Supply Chain Analytics
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Lecture-10
Demand Forecasting in a Supply Chain

Welcome back, so far we have discussed about supply chain strategy and at different stages of our discussions in previous classes. We discussed that how data analytics will help us in taking our decisions in a better way. So now we are moving actually into the use of data analytics. We are starting with forecasting that how you can have better forecasting in your supply chain. Now forecasting is a very important tool because rest of the planning of your entire supply chain depends on the forecasting.

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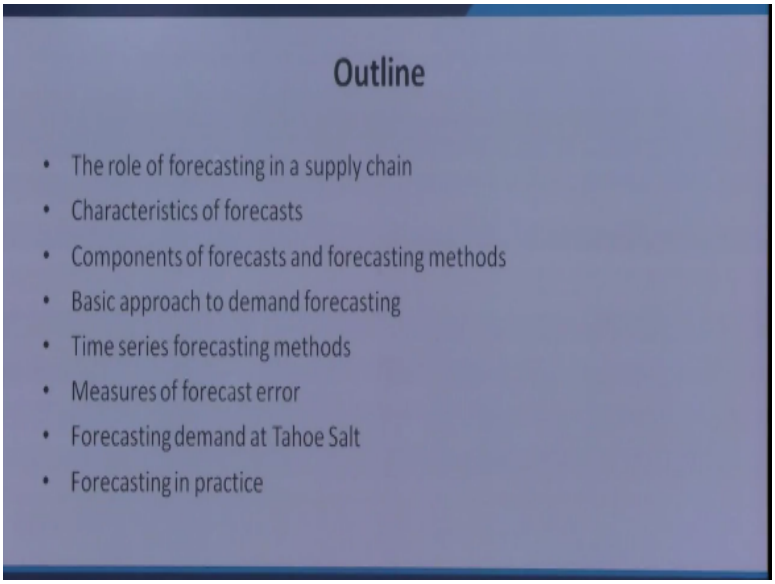

So now we will see that how forecasting is going to help us in achieving the results and these are the contents of our discussions.

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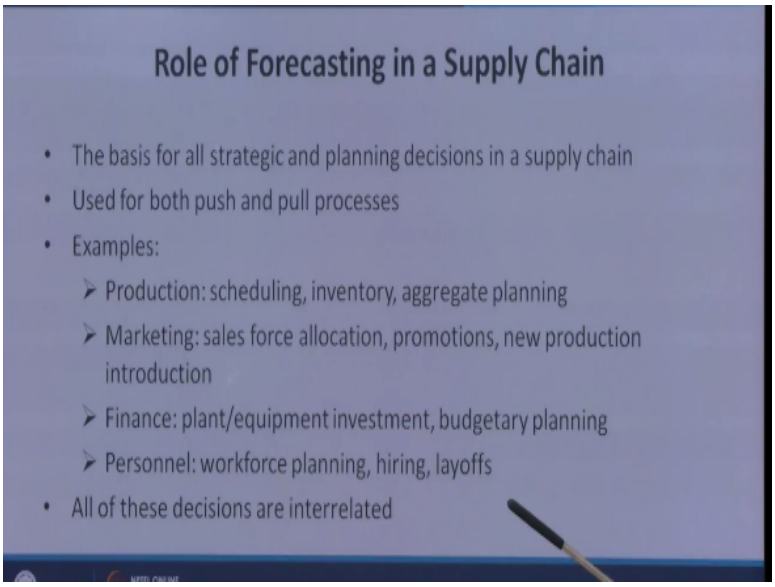

Now as I said that forecasting is the basis for all strategic and planning decisions in a supply chain. It is useful even in the push face or in the pull face of the supply chain process. And there are uses of forecasting in all activities of your value chain either in case of production, in case of marketing, in case of financing, in case of human resource and we know that the current environment. All these things are interrelated.

You have a very close coordination if you do not have you will not be able to achieve the desired. So it is very important to have it close coordination between production and marketing, finance, HR etc. And then only you will have a proper outcome of your organisation and forecasting actually provides input for all these activities in the organisation. So forecasting is a very important primary activity for the development of our strategic and planning process for the supply chain.

