FORECASTING

Pertemuan ke-14

What is Forecasting?

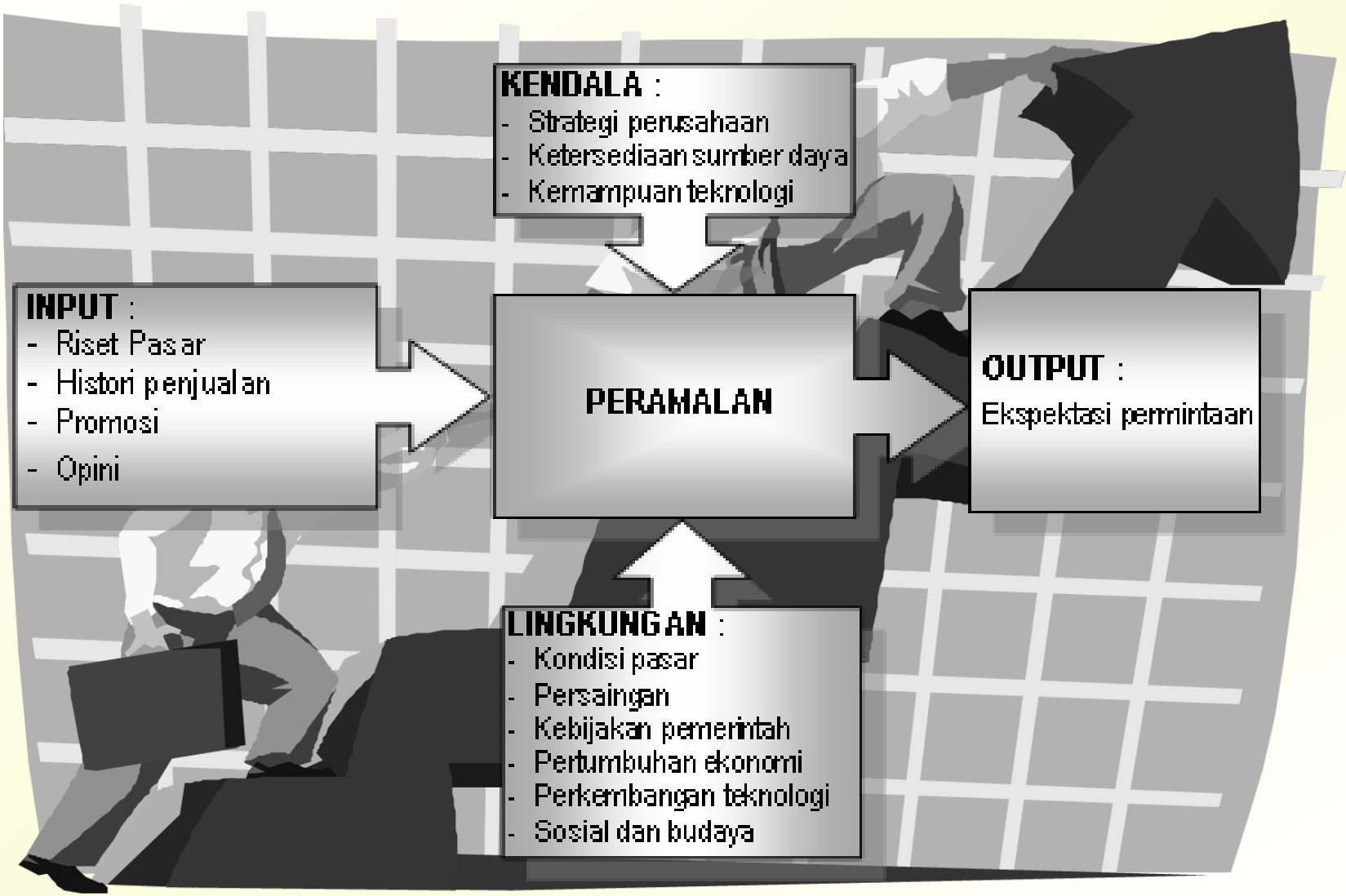
FORECAST:

- Pernyataan tentang nilai masa depan dari variabel yang diminati seperti permintaan..
- Prakiraan mempengaruhi keputusan dan aktivitas di seluruh organisasi
  - Accounting, finance
  - Human resources
  - Marketing
  - MIS (Management Information System)
  - Operations
  - Product / service design

Uses of Forecasts

Accounting	Cost/profit estimates (Estimasi biaya / keuntungan)
Finance	Cash flow and funding (Arus kas dan pendanaan)
Human Resources	Hiring/recruiting/training (Mempekerjakan/merekrut/melatih)
Marketing	Pricing, promotion, strategy (Harga, promosi, strategi)
MIS	IT/IS systems, services
Operations	Schedules, MRP, workloads (beban kerja)
Product/service design	New products and services

Peramalan Permintaan



Metode Peramalan Deret Waktu (Time Series Methods)

- Teknik peramalan yang menggunakan data-data historis penjualan beberapa waktu terakhir dan mengekstrapolasinya untuk meramalkan penjualan di masa depan
- Peramalan deret waktu mengasumsikan pola kecenderungan pemasaran akan berlanjut di masa depan.
- Sebenarnya pendekatan ini cukup naif, karena mengabaikan gejolak kondisi pasar dan persaingan

Langkah-langkah Peramalan Time Series (Deret Waktu)

