Preface

Dear student,

You are now reading the Supply Chain Management summary for the study of International Business Administration. Slim Academy summarized all the mandatory course literature you need to know for your exam, so that you may study in the best possible way. We would like to wish you good luck with studying!

Join our team
Slim Academy is always looking for motivated students! Would you like to work with us to summarize and review summaries? Then the role of StudyHero is definitely something for you. You can work from home, receive a generous compensation, and you have a study-related side job that looks good on your resume. Are you interested? Send your motivation and resume to klantenservice@slimacademy.nl.

Stay in contact with Slim Academy
Do you want to stay informed about the developments at Slim Academy? Get in contact via:
www.slimacademy.nl
@SlimAcademy.nl
klantenservice@slimacademy.nl
010 214 32 45

We would like to wish you good luck with studying and passing your exams!

Team Slim Academy

P.S. This summary is written in accordance with the author's own perception. It is still a summary that serves as an addition to the mandatory literature, not as a replacement!

Table of Contents

Week 1: Introduction

We will first include a short summary with examples of the content of this week, with a focus on the quantitative part. Afterwards, you can practice by yourself with practice exercises.

What is Supply Chain Management?
Formal definition:

> *'A set of approaches utilized to efficiently integrate suppliers, manufactures, warehouses, and stores, so that merchandise is produced and distributed in the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements.'*

The main objectives of supply chain management are:

- To optimize total system-wide costs (achieve efficiency);
- To optimize service levels.

Supply chain management integrates all parts of a supply chain by encompassing the firm's activities at three different levels:

- **Strategic level**: decisions have a long-lasting effect on the firm (e.g., product design, make/buy decisions);
- **Tactical level**: decisions are often updated and include e.g., production decisions, transportation strategies, inventory policies;
- **Operational level**: day-to-day decisions are related to the daily operations of the company (e.g., scheduling).

Forecasting
Naive approach
The **naive approach** assumes that the demand in the following period will be the same as the demand in the most recent period. Imagine if you sold 300 muffins yesterday, the approach will assume that you will sell 300 today. It is constructed in the following formula, where F is the forecast and A is the factual demand:

$$F = A_{t-1}$$

The change in the number of products in one period is the basis for the next period. This is the biggest disadvantage of this method. It does not take random variables or demand peeks into consideration. This makes it very susceptible to changes in demand. This model is most useful in cases with stable demand.

Example

In the table below, the demand and the forecast for a particular product is given over four years. The naive approach is used to fill in the forecast.

Naive approach

	2006	2007	2008	2009
Demand	100	150	200	250
Forecast		100	150	200

Source: Slim Academy,2023

The prediction of the next period is the demand from the last period.
In 2006 the demand was 100, so the prediction for 2007 is 100.
In 2007 the demand was 150, so the prediction for 2008 is 150.

Moving average method

The **moving average method** is based on a set of arithmetic averages of N previous periods. This method requires extensive historic data. It can only be used when there are no apparent trends in the data. By increasing the number of periods (n), one can smoothen the random variations in the data. This makes the method less susceptible to change as well. This method does not predict trends, but is a stable method. The following formula explains the moving average method:

$$Moving\ Average = \frac{\Sigma demand\ in\ previous\ n\ periods}{n}$$

In the table below, the forecasts are made according to the moving average method with *n* = 3.

Moving average method

	2004	*2005*	*2006*	*2007*	*2008*	*2009*
Demand	0	50	100	150	200	250
Forecast				50	100	150

Source: Slim Academy, 2023

$$\text{Forecast 2007} = \frac{100+50+0}{3} = 50$$
$$\text{Forecast 2008} = \frac{100+50+150}{3} = 100$$
$$\text{Forecast 2009} = \frac{100+200+150}{3} = 150$$

Exponential Smoothing

One would ideally want a forecasting method that is easy to use, predicts patterns in demand well, and is not overly sensitive to incidental changes in demand. In all the methods we discussed before, there is always one of these elements lacking. The ideal solution is somewhere in between these methods and is called **exponential smoothing**.

