Build4 Scale
U.S. Department of Energy

Communication, Selection, and Negotiation

Module 5C Distribution Plan

Motivation

Why is this module important?

- Predicting demand is always associated with errors (there is a need to quantify these errors and account for them in decision making)
- Results of reducing lead time through lead-time management:
  - —Increased productivity and employee effectiveness
  - —Increased profit margins of products or services through lowering costs of production and inventory
  - —Meeting changing customer needs
- Predicting demand is an effective tool to be responsive and reduce lead time

Module Outline

- Learning objectives
- Lead-time management
  - —Shipping-method selection
  - —Make-to-order versus make-to-stock versus make-to-forecast
- Forecasting
  - —Subjective and objective forecasting methods
  - —Forecast errors
  - —Causal methods of forecasting
  - —Time series forecasting
  - —Demand patterns

Learning Objectives

- LO1. Assess alternative **forecasting** methods
- LO2. Understand the roles of manufacturing resource planning (MRP-2) and enterprise resource planning (ERP) systems in distribution

What This Module Addresses

- The importance of managing and reducing lead time
- Main criteria in selecting a **third-party logistics** (3PL) provider
- Different production strategies (**make-to-order**, **make-to-stock**, or **make-to-forecast**)
- Forecasting methods, classifications, and forecast errors

Lead Time

Basics

- A **lead time** is the latency between the initiation and execution of a process
- There are many lead times to consider in the supply chain

Examples: manufacturing lead time, order preparation lead time, set-up lead time, inspection lead time, release of order lead time, receipt of goods lead time etc.

A couple lead times are common to all companies:

- Purchase lead time is the total time from placing an order with the supplier until the ordered goods are received internally
- Payment lead time is the total time from when the order is received internally until payment is received from the customer

Lead Time

Why manage it?

Lead-time management is critical to achieving lead-time reduction because:

- **Value for money** (VFM) to customers is inversely proportional to lead time
- Customer satisfaction is the result of increased VFM and reduced lead time
- More customer satisfaction means more new customers, more retained customers, more orders, and more profit
- Ideal situation: zero lead time. This means that the product should be available to the customer off-the-shelf (although it may seem theoretical, customers have good reasons to ask for it)

Less lead time = More Value for Money for your customers

Lead Time

Why manage it? (cont.)

Lead time exists in different forms for different business processes, such as:

- Time-to-market (from conceptualization to customer delivery)
- Product-development lead time
- Material-procurement lead time
- Recruitment lead time
- Sales order processing lead time
- Decision-making lead time
- Project approval lead time

Lead-Time Management

What it is and how it works

- A process that involves taking actions to achieve lead-time reduction

Involves multiple actions:

- Decreasing the key activity times throughout the company's value chain
- Using data analysis and optimization techniques to:
  - —Minimize waiting time
  - —Eliminate activities that do not add value
  - —Increase parallel processes
  - —Speed up decision making in an organization
- Decreasing processes' running times

Lead-Time Management

What it is and how it works (cont.)

If the focus is on reducing lead time to clients in order to maintain high service levels and customer satisfaction, two important aspects must be considered:

- Selecting shipping method; often known as selecting a **third-party logistics** (3PL) provider
- Considering make-to-order versus make-to-stock
  - —Should we only produce when we receive an order, or should we anticipate demand and produce in advance?

There is no unified standard technique for lead-time reduction

Third-Party Logistics Provider

Basics

- A 3PL provider is selected as a partner to a company that outsources warehousing, distribution, and shipping tasks

Third-Party Logistics Provider

Selection criteria

Cost:

- What cost savings does the 3PL provider offer?
- Are the 3PL provider's costs competitive?

Reliability:

- What is the 3PL provider's track record?
- What are my company's guarantees?

Responsiveness:

- Will my orders be shipped using my current order processing standards?
- What happens when things go wrong?

Third-Party Logistics Provider

Selection criteria (cont.)

