Production and Operations Management
Professor Rajat Agrawal
Department of Management Studies
Indian Institute of Technology, Roorkee
Lecture 07
Introduction to Forecasting

Welcome friends. This is our seventh session on this course on Production and Operations Management. So, far we have discussed the importance of Operations Management, the global trends which are affecting the Operations Management. In last two sessions, we discussed about different types of manufacturing systems and different types of services system.

We have time and again discussed this particular aspect that production and operations management, these things are not limited to manufacturing. These are equally applicable to services system also. So, therefore, we discussed what are the services, how can we classify those services and how operation management can play important role in improving the experience of those services, particularly from the productivity point of view.

Now, moving ahead, there are different types of decisions which we need to take in operations management and now we are starting the discussions on forecasting which is the most important, or you can say primary function of operations management. Based on forecasting we will be taking many other decisions.

So, first we need to importance of forecasting, what is the forecasting in a manufacturing system, what is the forecasting in a services system and then we will see what are the different types of forecasting methodologies, what are the different types of models which we can build for the forecasting; so all those things will be discussed in next few sessions. So, forecasting is the most primary function we do in operations management. And why forecasting is necessary?

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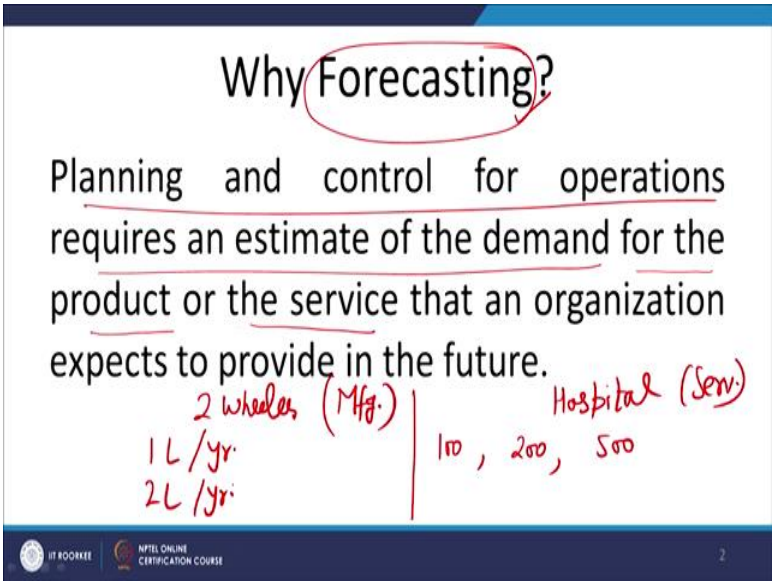

So, you see that we have to design so many activities in operations management. Now, for an example, one of the important thing that how much material to procure; now how much material to procure, that depends upon our forecasting. In case of a services organization, how many servers are required, that again depend on the forecasting; whether to have two servers, whether to have four servers, how much capacity you want to have for your service organization that also depends, that how much demand you are expecting.

So, planning and control for operations requires an estimation of the demand. So, whether it is a manufacturing function or a service function you need to have some kind of estimation that what is going to be the demand, and that estimation is forecasting. Now, this forecasting is equally responsible for product organizations, the manufacturing organization or the service organization. So, you are going to have a factory which is going to make 2 wheelers, you are going to open a hospital. These are examples of manufacturing and services.

Now, what should be the size of hospital, whether to have 100 bed hospital or a 200 bed hospital or a 500 bed hospital, whether to have the production capacity of 2 wheeler 1 lakh per year, 2 lakh per year or any other value, all these things depend upon forecasting. That how much demand you are expecting in future and not only in immediate future but in the long-term future because these are some very much capital-intensive decisions. So, forecasting is a very, very important thing when you are developing a new facility, and what should be the size of facility, that is very much dependent on your appropriate forecasting.

If you are not able to do correct forecasting, you will be incurring huge amount of losses. For an example, in India there are some of the very popular infrastructure projects which were developed with huge investments but because of poor forecasting, they are not able to provide the expected return on their investments.

