

Supply chain Management

**Prepared by Dr. Badur
elgasim**

Lecture 7

MGM 660

Demand Forecasting in a Supply Chain



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Learning Objectives

After reading this chapter, you will be able to:

- 1. Understand the role of forecasting for both an enterprise and a supply chain.**
- 2. Identify the components of a demand forecast.**
- 3. Forecast demand in a supply chain given historical demand data using time-series methodologies.**
- 4. Analyze demand forecasts to estimate forecast error.**

The role of forecasting in a supply chain

**Demand forecasts form the basis of all supply chain planning.
Consider the push/pull view of the supply chain.**

- **All push processes in the supply chain are performed in anticipation of customer demand, whereas all pull processes are performed in response to customer demand.**
- **For push processes, a manager must plan the level of activity, be it production, transportation, or any other planned activity.**

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For pull processes, a manager must plan the level of available capacity and inventory but not the actual amount to be executed. In both instances, the first step a manager must take is to forecast what customer demand will be.

For example, Dell orders PC components in anticipation of customer orders, whereas it performs assembly in response to customer orders. Dell uses a forecast of future demand to determine the quantity of components to have on hand (a push process) and to determine the capacity needed in its plants (for pull production).

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For example, consider the **value of collaborative forecasting** for Coca-Cola and its bottlers. Coca-Cola decides on the timing of various promotions based on the demand forecast over the coming quarter. Promotion decisions are then incorporated into an updated demand forecast. The updated forecast is essential for the bottlers to plan their capacity and production decisions. A bottler operating without an updated forecast based on the promotion is unlikely to have sufficient supply available for Coca-Cola, thus hurting supply chain profits

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Mature products with stable demand, such as milk or paper towels, are usually easiest to forecast. Forecasting and the accompanying managerial decisions are extremely difficult when either the supply of raw materials or the demand for the finished product is highly unpredictable. Fashion goods and many high-tech products are examples of items that are difficult to forecast. Good forecasting is very important in these cases because the time window for sales is narrow. If a firm has over- or under produced, it has little chance to recover. For a product with stable demand, in contrast, the impact of a forecasting error is less significant

Characteristics of forecasts

Companies and supply chain managers should be aware of the following characteristics of forecasts.

1. Forecasts are always wrong and should thus include both the expected value of the forecast and a measure of forecast error. To understand the importance of forecast error, consider two car dealers. One of them expects sales to range between 200 and 1,800 units, whereas the other expects sales to range between 700 and 1,300 units.

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Even though both dealers anticipate average sales of 1,000, the sourcing policies for each dealer should be very different given the difference in forecast accuracy. Thus, the forecast error (or demand uncertainty) must be a key input into most supply chain decisions.

Unfortunately, most firms do not maintain any estimate of forecast error.

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2. Long-term forecasts are usually less accurate than short-term forecasts; that is, long-term forecasts have a larger standard deviation of error relative to the mean than short-term forecasts. Seven-Eleven Japan has exploited this key property to improve its performance. The company has instituted a replenishment process that enables it to respond to an order within hours.

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For example,

if a store manager places an order by 10 A.M., the order is delivered by 7 P.M. the same day. Therefore, the manager only has to forecast what will sell that night less than 12 hours before the actual sale. The short lead time allows a manager to take into account current information, such as the weather, which could affect product sales. This forecast is likely to be more accurate than if the store manager had to forecast demand one week in advance

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3. Aggregate forecasts are usually more accurate than disaggregate forecasts, as they tend to have a smaller standard deviation of error relative to the mean. For example, it is easy to forecast the Gross Domestic Product (GDP) of the United States for a given year with less than a 2 percent error. , and it is even harder to forecast revenue for a given product with the same degree of accuracy. The key difference among the three forecasts is the degree of aggregation. The greater the aggregation, the more accurate is the forecast

Components of a forecast and forecasting methods

Predictions are usually difficult, especially about the future." One may be tempted to treat demand forecasting as magic or art and leave everything to chance. What a firm knows about its customers' past behavior, however, sheds light on their future behavior. Demand does not arise in a vacuum. Rather, customer demand is influenced by a variety of factors and can be predicted, at least with some probability, if a company can determine the relationship between these factors and future demand.

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To forecast demand, companies must first identify the factors that influence future demand and then ascertain the relationship between these factors and future demand. Companies must balance **objective** and **subjective** factors when forecasting demand.

Although we focus on quantitative forecasting methods in this chapter, companies must include human input when they make their final forecast. Seven-Eleven Japan illustrates this point

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Seven-Eleven Japan provides its store managers with a state-of-the-art decision support system that makes a demand forecast and provides a recommended order.

The store manager, however, is responsible for making the final decision and placing the order, because he or she may have access to information about market conditions that are not available in historical demand data. This knowledge of market conditions is likely to improve the forecast.

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For example, if the store manager knows that the weather is likely to be rainy and cold the next day, he or she can reduce the size of an ice cream order to be placed with an upstream supplier, even if demand was high during the previous few days when the weather was hot.