Information Technology (IT):

- What **warehouse management system** (WMS) does the 3PL provider use?
- How will this WMS system interface with my company's ERP system?

Relationship Management:

- Can my company have representatives on the 3PL provider's site?
- How will the 3PL provider interact with my customers?

Environmental Awareness:

- What is being done to create more environmentally friendly processes and workplaces?

Third-Party Logistics Provider

Selection criteria (cont.)

Financial Security:

- How financially stable is the 3PL provider's company?
- What happens if the 3PL provider goes out of business?

Locations:

- Is the 3PL provider in the correct location(s) to serve my company's customer base?

Global Presence:

- Does the 3PL provider have a global presence?

Production Strategies

Basics

Three common production strategies:

- **Make-to-order**: trigger production only upon receipt of a customer's order
- **Make-to-stock**: produce without waiting for a customer order and store in stock or warehouse
- **Make-to-forecast**: produce in anticipation to demand forecast

Note: more about on-demand forecasting later in this module

Production Strategies

Which strategy to use?

Use make-to-order when:

- ☐ The product cannot be inventoried
- ☐ The product is highly customized
- ☐ Prices are declining
- ☐ Customers will wait or the process is fast

Use make-to-forecast when:

- ☐ Customers won't wait or the process is long
- ☐ Capacity is constrained
- ☐ Product is perishable

Use make-to-stock when:

- ☐ Products are standard and do not involve much customization
- ☐ Product requires significant set-up time or capital investment

Forecasting

Basics

- **Forecasting**: the prediction of future events

Example: customer demand for a product or a number of failures of a certain machine

Forecasting

General rules

- Forecasts are typically wrong
- Forecasts are not a single number; need some associated measure of forecast error
- Short-term forecasts are more accurate than long-term forecasts

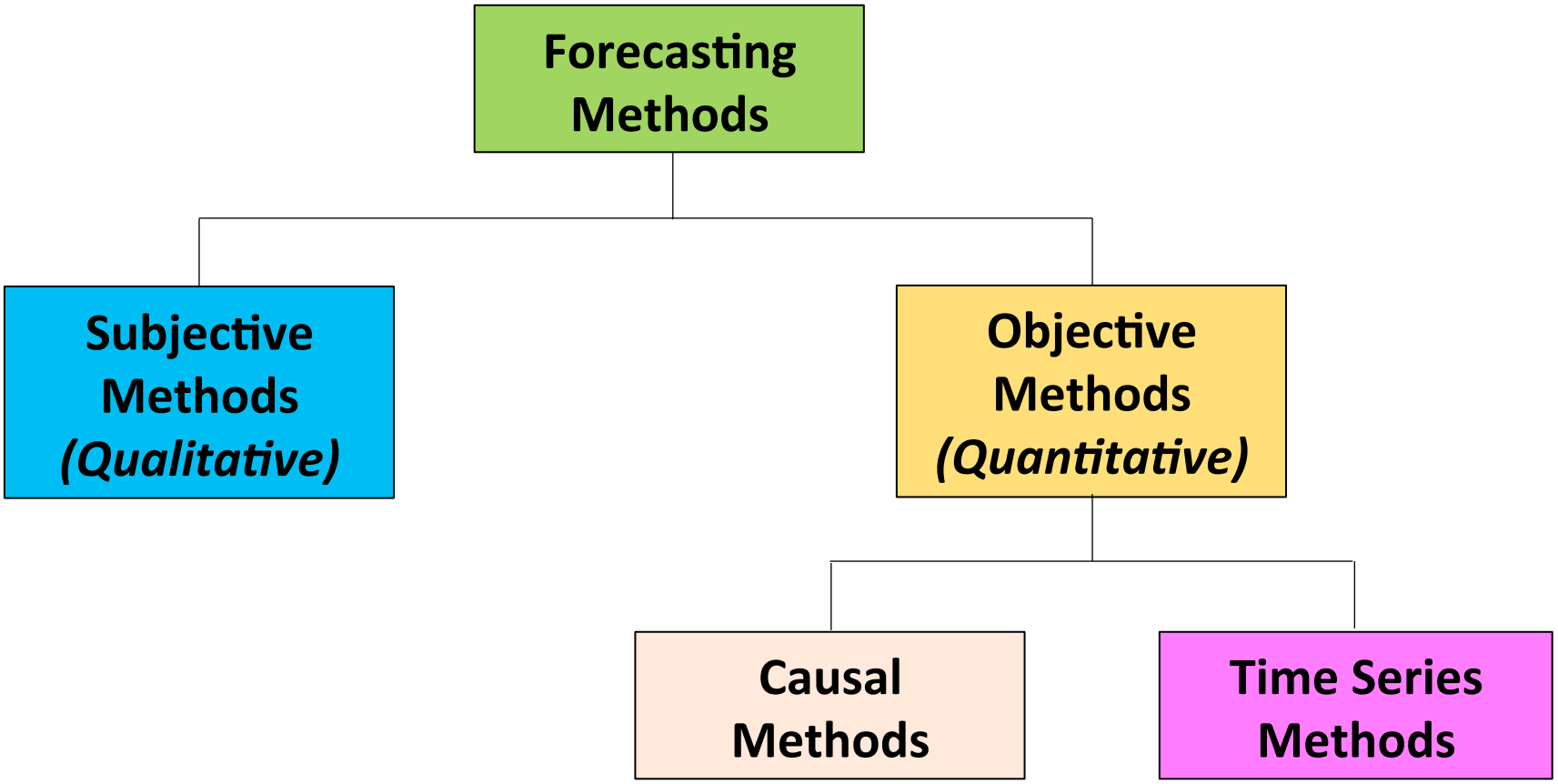
Example: forecasting next week's product demand is likely to be more accurate than forecasting next year's demand