So, forecasting and the accurate forecasting is very important thing for the success of your organization. So, forecasting is the first important thing. As we were just discussing these examples that where you are doing a very heavy capital investment and it determines the size of your organization

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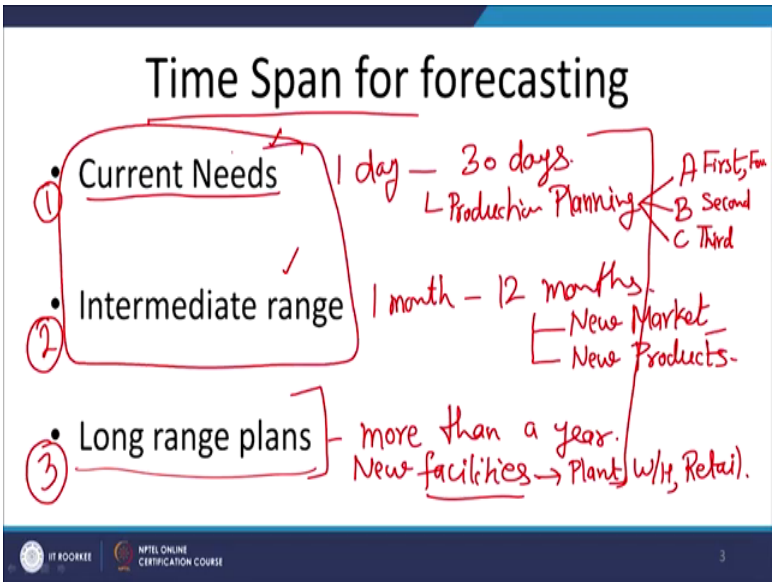

These are the forecasting which we do for the long range activities; and there may be some requirement that how much material I keep in my shop because tomorrow there is going to be some festival and there can be increase in demand and there should I keep more material in my shop that is for the current need so point is that forecasting can be divided on the basis of time span.

There can be three important time spans for which you can do forecasting; one for your current requirements. Current requirement time period normally is between 1 day to 30 days; so up to one month whatever is your requirement that is the current requirement in our language of forecasting.

From 1 month up to 12 months that is for intermediate range and forecasting which we are doing for more than a year, that is long range forecasting. Now, in our classes, in this session we will be discussing mostly the current and the intermediate range forecasting.

The forecasting related to long range planning are discussions of your strategic management. These are also part of business environment and these are also part of entrepreneurship activities. So, there are other disciplines also which contribute in your long range planning. But we will understand with the help of some examples that what we do in current needs, what we do in intermediate range and what we do in long range plans.

Like we need to do a production planning because my company is making three different types of products, A, B, C so now for the first week I am making Product A, second week I am making Product B, third week I am making Product C and again in the fourth week I am making Product A. So, this cycle of production is decided on the basis of my current needs and that is the short-term forecasting horizon.

Then you have intermediate forecasting horizon and that is for the purpose of development of a new market. Right now I am selling my products only in India. Now, I see there is a potential in African markets also and for that purpose I have to do some customization in my product. So, development of a new market, development of new products, these are the part of intermediate forecasting.

So, here my decisions may not be of immediate need but I will act on those decisions after 3 months, after 4 months, after 6 months, may be within a year. So, many a times, you see you plan that now ICC World Cup is starting and companies have planned that during the World Cup they are going to launch these new products. That type of forecast is the result of intermediate range forecasting.

Then comes the long range forecasting; long range forecasting is mostly related with the new facilities. Now, the meaning of facility is different for different persons. The facilities can be plant, it can be a warehouse, it can be a new retail outlet so all these are the examples of facilities. So, whether to start a new factory, or not to start a new factory, what should be the size of that factory, where to locate that factory, all these things are based on my long range forecasting.

As I said that I feel that Africa can be a good market, a good future market for my products. So, I may think that okay, let us start a new factory in Africa. Now, where in Africa? Whether I should open it in Zimbabwe or should I open it in South Africa, should I open it in Ghana or should I open in some other country like Kenya. So, where to locate that factory? What should be the size of that factory?

