Production Management (ME-419)

Guest Speaker

Amin Kaboli

Week 3 – Session 1 – September 26th, 2025

Production Management (ME-419)

Quiz

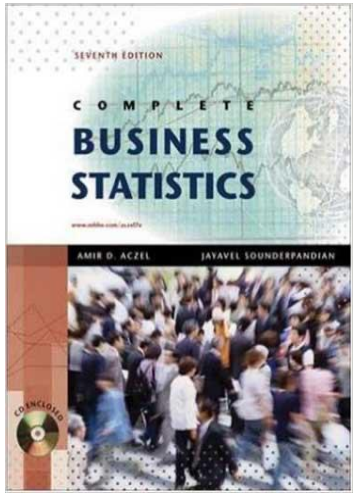
Amin Kaboli

Week 3 – Session 2 – September 26th, 2025

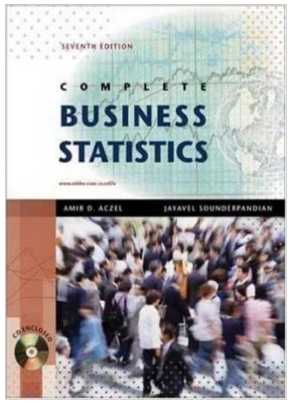
Learning Prerequisites – Required Courses

Required Courses

Probability & Statistics



Learning Prerequisites – Basic Statistics



Chapter 1	Chapter 3	Chapter 4	Chapter 5	Chapter 6	Chapter 10
Descriptive Statistics	Random Variable	Normal Distribution	Sampling & Distribution	Confidence Intervals	Regression & Correlation

Chapters are shared on Moodle

Closed-book exam, consisting of 12–15 multiple-choice questions

Production Management (ME-419)

Demand Management

Forecasting (Step 1& 2)

Amin Kaboli

Week 3 – Session 3 – September 26th, 2025

Course Framework

Business plan
Strategic plan
Financial plan

Production Management (ME-419)

Module 1	Module 2	Module 3	Module 4	
Introduction to PM	Demand Management	Supply Management	Next-Gen Production	Final Presentation
Sep	**Sep-Oct**	**Oct-Nov**	**Dec**	**Dec 17th & 19th**
Value adding network Production process Flows, Bill of materials, Production procedures, Items, value adding activities	Demand disruptions Forecasting Methods Qualitative methods Quantitative methods Demand plan	Supply disruptions Production Planning AP, MPS, MRP Capacity Planning Inventory Management Supply Plan	Latest trends in Production Management Orchestrating supply chain effectively From linear to circular models	Final presentation & solid understanding of the course

Learning Points

3 min

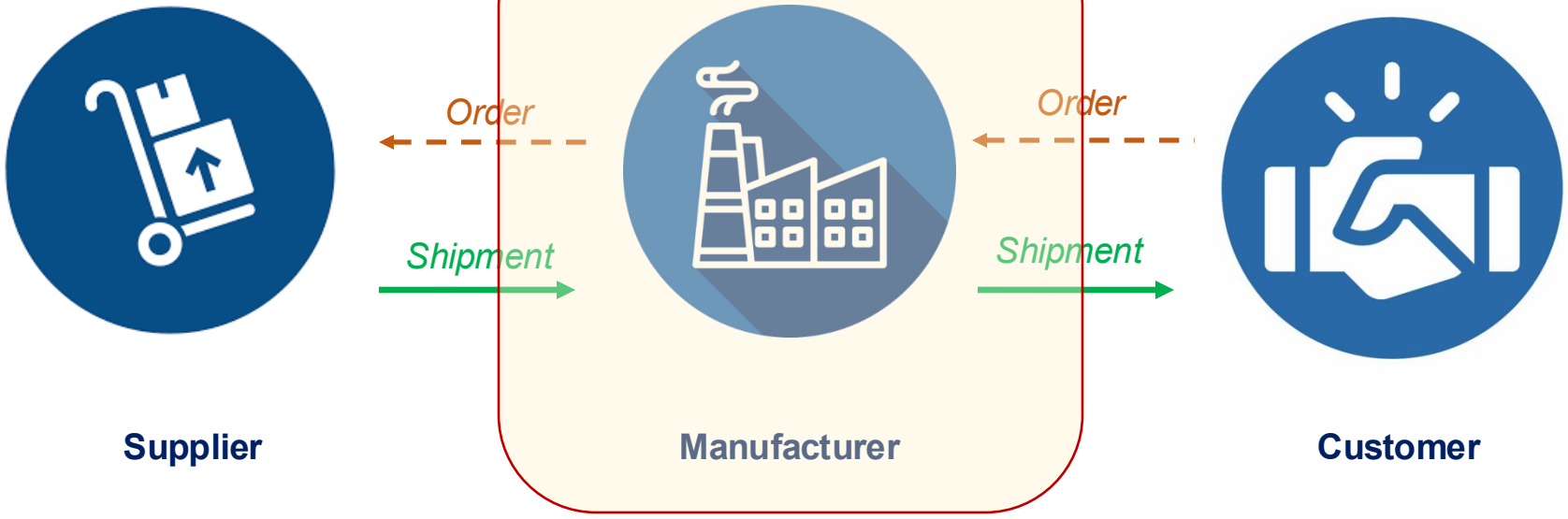
What did you learn the last week?

- Point 1
- Point 2
- Point 3
- …

Material & Information Dynamics & Flows – The Focus of PM

Q2: How to plan production to fulfill future demands?

Q1: How to use historical data to better plan production for future?



Q3: How to buffer stock against demand and supply disruptions?

Reactions to Demand Disruption

Simplified Supply Chain – Disruptions

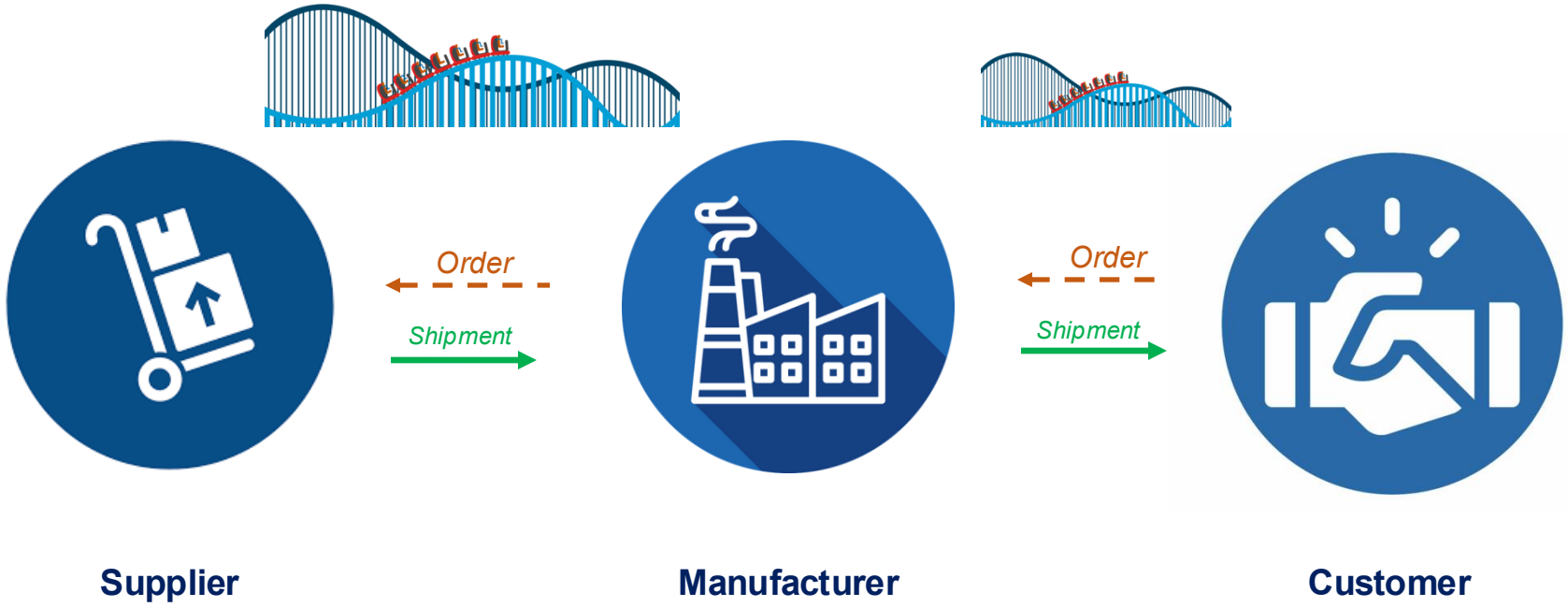
Demand disruption

1. Demand processing (forecast error)
2. Leadtime variability
3. Order batching (lot-sizing)
4. Promotions and forward buying (Price variation)
5. Behavioral reasons