- Aggregate forecasts are more accurate than several individual forecasts

Example: forecasting the demand for all GMC-brand trucks is more accurate than forecasting the demand for black GMC trucks

Forecasting Methods

Classification



Forecasting Methods

Basics

Subjective Forecasts:

- Qualitative
- Based on opinions and judgement (e.g., customer surveys, expert opinion)
- Relevant when used for new products with no historical sales data

Objective Forecasts (data driven):

- Quantitative
- Relies on analyzing historical data to make inferences about future demands
- The decision to use subjective versus objective methods generally depends on availability of historical data

Forecasting Methods

Subjective methods

Ways to attain insight for accurate subjective forecast include:

- Customer surveys and questionnaires
- **Jury of executive opinions**: an iterative procedure based on the input of experts from different divisions within the organization (operations, marketing, sales, etc.)
- **The Delphi method**: similar to the jury of executive opinions, but the analysis of experts' opinions takes place offline

Forecasting Methods

Objective methods

Causal methods:

- Based on analyzing a set of data different from the quantity we would like to forecast

Example: analyze data on median household income, school district ranking, and crime rate to forecast home sales in a district

Time series methods:

- Analyze data similar to what we would like to forecast

Example: analyze sales of smart phones from 2010 to 2017 to forecast demand for the same phone in 2018

Forecast Error

Basics

- Forecast error is the difference between the forecast (predicted) value and the actual realized value

Forecast error at some period *t* =

Forecasted* demand at time *t* - *actual* demand at time *t

Forecast Error

Metrics

- **Mean absolute deviation** (MAD): average of the absolute value of forecast errors over a specified time range
- **Mean squared error** (MSE): average of the square of forecast errors over a specified time range
- **Mean absolute percentage error** (MAPE): average of the absolute value of the ratio between forecast error and actual demand over a specified time range

Note: use training data that is already known to compute forecast errors, and then use this to inform future forecasts

Forecast Error

Metrics (cont.)