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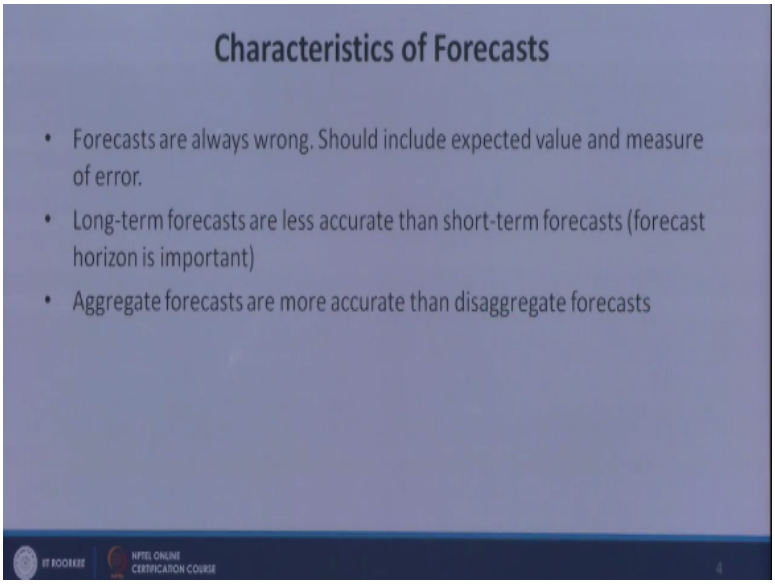

Now as we discussed if you remember in our last lecture we had a comparison of low implied demand uncertainty and high implied demand uncertainty. In case of low implied uncertainty the forecasting errors were just 10%. And in case of high uncertainties these errors were from 40% to 100%. So what I am trying to say that you will always have some kind of errors. Forecasts are always wrong.

It means was this is a very hard statement to write but what I am trying to say that you do not have the exact value of the forecast, these are the projections, these are just the projection. And with the help of better tools, with the help of more sophisticated models we are trying to reduce this level of error. And therefore in the development of forecast we calculate 2 things 1 is the expected value that what is the expected forecast, what is the expected demand of this product.

And at the same time what is the label of error associated with that level of demand. So that you know that my forecast has some kind of weather three percent 4%, 5%, 10%. So that is how you can take better decisions if you know both these things. So whenever we are going to calculate the forecast we will calculate both these things. Then another important thing related to forecast, because forecast can be done for different time horizons.

You can do forecast for your immediate requirement means maybe what will be the weather tomorrow, so probably you can focus this with more season with more accuracy and when I say what will be the weather after one year or after one month, after 6 months. So these

forecast will have less amount of accuracy, less precision. So the forecast for long term or less accurate and forecast for the short term are more important.

So what I am trying to say that time horizon is very important in case of forecast time horizon is more important normally the forecasting techniques can be classified on the basis of time horizon. You have long term time horizon where we do forecasting for more than 3-4 years and in that case you have different types of planning approaches and probably only few decisions we take based on those long term forecasts like development of new facilities.

This type of issues can be handled on the basis of long term planning horizon. Because you know that in South Asia the market is going to come up, so you want to locate a factory in that area, so it is a long term forecasting decision. But then there is a intermediate time horizon where you can take decision for around 6 months to 1 year time horizon and here also you take this is as which are strategic in nature.

And then you have time horizon where you take decision from one day to 3 months time period. And when you take decision for such a short time period these are not very strategic decisions, these are more operational decision, you have developed a Canvas you have developed a plan and now you are just execute in that plan based on this short of forecast which is for the immediate uses.

And most of the time with the help of available tools with the help of available data analytics techniques we get very accurate results for the short term forecast, probably long term forecast results may not be that much accurate. I discuss the example of Bandra Worli Sea Link in my previous class where long term forecast was the at around 12 lakh cars will be running on that bridge per day.

But we show that how imperfect, how inaccurate that forecast was, now the current data says that only 45000 cars are crossing that bridge on a particular day, so now you have more accurate data available with you and with the help of this more accurate data you can manage the short-term issues, the immediate issues coming up on that bridge. So the forecasting is very very important with respect to time horizon that which time horizon you are taking.

And accordingly you need to take into account a particular type of forecasting technique. Then aggregate forecast you see in our last class we discuss that number of SKUs are increasing, number of distribution channels are increasing know if I have more number of distribution channels, if I have more number of SKUs in my supply chain, in that case my demand is distributed over those number of channels on this number of SKUs.