The formula we use for this method is stated as follows:

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

Where:

- α =the smoothing constant that is determined by experts. The value has to be in the following range: $0 \leq \alpha \leq 1$;
- F_t =the prediction for period t;
- F_{t-1} =the prediction of the previous period: t-1;
- A_{t-1} =the actual demand in the previous period: t-1.

The closer alpha is to 0, the more stable the forecast is. When the alpha is closer to 1, it becomes more responsive to previous forecasts.

Example

Forecast the demand for the upcoming period *t* using the exponential smoothing method. The following data is given:

- Previous forecast, F_{t-1} ;
- Current value, A_{t-1} ;
- $\alpha = 0.4$.

Solution:

Insert this data into the formula $F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$

$$\text{Forecast} = 25 + 0.4 * (40 - 25) = 31$$

Measuring the forecast error

Mean Absolute Deviation (MAD)

For this method, you must take the absolute value (always positive). If not, some forecasting errors may balance each other out. Imagine if you make a forecast error of -100 products (too few) and subsequently an error of +100 (too many). If you took the sum of these results, it would appear as if you have not made any forecast error. The formula belonging to the MAD is stated as follows:

$$Mean\ Absolute\ Deviation\ (MAD) = \frac{\sum_{i=1}^{n} |A_i - F_i|}{n}$$

Mean Squared Error (MSE)

Using the squared principal causes only small errors to stay unnoticeable. Big errors made in calculations can immediately be spotted and corrected. MSE is calculated in the following way:

$$Mean\ Squared\ Error\ (MSE) = \frac{\sum_{i=1}^{n} (A_i - F_i)^2}{n}$$

Mean Absolute Percent Error (MAPE)

One can examine the size of the error in absolute terms using MAPE. The error in percentages is different for each forecasting method. MAPE is calculated in the following way:

$$Mean\ Absolute\ Percent\ Error\ (MAPE) = \frac{\left(\frac{\sum_{i=1}^{n} 100|A_i - F_i|}{A_i}\right)}{n}$$

Example

Table with demand and forecast

	2006	**2007**	**2008**	**2009**
Demand	100	150	200	250
Forecast	50	125	150	325

Source: Slim Academy, 2023

Calculate the MAD, MSE and MAPE using the data above.

Solution:

We will need to calculate the difference between forecast and demand for each year in order to calculate the MAD, MSE and MAPE. You will make it easier for yourself to create a table like this:

Table with demand, forecast & (percentage) deviation

	2006	**2007**	**2008**	**2009**
Demand	100	150	200	250
Forecast	50	125	150	325
Deviation $A_i - F_i$	100-50=50	150-125=25	200-150=50	250-325=-75
%deviation $\frac{\sum_{i=1}^{n} 100\|A_i - F_i\|}{A_i}$	$\frac{50}{100} = 50\%$	$\frac{25}{150} = 16.67\%$	$\frac{50}{200} = 25\%$	$\frac{75}{250} = 30\%$

Source: Slim Academy, 2023

Now we use the differences between forecast and demand to calculate the measurement errors.

MAD:

$$Mean\ Absolute\ Deviation\ (MAD) = \frac{\sum_{i=1}^{n} |A_i - F_i|}{n}$$

$$MAD = \frac{50+25+50+75}{4} = 50$$

MSE:

$$Mean\ Squared\ Error\ (MSE) = \frac{\sum_{i=1}^{n} (A_i - F_i)^2}{n}$$

$$MSE = \frac{50^2+25^2+50^2+75^2}{4} = 2812.5$$

MAPE:

$$Mean\ Absolute\ Percent\ Error\ (MAPE) = \frac{\left(\frac{\sum_{i=1}^{n} 100|A_i - F_i|}{A_i}\right)}{n}$$

$$MAPE = \frac{50\%+16.67\%+25\%+30\%}{4} = 30.42\%$$

Seasonal indices

We can also correct data for seasonal variances. Seasonal variances can be prevented by, for example, selling jet skis in the summer and snowmobiles in the winter. This allows for potentially stable sales the whole year through. The **seasonal index** is used to correct your forecast. You calculate an expected value for each month and multiply this by the seasonal index. We can make an estimation based on the steps below:

- Find the average historic demand for each solution;
- Calculate the average demand for all seasons;
- Calculate a seasonal index for each season;
- Estimate the total demand in the upcoming year;
- Distribute the estimation of the total demand over the number of seasons, and multiply these by the seasonal index for the relevant season.