- Kumpulkan data historis penjualan
- Petakan dalam diagram pencar (scatter diagram)
- Periksa pola perubahan permintaan
- Identifikasi faktor pola perubahan permintaan
- Pilih metode peramalan yang sesuai
- Hitung ukuran kesalahan peramalan
- Lakukan peramalan untuk satu atau beberapa periode mendatang

UKURAN AKURASI HASIL PERAMALAN

Ukuran akurasi hasil peramalan yang merupakan ukuran kesalahan peramalan yang ukuran tentang tingkat perbedaan antara hasil peramalan dengan permintaan yang sebenarnya terjadi. Ukuran yang biasa digunakan, yaitu:

1. Rata-rata Deviasi Mutlak (Mean Absolute Deviation = MAD)
2. Rata-Rata Kuadrat Kesalahan (Mean Square Error = MSE)
3. Rata-rata Peramalan Kesahalan Absolut (Mean Absolute Percentage Error = MAPE)

UKURAN AKURASI HASIL PERAMALAN

1. **Rata-rata Deviasi Mutlak (Mean Absolute Deviation = MAD)**
   MAD merupakan rata-rata kesalahan mutlak selama periode tertentu tanpa memperhatikan apakah hasil peramalan besar atau lebih kecil dibandingkan kenyataannya.
2. **Rata-Rata Kuadrat Kesalahan (Mean Square Error= MSE)**
   MSE dihitung dengan menjumlahkan kuadrat semua kesalahan peramalan pada setiap periode dan membaginya dengan jumlah periode peramalan.
3. **Rata-rata Peramalan Kesahalan Absolut (Mean Absolute Percentage Error + MAPE)**

   MAPE merupakan kesalahan relatif. MAPE menyatakan persentase kesalahan hasil peramalan terhadap permintaan aktual selama periode tertentu yang akan memberikan informasi persentase kesalahan terlalu tinggi atau terlalu rendah.

Forecast Error

- Bias - The arithmetic sum of the errors

$$Forecast\ Error = A_t - F_t$$

- Mean Square Error - Similar to simple sample variance

$$MSE = \sum_{t=1}^{T} |\text{ forecast error }|^2 \ /T$$

$$= \sum_{t=1}^{T} (A_t - F_t)^2 \ / T$$

- MAD - Mean Absolute Deviation

$$MAD = \sum_{t=1}^{T} |\text{ forecast error }| /T = \sum_{t=1}^{T} |A_t - F_t| / T$$

- MAPE – Mean Absolute Percentage Error

$$MAPE = 100 \sum_{t=1}^{T} [|A_t - F_t| / A_t] / T$$

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=	9,50					
MAPE=	1,28					

Techniques for Averaging

- Moving average
- Weighted moving average
- Exponential smoothing

Moving Averages

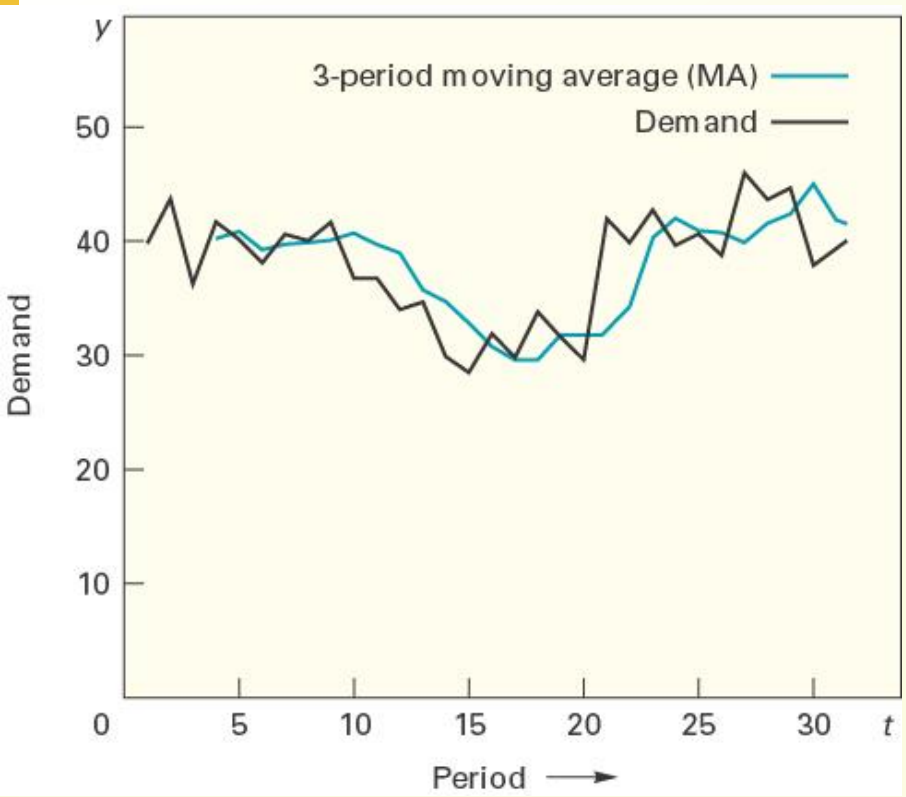
- *Moving average* – A technique that averages a number of recent actual values, updated as new values become available.