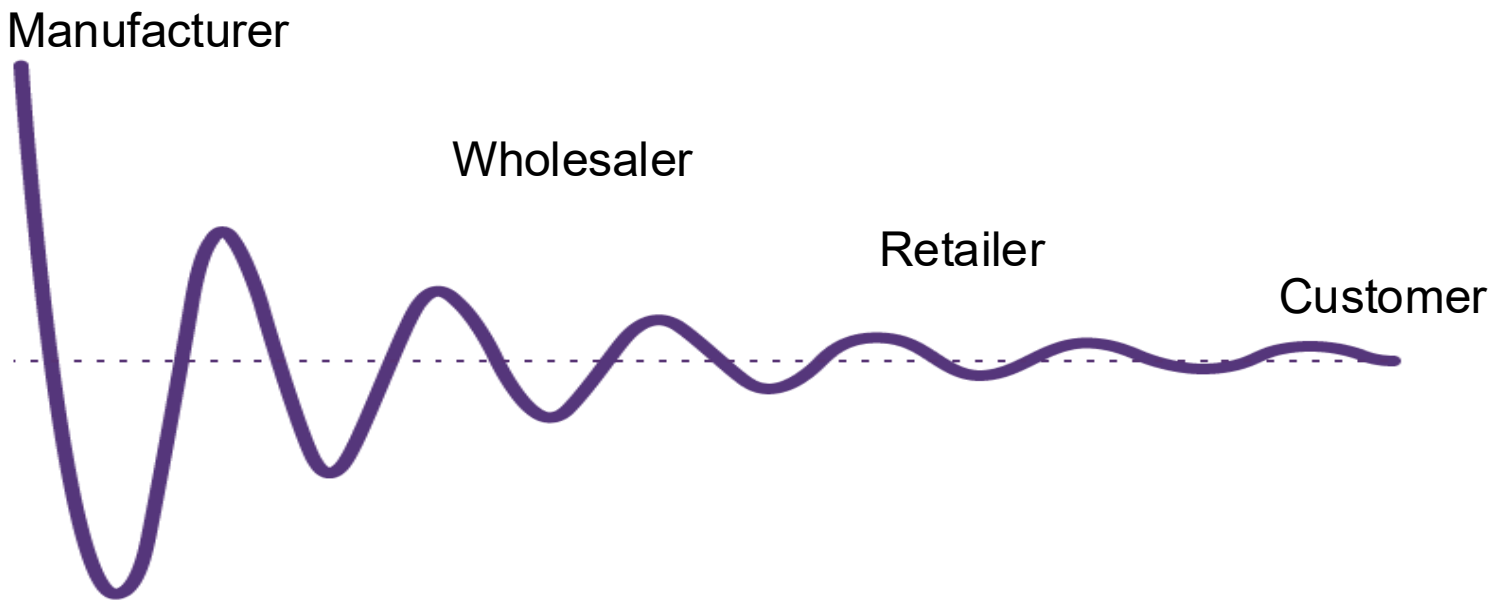
Supply disruption

1. Pandemic
2. Natural disaster
3. Capacity limitation
4. Delivery prioritization
5. Behavioral reasons

Demand Disruption – Order Variability & Amplification

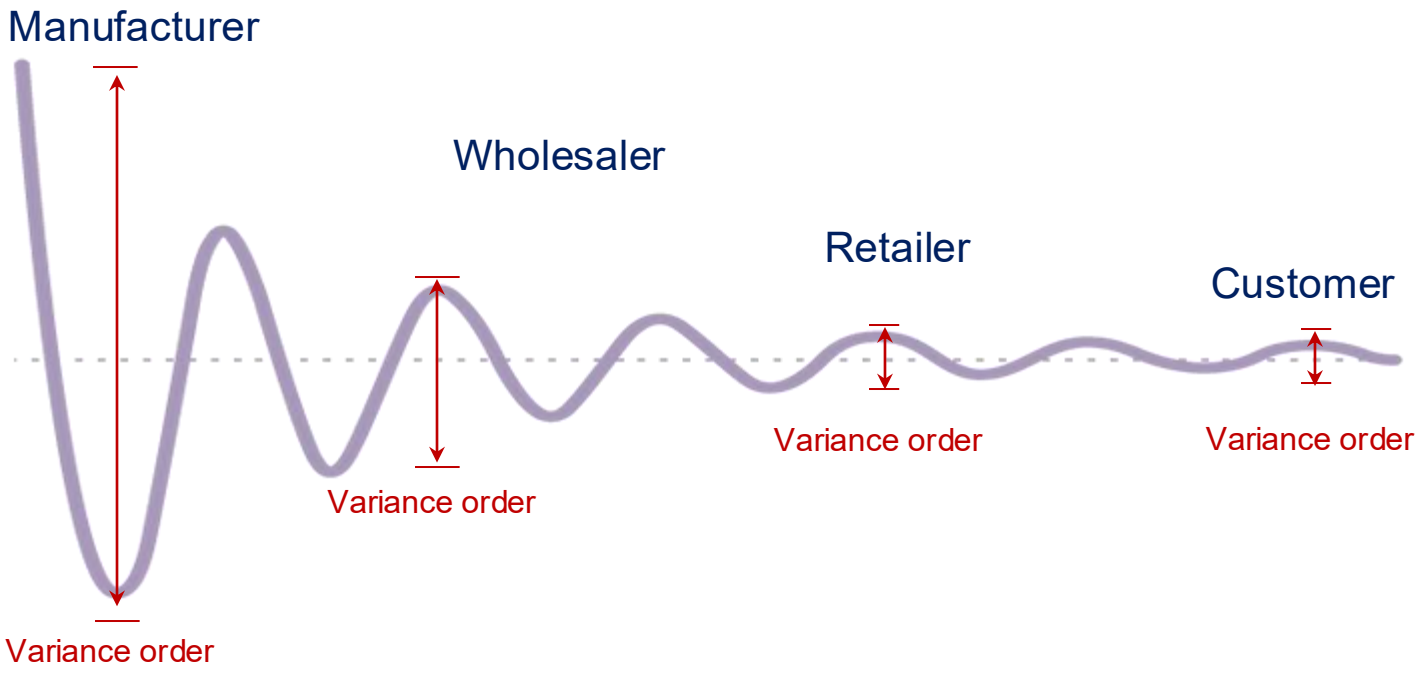


Bullwhip Effect



Bullwhip effect: The demand variabilities (amplification and oscillation) along the supply chain.

Measuring Bullwhip Effect



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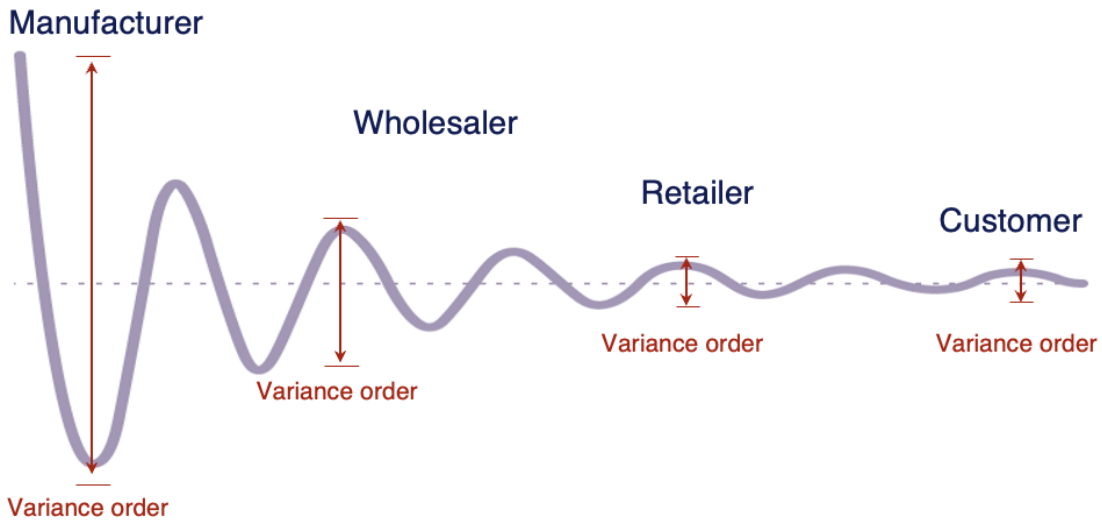


1. Bullwhip Effect Formula for Each Echelon

For each stage in the supply chain, the **bullwhip effect (BWE)** is calculated as:

$$BWE_i = \frac{\text{Variance of Orders Received at Echelon } i}{\text{Variance of Orders Sent to Next Echelon } (i+1)}$$

Where:

- i represents an echelon (e.g., Manufacturer, Wholesaler, Retailer).
- A **higher BWE value** means greater demand amplification at that echelon.

