Advantages :

(i) The sales force is the group closest to the customers. The sales persons are most likely to know which products or services, customers will be buying in the near future and in what quantities.

(ii) Sales territories often are divided into districts or regions and forecasts for districts or regions will be useful in inventory management, distribution and salesforce staffing.

Disadvantages :

(i) Individual biases of sales people may affect the sales forecast (some are optimistic and some are pessimistic).

(ii) Sales people may be unable to distinguish between what customers would like to do and what they actually will do.

(iii) Sometimes, sales people may be overly influenced by their recent experiences.

(iv) If the firm uses individual sales person's estimate as a performance measure, sales people may deliberately underestimate their forecasts so that their performance will look good when they exceed their quotas which are fixed based on their estimates.

3. **Market Research Method (or Consumer Survey Method) :** This is a systematic approach to determine consumer interest in a product or service by conducting a consumer survey and sample consumer opinions. This method may be used to forecast demand for the short, medium and long term.

Market research method or consumer survey method determines consumer interest in a product or service by means of a consumer survey.

Advantage is that consumers' opinion regarding their future purchasing plans are better than executive opinion or sales force opinion because it is the consumers who ultimately determine demand. Also, information that might not be available elsewhere can be obtained by consumer surveys.

Disadvantages are :

(i) It may not be possible to contact every customer or potential customer and opinions are obtained from sample customers which may lead to forecast error if the sample size is inadequate.

(ii) Surveys require considerable amount of knowledge and skill to handle correctly.

(iii) Surveys can be expensive and time consuming.

(iv) The response rate for mailed questionnaire may be poor.

(v) The survey results may not reflect the opinions of the market.

4. **Other Judgemental Methods : Delphi Method :** In this method opinions are solicited from a number of other managers and staff personnel. The decision makers consist of a group of 5 to 10 experts who will be making the actual forecast. The staff personnel assist decision makers by preparing, distributing, collecting and summarising a series of questionnaires and survey results.

Delphi method is a judgemental method which uses a group process that allows experts to make forecasts.

The managers whose judgements are valid are the respondents. This group provides input to the decision makers before forecast is made. Responses of each respondent are kept anonymous which tends to encourage honest responses. Each new questionnaire is developed using the information extracted from the previous one, thus enlarging the scope of information on which participants can base their judgements. The goal is to achieve consensus forecast.

Advantages :

(i) This method can be used to develop long-range forecasts of product demand and sales projections for new products.

(ii) A panel of experts may be used as participants (respondents).

Disadvantages :

(i) The process can take a long time.

(ii) Responses may be less meaningful because respondents are not accountable due to anonymity.

(iii) High accuracy may not be possible.

(iv) Poorly designed questionnaire will result in ambiguous or false conclusions.

I OVERVIEW OF QUANTITATIVE METHODS

There are five quantitative forecasting methods, all of which use historical data. They fall into two categories.

1. (a) Naive approach
   (b) Moving averages method
   (c) Exponential smoothing method
   } Time series models

2. (a) Trend projection
   (b) Linear regression analysis
   } Causal models

Time series models use a series of past data to make a forecast for the future.

Time series models predict on the assumption that the future is a projection of the past. They look at what has happened over a period of time and use a series of past data to make a forecast for the future.

Associative or causal models incorporate the variable or factors that might influence the quantity being forecast.

Causal (or association) models such as linear regression, incorporate the variables or factors that might influence the quantity being forecast. The demand or sales forecast is a dependent variable and other factors that affect demand are *independent variables* (causal variables). In linear regression the dependent variable (*i.e., demand or sales*) is related to one or more independent variables by a linear equation. The *time series models and causal models* are discussed in greater detail in the following section.

Time Series Forecasting Methods

Time series is a time-ordered sequence of observations taken at regular intervals over a period of time.

A **time series** is a time-ordered sequence of observations taken at regular intervals over a period of time (e.g., hourly, daily, weekly, monthly, quarterly or annually). The data may be measurement of demand, earnings, profits, outputs, productivity, consumer price index etc.