All these things are based on my long range forecasting that over a period of time this much demand I may be able to generate in Africa so I must have a local facility in that area. This will help me in reduced tariff. This will help me in better able to design products as per the local requirement so all these decisions are your long range forecasting decisions.

In case of current forecasting and intermediate forecasting we deal mostly with data. So, you require more numerical values at the output of your current forecasting and intermediate forecasting. While in case of long range forecasting many times we deal with qualitative aspects also because data may not be appropriately available for doing the long range forecasting. Some amount of data, some amount of numerical digits are available but lot of qualitative inputs are also used in case of long range planning.

So, as I am saying that in this particular course our focus will be largely on these two types of forecasting that is the short-term forecasting and intermediate forecasting though with the help of some qualitative examples we will discuss long range forecasting also but not to a very great depth.

Now, what are the different methodologies, different categories of forecasting? There is one classification of forecasting which is based on time span, time intervals. So, we discuss three time intervals; short-term, intermediate and long range.

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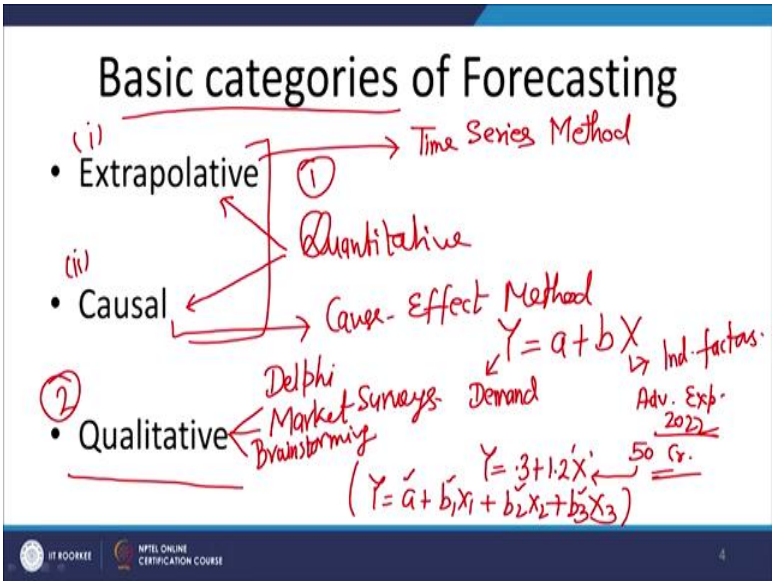

Now, other important classification of forecasting can be done on the basis of methodologies. Now, there are two primary methodologies which are available for forecasting. One is

quantitative and second is qualitative. When you see books, they may say there are three types of forecasting categories.

So, therefore, we have one extrapolative and second causal type of forecasting. But both these are actually categories of your quantitative forecasting, so where we have some kind of data. And how do we handle that data; that may be either through extrapolative methods or through causal methods.

Extrapolative methods are also known as, popularly Time Series Method and causal methods, as the name indicates, these are Cause Effect Method. So, these are two types of very popular quantitative methods where you have in the first case, some historical data available with you. Historical data means past data. And now using that past data you will forecast for coming periods.

Now, it is like if I give you a simple analogy, so you are driving a car. When you are driving a car you are moving ahead. But you are driving car by seeing not in front what is going to happen in front of you; rather you are driving a car by seeing what is happening in your rear side. So, you are seeing in your rear mirror and with the rear mirror images you are driving car in front.

So, that you can say, a type of limitation also of these Time Series analysis, that you are doing forecasting for the coming period but the information, the data which you are using for that purpose that is of the previous period. But nevertheless it is one of the most popular method of forecasting. So, that is Time Series analysis.

The second is causal method, Cause Effect method. Now, in Cause Effect method, we understand that demand is going to depend on various factors. Demand is going to depend on various factors. These factors can be like; if I feel that I do more advertisement expenses the demand of the product is going to increase. So, demand of the product is directly related to the advertisement expenses.