In this instance, a change in market conditions (the weather) would not have been predicted using historical demand data. A supply chain can experience substantial payoffs from improving its demand forecasting through qualitative human inputs.

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A company must be knowledgeable about numerous factors that are related to the demand forecast. Some of these factors are listed next.

- **Past demand**
- **Lead time of product**
- **Planned advertising or marketing efforts**
- **State of the economy**
- **Planned price discounts**
- **Actions that competitors have taken**

A company must understand such factors before it can select an appropriate forecasting methodology

Types of forecasting methods



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Forecasting methods are classified according to the following four types:

1. Qualitative: Qualitative forecasting methods are primarily subjective and rely on human judgment. They are most appropriate when little historical data is available or when experts have market intelligence that may affect the forecast. Such methods may also be necessary to forecast demand several years into the future in a new industry.

2. Time series: Time-series forecasting methods use historical demand to make a forecast. They are based on the assumption that past demand history is a good indicator of future demand. These methods are most appropriate when the basic demand pattern does not vary significantly from one year to the next. These are the simplest methods to implement and can serve as a good starting point for a demand forecast.

3. Causal: Causal forecasting methods assume that the demand forecast is highly correlated with certain factors in the environment (the state of the economy, interest rates, etc.). Causal forecasting methods find this correlation between demand and environmental factors and use estimates of what environmental factors will be to forecast future demand.

For example, product pricing is strongly correlated with demand. Companies can thus use causal methods to determine the impact of price promotions on demand.

4. Simulation: Simulation forecasting methods imitate the consumer choices that give rise to demand to arrive at a forecast. Using simulation, a firm can combine time-series and causal methods to answer such questions as: What will be the impact of a price promotion? What will be the impact of a competitor opening a store nearby? Airlines simulate customer buying behavior to forecast demand for higher-fare seats when there are no seats available at the lower fares.

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A company may find it difficult to decide which method is most appropriate for forecasting. In fact, several studies have indicated that using multiple forecasting methods to create a combined forecast is more effective than using any one method alone.. With any forecasting method, there is always a random element that cannot be explained by historical demand patterns. Therefore, any observed demand can be broken down into a systematic and a random component: Observed demand (O) = systematic component (S) + random component (R)

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The systematic component measures the expected value of demand and consists of, the current depersonalized demand; trend, the rate of growth or decline in demand for the next period; and seasonality, the predictable seasonal fluctuations in demand. The random component is that part of the forecast that deviates from the systematic part. A company cannot (and should not) forecast the direction of the random component

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A manager should be skeptical of a forecasting method that claims to have no forecasting error on historical demand. In this case, the method has merged the historical random component with the systematic component. As a result, the forecasting method will likely perform poorly. The objective of forecasting is to filter out the random component (noise) and estimate the systematic component. The forecast error measures the difference between the forecast and actual demand.

Basic approach to demand forecasting

The following basic, **six-step approach** helps an organization perform effective forecasting.

1. Understand the objective of forecasting.
2. Integrate demand planning and forecasting throughout the supply chain.
3. Understand and identify customer segments.
4. Identify the major factors that influence the demand forecast.
5. Determine the appropriate forecasting technique.
6. Establish performance and error measures for the forecast.

Understand the objective of forecasting



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Every forecast supports decisions that are based on the forecast, so an important first step is to identify these decisions clearly.

Examples of such decisions include how much of a particular product to make, how much to inventory, and how much to order. All parties affected by a supply chain decision should be aware of the link between the decision and the forecast.

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For example, Wal-Mart's plans to discount detergent during the month of July must be shared with the manufacturer, the transporter, and others involved in filling demand, as they all must make decisions that are affected by the forecast of demand. All parties should come up with a common forecast for the promotion and a shared plan of action based on the forecast. Failure to make these decisions jointly may result in either too much or too little product in various stages of the supply chain.

Integrate demand planning and forecasting throughout the supply chain

A company should link its forecast to all planning activities throughout the supply chain. These include capacity planning, production planning, promotion planning, and purchasing, among others. This link should exist at both the information system and the human resources management level.

As a variety of functions are affected by the outcomes of the planning process, it is important that all of them are integrated into the forecasting process. .

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In one unfortunately common scenario, a retailer develops forecasts based on promotional activities, whereas a manufacturer, unaware of these promotions, develops a different forecast for its production planning based on historical orders. This leads to a mismatch between supply and demand, resulting in poor customer service. To accomplish this integration, it is a good idea for a firm to have a cross-functional team, with members from each affected function responsible for forecasting demand and an even better idea is to have members of different companies in the supply chain working together to create a forecast.

Understand and identify customer segments

A firm must identify the customer segments the supply chain serves. Customers may be grouped by similarities in service requirements, demand volumes, order frequency, demand volatility, seasonality, and so forth. In general, companies may use different forecasting methods for different segments.

A clear understanding of the customer segments facilitates an accurate and simplified approach to forecasting.