2. Bullwhip Effect Formula for the Whole Supply Chain

To measure the **overall bullwhip effect** across the entire supply chain (from the customer to the manufacturer), we compare the **order variance at the manufacturer** with the **demand variance at the customer**:

$$BWE_{\text{Total}} = \frac{\text{Variance of Orders Received by Manufacturer}}{\text{Variance of Customer Demand}}$$

Where:

- **Numerator:** Captures the variance at the manufacturer (which is the most volatile in the chain).
- **Denominator:** Represents the demand variance at the customer (which is the source of the orders).

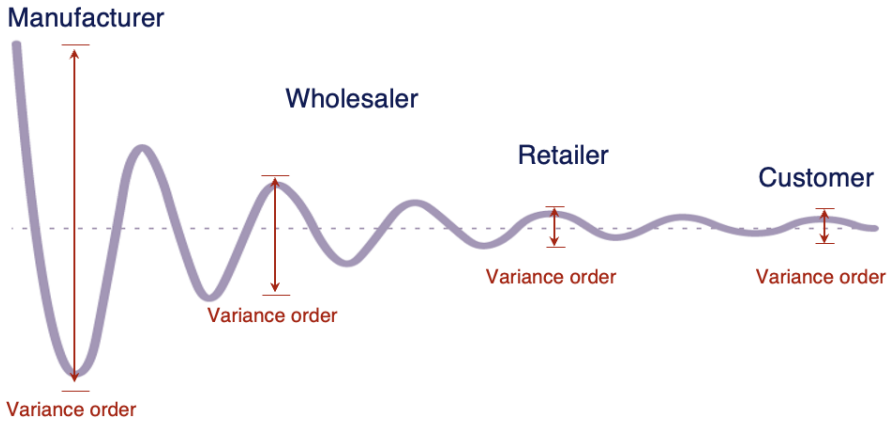
3. Alternative Approach: Multiplicative Form Across Echelons

Since the bullwhip effect accumulates across multiple echelons, we can also express it as:

$$BWE_{\text{Total}} = BWE_{\text{Wholesaler}} \times BWE_{\text{Retailer}} \times BWE_{\text{Manufacturer}}$$

This approach assumes each echelon amplifies the variance, and the total effect is the product of individual echelons' bullwhip ratios.

Demand Disruption – Causes of Bullwhip Effect



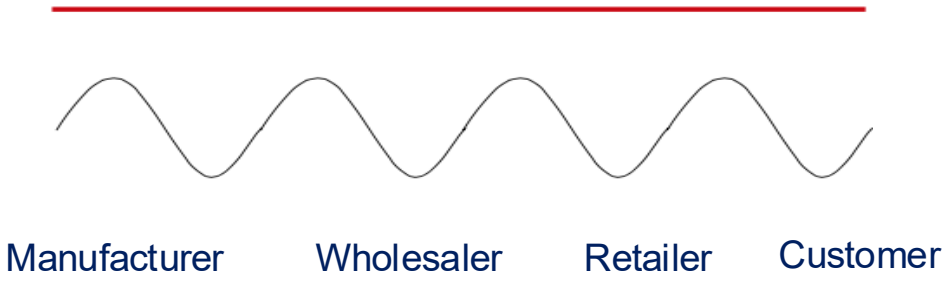
Operational Reasons

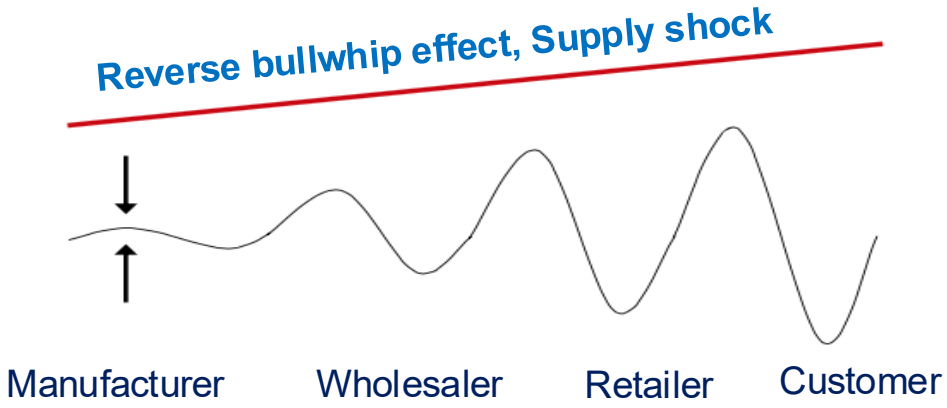
- Demand processing (forecast errors)
- Leadtime variability
- Lot-sizing
- Promotions and forward buying

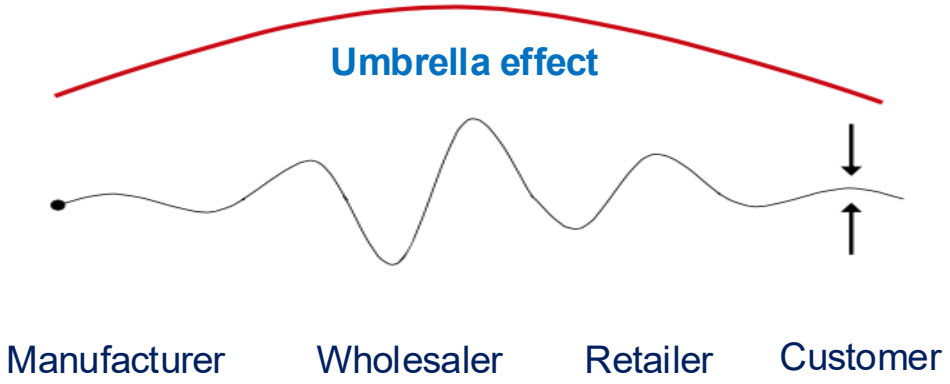
Behavioral Reasons

- Trust
- Mis-perceptions of feedback and time lags
- Panic ordering after unmet demand
- Perceived risk of bounded rationality of others

Bullwhip Effect – Types





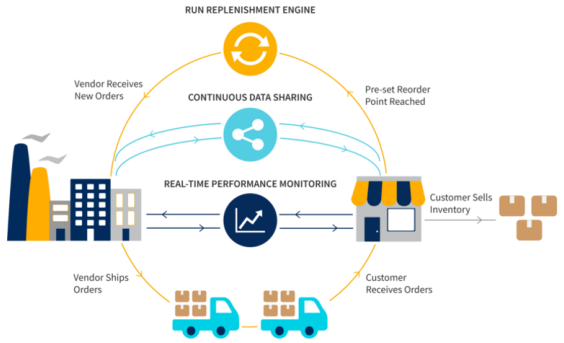


Bullwhip Effect – How to Tame it

Prediction (demand forecasting) & Information sharing

Just in Time (JIT)

…



Vendor Managed Inventory (VMI)

Avoiding price games

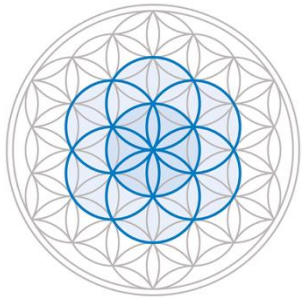
Prediction – A Response to Change

Prediction: statement about the future event

Non-Scientific (Prophecy)