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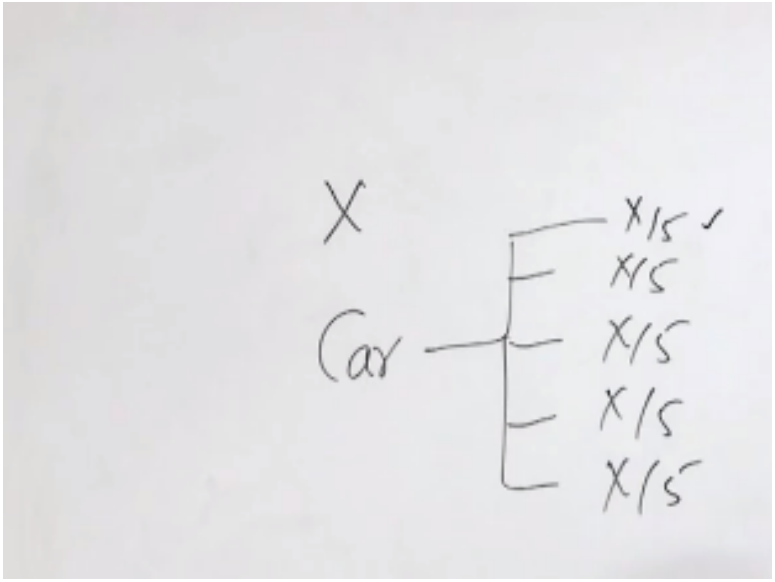

I am having a car I am an automobile company and I have 5 different types of variance of this car. So now overall demand of car that is x is now distributed in five different variants and this I am taking that the demand is uniformly distributed for all these 5 variance. Now in each variant you have some amount of imperfection with respect to forecast. So when I am talking of disaggregated demand the inaccuracy the procedure is less.

But when I am talking only for car and I am taking the decision only for this x i will have a better forecast, a forecast with less error. So sometime I need to plan for each component then I have to go for different different SKUs, but sometime we can consolidate the demand of different SKUs and we can take aggregate demand and then forecast, so it will have less amount of forecasting error. So these are another important characteristic of forecasting.

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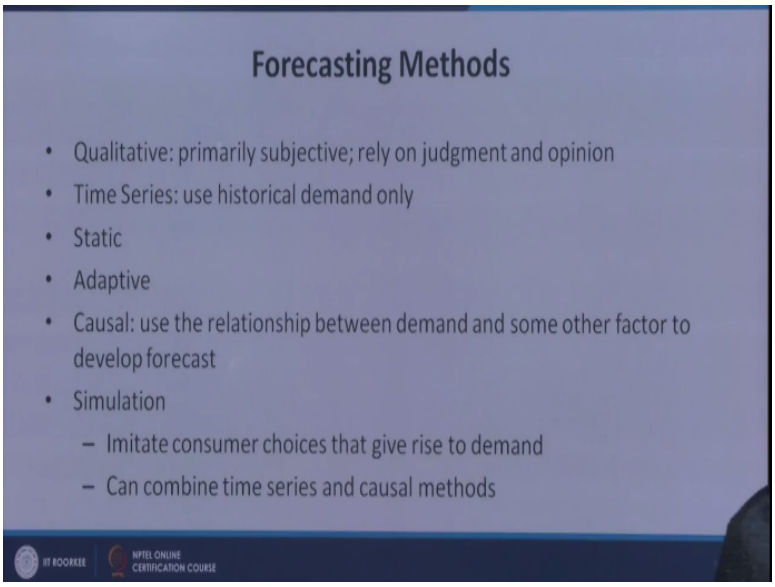

Now coming to forecasting methods what type of forecasting methods available to us because we have different types of forecasting methods which can be used depending upon different type of time Horizon. The forecasting methods are primarily classified into two broad categories and these broad categories are one is qualitative and another is quantitative.

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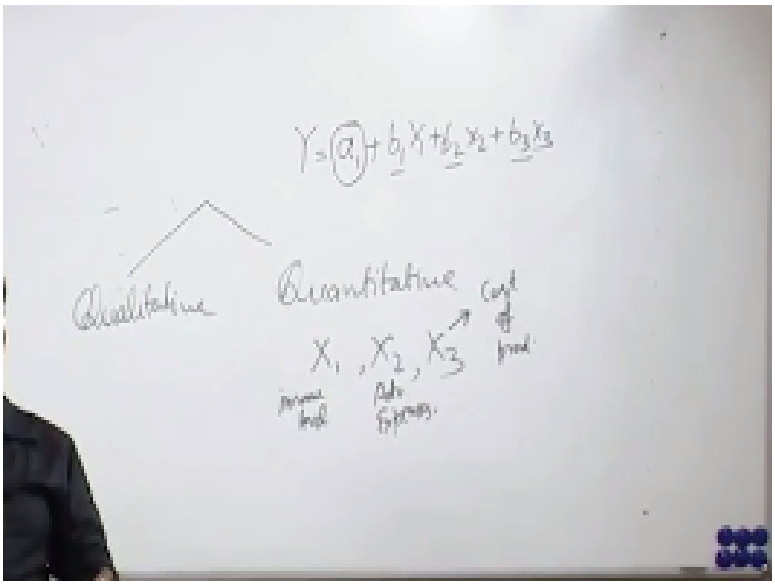