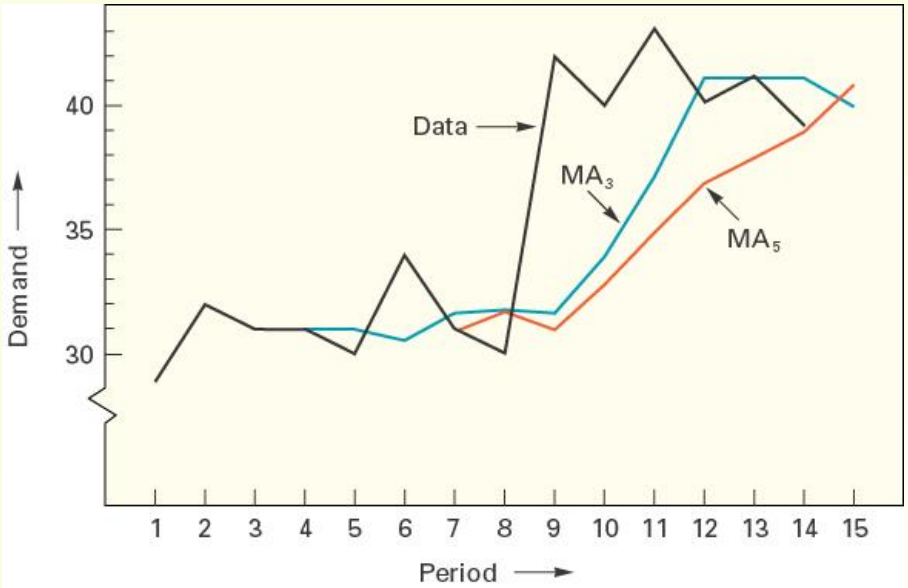
$$MA_n = \frac{\sum_{i=1}^{n} A_i}{n}$$

- The demand for wheels in a wheel store in the past 5 weeks were as follows. Compute a three-period moving average forecast for demand in week 6.

83 80 85 90 94

Moving average & Actual demand





Moving Averages

Wallace Garden Supply

Forecasting

Storage Shed Sales

Period	Actual Value	Three-Month Moving Averages
January	10	
February	12	
March	16	
April	13	10 + 12 + 16 / 3 = 12.67
May	17	12 + 16 + 13 / 3 = 13.67
June	19	16 + 13 + 17 / 3 = 15.33
July	15	13 + 17 + 19 / 3 = 16.33
August	20	17 + 19 + 15 / 3 = 17.00
September	22	19 + 15 + 20 / 3 = 18.00
October	19	15 + 20 + 22 / 3 = 19.00
November	21	20 + 22 + 19 / 3 = 20.33
December	19	22 + 19 + 21 / 3 = 20.67

Moving Averages Forecast

Wallace Garden Supply

Forecasting 3 period moving average

Input Data

Period	Actual Value
Month 1	10
Month 2	12
Month 3	16
Month 4	13
Month 5	17
Month 6	19
Month 7	15
Month 8	20
Month 9	22
Month 10	19
Month 11	21
Month 12	19

