Modelling and Analytics for Supply Chain Management
Professor Anupam Ghosh
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur
Lecture 49
Forecasting: Trend: Holt's and Winters' method

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Hello and welcome to Modelling and Analytics for Supply Chain Management. We are into week 9; lecture 49 and as you were aware, we were discussing the crucial aspect of supply chain that is forecasting. Now, forecasting, we have mentioned that there are two ways, forecasting, one is forecast. Forecast can never be accurate.

But our job is to forecast it in a scientific manner so that the deviations or abrasions are minimal. We cannot exactly forecast how much food you will eat tomorrow morning. How much breakfast you will take tomorrow morning. There is minor abrasion. May be one grain more, may be one grain less. So, forecasting can never be accurate, but our job is to minimize the error chances or minimize errors in forecasting.

So, and what are the problems with inaccurate forecast? See, if you overproduce, that is, if you over forecast and your demand is not that much, then the product stay in the gowdown and the product staying in the gowdown means you are incurring cost. If you under produce that is, if you under forecast, what is happening? That is, your demand is 100 and forecasting 80 then what is happening? That 20 is going to your competitor and those 20 customers or those20 product units, SKUs will never come back to you, very little chance, because your competitor also has the same quality and may be, in some aspects, are better than you.

So, that is why, we want to have a proper forecasting and that gives us, that bring us to the all important topic of forecasting and that is the relevance of forecasting and the importance of forecasting in today's world. And that is why; also, you will see that companies are not only satisfied with having or doing a forecast using only one method. They are trying to look at it from different angles and see whether their forecasting is correct or not, or accurate or not.

So, to this light, we have studied simple average, weighted average, exponentials smoothing, seasonality and linear regression and with that, we ended the previous class and then we said something before we ended, we said something.

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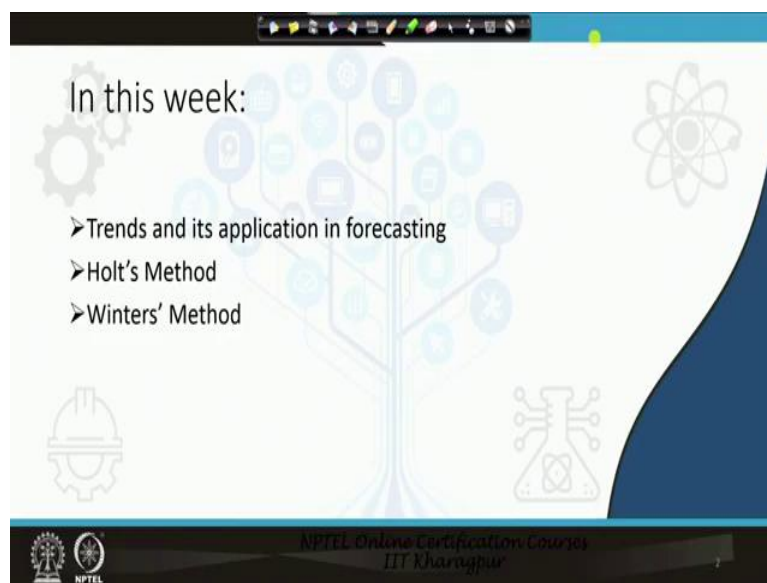
In linear programming, your level and trend, both are considered to be fixed. Level and trend considered to be fixed means that you are assuming that the same level of production and consumption will carry on and on and on, but in reality, that should not happen, that will not happen and that should not happen also because then there is no growth. So, the level and the trend both should increase or should at least vary over a period of time but their pure regression equations do not capture that. While we are forecasting, we are assuming the same trend moving through out.

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So, Holt's method takes care of this problem. Holt's assumes that the level as well as the trend, that is the level, that is a, as well as the trend, that is the b, both can be forecasted. That is why it is called as the double exponential method of smoothing.

