the demand for that period. Let us say the weight is being given for certain period, January demand is 15, weight

is being given 3, for February the demand is 20, weight is being given 4 and for March the demand is say 18 and the weight is being given 5.

So these are the weights being assigned and this is the demand and this is the period only. So here what we have to do, we have to just sum up all this. We have to just make the calculations like the demand into the weight assigned, so product of the weight assigned into the demand for that period.

So likewise some of the weight into the demand values is obtained and then it is divided with the sum of all weights which are being assigned. So here when we do this, say 18 into 5 plus 20 into 4 plus 15 into 3 divided by sum of all these weights. So sum of all these weights means 3 plus 4 plus 5. So this is how we get 90 plus 80 plus 45 divided by (9) 12. So this is how we get the weighted moving average.

So this is another approach only to give the different relative weightages to the past demand data, more weightage is usually given to the most recent data. So there are 2 ways. One, either we give the weights like this or we express the things in percentage, the weight is expressed in to the different demand data in percentage term.

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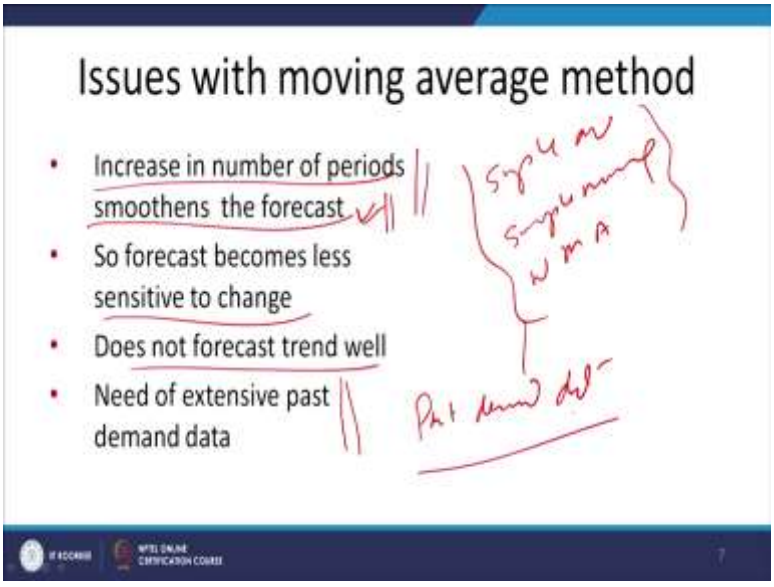

So what we have seen that there is a simple average method and a simple moving average method and the weighted moving average method. But in all these methods, there are various

issues, because many times it is not able to forecast the things properly and we get lot of error in forecast. Why because as we increase the number of periods in, what is normally observed, as we increased the number of periods for which the demand data is being considered to forecast the next future demand it smoothens the forecast.

So increasing the number of the periods, for which the demand data is being considered to forecast this smoothens the forecast means the fluctuations in the demand periods are smoothen out and we really do not, we are not able to see really the forecast which will be close to the actual demand.

So the forecast becomes less sensitive to the change, means what are the fluctuations in actual demand where there those are not incorporated effectively because of the greater averaging effective and that is why these methods do not forecast the trend or the demand pattern. Well, and another thing is that all these methods, extensive past demand data, so a lot of record keeping and the data maintenance is required for using these methods.