Astrology

Numerology

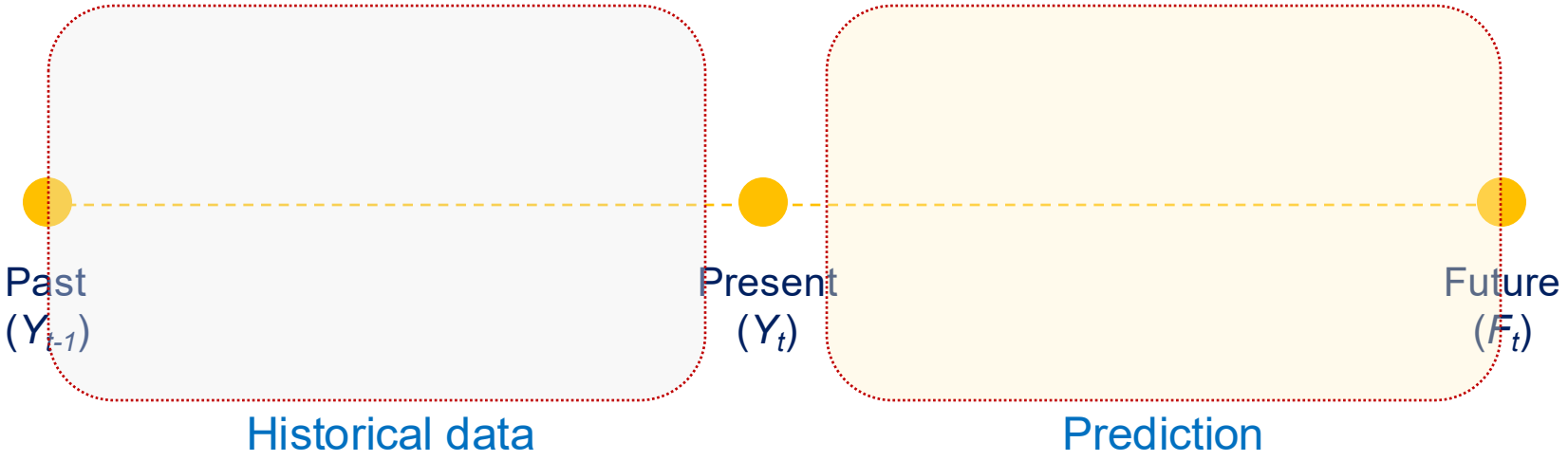


Symbols

Scientific

Facts/Data-Driven

Prediction – Data-Driven



Assumption: The future will be the same as the past!

- F_t : demand forecast for period *t*
- Y_t : actual demand for period *t*

Prediction – Other Scientific Equivalent

Forecasting

Estimation

Prediction, Forecasting, Estimation – Some Implications

Weather

Finance

Travel

Retail

Production

2 min

What are the best ways to tackle market demand?

Demand Management – Forecasting Steps

Demand forecast at the item and aggregate levels

Goal: What is the purpose of the forecast (Type of products, Granularity, Horizon)

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Method: Select a forecasting method (Qualitative *vs* Quantitative)

Forecast: Make the forecast

Performance: Monitor the forecast errors

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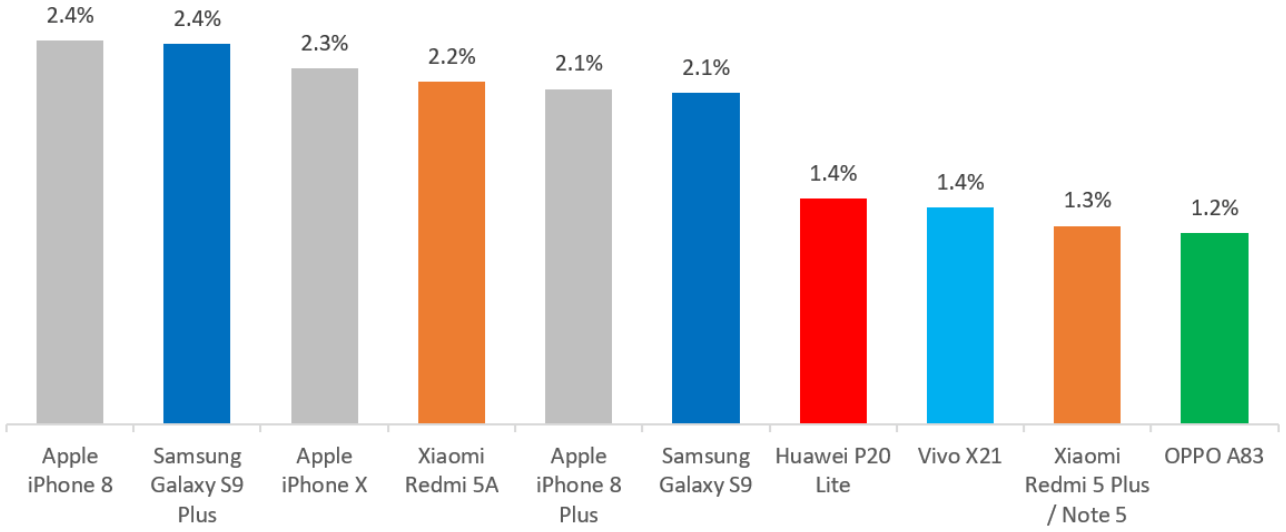
Demand Forecast – Step 1: Goal (Product)

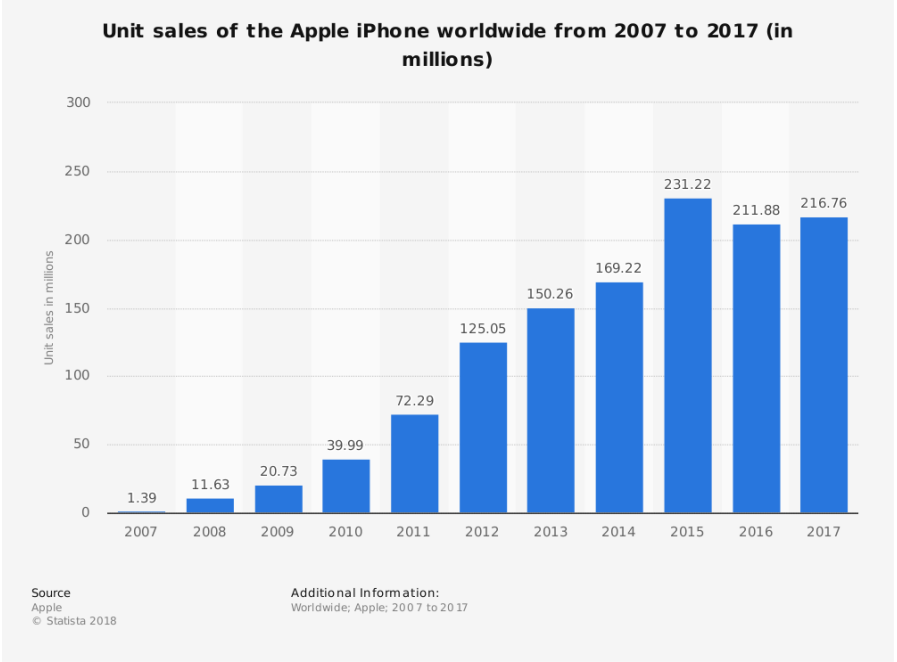
Current Product
Phase In/Out?
Limited Edition?
…

New Product Launch?
Limited Edition?
Prototype?
…

Demand Forecast – Step 1: Goal (Granularity)