- The previous metrics can be used to rank different forecasting methods (better forecasting method yields lower values of these metrics)
- **Rule of thumb**: it is uncommon that a particular forecasting method would yield lower values of all the metrics (typically, the forecaster would select a specific metric to compare methods)

Forecasting Methods

Causal methods

- **Philosophy**: let the quantity that we want to forecast, ***y***, be a function of some different variables, ***x***:

$$y = f(x)$$

The objective of causal methods is to find the function ***f*** that captures the relationship between ***y*** and ***x*** by analyzing historical data

- Most common tool used in causal methods is Regression: a set of methods for determining the relationships among variables
  - —Univariate regression (***y*** is a function of one variable ***x***)
  - —Multivariate regression (***y*** is a function of multiple variables, $\mathbf{x_1}$, $\mathbf{x_2}$… $\mathbf{x_n}$)
  - —The function ***f*** can either take a linear form (linear regression) or some other form (e.g., quadratic, exponential)

Forecasting Methods

Time series forecasting

- A time series is a collection of past values of the variable being predicted (also known as naïve methods)
- Goal: to isolate patterns in past data to predict future values

Note: examples in following slides

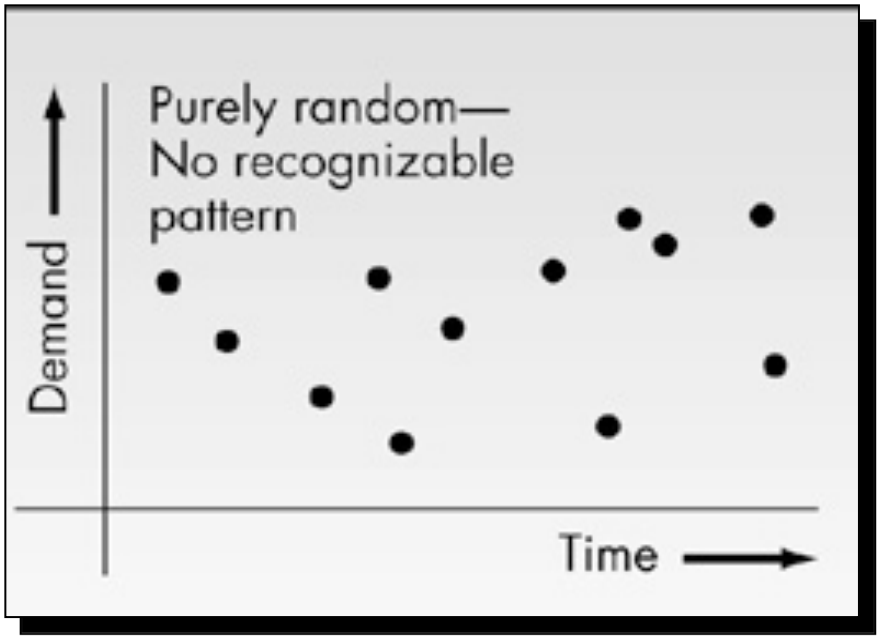
Types of time series forecasting:

- Trend
- Seasonality
- Cycles
- Randomness

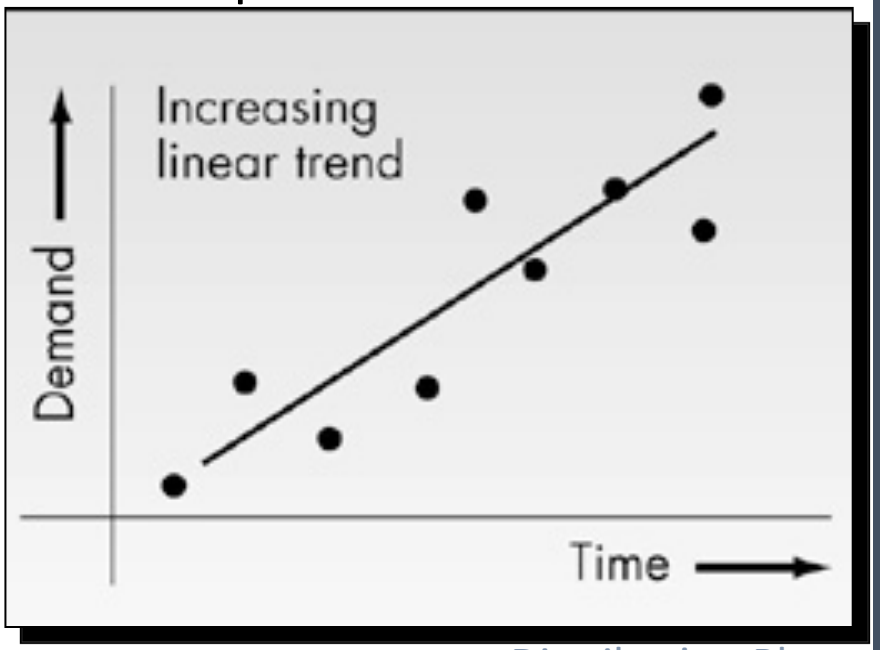
Source: Forecasting Models R. Lindeke, Ph. D.
www.d.umn.edu/~rlindek1/POM/assets/IE3265_Forecasting.ppt

Forecasting Methods

Examples – Time series forecasting



- Prediction lines based on "Trend Fitting Line" over time within what otherwise looks like randomly scattered data points



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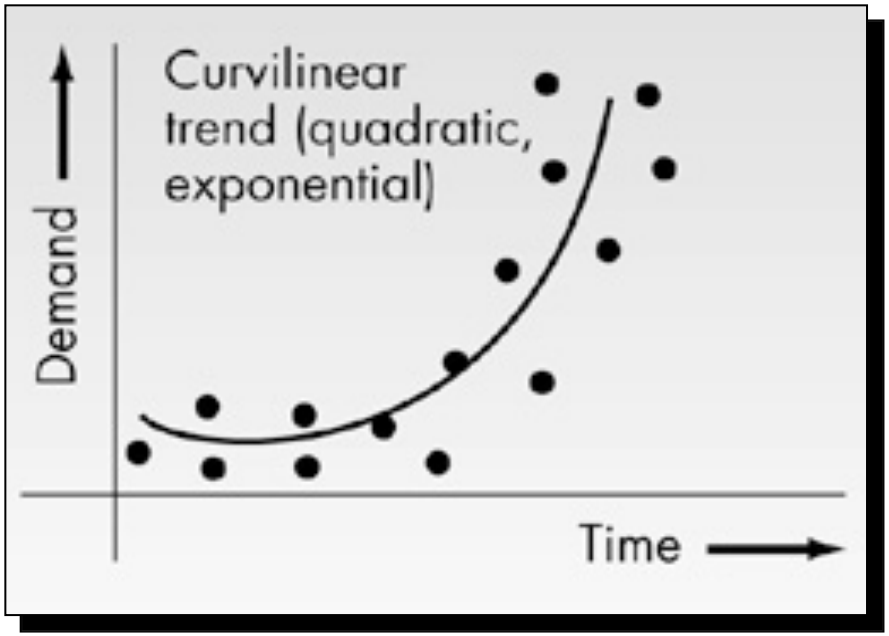
Forecasting Methods

Examples – Time series forecasting (cont.)