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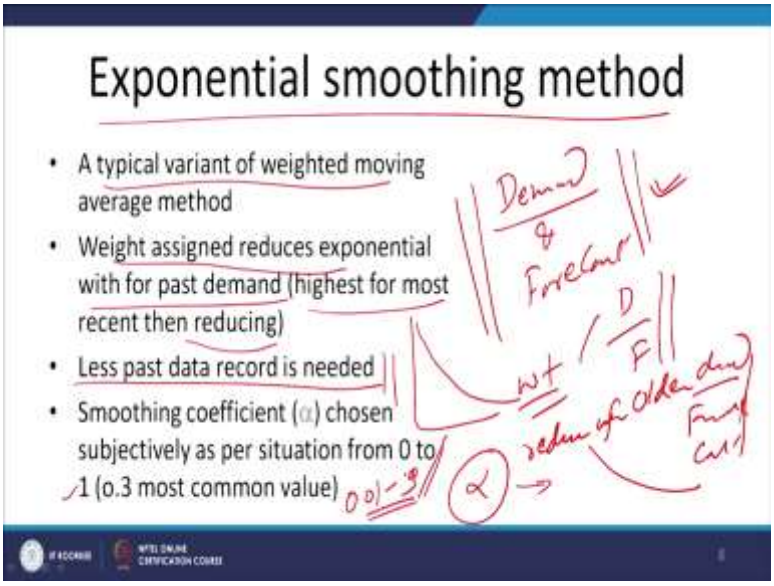

There is a one more method of forecasting. In this method the difference with the average based methods was that in those methods we considered just demand only. But the exponential smoothing method considers the demand as well as the most recent forecasts both. So if there is

any correction, what is the weightages is to be given to the recent forecast or actual demand, which was there.

So basically if in earlier methods, we did not consider the forecast in the exponential smoothing method, we will be considering the forecast also, this is one thing, but similar to the weighted moving average, this method also considers the weightage being given to the demand as well as to the forecast and the weightage being given to the recent demands and forecasts typically reduce for the older demand and forecast data.

So the weightage being assigned to the older demand and forecast data decreases exponentially. So this is a high for the most recent data and then it keeps on decreasing rapidly. So the coefficient which is indicating the kind of weightage being given to the demand data or the forecast data that is indicated through the alpha, this is called is smoothing coefficient and the value of this smoothing coefficient decreases exponentially with the, for the past data with the increasing past period's data values.

So here if you see this is the typical variant of the weighted moving average method. Weights assigned to the like say the demand and forecast reduces, weight assigned reduces exponentially for the past demand data, obviously highest for the most recent and then it keeps on reducing and this method does not require much of the past data, this is another good part.

Very effectively used if we have 1 or 2 past data regarding the demand and the forecast, so less past data is needed and smoothing coefficient is choosing subjectively. This is the only subjective aspect and this has done iteratively to find out the more appropriate. Its value can be like range from 0 to 1. Most commonly it is used is 0.0 to 0.3, is the most commonly used or value of the alpha.

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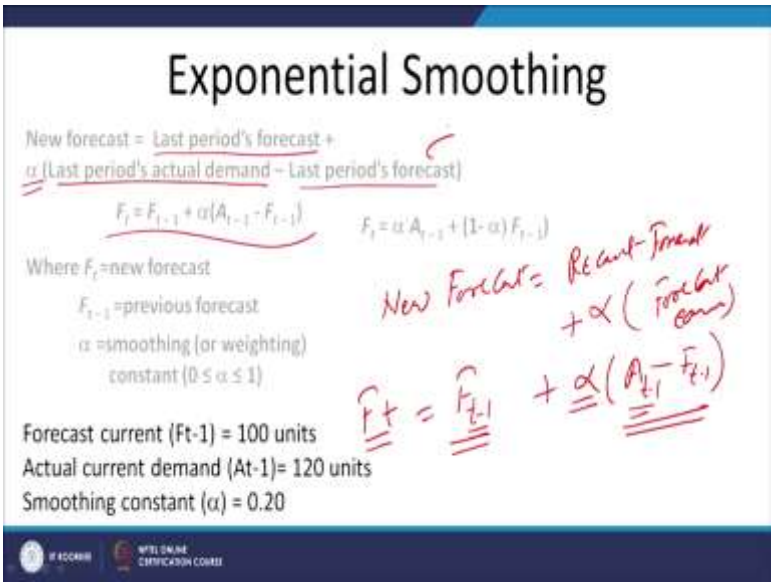

So here the kind of the equations which are used the new forecast, if we see the new forecast. New forecast considers the most recent forecast. Whatever the most recent forecast was there, that is given lot of weightage then whatever is the error in forecast, basically alpha is the smoothing coefficient and then the kind of error in forecast, which was their forecast error.

