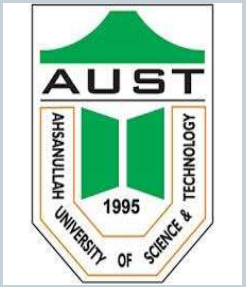
Forecasting



IPE 4111

Presented by
Mahjabin Moon
Lecturer
Department of Mechanical and Production Engineering
Ahsanullah University of Science & Technology

Introduction

- Art & science of predicting or estimating future events or trends based on past and present data.
- May involve taking historical data & projecting them into the future with some sort of mathematical model.
- Forecasts are important input to both long-term strategic decision making as well as for day-to-day operations.

Elements of Good Forecasting

- Accurate
- Timely
- Reliable
- Meaningful
- Written
- Easy to use

Forecasts by Time Horizon

1. Short range forecast
2. Medium range forecast
3. Long range forecast

Forecasts by Time Horizon

Short Range Forecast

- Generally spans from 1 day to 3 months
- It is used for
  - planning purchasing
  - job scheduling
  - workforce levels
  - job assignment
  - production levels

Forecasts by Time Horizon

Medium Range Forecast

- Generally spans from 3 months to 3 years
- It is used for
  - sales planning
  - production planning & budgeting
  - cash budgeting

Forecasts by Time Horizon

Long Range Forecast

- Generally 3 years or more in time span
- It is used in
  - planning for new products
  - capital expenditures
  - facility location and expansion
  - research and development

Types of Forecasts

- Economic forecast
- Technological forecast
- Demand forecast

Types of Forecasts

Economic Forecast

- Address business cycle by predicting
  - inflation rates
  - money supplies
  - housing starts

Types of Forecasts

Technological forecast

- Concerned with the rate of technological progress which can result in exciting new product requiring new plant and equipment.

Types of Forecasts

Demand forecast

- Projection of demand for a company's products or services.
- Drives a company's production capacity, scheduling system.
- Serves as input to financial, marketing and production personnel.

Forecasting Approaches

There are 2 types of forecasting approach

- Qualitative Approach
- Quantitative Approach

Qualitative Approach

- Forecasts that incorporate factors such as decision maker's intuition and personal experience.
- Generally used when data are limited, unavailable or not currently relevant.

Types of Qualitative Approaches

4 types

- Jury of executive opinion
- Delphi method
- Sales force composite
- Customer market survey

Types of Qualitative Approaches

1. Jury of executive opinion

- Forecasting technique that uses the opinion of a small group (5-10) of high level managers to form group.
- Relatively quick.
- 'Group-think' disadvantages.

Types of Qualitative Approaches

2. Delphi Method

- 3 types of participants
  - Decision Makers: consists of 5-10 experts who will make actual forecast.
  - Staff Personnel: assist decision makers by preparing, distributing, collecting and summarizing a series of questionnaires.
  - Respondents: a group of people whose judgments are valued.

Types of Qualitative Approaches

3. Sales Force Composite

- Each salesperson projects his or her sales
- Combined at district and national levels

4. Consumer / Market Survey

- Ask customers about purchasing plans
- What consumers say, and what they actually do are often different
- Sometimes difficult to answer

Advantages & Disadvantages of Qualitative Method

Advantages :

- Take intangible factors into consideration.
- Useful when there are little data available (new product, new market, new business unit).

Disadvantages :

- Long consultation process
- High risk of getting a biased forecast
- Expensive
- Usually not precise

Quantitative Approach

It is used when-

- Situation is ‘stable’ and historical data exist
- Existing products
- Current technology
- Involves mathematical techniques

Advantages & Disadvantages of Quantitative Approach

Advantages :

- Easy to use once the right model has been developed.
- Data collection is quick and easy since most of the required information is already in the business' systems (ex. previous sales) or readily available (ex. consumer price index).

Disadvantages :

- Do not take new information into consideration.