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Now, given the actual demand Dt, forecast Ft and the estimates of level Lt and trend for period, the forecast for period t plus 1 is given by these equations. Ft plus 1 is equal to, that is forecast, let us see, see the first equation, forecast is equal to level plus trend, very simple. But, what is that level?
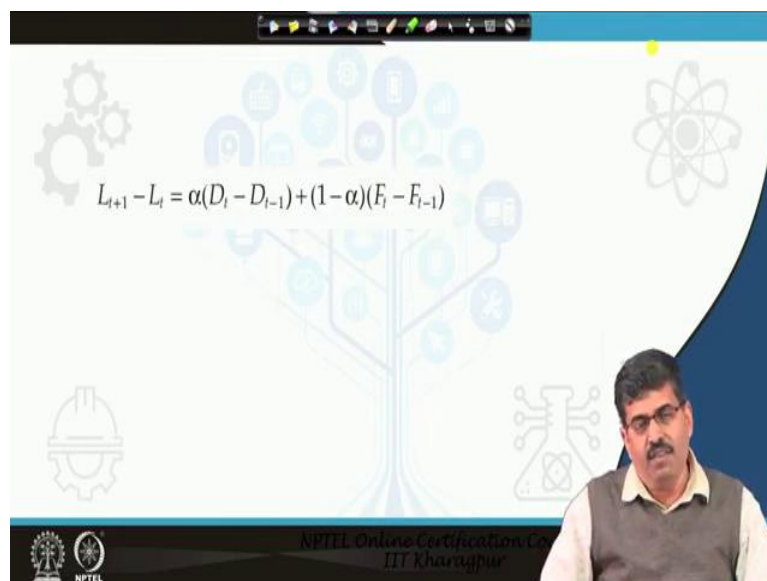
L is a function of demand and a function of the previous time period's forecast, okay. L is a function of the demand of the previous period and there is a level, the level is a function of

the demand of the previous period, and the function of the forecast of the previous period. So, that is the level.

And what about the trend? Trend is the function of the level, the difference and the trend of the previous part. So, your forecast is depending on the level and the trend. This formula is no rocket science. You can easily see, formula number one, forecast is dependent on level plus trend. That is your formula one.

What is the level? That is formula two. Level depends on the previous year's demand and the previous year's forecast and third equation, trend. Trend depends on the difference between the level in this year vis-à-vis with the previous year, Lt plus 1 minus Lt and the function of the trend of the previous year, which is very obvious, that is the trend today, a trend in future will depend on the level today and the trend of the previous day. This is simple language what Holt's method is all about, okay.

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$$L_{t+1} - L_t = \alpha(D_t - D_{t-1}) + (1-\alpha)(F_t - F_{t-1})$$

And your level, there is change in level is a function of change in demand and change in forecast. Change in level is a function of change in demand and change in forecast. So, this is your Holt's method.

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What Winters' model does is? Winter remember, apostrophe it is not Winter apostrophe s, it is the surname is Winters', so winters' apostrophe. There is nothing wrong in the spelling, Winters' is the surname and this model was first developed in 1960. Later on, it has been regularly modified, etc., etc. and the latest addition to it was Chopra (()) (0:06:17) modified it further.

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What he has done? Winters' has extended the Holt's method by updating seasonality. Remember, what was regression doing? Regression was looking at the trend but seasonality was not built into it. So, Winters' have built seasonality into it. Remember, for the forecasting this week, we had given few diagrams right at the beginning.

One of the diagram showed what is a trend, what is a level, and one was increasing trend with seasonality, something like that. That is what Holt's has mentioned, is what Winters' has mentioned. He has borrowed Holt's and have used it to update seasonality.

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So, this is the formula that Winters' has to propose, Ft plus 1, that is our first equation, Lt plus 1 plus T subscript t plus 1 into seasonality index. The seasonality index has come in. So, your forecast for the next period is a function of the level for the previous period, trend for the previous period and seasonality index for the coming period. Sorry, probably not the previous level, level, sorry I will stand correct, level for the coming period, trend for the coming period multiplied by the seasonality.

Let us rephrase it; your forecast for the next year is a function of the level for the next year, trend for the next year and the seasonality index for the next year. Now, you know none of this. That is taken care by the second equation. Your level for the previous year is a function of the demand for the present year and the seasonality index for the present year, multiplied by 1 minus alpha, into level for previous year and trend for previous year.

With these equations, if you see, all are similar with the earlier equations. Similarly, for trend, trend for previous year depends on the level, difference and the previous year's trend and seasonality index depends on actual demand by actual level into seasonality index of the previous year. So, this is what your Winters' model is all about.

Now, having said this, we will introduce you to another topic called 'Croston's' method or the 'spare part' forecasting method. Spare part forecasting method is something that does not come under this category.