Decomposition of a Time Series

Analysis of time series data requires the analyst to identify the underlying behaviour of the series. This can be done by plotting the data with time on the 'X' axis and data on 'Y' axis and visually examining the plot. One or more patterns might appear. They are **trends, seasonal variations, cycles** and **random** or **irregular variations** (error).

Trend refers to gradual, long term, upward or downward movement in the data over time

Trend refers to gradual, long term, upward or downward movement in the data over time. Changes in income, population, age distribution or cultural views may account for such movements.

Seasonality refers to short-term, fairly regular variations related to factors such as weather, holidays, vacation etc.

Seasonality refers to short-term, fairly regular variations related to factors such as weather, holidays, vacation etc. Seasonal variations can be daily, weekly or monthly.

Cycles are wavelike variations of more than one year's duration or which occur even several years. They are usually tied with business cycle related to a variety of economic, political or agricultural conditions.

Random variations are residual variations which are blips in the data caused by chance and unusual situations which can not be predicted (*e.g.*, war, earthquake, flood etc.).

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Techniques for Averaging

Historical data contain a certain amount of random variation, or **noise** which tends to observe systematic movement in the data. It is desirable to completely remove any randomness from the data and leave only "real" variation such as changes in demand.

Averaging techniques smooth fluctuations in a time series so that the forecast can be based on an average, to exhibit less variability than the original data. Averaging techniques generate forecasts to reflect recent values of a time series. Three techniques for averaging are:

(i) Naive forecasts or Naive approach, *(ii)* Moving averages (Simple and weighted) and *(iii)* Exponential smoothing.

Native approach: A simple way to forecast in which the forecast of demand for the next period is assumed to be equal to the actual demand in the current period.

1. **Naive Approach :** The simplest way to forecast is to assume that forecast of demand in the next period is equal to the actual demand in the most recent period (*i.e.*, the current period). *For example,* if the actual sales for a product in January 2003 is 100 units, the forecast demand for February 2003 will also be 100 units.
2. **Moving Averages Method :** A moving average forecast uses a number of most recent historical actual data values to generate a forecast. The moving average for 'n' number of periods in the moving average is calculated as :

Moving average: A forecasting method that uses an average of the 'n' most recent periods of demand data to forecast the next period demand.

$$\text{Moving average} = \frac{\sum \text{demand in previous n periods}}{n}$$

n may be 3, 4, 5 or 6 periods for 3, 4, 5 or 6 period moving average.

The "simple moving average method" is used to estimate the average of a demand time series and remove the effects of random fluctuation. It is most useful when demand has no pronounced trend or seasonal fluctuations. In this method, if we use 'n' period moving averages, the average demand for the 'n' most recent time periods is calculated and used as forecast for the next time period. For the next period, after the demand is known, the older demand from the previous average is replaced with the most recent demand and the average is recalculated. *For example,* We use a 3 month simple moving average method and the demand data is as below :

Month (period)	*Actual Demand*	*Forecast Based on Simple Moving Average*
1	d_1	
2	d_2	
3	d_3	
4	d_4	$\frac{d_1 + d_2 + d_3}{3}$ (forecast for month 4)
5	d_5	$\frac{d_2 + d_3 + d_4}{3}$ (forecast for month 5)
6	d_6	$\frac{d_3 + d_4 + d_5}{3}$ (forecast for month 6)
7	?	$\frac{d_4 + d_5 + d_6}{3}$ (forecast for month 7)

In the **weighted moving average method** each historical demand in the moving average can have its own weight and the sum of the weight equals one. *For example,* in a 3 period weighted moving average model, the most recent period might be assigned a weight of 0.50,

the second most recent period might be assigned a weight of 0.30 and the third most recent period with a weight of 0.20.

$$\text{Then forecast, } F_{t+1} = \frac{0.50\ D_t + 0.30(D_{t-1}) + 0.20\ D_{t-2}}{\text{Sum of the weights (i.e., } 0.5+0.3+0.2)}$$

(*i.e.*, the average is obtained by multiplying the weight of each period by the value for that period and by adding the products together).