These are the two broad categories of forecasting methods. So qualitative methods are very subjective, you take the interviews, you have certain qualitative research tools and these are based on purely opinions of some experts, but sometime when we don't have any kind of data we have to rely on this qualitative method. But whenever we have data we go with quantitative methods when data is there is only did you are purely opinion based these are purely judgemental based.

But quantitative forecasting methods are data based. So now you can have different type of quantitative methods and I have listed few here you have the most popular method of quantitative forecasting that is the time series analysis. Time series analysis is the most popular way of forecasting and time series can be used for immediate requirement as well as for intermediate requirement. Qualitative methods are mostly used for long term forecasting.

If I am putting the time Horizon for these things, so qualitative methods for the long term forecasting and quantitative methods for the immediate and intermediate, so far these two time bridals baby you can say up to 1 year we can use quantitative methods and beyond 1 year we go with the help of qualitative methods. In quantitative time series methods are most important methods, the widely used method and you have static time series methods.

And you have adaptive time series methods. So now in our analytics course we will see the use of adaptive methods that how the model itself takes care of new data, the most recent data and how the model itself evolves, the formula itself evolves over a period of time. So that you have the best of the best forecasting. So time series where we have the lot of historical data available with us and with the help of the data we do this type of analysis.

So use of data is come is very very important in the development of time series models what type of adaptive method is useful that is also very important because each set of data has its own characteristics, so we need to understand that what type of characteristics are exhibited by a particular set of data and accordingly we need to develop methods, models to forecast. The 2nd type of quantitative method is the regression analysis which is very popular name or in our language of forecasting we call it causal analysis, cause effect analysis.

So cause effect analysis is basically you identify some kind of independent factors, you identify some independent factors which are affecting the demand and then you develop mathematical relationship between those independent vectors and demand and now from some independent sources you know that how the values of those independent factors will change over a period of time.

And then you substitute those values and get the value of demand corresponding to changing values of those independent factors, so this is the causal relationship and as I mentioned that it is the relationship between demand and some other factors to develop the forecast, so what

I am trying to say that in causal you identify certain factors, these factors can be X1, X2, X3. X1 X2 X3 can be the income level, X 2 can be the advertising expenses and X3 can be the let us say our cost of the product.

Now these are the three independent factors which can affect the demand of my product, so my products demand is being represented by Y, Y is the demand of the product and I try to develop a relationship of this nature A1 + B 1X1 + B2 X 2 + B3X3, so developing this kind of relationship that how these factors are going to affect the demand of my product, that is causal analysis.

So in this case I am interested in knowing the values of a A1 B1 B2 and B3. One I determine the value of A1, B1 and B2,B3 it means I have developed the relationship and now from some independent sources I will determine the values of X1 X2 and X3 will substitute that values in this relation and correspondingly for that period I will determine the demand of the product.

So this is also a very interesting predictive method for demand forecasting. You have protected from some other sources the X1, X2 and X3. The interesting part is that you have used some pass data to determine this relationship, but you are using future data future data of X1, X2 and X3 for determining values of Y. So it is a kind of more interesting important method.

And as we go ahead with the help of our computational tools we keep on changing the values of A1, B1, B2, B3, so that our relationship becomes more dynamic, it becomes more adaptive to changing values of Ys and Xs. This relationship I have shown as a linear type of relationship but during our course of discussion we will see that this relationship can be nonlinear also.

So as we go for more and more complicated models we will find any kind of general relationship which is prevalent in between the demand and these other independent factor. Then we have other quantitative type of tool which is simulation tool. Here in case we are not able to develop a proper mathematical model for our demand forecasting purpose, so in this case we can go for the simulation exercises also.

And this is also very interesting way of forecasting that you have more future data to use for predict, you use lot of random future data and with the help of that random future data you have some kind of sections that is also possible. So we will see we use of an hour course the time series methods causal methods and simulation methods for the forecasting purposes.