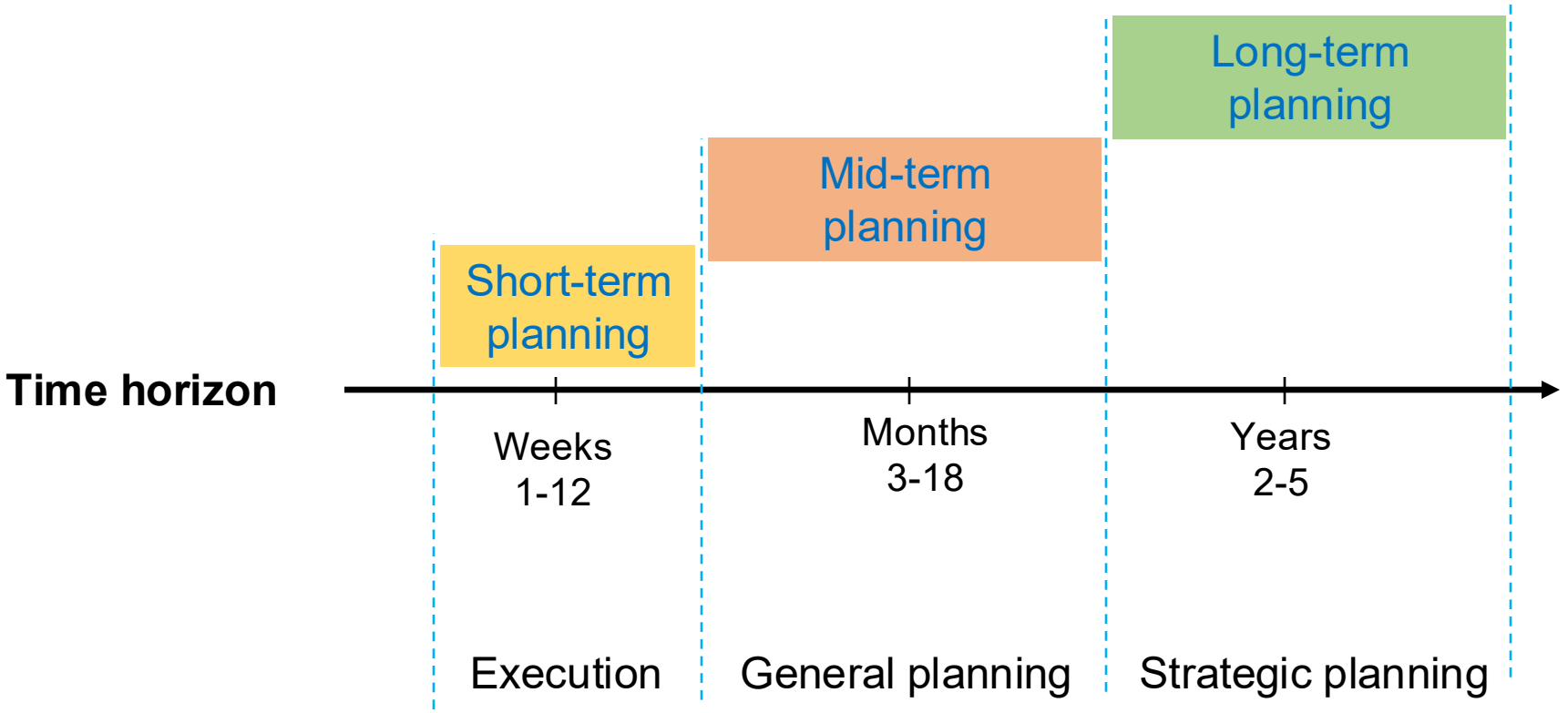


Product level



Product Family level (Aggregated)

Demand Forecast – Step 1: Goal (Time Horizon)



Demand Management – Forecasting Steps

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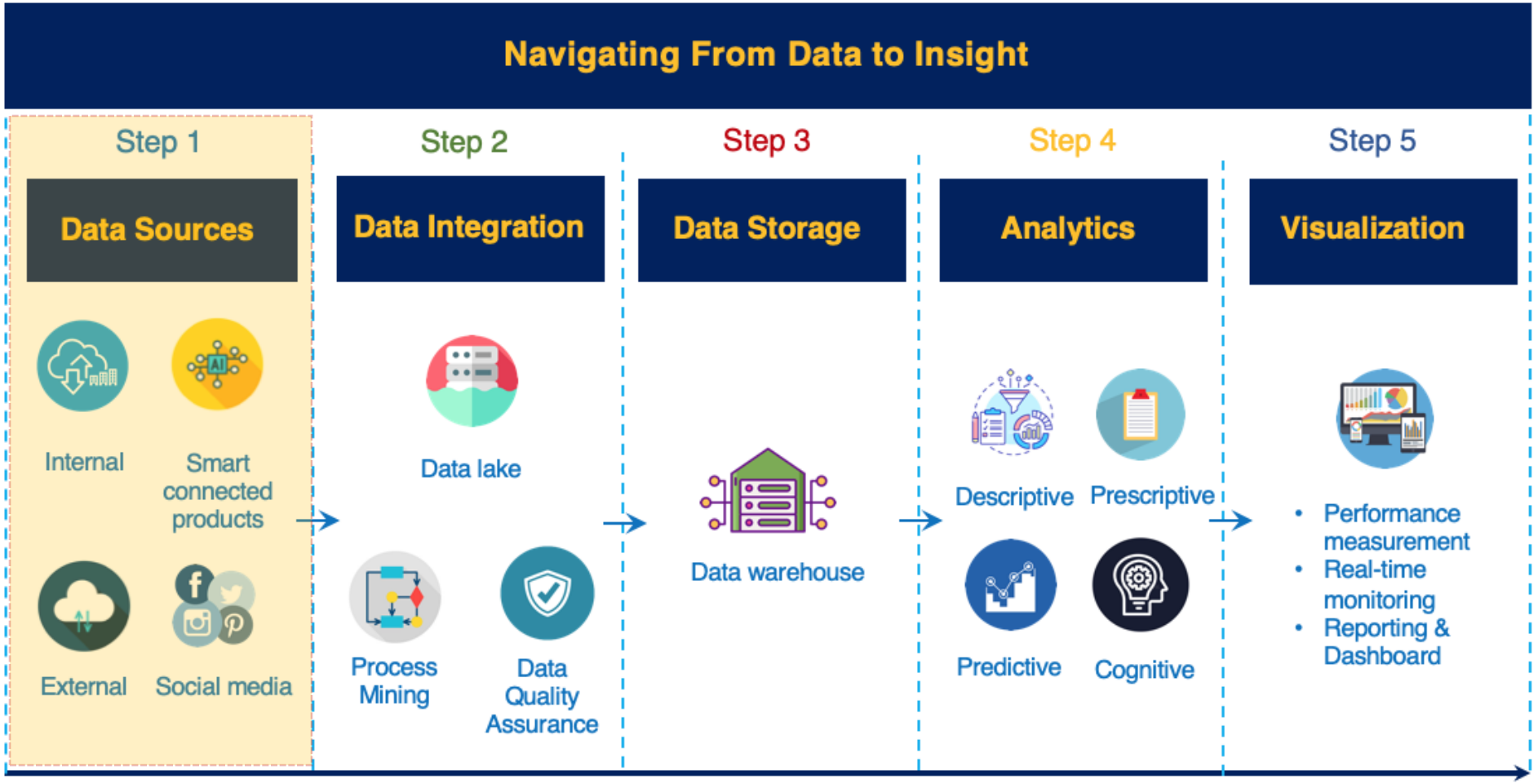
Reminder: The Journey



Data Sources

	Data Category	Data Type	Data Sources	Data Structure	Data Quality	Data Ownership
1.	Internal	Sales, demands, shipments, SKUs, BOMs, Product families, ...	ERP, SAP, PLM, POS, ...	Structured	Medium	Private
2.	Smart Connected Products	Location, conditions, usage, ...	Smart connected devices (Sensors, RFID scanners, cameras, ...)	Structured/ Semi-Structured	High	Private
3.	Social Media	Likes, comments, shares, engagements, audience demographic info, ...	Twitter, Meta, LinkedIn, ...	Unstructured	Low	Public/ Private
4.	External	Governmental policies (tax, tariff, incentive), Geopolitical data, Risks, Climate, Unemployment, Inflation, Sustainability scores, ...	Various sources (IMF, World bank, Governments, European Union, ...)	Structured	Low/ Medium	Public/ Private

Demand Forecast – Step 2: Data

1			3			5			7			9			11			21			23		
	1	64		41	171		81	86		121	98		161	96		201	151		401	131		441	216
	2	62		42	168		82	81		122	99		162	88		202	134		402	162		442	202
	3	64		43	126		83	91		123	118		163	81		203	174		403	169		443	235
	4	88		44	134		84	111		124	96		164	103		204	183		404	164		444	192
	5	72		45	153		85	97		125	99		165	108		205	146		405	157		445	204
	6	86		46	178		86	103		126	112		166	90		206	160		406	168		446	208
	7	71		47	165		87	110		127	87		167	85		207	159		407	170		447	188
	8	95		48	176		88	107		128	85		168	115		208	140		408	144		448	266
	9	106		49	166		89	111		129	119		169	111		209	149		409	153		449	257
	10	78		50	163		90	114		130	100		170	85		210	143		410	140		450	197
	11	104		51	225		91	85		131	86		171	84		211	174		411	147		451	241
	12	103		52	186		92	99		132	107		172	105		212	159		412	135		452	237
	13	4850		53	211		93	117		133	102		173	103		213	123		413	153		453	257
	14	114		54	230		94	84		134	95		174	98		214	131		414	160		454	244
	15	109		55	215		95	94		135	113		175	116		215	129		415	135		455	223
	16	89		56	208		96	117		136	98		176	93		216	163		416	171		456	197
	17	86		57	209		97	105		137	99		177	113		217	179		417	165		457	203
	18	88		58	199		98	106		138	117		178	118		218	166		418	143		458	189
	19	94		59	202		99	118		139	86		179	93		219	169		419	157		459	242
	20	96		60	141		100	114		140	88		180	101		220	153		420	172		460	218
2	21	95	4	61	132	6	101	87	8	141	109	10	181	93	12	221	151	22	421	185	24	461	196
	22	88		62	124		102	117		142	105		182	105		222	145		422	179		462	195
	23	117		63	93		103	81		143	97		183	105		223	115		423	151		463	209
	24	123		64	108		104	85		144	113		184	107		224	106		424	176		464	202
	25	83		65	109		105	90		145	11		185	143		225	134		425	190		465	146
	26	88		66	113		106	110		146	83		186	146		226	123		426	213		466	177
	27	110		67	98		107	108		147	110		187	138		227	86		427	170		467	152
	28	109		68	115		108	119		148	112		188	139		228	122		428	191		468	170
	29	117		69	90		109	88		149	84		189	120		229	107		429	197		469	146
	30	111		70	112		110	81		150	94		190	141		230	99		430	239		470	128
	31	93		71	117		111	86		151	96		191	168		231	102		431	206		471	130
	32	107		72	107		112	108		152	103		192	176		232	81		432	217		472	161
	33	122		73	91		113	114		153	102		193	166		233	77		433	235		473	130
	34	116		74	105		114	92		154	96		194	149		234	96		434	214		474	146
	35	108		75	86		115	118		155	89		195	158		235	81		435	269		475	123
	36	124		76	106		116	106		156	95		196	136		236	94		436	215		476	117
	37	144		77	104		117	84		157	85		197	175		237	66		437	209		477	107
	38	127		78	101		118	83		158	105		198	183		238	90		438	269		478	127
	39	137		79	118		119	95		159	111		199	168		239	81		439	193		479	126
	40	129		80	113		120	104		160	103		200	138		240	85		440	231		480	108