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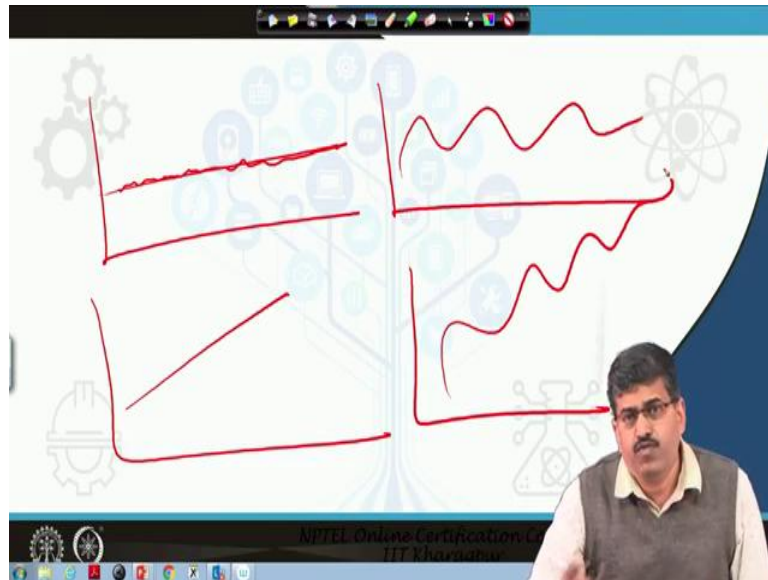
Now, as we were saying, that forecasting, all along, we have learned about the normal methods of forecasting. For example, there has been a single trend, for example, there has been a seasonality. This trend is, of course a zig zag-zig zag-zig zag. Then there has been an increasing trend, then there has been an increase in with seasonality, all along we have taught the primarily these four methods. But these are not the only ones that we should be concerned about. There are so many other products, in and around us that, which we do not forecast in the real sense of the term.
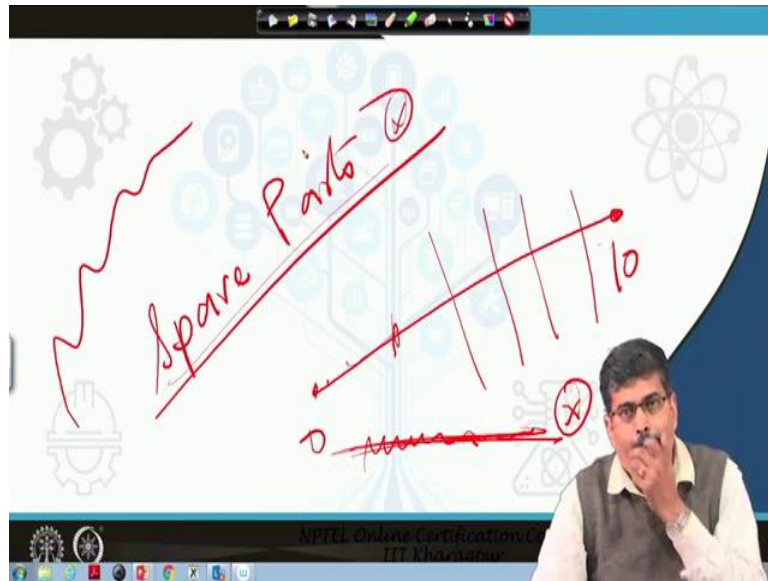
And one of the most important ones is your spare parts. Now, this you do not bother about forecasting for spare parts but this is very very crucial. For example, your factory might be having machines that are just five years old. So, you do not require that many spare parts today because it is still working.

But, after seven, eight, nine, ten years slowly, one by one, the machines will ask you for spare parts, that means you will have to replace some parts of the production machines. But you have purchased now and you are buying, or you are looking for the spare parts after ten years. What does that mean? The company that has manufactured this original machine might have gone extinct. So, where will you get the spare parts?

Some spare parts are in the market, but when you go to the market, market means industrial products market, when you go to the market and ask, they say, " no, we do not have spare parts for such old machines." And you cannot upgrade your machine, you cannot buy a new one every year. Then your production cost will be so much that you will die, not you will die, means your business will die. So, there is need, and that is number one.

Second is also, the machine is running very smoothly. Suddenly it develops a slag. So, immediately some spare part is required so that the machine will keep on running. So, spare parts requirement, though we try, though actually we do not look at it that way but spare parts is a huge component in industrial products, not the consumer products, but in industrial product spare parts is a huge requirement.

Look at your car. Look at the car or the two wheeler you have. Look at how many spare parts does it have. And when did you purchase your car? Was it just yesterday? It might be two years old, three years old, five years old. So, after sometimes if you will go, they will say that this spare parts is not available.

More than that very close to you, your computers. One chip gone, what will happen? They will say that this chip is not there. This RAM is not there. Earlier it was a 40GB hard drive. Today, can you think of a 40GB hard drive? No. DDR 1 RAM. Today, it is DDR 3 RAM. Then something else, something else, lot of advancements.

Now today, if you go and want to purchase a DDR 1 RAM, they will look at you as if you have come from a different planet. So, you have to stock some spare parts. That is what I want to say and that is why spare part forecasting is very very important.