And how do we calculate that, alpha into the actual demand, most recent actual demand minus the most recent forecast. So the recent forecast, most recent forecast Ft minus 1 into the Ft minus 1 most recent actual data and At minus 1 and Ft minus 1 is the most recent forecast.

So the difference of the At minus 1 and Ft minus 1 is basically the forecast error and when we multiply this with the smoothing coefficient, and sum of, with the most recent forecast, this gives us the forecast for the next period. So this is what is then the last period's forecast plus the smoothing coefficient into the last period's actual demand minus last period's forecast. So this gives us like we are considering the last period's forecast and last periods actual demand. These are the 2 values which are being used.

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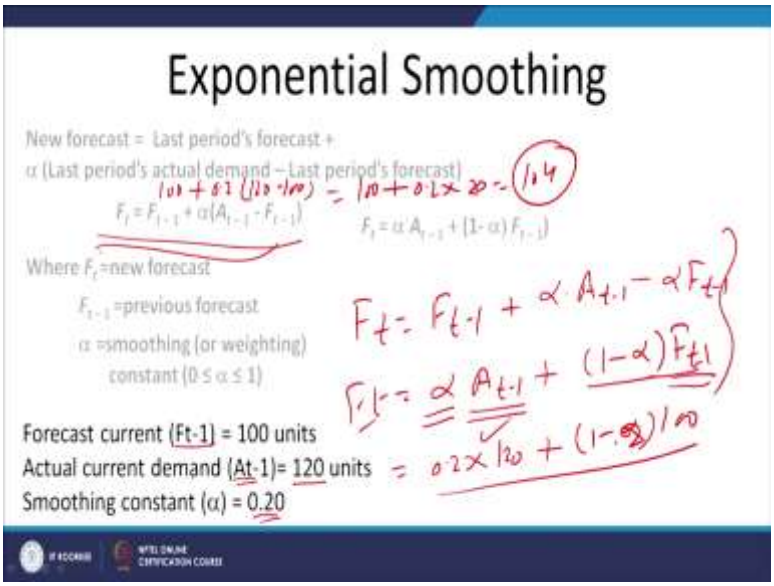

If we solve this little bit more than what we get, if we solve this equation little bit more than what we get. Ft is equal to Ft minus 1 into alpha At minus 1 minus alpha Ft minus 1. So if you see here alpha into At minus 1, this is the actual demand data multiplied by alpha and then what we can write Ft is common, so like 1 minus alpha into Ft minus 1. So this is the most recent actual demand, this is the most recent forecast and 1 minus alpha and alpha.

So these are the, these will be indicating the kind of weightage being given to the actual demand and the forecast. So this is the rewritten, this is in simplified form. On rewriting this is what we get, alpha into At minus 1 that is the, alpha into actual demand plus 1 minus alpha into the most recent forecast.

So say just for an example, if the forecast Ft minus 1 is a 100 units and actual demand for the most recent period was 120 units, smoothing coefficient is 120, then what we get, we get very simple. Like, say, if you use this simple equation, then what we get, like 0.2 into the actual demand 120 plus 1 minus alpha into 100, alpha is 0.2 into 100. This is one way.

Another way is more simple like Ft here is forecast is 100, alpha is 0.2 and the difference of demand and forecast is like say 120 minus 100. So here, 100 plus 0.2 into 20 that will be giving us 104, so 104 will be the next forecast. So here it is considering both the actual demand and the recent forecast for determining the next period's forecast.

Now I will summarize this presentation. In this presentation basically I have talked about the 3 more methods, like the simple moving average method, weighted moving average method and exponential smoothing method for forecasting the demand. Thank you for your attention.