Overview of Quantitative Approaches

1. Naive approach
2. Moving averages
3. Exponential smoothing
4. Trend projection
5. Linear regression

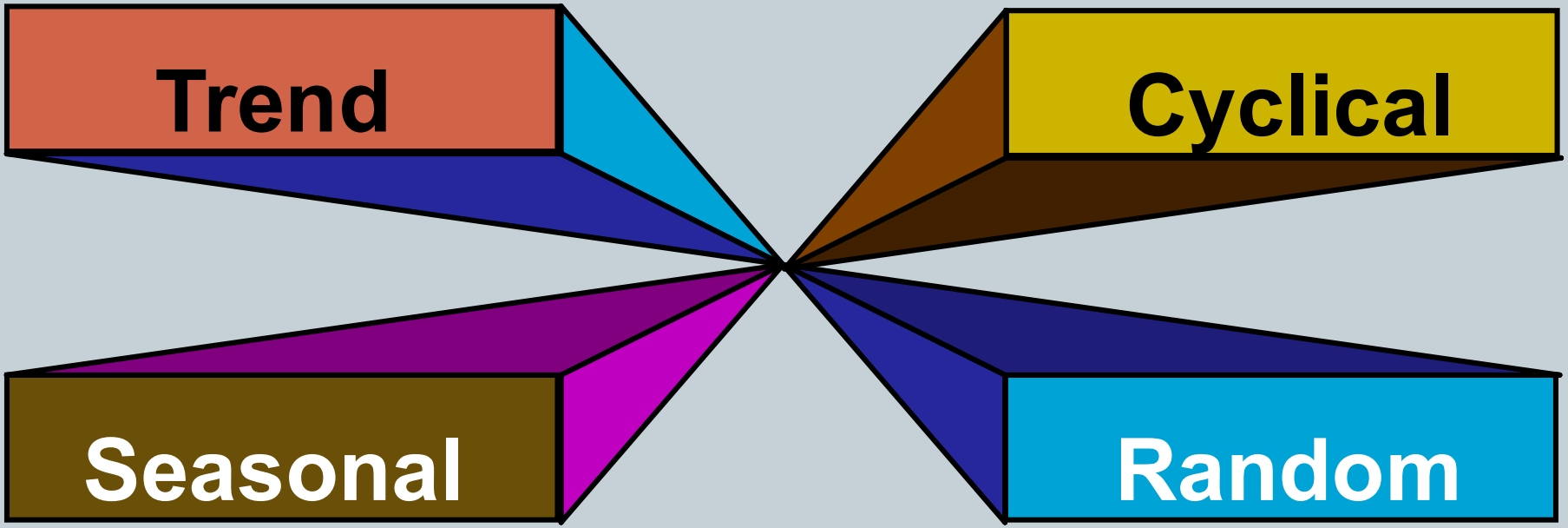
Time-Series Models

Associative Model

Time Series Forecasting

- Data which is related to time.
- Example: data of rainfall with respect to date and time, data of sales records with respect to month or year etc.

Time Series Components



Demand behavior

- Trend

  A gradual, long-term up or down movement of demand, linear, exponential, several year duration.

- Seasonal pattern

  An up-and-down repetitive movement in demand occurring periodically (short term).

  - Due to weather, habits etc.

  - Occurs within a predefined period: year, month, week, day.

Demand behavior

- Cycle

  An up-and-down repetitive movement in demand (long term), due to interactions of factors influencing economy.

  - Usually 2-10 years duration.

- Random variations

  Movements in demand that do not follow a pattern.

Naive Approach

- Assumes demand in next period is the same as demand in most recent period.
  - e.g., If January sales were 68, then February sales will be 68
- Sometimes cost effective and efficient.
- Can be good starting point.

Simple Moving Average

- The simple moving average model assumes an average is a good estimator of future behavior.
- A technique that averages a number of recent actual values, updated as new values become available.
- The formula for the simple moving average is:

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

Moving Average Example

- Donna's Garden Supply wants a 3-month moving average forecast, including a forecast for next August, for shed sales. Actual sales till July are given in the table.

Month	Actual sales
January	10
February	12
March	13
April	16
May	19
June	23
July	26

Moving Average Example

Month	Actual Shed Sales	3-Month Moving Average
January	10	
February	12	
March	13	
April	16	(10 + 12 + 13)/3 = 11.667
May	19	(12 + 13 + 16)/3 = 13.667
June	23	(13 + 16 + 19)/3 = 16
July	26	(16 + 19 + 23)/3 = 19.333

Forecast for July is 19.333.

So, forecast for coming August = (19+ 23 + 26)/3 = 22.667

Weighted Moving Average

- A model that applies different "weights" to each value in the moving average calculation.
- The formula for the moving average is:

$$\text{Weighted moving average} = \frac{\sum(\text{Weight for period n})(\text{Demand in period n})}{\sum \text{Weights}}$$

Weighted Moving Average Example

- Donna's Garden Supply wants to forecast shed sales by weighting the past three months, with more weight given to recent data to make them more significant. Actual sales till July and weights are given in the following tables.

Month	Actual sales
January	10
February	12
March	13
April	16
May	19
June	23
July	26

Weights Applied	Period
3	Last month
2	Two months ago
1	Three months ago

Weighted Moving Average Example

Weights Applied	Period
3	Last month
2	Two months ago
1	Three months ago

Month	Actual Shed Sales	3-Month Weighted Moving Average
January	10	
February	12	
March	13	
April	16	$[(3 \times 13) + (2 \times 12) + (10)]/6 = 12^1/_6$
May	19	$[(3 \times 16) + (2 \times 13) + (12)]/6 = 14^1/_3$
June	23	$[(3 \times 19) + (2 \times 16) + (13)]/6 = 17$
July	26	$[(3 \times 23) + (2 \times 19) + (16)]/6 = 20^1/_2$

Exponential Smoothing

New forecast = Last period's forecast + α (Last period's actual demand – Last period's forecast)

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

where
F_t = new forecast
F_{t-1} = previous forecast
α = smoothing (or weighting) constant ($0 \leq \alpha \leq 1$)

Exponential Smoothing Example

- In January, a car dealer predicted February demand for 142 Ford Mustangs. The actual February demand was 153. Using a smoothing constant $\alpha = 0.20$ chosen by management, the dealer wants to forecast March demand using the exponential smoothing model.