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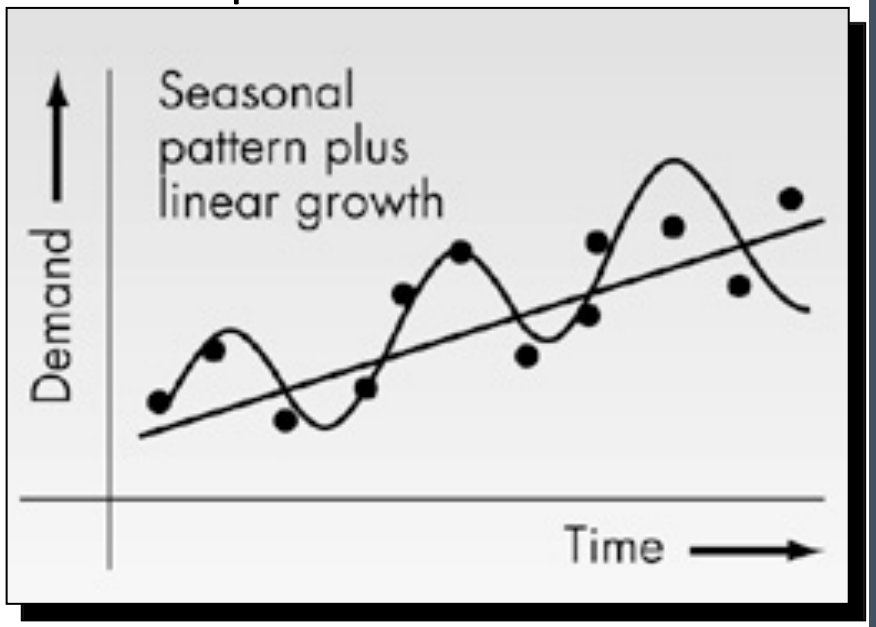

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Time Series Forecasting

Considerations

- Determining the demand pattern is the first step toward selecting a forecasting method
- For each type of demand series, there are dedicated methods that work best
- Forecasting is more of an art than a science

Time Series Forecasting

How to determine demand?

Common methods used for each demand pattern:

Stationary Series:

- Moving average
- Exponential smoothing

Trend Series:

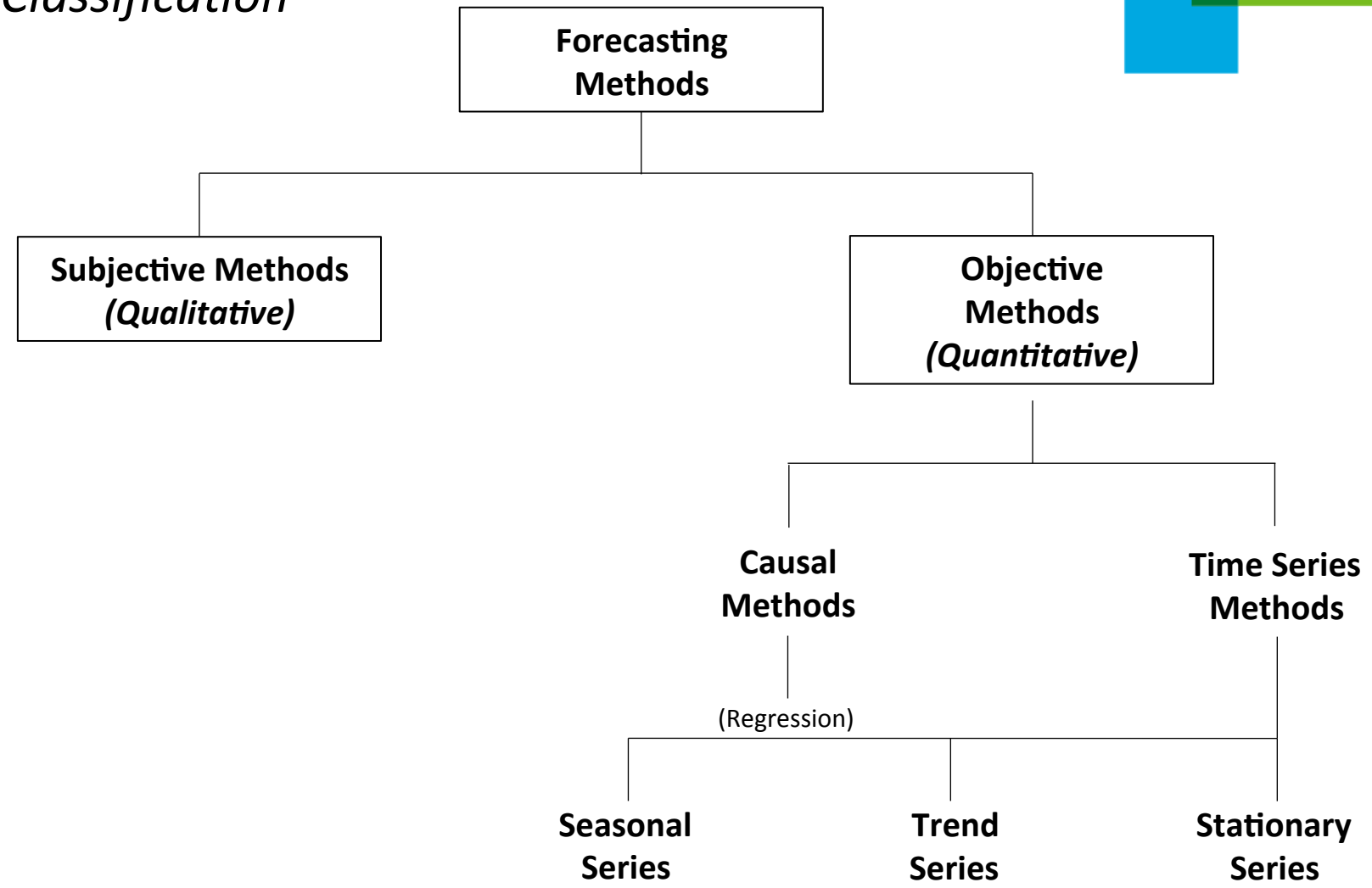
- Univariate regression (with variable ***x*** representing time)
- Double exponential smoothing (also known as Holt's method)