The advantage of a weighted moving average method is that it allows to emphasize recent demand over earlier demand.

Exponential smoothing method: A weighted moving average method in which data points are weighted by an exponential function.

3. **Exponential Smoothing Method :** It is a sophisticated weighted moving average method that is still relatively easy to understand and use. It requires only three items of data : the period's forecast, the actual demand for this period and α which is referred to as *smoothing constant* and having a value between 0 and 1. The formula used is

$$\text{Next period's forecast} = \text{This period's forecast} + \alpha \left(\begin{matrix}\text{This period's} \\ \text{actual demand}\end{matrix} - \begin{matrix}\text{This period's} \\ \text{forecast}\end{matrix} \right)$$

or $$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

Where F_t = Forecast for the this period (t)

F_{t-1} = Forecast for the previous period $(t-1)$

A_{t-1} = Actual demand for the previous period $(t-1)$

α = Smoothing constant (value varies from 0 to 1)

Selecting a smoothing constant is basically a matter of judgement or trial and error. Commonly used values of α range from 0.05 to 0.5. Detailed discussion of causal models is beyond the scope of this book.

Factors to be considered in the selection of a forecasting method are : *(i)* cost *(ii)* accuracy, *(iii)* data available, *(iv)* time span, *(v)* nature of products and services and *(vi)* impulse response and noise dampening.

These factors are discussed below :

Factors to be considered in selectioin of a forecasting method are:
- **Cost and Accuracy**
- **Data available**
- **Time span**
- **Nature of products and Services**
- **Impulse response and Noise dampening.**

***(i)* Cost and Accuracy :** A trade-off may result between cost and accuracy in choosing forecasting method. This means high forecast accuracy can be obtained at a high cost. High accuracy approaches use more data, which are more difficult to obtain and the models are costly to design, implement and operate. Examples of high cost models are complex econometric models, Delphi and market research methods. Statistical models based on historical data and jury of executive opinion method are of low or moderate cost.

***(ii)* Data Available :** The availability of relevant data for forecasts is an important factor in the choice of forecasting method. *For example*, if the attitudes and intentions of customers are relevant for the forecasts and if the data can be economically obtained from customers about their attitudes and intentions, then a survey of customers (market research method) may be an appropriate method for forecasting the demand.

***(iii)* Time Span :** The choice of an appropriate forecasting method is affected by the nature of the production resource to be forecasted. Workforce, cash, inventories and machine schedules are short range in nature and can be forecasted using moving average and exponential smoothing models. Long-range production resources such as plant capacities and capital funds can be forecasted by regression analysis, executive committee consensus (*i.e.*, jury of executive opinion) or market research methods.

***(iv)* Nature of Products and Services :** Different forecasting models have to be used for different products. The choice of the forecasting method is affected by factors such

volume of production, cost of the product, nature of the products (*i.e.*, goods or services), whether product demand has seasonal fluctuations or growth or decline and whether the product is in its life cycle etc.

(v) **Impulse Response and Noise Dampening :** How responsive we want the forecasting model to be to changes in the actual demand data must be balanced against our desire to suppress undesirable chance variation or noise in the data. Each model differs in its impulse response and noise dampening abilities and the model selected must fit the forecasting situation.

Some Reasons for Ineffective Forecasting

1. Not involving a broad cross section of people in forecasting.
2. Not recognising the fact that forecasting is integral to business planning.
3. Not recognising that forecasts will never be correct or accurate.
4. Not forecasting the right things. *For example,* forecasting the demand for raw materials that go into the products is not necessary as it can be computed based on the demand for products.
5. Not selecting an appropriate forecasting method.
6. Not tracing the performance of the forecasting models so that forecast accuracy can be improved and the forecasting model can be modified if needed.