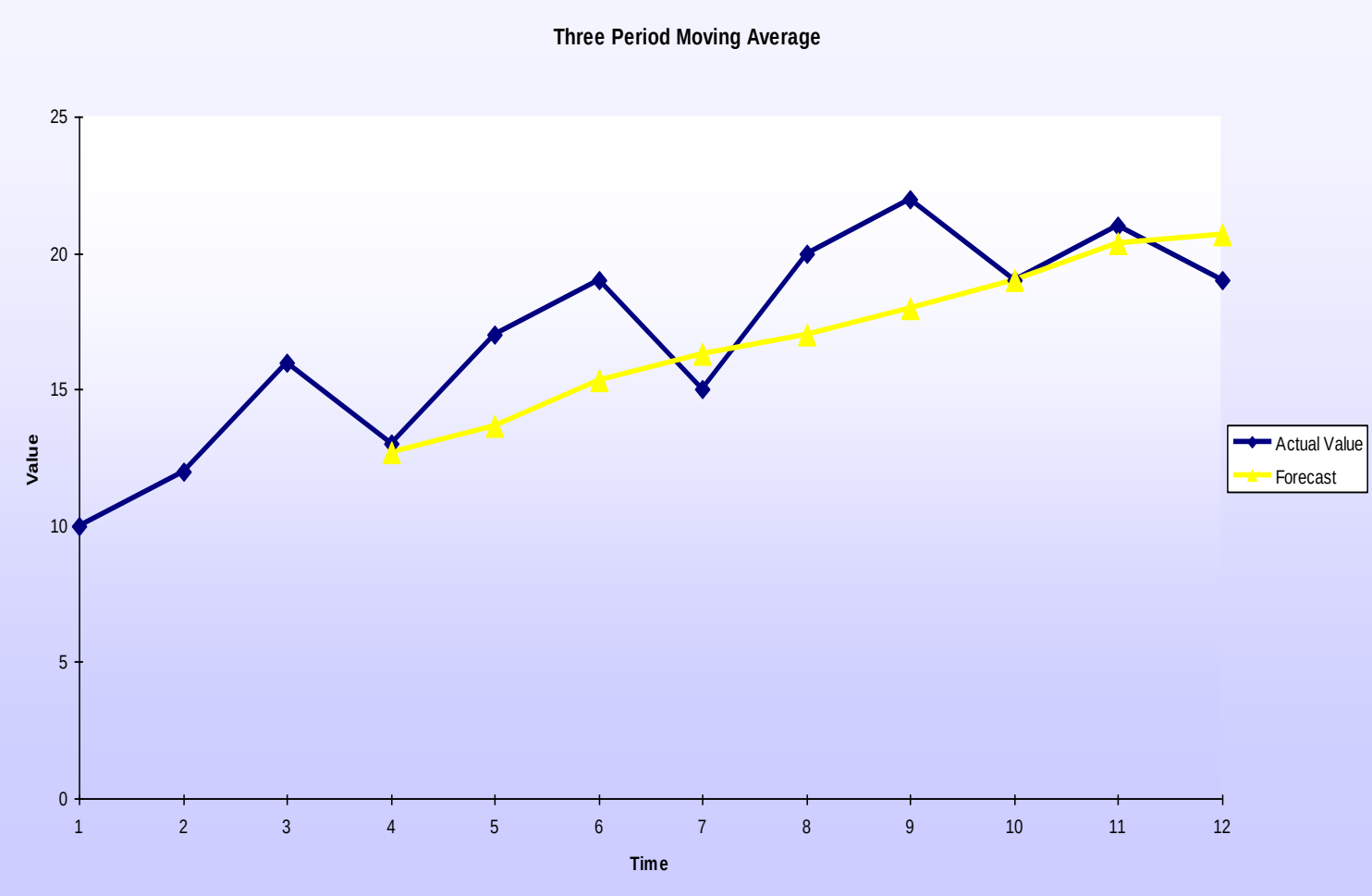
Next period **19,667**

Forecast Error Analysis

Actual Value - Forecast

Forecast	Error	Absolute error	Squared error	Absolute % error
12,667	0,333	0,333	0,111	2,56%
13,667	3,333	3,333	11,111	19,61%
15,333	3,667	3,667	13,444	19,30%
16,333	-1,333	1,333	1,778	8,89%
17,000	3,000	3,000	9,000	15,00%
18,000	4,000	4,000	16,000	18,18%
19,000	0,000	0,000	0,000	0,00%
20,333	0,667	0,667	0,444	3,17%
20,667	-1,667	1,667	2,778	8,77%
Average	12,000	**2,000**	**6,074**	**10,61%**
	BIAS	**MAD**	**MSE**	**MAPE**

Moving Averages Graph



Moving Averages

- *Weighted moving average* – More recent values in a series are given more weight in computing the forecast.
  - Assumes data from some periods are more important than data from other periods (e.g. earlier periods).
  - Use weights to place more emphasis on some periods and less on others.

Example:

- For the previous demand data, compute a weighted average forecast using a weight of .40 for the most recent period, .30 for the next most recent, .20 for the next and .10 for the next.
- If the actual demand for week 6 is 91, forecast demand for week 7 using the same weights.

Weighted Moving Average

Wallace Garden Supply

Forecasting

Storage Shed Sales

Period	Actual Value	Weights	Three-Month Weighted Moving Averages
January	10	0,222	
February	12	0,593	
March	16	0,185	
April	13		2,2 + 7,1 + 3 / 1 = 12,298
May	17		2,7 + 9,5 + 2,4 / 1 = 14,556
June	19		3,5 + 7,7 + 3,2 / 1 = 14,407
July	15		2,9 + 10 + 3,5 / 1 = 16,484
August	20		3,8 + 11 + 2,8 / 1 = 17,814
September	22		4,2 + 8,9 + 3,7 / 1 = 16,815
October	19		3,3 + 12 + 4,1 / 1 = 19,262
November	21		4,4 + 13 + 3,5 / 1 = 21,000
December	19		4,9 + 11 + 3,9 / 1 = 20,036

Next period **20,185**

Sum of weights = **1,000**

Weighted Moving Average

Wallace Garden Supply

Forecasting 3 period weighted moving average

Input Data

Period	Actual value	Weights
Month 1	10	0.222
Month 2	12	0.593
Month 3	16	0.185
Month 4	13	
Month 5	17	
Month 6	19	
Month 7	15	
Month 8	20	
Month 9	22	
Month 10	19	
Month 11	21	
Month 12	19	

Next period **20.185**

Sum of weights = **1.000**

Forecast Error Analysis

Forecast	Error	Absolute error	Squared error	Absolute % error
12.298	0.702	0.702	0.492	5.40%
14.556	2.444	2.444	5.971	14.37%
14.407	4.593	4.593	21.093	24.17%
16.484	-1.484	1.484	2.202	9.89%
17.814	2.186	2.186	4.776	10.93%
16.815	5.185	5.185	26.889	23.57%
19.262	-0.262	0.262	0.069	1.38%
21.000	0.000	0.000	0.000	0.00%
20.036	-1.036	1.036	1.074	5.45%
Average	**1.988**	**6.952**	**6.952**	**10.57%**
	BIAS	**MAD**	**MSE**	**MAPE**

Exponential Smoothing

- ES didefinisikan sebagai:

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

Keterangan:

F_{t+1} = Ramalan untuk periode berikutnya

D_t = Demand aktual pada periode t

F_t = Peramalan yg ditentukan sebelumnya untuk periode t

α = Faktor bobot

- α besar, smoothing yg dilakukan kecil
- α kecil, smoothing yg dilakukan semakin besar
- α optimum akan meminimumkan MSE, MAPE

Exponential Smoothing

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

- Weighted averaging method based on previous forecast plus a percentage of the forecast error
- A-F is the error term, α is the % feedback

Exponential Smoothing Data

Wallace Garden Supply

Forecasting

Storage Shed Sales

Period	Actual Value
January	10
February	12
March	16
April	13
May	17
June	19
July	15
August	20
September	22
October	19
November	21
December	19