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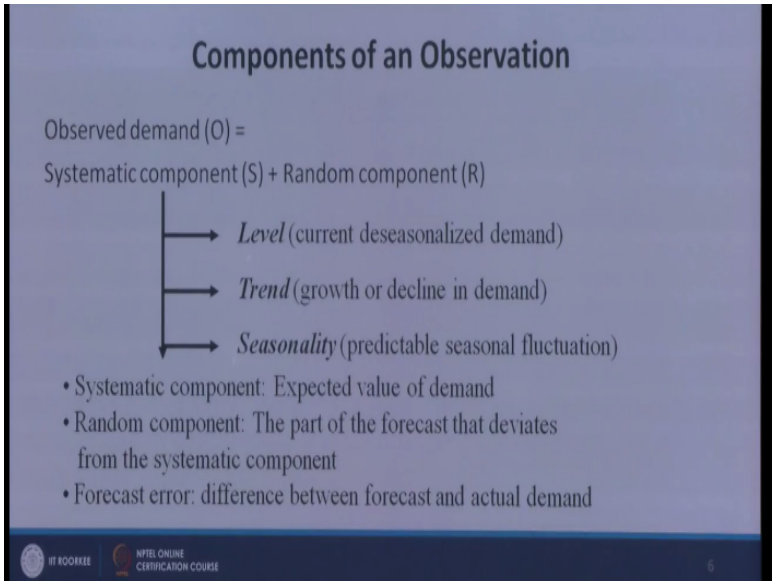

Now when we are talking of, so now the focus is only on this quantitative part of the forecasting, we are not going to touch the qualitative forecasting part in our discussion so we will focus only the quantitative part. Now when we are talking of quantitative forecasting method I am saying that the data which we have it has different types of characters and we need to identify those characteristics and accordingly we will use appropriate method of forecasting.

Now in the any kind of data there are two types of components, one is systematic component which is represented as S and another is the random component that is R. Now with the help of our models, with the help of our mathematical formulas we can determine the systematic component. The random component as the name suggests is random in nature and our limitation is there that we cannot predict, we cannot determine with the use of our analytical tools the values of these random component.

So these random components are attributed to watch forecasting and now the duty is that we should try to use good model, so that we can find the values of the systematic component more accurately. So that the errors are only because of the random component, but if because

of our casual approach, because of our limitation if we are not able to use good methods to determine systematic component.

So you can understand there are already certain errors because of random component which you cannot determine and some users may come because of your wrong choice of method of knowing the systematic component so error will further magnified. So the first important thing is use appropriate method for determining the systematic component. Now what let me give you some idea about the systematic component and random component?

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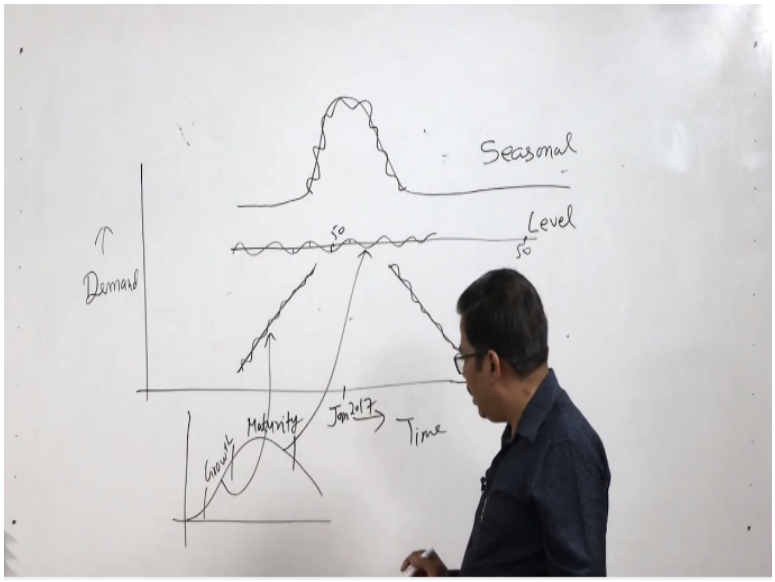

Like in case of a product when I say that demand is almost constant so this is the time and this is the label of demand and when I am seeing the demand is almost constant so this is how you represent the demand, but actually demand is not this state line, this demand is actually fluctuating around this state light. Demand is actually fluctuating around this state line.

So sometime it is going above the straight line, sometime it is coming down this state line. So these vitiations around this straight line these are the random components**.** At this I cannot determine that how much randomness is there. The straight line is the systematic component here, so this I can determine if it is a horizontal, so if it is on January 2017 it is at a particular level let us it is 50 units.