And also, that is also, if you see, since the demand is not in a straight line sorry, this is a demand is not in a straight line, no traditional method or the demand is not in a cyclic, no traditional method can forecast spare parts.

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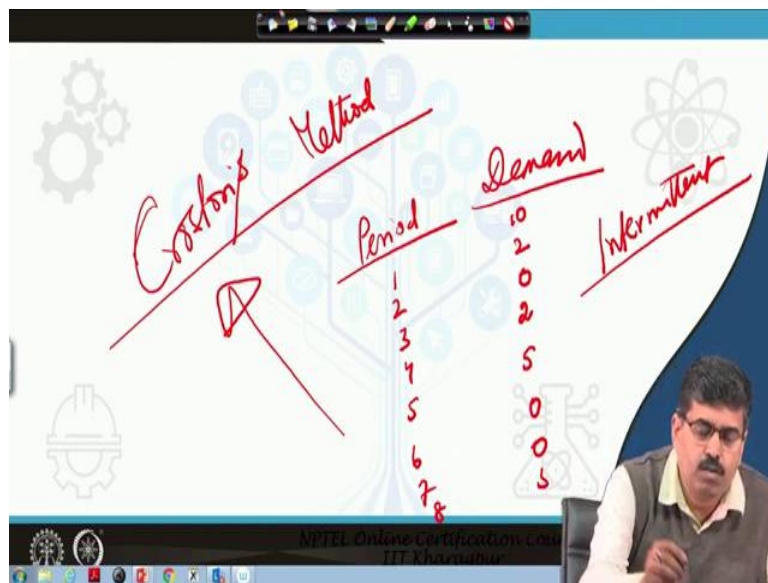
So, the method that we use is called 'Croston's method'. Croston's method takes care, say this is period one and demand, demand for spare parts by the shop floor. So, period 1, 2, 3, 4, 5, 6. Demand is 10, 2, then certainly 0, then 2, 5, 0, 0 again 5. So, this is the pattern of demand. You can say these are the term that you can use is 'intermittent demand'. So, this is what I want to say that during the periods of intermittent demand, you have to use method called Croston's method.
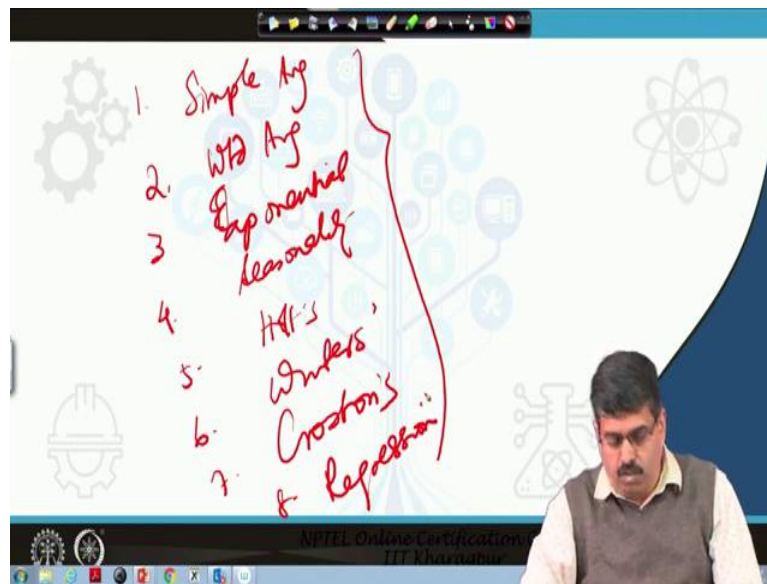
So, now let us sum up what have we learned until now in forecasting so that we do not go anywhere. One is simple average, second is weighted average, third; exponential smoothing, fourth; seasonality, Holt's, Winters', Croston's. So, these seven methods, we have learned and if you have noticed that all these seven methods, and of course eight, we have forgotten that, our very own dear old regression. So, if you see, we have done eight methods and if you see all these eight methods scattered to eight types of situations in forecasting.
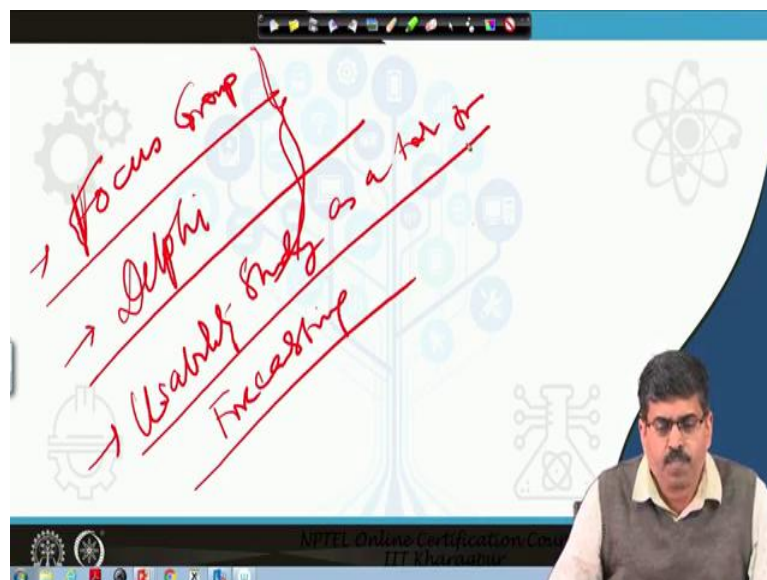
Now, as I was saying that forecasting, today, has become so important that you do not rely on only one forecasting technique, you use sometimes multiple techniques. That is why your forecasting also includes something called 'focus group'. Earlier, this was used extensively in