Seasonal Series:

- Seasonal decomposition method
- Triple exponential smoothing (also known as Winter's method)

Forecasting Methods

Classification



Glossary

Module 5C

Lead Time is the latency between the initiation and execution of a process. For example, the lead time between the placement of an order and delivery of a new car from a manufacturer may be anywhere from 2 weeks to 6 months. In industry, lead time reduction is an important part of lean manufacturing.

Value for Money (VFM) A utility derived from every purchase or every sum of money spent. Value for money is based not only on the minimum purchase price (economy) but also on the maximum efficiency and effectiveness of the purchase.

Forecasting is the process of making predictions of the future based on past and present data and most commonly by analysis of trends.

Third party Logistics (3PL) in logistics and supply chain management is a company's use of third-party businesses to outsource elements of the company's distribution and fulfillment services.

Warehouse Management System (WMS) is a software application, designed to support and optimize warehouse or distribution center management.

Make-to-Order is a production approach where products are not built until a confirmed order for products is received.

Make-to-Stock is a build-ahead production approach in which production plans may be based upon sales forecasts and/or historical demand.

Make-to-Forecast is a building of inventory to meet the anticipated level of customer demand. This requires a very accurate forecasting method as very few customers will guarantee purchase of inventory prior to an official written purchase order.

Mean Absolute Deviation (MAD) is the average of the absolute deviations from a central point.

Mean Squared Error (MSE) measures the average of the squares of the errors or deviations—that is, the difference between the estimator and what is estimated.

Mean Absolute Percentage Error (MAPE) - is a measure of prediction accuracy of a forecasting method in statistics, for example in trend estimation. It usually expresses accuracy as a percentage.

Stationery Series is the historical demand data which is randomly scattered about some constant value.

Trend Series is historical demand data which exhibits an increasing (or decreasing) trend that can be linear or nonlinear.

Seasonal Series reflects cyclic or seasonal variations in a consistent manner. Time series data can contain trends which may be either linear or exponential or mixed. Smoothing on this data is required to predict the values for forecasting.