Demand Forecast – Step 2: Data (Graphical Observation)

1	64	41	171	81	86	121	98	161	96	201	151	401	131	441	216
2	62	42	168	82	81	122	99	162	88	202	134	402	162	442	202
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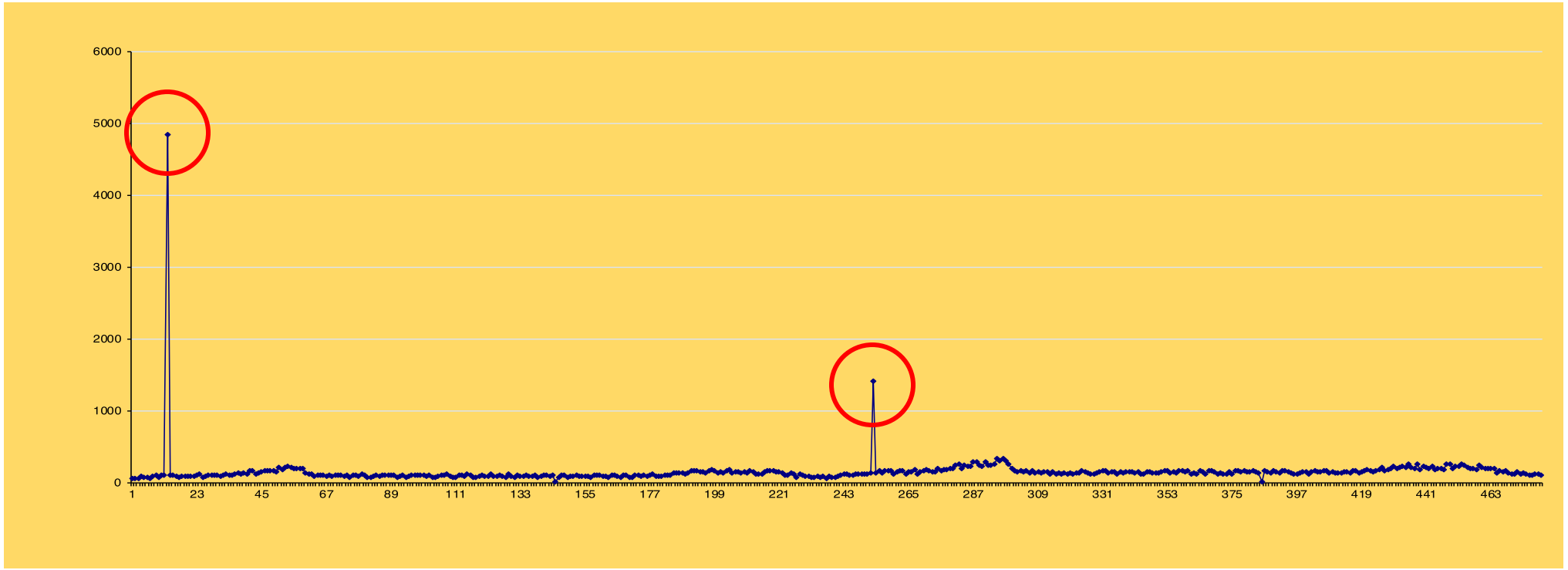
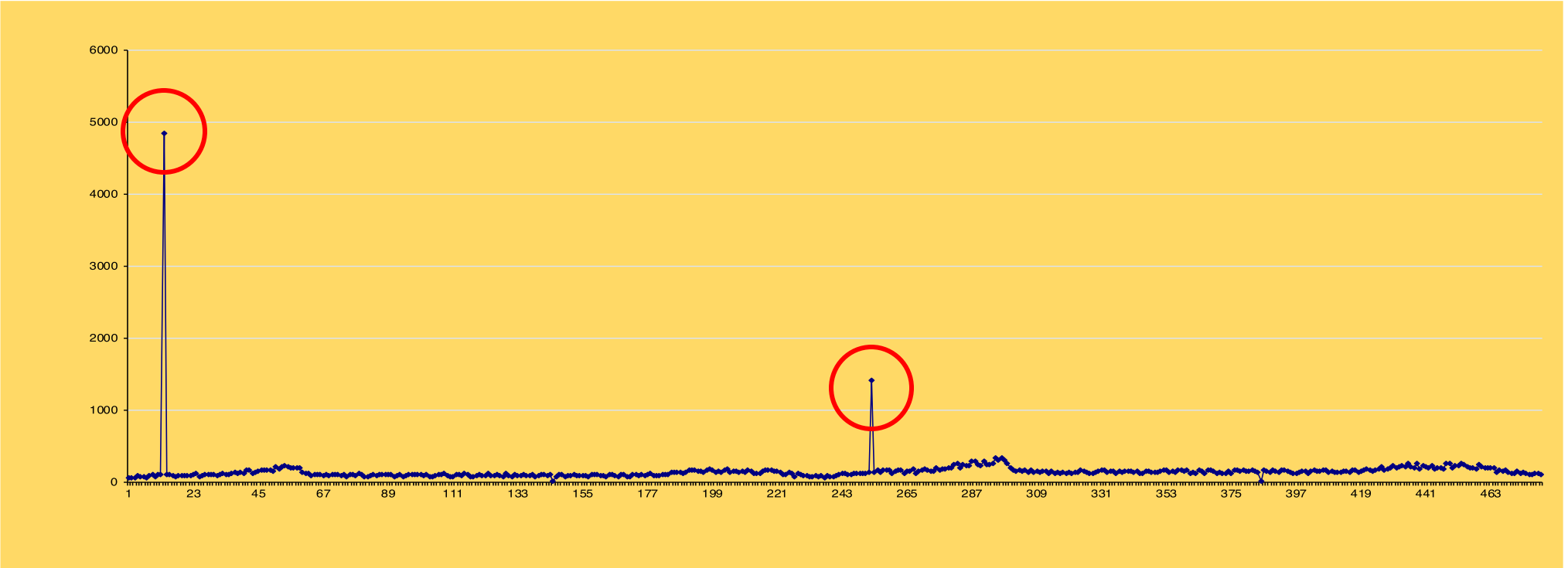


Demand Forecast – Step 2: Data (Finding Outliers)