marketing studies to understand what customers are looking for when they are buying a product.

But now forecasting is being looked at, even focus group interviews are being done to understand what might be my possible future demand. And Delphi, Delphi technique. Delphi technique, what is happening? That each one is giving, I think I have discussed this in one of the earlier lectures, each one is giving a forecast and we see that the actual fields (exec) sales executive, who is giving a forecast, his forecast is the closest to the actual demand because, as we know that this person is in the field and he knows the market very well. So, focus group techniques and Delphi technique are other methods.

Now, next thing that we have to understand that all along, we have now focus group, the third one, sorry, yeah the next thing that we need to consider is usability study as a tool for forecasting. Now, again, this usability study has borrowed from marketing discipline. What happens in marketing?

Nowadays, because products, there is so much of competition. No company wants to do a test marketing. Because by the time you have finish off your test market, some other competitor has entered the market in a full-fledged manner. So, your product does not get any benefit of being the first mover. The company has taken the first mover advantage.

So, every company now, instead of going into a test marketing, but they cannot delete test marketing from their system. So, instead of doing that, they are doing something called this third point, usability study. What is usability study? You give your product to some people who use it and give you the feedback and based on the feedback, you keep on changing, adding, altering, etc. Usability study, this is one version of usability study.

Second version of usability study is, the person physically uses the product and gives the feedback within a short span of time, may be three days, and then company modifies. For example, if you see, when you were in school, there used to be an umbrella, automatic umbrella we used to call. In the automatic umbrella, we have to press the button at the end, near the handle, and the umbrella will open up in front of you. You have to press the button at the handle and the umbrella will open up.

Now, it was a very popular one among the Indian community, Indian masses that they did not see this type of umbrella before and people used to call 'automatic umbrellas'. Now, what happen is, usability studies would have pointed out that when these umbrellas open up, it

recoils just like a rifle, it recoils, so the umbrella also pushes back and if you don't know it might hit you, right here. So, that usability study will point out to that that this umbrella, this is the problem. Now, what is the relevance of all these that I am talking for forecasting?

Today, usability study is being done to understand the acceptability of the product, then it is given to the focus group, then parallel, the mathematical calculations are being done, Delphi technique is being done, another mathematical techniques are being done to find out the number.

And that is all these studies are being done, all these studies are estimating some numbers then only you are able to take a decision. That is what I want to say. So, usability study also helps you to generate some numbers. If the usability study reports that the product is too simple to operate, you can have some numbers. Little bit complex, some numbers and very complex to operate, you have very little numbers. So, that is the benefit of usability study.

Now, second thing we want to say is that these are all single period, so this is another one. So, we have done eight, nine, ten, eleven; eleven methods of forecasting, we have looked into.

Now, this is, now if you see these are all single period forecasting models and we do not know about multi period forecasting models. We have not done them. These multi period forecasting models, we will deal with, we will discuss with in the next module. In the next module, we will deal with multi period forecasting models, in the next week rather, in the next lecture.

Now, the question is how good or how accurate is my forecast? This also, we will look at when we take up the lecture in the next, in the next lecture. The deviation from the actual and we will see how good our forecast is? So, pretty much, if you look at it, single period forecasting models, we have taken up eleven models for single period forecasting and some of these model, we have solved in the class, some of models, we have not solved but we have given you an overall orientation and appreciation of how you should do forecasting for supply chain. So, with this, we will end this week's lecture, we will move with multi period forecasting model in the next class. Thank you.