So, now, my duty in the case of causal method to develop a relationship, a mathematical relationship between demand and advertisement expenses and by using this relationship, this mathematical equation which may be normally in the form of Y equals to a plus b X where Y is demand and X is those independent factors.

Now, the beauty is that we need to identify those independent factors for which data can be available to us from some other sources. So, if data is available from some other independent sources we can use that data for future period.

For an example, if I say that advertisement expenses in 2022 will be 50 crore Rupees and I have equation Y equals to 0.3 plus 1.2 into X, something of this type. Now, I can substitute this value of 50 crore in this equation at the place of X and for that year 2022 I can determine the forecast.

This is a very simple example but in more complicated cases we will have Y equals to a plus b1 X1 plus b2 X2 plus b2 X3. So, here three independent factors are affecting my demand. So, we can go to the details of regression analysis and that regression analysis will help us in developing these kind of mathematical relationship between demand and various independent factors.

So, again you see it is more quantitative in nature. It requires lot of data and with the help of that data we will be developing the values of a, b1, b2, b3, etc and that equation will be used for determining the demand for my future period. So, these are the two methods which are largely used for your short term and intermediate periods And in our, this course we will be focusing only on these two methods, extrapolative or Time Series analysis or causal method which is also known as regression analysis.

The second type of methods are qualitative methods. In qualitative methods we do some qualitative analysis. Why we do qualitative analysis? Because data is not available. The historical data not available because you are entering into a new market so no historical data is available. You also do not know what are the factors which can affect the demand. So, you are also not able to develop a mathematical relation like Y equals to a plus b X.

So, when you have this type of limitation that historical data is also not available, you are not knowing the factors which are affecting the demand so in that case you go for the qualitative kind of analysis, qualitative forecasting and there are some very popular methods which we use in qualitative forecasting.

For example Delphi, we will discuss in more detail about Delphi. So, Delphi is a method which is very popularly used for qualitative analysis. We use market surveys. We use brainstorming sessions. So, all these are different types of qualitative forecasting methods which are used for the purpose of your forecasting.

So, these are basic categories of forecasting where extrapolative and causal methods will be dealt in more detail and that will give us insights about model building for forecasting. We will not be able to discuss large amount of models because of the syllabus requirements but it will help us to understand that how different types of models can be built, and similarly, the causal methods, we will develop some kind of basic equations but when we go to classes of econometrics we can see that variety of equations are possible.

We have just discussed the simple regression where linear relations are there but non-linear relations are also possible. So, all those things require more discussions that we will be doing in our coming classes.

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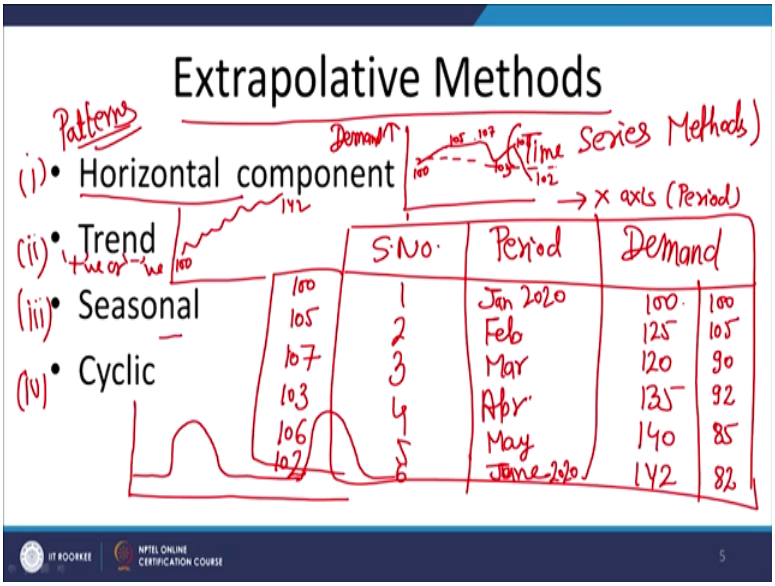

Now, we first start with the extrapolative methods which are also known as Time Series methods. Now, as we just discussed that Time Series methods are based on historical data. So, you require some past data and past data will help you in understanding this Time Series analysis.