Identify major factors that influence the demand forecast

Next, a firm must identify demand, supply, and product-related phenomena that influence the demand forecast. On the demand side, a company must ascertain whether demand is growing, declining, or has a seasonal pattern. These estimates must be based on demand-not sales data. For example, a supermarket promoted a certain brand of cereal in July 2005. As a result, the demand for this cereal was high while the demand for other, comparable cereal brands was low in July

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The supermarket should not use the sales data from 2005 to estimate that demand for this brand will be high in July 2006, because this will occur only if the same brand is promoted again in July 2006 and other brands respond as they did the previous year. When making the demand forecast, the supermarket must understand what the demand would have been in the absence of promotion activity and how demand is affected by promotions and competitor actions.

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On the supply side, a company must consider the available supply sources to decide on the accuracy of the forecast desired. If alternate supply sources with short lead times are available, a highly accurate forecast may not be especially important.

However, if only a single supplier with a long lead time is available, an accurate forecast will have great value.

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On the product side, a firm must know the number of variants of a product being sold and whether these variants substitute for or complement each other. If demand for a product influences or is influenced by demand for another product, the two forecasts are best made jointly. For example, when a firm introduces an improved version of an existing product, it is likely that the demand for the existing product will decline because new customers will buy the improved version.

Determine the appropriate forecasting technique

In selecting an appropriate forecasting technique, a company should first understand the dimensions that are relevant to the forecast. These dimensions include geographic area, product groups, and customer groups. The company should understand the differences in demand along each dimension and will likely want different forecasts and techniques for each dimension.

At this stage, a firm selects an appropriate forecasting method from among the four methods discussed earlier--qualitative, time-series, causal, or simulation. As mentioned earlier, using a combination of these methods is often most effective.

TIME-SERIES FORECASTING METHODS

The goal of any forecasting method is to predict the systematic component of demand and estimate the random component. In its most general form, the systematic component of demand data contains a level, a trend, and a seasonal factor. The equation for calculating the systematic component may take a variety of forms, as shown following.

- **Multiplicative:** $\text{Systematic component} = \text{level} \times \text{trend} \times \text{seasonal factor}$
- **Additive:** $\text{Systematic component} = \text{level} + \text{trend} + \text{seasonal factor}$
- **Mixed:** $\text{Systematic component} = (\text{level} + \text{trend}) \times \text{seasonal factor}$

Measures of forecast error



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As mentioned earlier, every instance of demand has a random component. A good forecasting method should capture the systematic component of demand but not the random component. The random component manifests itself in the form of a forecast error. Forecast errors contain valuable information and must be analyzed carefully for two reasons:

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- 1. Managers use error analysis** to determine whether the current forecasting method is predicting the systematic component of demand accurately.

For example, if a forecasting method consistently produces a positive error, the forecasting method is overestimating the systematic component and should be corrected.

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2. All contingency plans must account for forecast error. For example, consider a mail order company with two suppliers. The first is in the Far East and has a lead time of two months. The second is local and can fill orders with one week's notice. The local supplier is more expensive, whereas the Far East supplier costs less. The mail-order company wants to contract a certain amount of contingency capacity with the local supplier to be used if the demand exceeds the quantity the Far East supplier provides. The decision regarding the quantity of local capacity to contract is closely linked to the size of the forecast error.

The role of IT in forecasting



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There is a natural role for IT in forecasting, given the large amount of data involved, the frequency with which forecasting is performed, and the importance of getting the highest-quality results possible. The forecasting module within a supply chain IT system, often called the demand planning module, is a core supply chain software product. There are several important advantages to utilizing the capabilities of IT in forecasting.

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Commercial demand planning modules come with a variety of forecasting algorithms, which can be quite advanced and are sometimes proprietary. These methodologies often give a more accurate forecast than what can be produced through the use of a general package such as Excel. Most demand planning applications make it fairly easy to test the various forecasting algorithms against historical data to determine the one that provides the best fit to the observed demand patterns.

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The availability of a variety of forecasting options is important because different forecasting algorithms provide different levels of quality depending on the actual demand patterns.

The IT system can thus be used to best determine forecasting methods not just for the firm overall, but also by product categories and markets.

Risk management in forecasting



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The risks associated with forecast error must be considered when planning for the future. Errors in forecasting can cause significant misallocation of resources in inventory, facilities, transportation, sourcing, pricing, and even in information management.

Forecast errors during network design may cause too many, too few, or the wrong type of facilities to be built.

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At the planning level, plans are determined from forecasts so the actual inventory, production, transportation, sourcing, and pricing plans that a company produces and follows depend on accurate forecasting. Even on an operational level, forecasting plays a role in the actual day-to-day activities that are executed within a company. As one of the initial processes in each of these phases that affects many other processes, forecasting contains a significant amount of inherent risk.

Forecasting in practice

Collaboration with your supply chain partners can often create a much more accurate forecast. It takes an investment of time and effort to build the relationships with your partners to begin sharing information and creating collaborative forecasts. However, the supply chain benefits of collaboration are often an order of magnitude greater than the cost. The reality today, however, is that most forecasts do not even account for all the information available across the different functions of a firm. Progress needs to be made before all supply chain information is accounted for and utilized.

Reference

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Strategy, Planning, and Operation

By: Sunil Chopra, 3rd ed.

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