And I say the demand is horizontal, so in May 2017 it will be projected as 50 only. But since there are certain random components, so because of those random components in May 2017 it can be either 55 or it can be either 45 also. So these are because of the random component

in the demand data. So we have to clear, we need to understand that how much demand is coming because of systematic components and how much demand is coming because of the random component.

Now in systematic component there are three types of characteristics, you have level, you have trend and you have seasonality. These are the three types of characteristics which are present in the systematic component. This example where showing a horizontal line, this example is the example of level data that you have almost horizontal type of demand data.

What is the meaning of deseasonalized demand that we will discuss slightly later. Then you have the second type of data where you have trend. Now trend is this type either you can have positive trend or you have negative trend. So when you are having a continuous increase in the demand of your product which is normally during the growth stage or the launching stage of the product.

So when the product is in the growth stage you have a positive trend demand is continuously increasing over a period of time, so you have this type of systematic component. When the project is in the decline stage at that time you have this type of systematic component where the trend is negative, demand is decreasing over a period of time continuously. But again it is not this type of straight lines, straight line increasing, straight line decreasing.

Actually the data is like this and similarly like this, you have systematic component and you have some type of random component. But just for understanding the systematic component I am giving only the straight lines. Then you have another type of component in the systematic data that is the seasonality. Now there are products which exhibit this behaviour of seasonality, products have a particular period, a particular season where the demand increases 2 peak level.

And in rest of the period demand is at very low level. So now the demand is like this and a particular season comes and demand increases to every high level and then it is like this, so you have winters and when in winters the demand of woollen clothes increases to a very high level, you have the period of Diwali demand of crackers increase to a very high level and so on you have lot of seasonal product and in the signal products demand increases to a very high level.

So now you are demand data may exhibit this type of seasonality behaviour, that every time a particular period comes and demand increases to a very high level and again it is not this type of straight curves there will be actually this type of fluctuations, so these fluctuations again we will a tribute to the random component and we need to see that how far we are able to filter random component from the systematic component to have a better modelling better exercise related to forecasting.

So we saw that horizontal trend and seasonality. Now in level data we have written the word current sesonalized demand. Now desesonalized means that when I remove seasonality factor that demand is increasing by 30% in a particular period, so that is a particular seasonal effect, so when I remove that component of 30% so it should behave like this type of level data, this type of horizontal data. So this is a case of seasonal demand.

And when I remove seasonality I get this type of level data and when I have the increasing or decreasing trend that I have a trend data and now for level and trend to give you an example we can again take the help of product life cycle. In product life cycle we have the situation where you introduce a product and after that a period of growth comes during the period of growth you have actually increasing trend.

Then the period of maturity comes and during the period of maturity you have the level data and then phase of decline comes and during the phase of decline you have negative trend. So therefore you can very well relate the three systematic components level positive trend and negative trend with the help of this product life cycle where positive trend growth period, level data is the maturity period and the decline trend, the negative trend is 1 the product is coming out of the market.

So this understanding will help us initially to screen the method which type of method. If I am in the growth stage so those models which are helpful if my product is in the growth stage I know as a marketer that my product is right now in the growth stage, so as a marketer when I am going that my product is in the growth stage. So I will select a method which is helpful in dealing the positive trend.

I should not select a method which deals with level data or which deals with negative tired. So this understanding of product life cycle with the systematic component of my demand data will help me to initially screen my method. If I am in my maturity period of demand data in my product life cycle, so I should not select a method which is useful for the trend kind of components. I should select a method which can handle the level data.

So this way I can filter out my models, I can filter out my methods and this initial knowledge of various components which are available in my forecasting data will help me a lot in selecting the right type of methods for the forecasting purpose and this as I mentioned the expected component is the systematic component, the random component that is the deviation from the systematic components.

So all the fluctuations which I have work these are the results of those random component and then another thing is the forecasting error that is the difference between the forecasted value and the actual demand and we always use this forecasting error to update our forecasting models and that is the beauty of adaptive forecasting system in time series we have the adaptive forecasting system where our model is continuously updated with the help of most recent data.

So we now have understood the usefulness of forecasting, the various methods of forecasting, the relationship of those methods with respect to time horizon and then we started discussions about the time series analysis we just saw the various components which are present in my time series data and with the help of the example of product life cycle we related the systematic components, the level components, the trend components and the seasonality component in my product life cycle data. Thank you very much.