Exponential Smoothing

F_t		α		A_t		F_t		F_{t+1}
10		0,1						
10	+	0,1	*(	10	-	10	) =	10,000
10	+	0,1	*(	12	-	10	) =	10,200
10	+	0,1	*(	16	-	10	) =	10,780
11	+	0,1	*(	13	-	11	) =	11,002
11	+	0,1	*(	17	-	11	) =	11,602
12	+	0,1	*(	19	-	12	) =	12,342
12	+	0,1	*(	15	-	12	) =	12,607
13	+	0,1	*(	20	-	13	) =	13,347
13	+	0,1	*(	22	-	13	) =	14,212
14	+	0,1	*(	19	-	14	) =	14,691
15	+	0,1	*(	21	-	15	) =	15,322

Exponential Smoothing

Wallace Garden Supply

Forecasting Exponential smoothing

Input Data

Period	Actual value
Month 1	10
Month 2	12
Month 3	16
Month 4	13
Month 5	17
Month 6	19
Month 7	15
Month 8	20
Month 9	22
Month 10	19
Month 11	21
Month 12	19

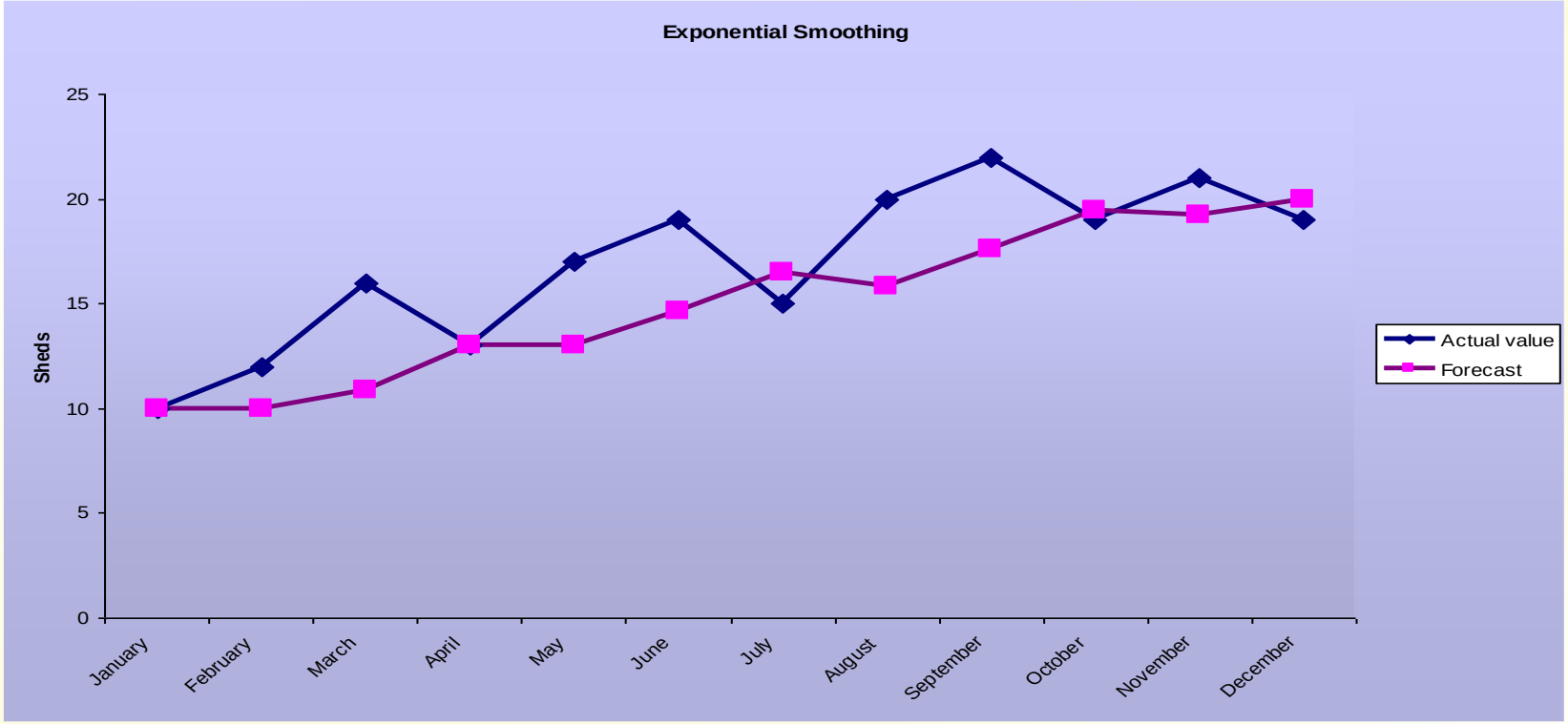
Alpha	0.419

Next period **19.573**

Forecast Error Analysis

Forecast	Error	Absolute error	Squared error	Absolute % error
10.000				
10.000	2.000	2.000	4.000	16.67%
10.838	5.162	5.162	26.649	32.26%
13.000	0.000	0.000	0.000	0.00%
13.000	4.000	4.000	16.000	23.53%
14.675	4.325	4.325	18.702	22.76%
16.487	-1.487	1.487	2.211	9.91%
15.864	4.136	4.136	17.106	20.68%
17.596	4.404	4.404	19.391	20.02%
19.441	-0.441	0.441	0.194	2.32%
19.256	1.744	1.744	3.041	8.30%
19.987	-0.987	0.987	0.973	5.19%
Average		**2.608**	**9.842**	**14.70%**
		MAD	**MSE**	**MAPE**