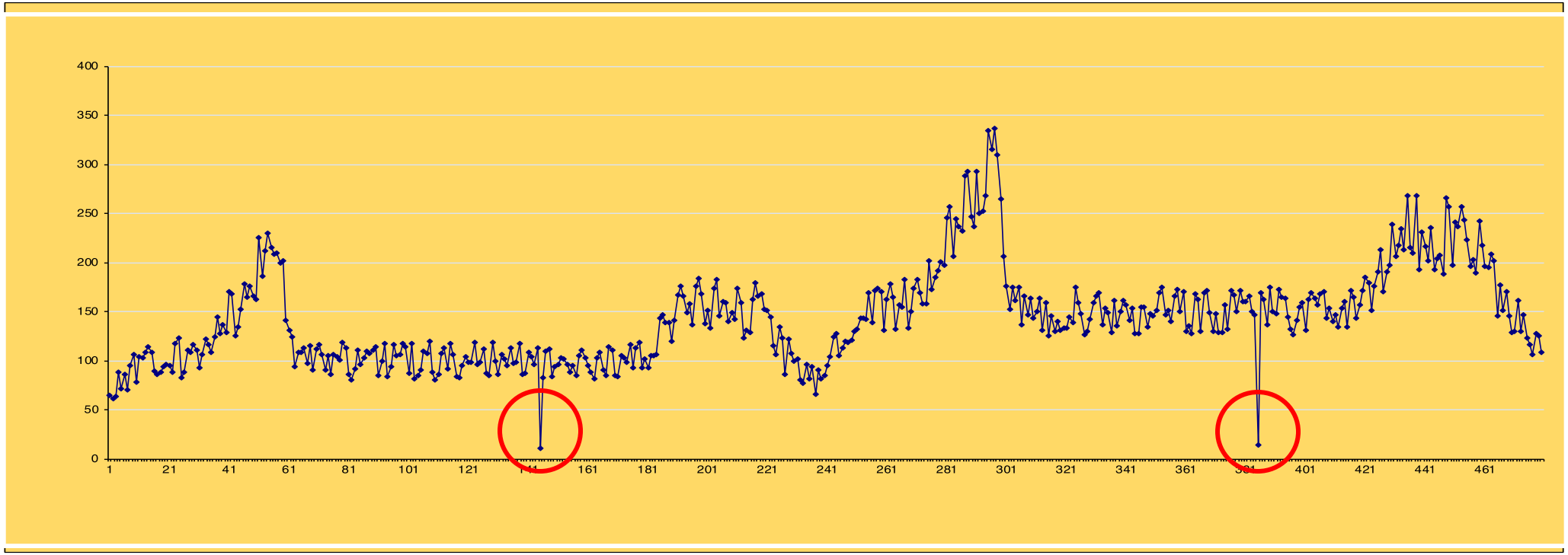
Test for extreme values (outliers) using $IC = \bar{Y} \pm 1.96\sigma_Y$

Mean = 156
Std. Dev. = 228
IC sup. = 602

Test extreme values:
Value 1 (d = 13) = 4850 → abnormal
Value 2 (d = 253) = 1417 → abnormal

Replace extreme values:
Value 1* (d = 13) = 109
Value 2* (d = 253) = 143

Demand Forecast – Step 2: Data (Finding Outliers)



Test for extreme values (outliers) using $IC = \bar{Y} \pm 1.96\sigma_Y$

Mean = 143
Std. Dev. = 48
IC inf. = 49

Test extreme values:
Value 1 (d = 145) = 11 → abnormal
Value 2 (d = 385) = 15 → abnormal

Replace extreme values:
Value 1* (d = 145) = 98
Value 2* (d = 253) = 158

Demand Management – Forecasting Steps

Demand forecast at the item and aggregate levels

Goal: What is the purpose of the forecast (Type of products, Granularity, Horizon)

Data: Obtain, clean, and analyze appropriate data

Method: Select a forecasting method (Qualitative *vs* Quantitative)

Forecast: Make the forecast

Performance: Monitor the forecast errors

Demand Management – Step 3: Forecasting Methods

Forecasting Methods

Qualitative methods

Executive opinions

Salesforce opinions

Customer surveys

Delphi method

Quantitative methods

Causal models

Time series

Machine Learning

Demand Management – Forecasting Steps

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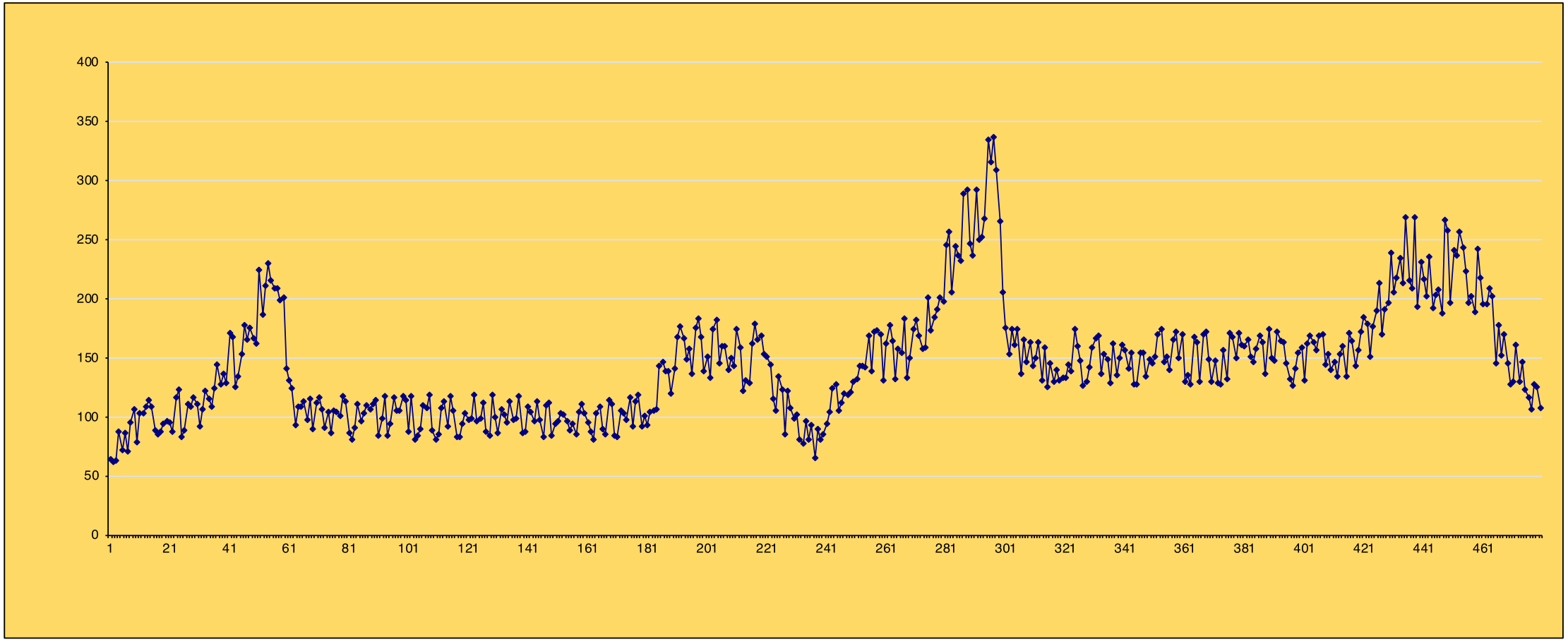
Demand Forecast – Step 4: Forecast