Now, what is this past data? I just give you an example. We have three columns in this table. Now, this is an example of past data. From January 2020 to June 2020 what is the demand of a product? So demand varies from 100 units in the first period, then 125, 120, 135, 140 or 142. Now, this demand has some kind of pattern. This historical data has some kind of pattern.

For our good Time Series analysis, we need to identify that pattern in the historical data. Then only you can do a good forecast. Now, there are different types of patterns which are

possible in my historical data and these are primarily four types of patterns. These are the patterns in my historical data.

Now, if you see this data, this table from 100 to 142 it is very difficult for us to say that what type of pattern this data is exhibiting. So, we require some more insight and thanks to IT, that now with the help of softwares, identification of pattern has become much easier. Earlier we used to do lot of computations manually for determining the pattern of the data.

Now, what types of patterns are possible? First is horizontal component. That data is more or less horizontal in nature. So, like for that purpose I am giving you some data and that data will help you that whether it is horizontal or not. Like in the first period it is 100, then it moves to 105, then it moves to 107, it comes to 103, then it goes to 106, then it comes to 102. So, like if this type of data is there that is more or less horizontal demand data.

So, here, if I plot this data of 100 to 102 from period number 1 to period number 6, so on my x axis we have period and on my y axis I have demand. And you see it is 100, 105, then 107 then coming to 103, 106, 102. So, it is fluctuating around a straight line, some minor fluctuations are there but more or less it is around a straight line. Some minor fluctuations will be there. It is almost impossible that you have almost same data of demand over a period of time. But there is no visible trend in this particular case.

So, here, by plotting this data on this x y axis where on x axis you have period or time and on y axis you have demand, historical demand you found that there is no significant movement, there are some random fluctuations around this dotted line. So, you can say that the data has horizontal component.

Now, coming to trend, take this data which is there. Now, 100, 125, 120, 135, 140, 142; now you use this data; again on x axis you have time and on y axis you have demand. When you plot this data you will see this type of movement. There will be some local fluctuations but overall demand has moved from 100 unit to 142 units in the same period from period 1 to period 6.

So, here you see some local fluctuations are there that in period number 3, demand has decreased from 125 to 120. So, that type of fluctuations are there but overall from period number 1 to period number 6, demand has increased from 100 to 142. So, this shows a positive trend that demand has increased from 100 to 142.

Similarly, it is also possible that in the period first, demand is 100, then it moves to 105, then it became 90, then it became 92, then it becomes 85, then it becomes 82. This type of data shows a negative trend. So, trend can be positive or negative.

So, both type of trends are possible; that demand may have some local fluctuations. Please remember that it will not be a smooth curve. It will not be a smooth curve. There will be zigzag movements but overall effect is either increasing or decreasing.

Then you have third type of component in your historical data that is seasonal fluctuations. We know that in some cases; particularly take an example of umbrella. So, when winter season comes, rainy season comes, in that time you have more demand of umbrellas. When sunny season comes you have more demand of sunglasses. When winter season comes you have more demand of woolen clothes and in rest of the period demand is very low. So, during a particular season demand increases to a high value and for rest of the period, demand remains to a very low level. So, that is the seasonal fluctuations.

So, if I plot the seasonal fluctuation data it is like this, low level and then demand increases to a high level and then it remains like this. Then again the same season will come and demand will increase. So, seasonal fluctuations are like that where after a particular interval demand will increase to a high level and for rest of the period demand remains to a low level. For the rest of the period you can say demand shows the horizontal type of behavior and for a particular season demand increases to a very high level.

Then another component of your historical data is cyclical fluctuations. In cyclical fluctuations, it is very much similar to seasonal fluctuations but there are two very important differences.