Solution:

Predicted demand = 142
Actual demand = 153
Smoothing constant $\alpha = 0.20$

$$\begin{aligned}\text{New forecast} &= 142 + .2(153 - 142)\\ &= 142 + 2.2\\ &= 144.2 \approx 144 \text{ cars}\end{aligned}$$

Exponential Smoothing with Trend Adjustment

When a trend is present, exponential smoothing must be modified.

$$\text{Forecast including trend } (FIT_t) = \text{Exponentially smoothed forecast } (F_t) + \text{Exponentially smoothed trend } (T_t)$$

Exponential Smoothing with Trend Adjustment

$F_t = \alpha$ (Last period's actual demand) + (1-α) (Last period's forecast – Last period's estimated trend)

or

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

$T_t = \beta$ (This period's forecast - Last period's forecast) + (1- β) (Last period's estimated trend)

or

$$T_t = \beta (F_t - F_{t-1}) + (1- \beta)T_{t-1}$$

Exponential Smoothing with Trend Adjustment

Step 1: Compute F_t

Step 2: Compute T_t

Step 3: Calculate the forecast $FIT_t = F_t + T_t$

Exponential Smoothing with Trend Adjustment Example

- A large manufacturer wants to forecast demand for a pollution control equipment. A review of past sales, as shown in the table, indicates that an increasing trend is present. Smoothing constants are assigned the value of $\alpha = 0.2$ and $\beta = 0.4$. The firm assumes the initial forecast for month 1 was 11 units and the trend over that period was 2 units. Calculate the forecast of month 10 considering the trend.

Month	Actual Demand
1	12
2	17
3	20
4	19
5	24
6	21
7	31
8	28
9	36
10	?

Exponential Smoothing with Trend Adjustment Example

Month(t)	Actual Demand (A_t)	Smoothed Forecast, F_t	Smoothed Trend, T_t	Forecast Including Trend, FIT_t
1	12	11	2	13
2	17	12.80	1.92	14.72
3	20	15.18	2.10	17.28
4	19	17.82	2.32	20.14
5	24	19.91	2.23	22.14
6	21	22.51	2.38	24.89
7	31	24.11	2.07	26.18
8	28	27.14	2.45	29.59
9	36	29.28	2.32	31.60
10	-	32.48	2.68	35.16

Forecast Accuracy

- Error - difference between actual value and predicted value
- Mean Absolute Deviation (MAD)
  - Average absolute error
  - Easy to compute
  - Weights errors linearly
- Mean Squared Error (MSE)
  - Average of squared error
  - More weight to large errors
- Mean Absolute Percent Error (MAPE)
  - Average absolute percent error
  - Puts errors in perspective

MAD, MSE, and MAPE

$$\text{MAD} = \frac{\sum(|\text{Actual} - \text{Forecast}|)}{n}$$

$$\text{MSE} = \frac{\sum(\text{Actual} - \text{Forecast})^2}{n - 1}$$

$$\text{MAPE} = \frac{\sum((|\text{Actual} - \text{Forecast}| / \text{Actual}) \times 100)}{n}$$

Example

- Actual and forecasted data of a calculator manufacturing company is presented in the table. Calculate the forecasting error in terms of MAD, MSE and MAPE.

Period	Actual	Forecast
1	217	215
2	213	216
3	216	215
4	210	214
5	213	211
6	219	214
7	216	217
8	212	216

Example

Period	Actual	Forecast	(A-F)	|A-F|	(A-F)^2	(|A-F|/Actual)*100
1	217	215	2	2	4	0.92
2	213	216	-3	3	9	1.41
3	216	215	1	1	1	0.46
4	210	214	-4	4	16	1.90
5	213	211	2	2	4	0.94
6	219	214	5	5	25	2.28
7	216	217	-1	1	1	0.46
8	212	216	-4	4	16	1.89
			-2	22	76	10.26

MAD = 2.75

MSE = 10.86

MAPE = 1.28

Choosing a Forecasting Technique

- No single technique works in every situation
- Two most important factors
  - Cost
  - Accuracy
- Other factors include the availability of:
  - Historical data
  - Computers
  - Time needed to gather and analyze the data

Thank You