Exponential Smoothing



Time Series Methods

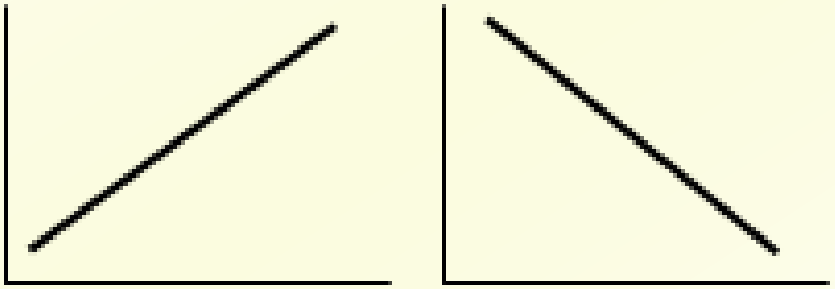
Trend , Seasonality Analysis

- *Trend* - long-term movement in data
- *Cycle* – wavelike variations of more than one year's duration
- *Seasonality* - short-term regular variations in data
- *Random variations* - caused by chance

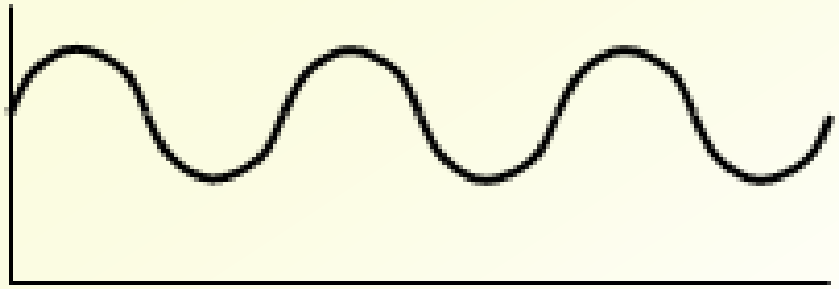
Pola Kecenderungan Data Historis Penjualan