I MONITORING AND CONTROLLING FORECASTS

Once a forecast has been completed, it needs to be monitored and corrected periodically by determining why actual demand (or whatever variable is being examined) differed significantly from that projected. This can be done by setting upper and lower limits on how much the performance characteristic of a forecasting model can deteriorate before we change the parameters of the model.

One way to monitor forecasts to ensure that they are performing well is to use a *tracking signal.* A **tracking signal** is a measurement of how well the forecast is predicting actual values.

$$\text{Tracking signal} = \frac{\text{Running sum of the forecast errors}}{\text{Mean Absolute Deviation}}$$

$$= \frac{\text{RSFE}}{\text{MAD}}$$

$$\text{RSFE} = \sum_{i=1}^{n}\left[\begin{pmatrix}\text{Actual demand}\\ \text{in period i}\end{pmatrix} - \begin{pmatrix}\text{Forecast demand}\\ \text{in period i}\end{pmatrix}\right]$$

$$\text{MAD} = \sum_{i=1}^{n}\left[\frac{\left|\begin{matrix}\text{Actual demand} \\ \text{in period i}\end{matrix} - \begin{matrix}\text{Forecast demand} \\ \text{in period i}\end{matrix}\right|}{n}\right]$$

or

$$= \sum_{i=1}^{n}\left[\frac{|\text{Forecast errors}|}{n}\right]$$

Tracking signal: A measurement of how well the forecast is predicting actual values.

I SOLVED PROBLEMS

1. *The table below shows the monthly demand over 6 months period for a product.*
   (a) *Determine the forecast of demand for the 7th month using 3 month simple moving average method.*

(b) *If the weightage given for the demand for 6th, 5th and 4th months are 0.5, 0.3 and 0.2 respectively, determine the forecast of demand for 7th month using weighted moving average method.*

Month	1	2	3	4	5	6
Demand (units)	120	130	110	140	110	130

Solution :

(a) Forecast of demand for 7th month using simple moving average (3 month) is calculated as below :

$$\text{Forecast of demand for 7th month} = \frac{d_6 + d_5 + d_4}{3}$$

$$= \frac{130 + 110 + 140}{3} = \frac{380}{3} = 126.67 \text{ units}$$

(b) Forecast of demand for 7th month using weighted moving average (3 month) is calculated as follows :

$$\text{Forecast of demand for 7th month} = \frac{w_1 d_6 + w_2 d_5 + w_3 d_4}{w_1 + w_2 + w_3}$$

$$= \frac{(0.5 \times 130) + (0.3 \times 110) + (0.2 \times 140)}{0.5 + 0.4 + 0.3} = 126 \text{ units}$$

2. *ABC company predicted the sales for a product as 150 units for February 2003. Actual demand for February 2003 was 158 units. Using a smoothing constant (α) of 0.3, forecast the demand for March 2003.*

Solution :

$$F_{March} = F_{Feb} + \alpha (D_{Feb} - F_{Feb})$$

F_{Feb} = Forecast for Feb. = 150 units D_{Feb} = Actual demand for Feb. = 158 units

F_{Mar} = Forecast for March α = Smoothing constant.

$$F_{Mar} = 150 + 0.3 (158 - 150)$$

$$= 150 + (0.3 \times 8) = 152.4 \approx 152 \text{ units}$$

QUESTIONS

1. Define the term "forecasting".
2. Mention the uses of forecasts.
3. State the elements of a good forecast.
4. Define the terms "mean absolute deviation" and "tracking signal".
5. State the reasons for ineffective forecasting.
6. Discuss the need for forecasting.
7. What is "forecasting time horizon"? Discuss the characteristics of the three categories of forecasts based on time horizon for forecasting.
8. Write short notes on (a) Technological forecast, (b) Economic forecast and (c) Demand forecast.
9. Discuss the features which are common to all types of forecasts.
10. Discuss the short range and long range objectives of demand forecasting.
11. Explain the steps involved in the forecasting process.
12. Briefly discuss the qualitative and quantitative methods used for forecasting demand.
13. Discuss the factors to be considered in the selection of a forecasting method.