Demand Management – Forecasting Steps

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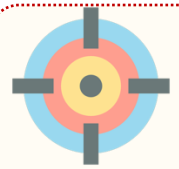
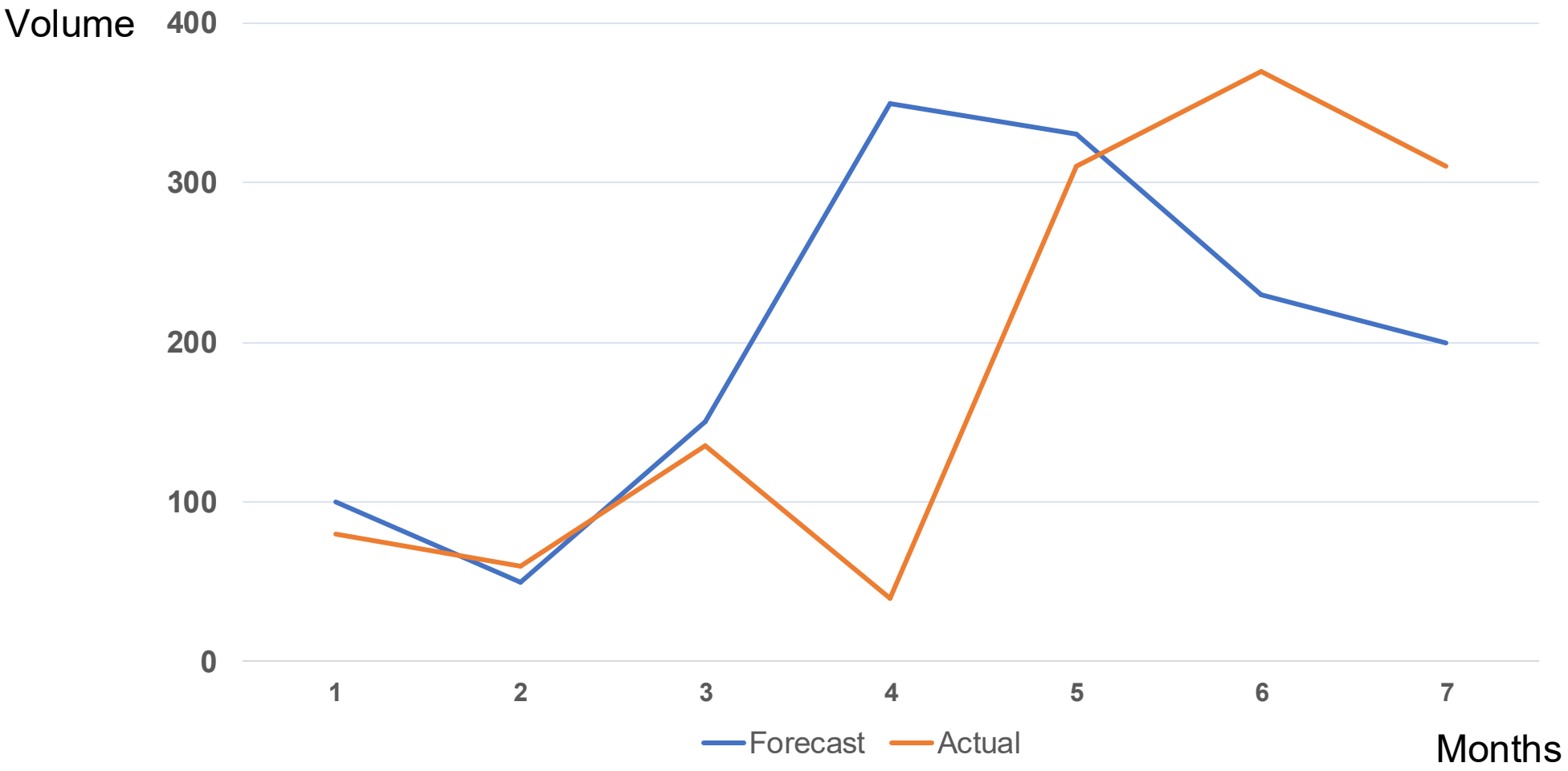
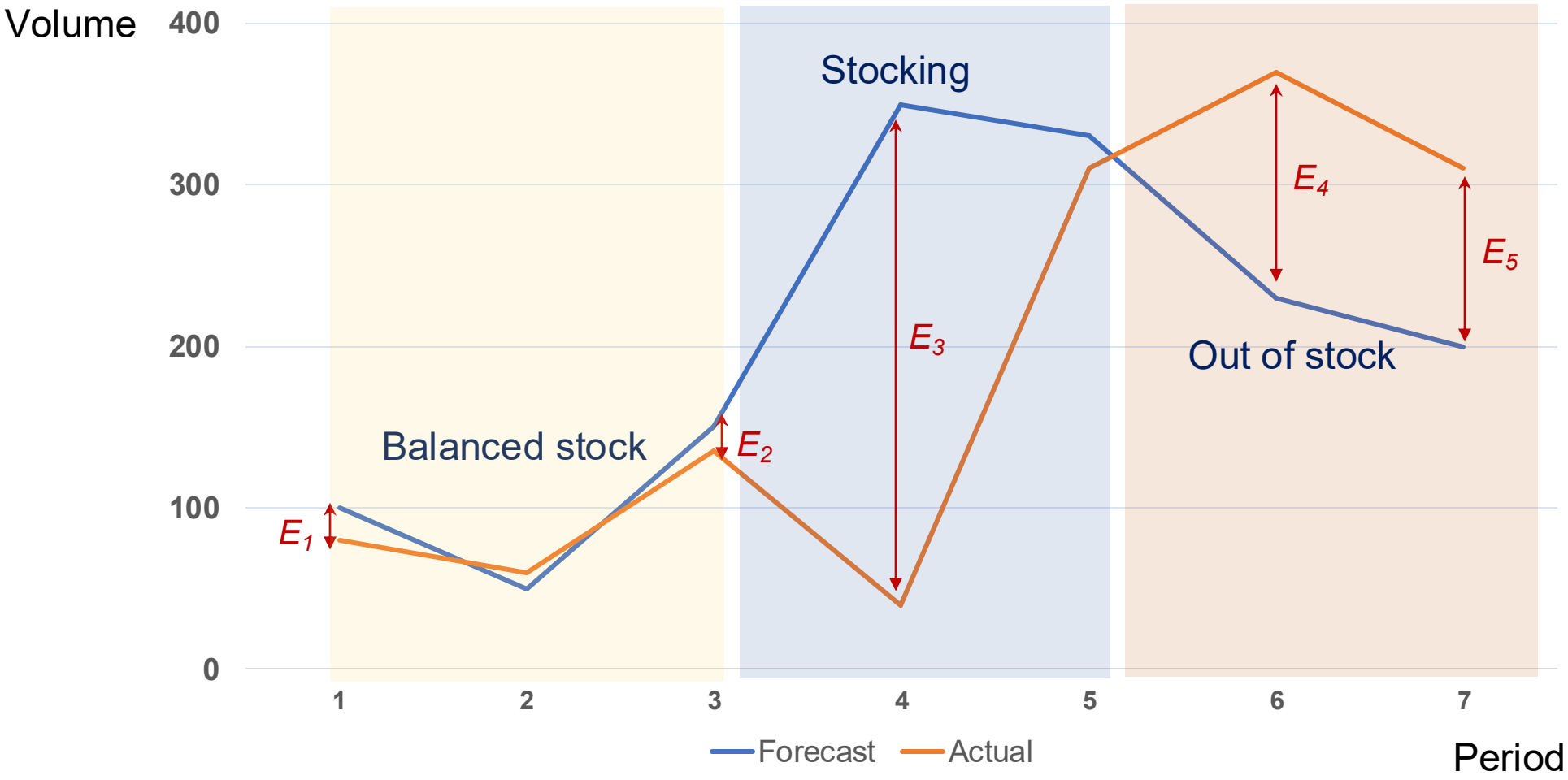


Performance: Monitor the forecast errors

Demand Forecast – Step 5: Performance



Demand Forecast – Step 5: Performance



Assignment 3 – Tasks

1) Align on the goal of forecasting within your group

2) Obtain data (from Moodle) – Your dataset is shipment or sales data

3) Draw graphs of the historical gross shipment/sales data

4) Clean the historical shipment/sales data comprising:

- Abnormal observed values
- Historical delivery data after cleaning

5) Aggregation of the cleaned shipment/sales data according to the most appropriated reference planning period for the considered enterprise (day, week, month, quarter …)

6) Aggregation of the cleaned historical shipment/sales data per reference planning period and per product family

Production Management (ME-419)

Coaching Rooms

Amin Kaboli

Week 3 – Session 4 – September 26th, 2025

Meet Your Coaches & Group Members

Coaches

Seung

CM1100

Maria

CM1106

Lucie

CM1104

The Art of Giving and Receiving Effective Feedback

Feedback is a gift

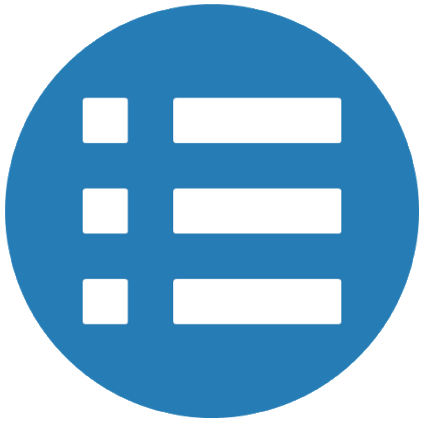
Feedback/comments are always welcome

Giving Effective Feedback

Respectful

Ask for permission

May I share my observation



Fact-based

Share facts/ your feelings

What I observed/felt is that …

Constructive

Stay focused on growth

What I suggest is that …

Concise

Be to-the-point and short

Max three key points

Open

Be open to any reaction

I respect your feeling …

Receiving Effective Feedback

Receive the gift

Be open and receptive

I appreciate your feedback

Listen

Listen to listen!

The goal is to listen not to answer, no interruption (zip it)

Understand

Focus on THE message

The goal is to understand, ask questions, clarify, repeat key points, …

Decide

You always have a choice

Thank you, I have never seen it this way

OR

Thank you, let me reflect and get back to you?

Follow up

Reach a common understanding

There are many ways to follow up: revise the work, set up a meeting, …