Faktor Keacakan

Faktor Tren



Faktor Siklik

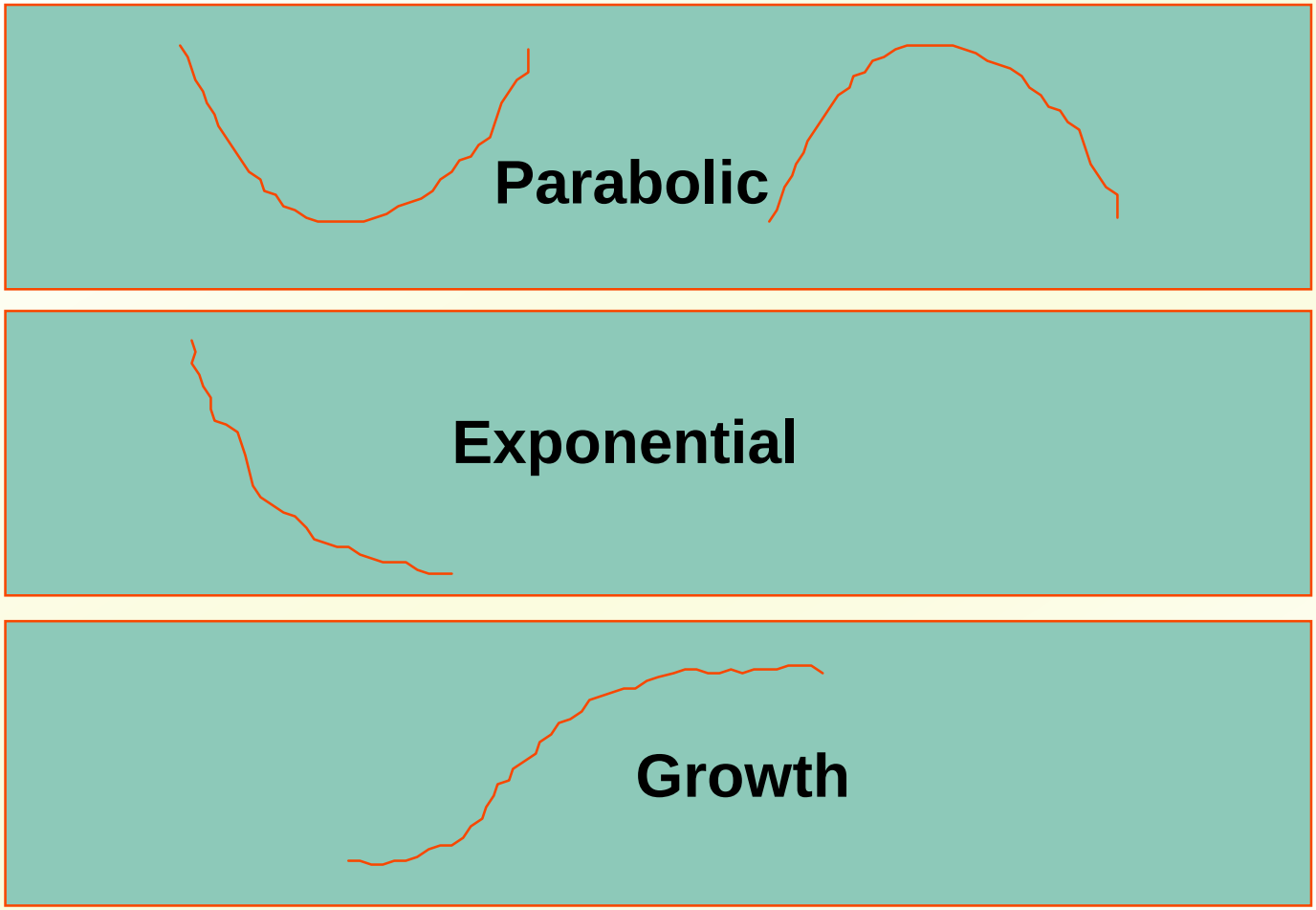


Faktor Musiman

Techniques for Trend

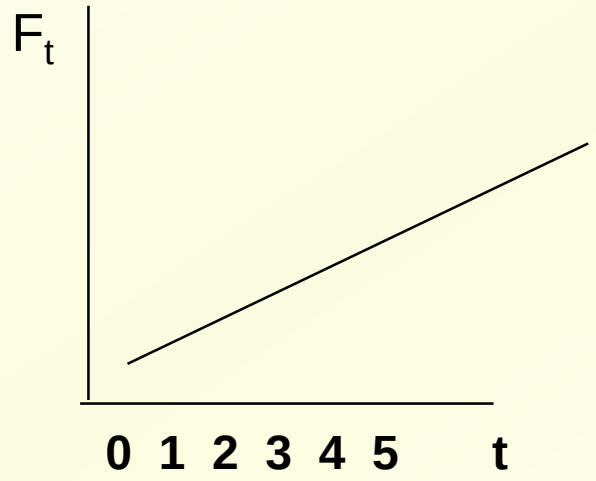
- Develop an equation that will suitably describe trend, when trend is present.
- The trend component may be linear or nonlinear
- We focus on linear trends

Common Nonlinear Trends



Linear Trend Equation

$$F_t = a + bt$$



- F_t = Forecast for period t
- t = Specified number of time periods
- a = Value of F_t at t = 0
- b = Slope of the line

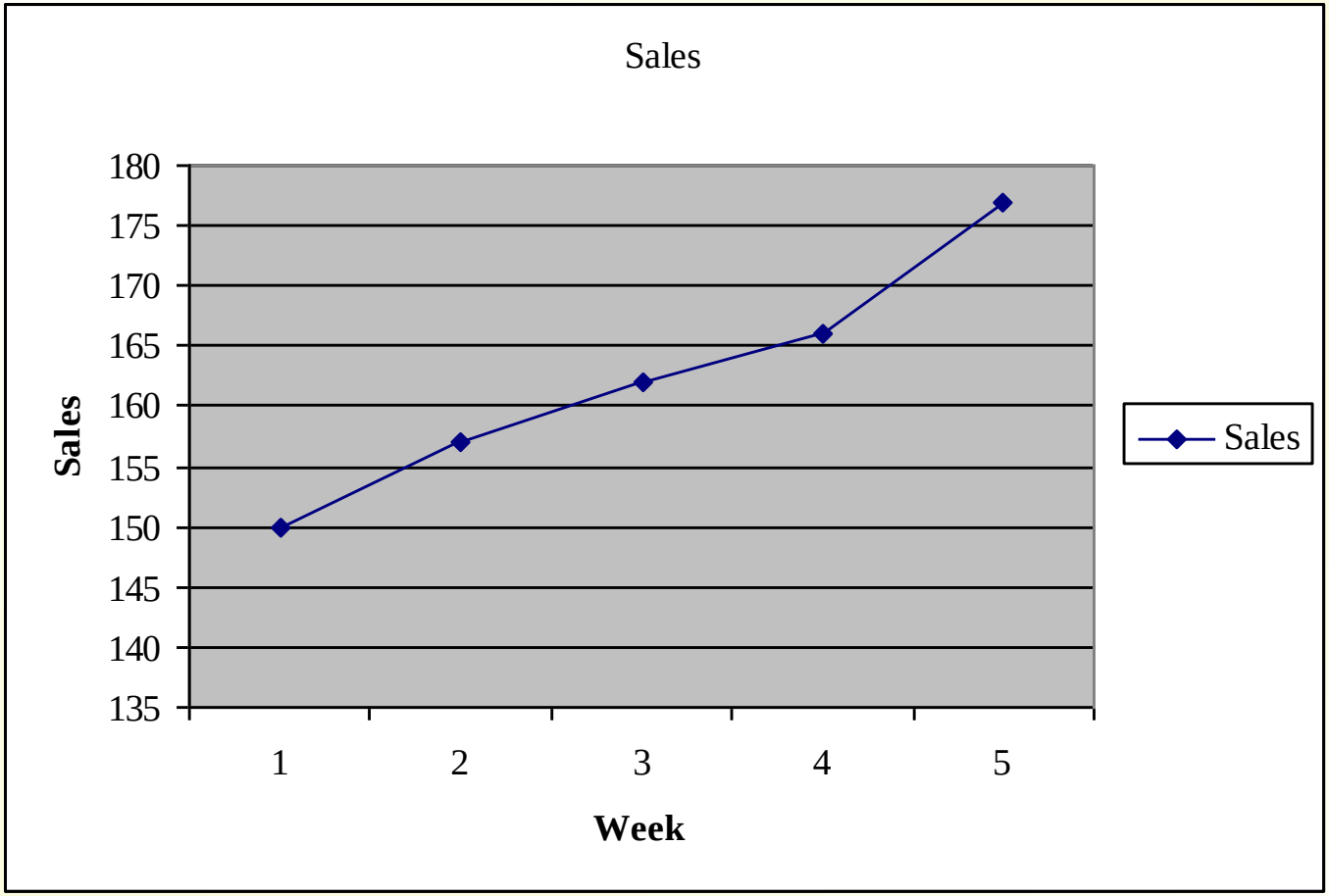
Example

- Sales for over the last 5 weeks are shown below:

Week:	1	2	3	4	5
Sales:	150	157	162	166	177

  - Plot the data and visually check to see if a linear trend line is appropriate.
  - Determine the equation of the trend line
  - Predict sales for weeks 6 and 7.