One is the period of cycle is unknown. You do not know when the period of cyclic fluctuation will come. The period of seasonal fluctuation you know that ever year demand is going to increase in the month of July. So, every year the period of seasonality is fixed. But in case of cyclic fluctuation when demand is going to increase, that you do not know.

And second difference, we know that in case of seasonal fluctuations demand is going to be high for about 15 days or for 1 month or for 2 months as long as that season is remaining. But in case of cyclic fluctuation we do not know that how long that fluctuation is going to be there. It may be for 1 month, 2 months, 15 days or just for 1 week. So, more uncertainties are there with respect to cyclic fluctuations.

So, horizontal and trend data, low amount of uncertainties, uncertainties increase to slightly higher level in case of seasonal fluctuations and very high uncertainties in case of cyclic fluctuations and accordingly our modeling abilities require more efforts.

For horizontal data you can very easily forecast. Trend data requires some amount of efforts. Seasonal data require more efforts and cyclic fluctuations require extraordinary efforts. So, that is the different types of methods which we will be seeing in case of Time Series analysis in our future classes.

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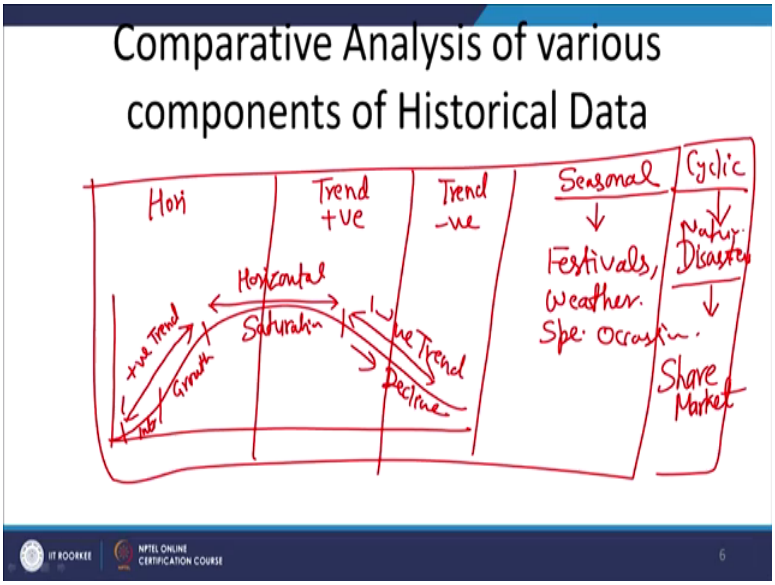

Now, with the help of this discussion we just saw that four different types of data is available and when we see the four different types of data and if I ask you some kind of generic example of these four different types of data like horizontal trend and in trend also we have positive trend and trend which is negative trend. And then you have this seasonal component.

So, many of you might be aware of concept known as product life cycle. So, if I see the product life cycle where different stages are there in the life of a product, it has this type of curve. And in this, this period which is introduction and growth phase, this is intro, this is growth, this is saturation and then this is decline.

So, this introduction and growth, this phase represents positive trend. The saturation phase, it represents horizontal component of demand data. And this decline phase, this represents the negative trend.

So, this example of product life cycle is a very generic example to understand horizontal demand, positive trend and examples of seasonality are like your products which are related to festivals, products which are related to weather, products which are related to special occasions, so these are the seasonal products, and cyclic fluctuations, products which are related to disasters, natural disasters particularly and in that also particularly we can name like earthquake.

So, during earthquake management, post-disaster, all of a sudden, demand of some of the products increases to a very high level. So, that is an example of cyclic fluctuation type of products.

The products of share market, there is no algorithm which can tell you when the prices of a share will touch some new height, and that is again a very uncertain kind of environment. So, wherever uncertainty is very high, you will have, you can see the cyclic fluctuation in that type of data.

So, these are the four different types of components in my Time Series data and based on characteristics of my Time Series data we will actually do different types of modeling. So, with this we come to end of this session. Thank you very much.