Line chart


Sales
180
175
170
165
160
155
150
145
140
135
Sales
1
2
3
4
5
Week
Sales

Calculating a and b

$$b = \frac{n\sum(ty) - \sum t \sum y}{n\sum t^2 - (\sum t)^2}$$

$$a = \frac{\sum y - b\sum t}{n}$$

Linear Trend Equation Example

t Week	t^2	y Sales	ty
1	1	150	150
2	4	157	314
3	9	162	486
4	16	166	664
5	25	177	885
$\Sigma t = 15$ $(\Sigma t)^2 = 225$	$\Sigma t^2 = 55$	$\Sigma y = 812$	$\Sigma ty = 2499$

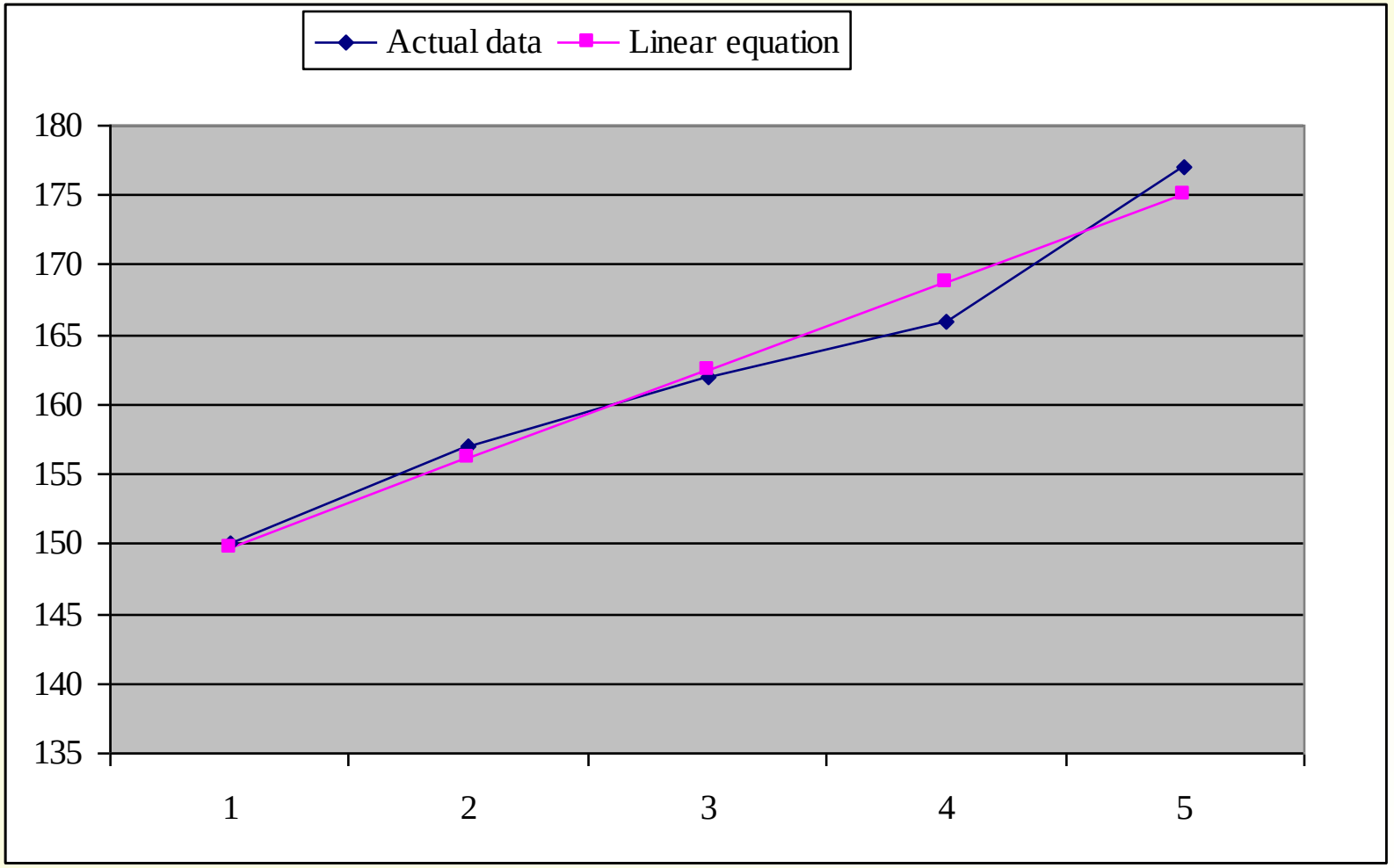
Linear Trend Calculation

$$b = \frac{5\,(2499) - 15(812)}{5(55) - 225} = \frac{12495 - 12180}{275 - 225} = 6.3$$

$$a = \frac{812 - 6.3(15)}{5} = 143.5$$

$$F_t = 143.5 + 6.3t$$

Linear Trend plot



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