Example

A restaurant has the following historical demand.

Historical demand

	Period 1	**Period 2**	**Period 3**	**Period 4**
Year 1	100	150	200	250
Year 2	125	125	250	250

Source: Slim Academy, 2023

In year 3, the restaurant owner expects a demand of 800. Based on this expectation, what will be the demand in period 2 of year 3?

Solution:
Average demand period 2 = (150 + 125) / 2 = 137.5
Demand year 1 = 100 + 150 + 200 + 250 = 700
Demand year 2 = 125 + 125 + 250 + 250 = 750
Average yearly demand = (700 + 750) / 2 = 725
Seasonal index period 2 = 137.5 / 725 = 0.189655
800 * 0.189655 = 151.72
Expected demand period 2 of year 3 = 152

Tracking Signal
The formula for the tracking signal is:

$$Tracking\ signal = \frac{RSFE(=All\ forecast\ errors)}{MAD} = \frac{\sum(Ai-Fi)}{\left(\sum|Ai-Fi|/n\right)}$$

Practice Questions Week 1

Practice Question 1
There are two forecasts based on two different methods given below. They represent the number of litres of oil, in thousands, that is demanded from oil companies in the relevant weeks. The demand levels are given, in thousands.

Demand & Forecast table

Week	Forecast Method 1	Forecast Method 2	Actual Demand
1	0.90	0.80	0.70
2	1.05	1.20	1.00
3	0.95	0.90	1.00
4	1.20	0.82	1.00

Source: Slim Academy, 2023

Calculate the MAD and MSE for both forecasting methods. Which forecasting method is the best?

Practice Question 2
The table below represents the demand for airplanes for an airplane producer. Assume that the original forecast for year 4 was 68 airplanes.

Year	Demand
1	60
2	71
3	65
4	63
5	?

Source: Slim Academy, 2023

What is the forecasted demand for year 5 when using exponential smoothing with a smoothing constant of 0.45?

Practice Question 3
Which of the following is not one of the characteristics of forecasting?

A. Forecasts are always wrong.
B. Aggregate forecasting is more accurate than forecasting for single items.
C. The longer the time horizon, the worse the forecast.
D. Forecasting is always a cause of the variability in the supply chain.

Practice Question 4
Which of the below does not fit the term 'development chain'?

A. Economies of scale
B. Decisions to make/buy
C. Technology clock speed
D. Product Structure

Answers Week 1

Practice Question 1

Week	|A-F| meth. 1	|A-F| meth. 2	$(A-F)^2$ meth. 1	$(A-F)^2$ meth. 2
1	0.20	0.10	0.04	0.01
2	0.05	0.20	0.0025	0.04
3	0.05	0.10	0.0025	0.01
4	0.20	0.18	0.04	0.0324
Total	0.50	0.58	0.085	0.0924

Source: Slim Academy, 2023

$$Mean\ Absolute\ Deviation\ (MAD) = \frac{\sum_{i=1}^{n} |A_i - F_i|}{n}$$

$$Mean\ Squared\ Error\ (MSE) = \frac{\sum_{i=1}^{n} (A_i - F_i)^2}{n}$$

MAD method one: 0.50 / 4 weeks = 0.125
MAD method two: 0.58 / 4 weeks = 0.145
MSE method one: 0.085 / 4 weeks = 0.02125
MSE method two: 0.0924 /4 weeks = 0.0231

Method 1 is the best based on the MAD and MSE, because both the MAD and MSE are smaller for method 1 than they are for method 2.

Practice Question 2

To make a forecast for year 5, we need the forecast for year 4, which is given in this scenario. The forecast for year 4 was 68. Use the following formula for your calculation:

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

$$F_{year\ 5} = 68 + 0.45(63 - 68) = 65.75$$

The forecasted demand for year 5 is 66 airplanes.

Practice question 3

The correct answer is D.
While statements A, B and C are correct, statement D is incorrect as variability in the supply chain can have many reasons unrelated to forecasting.

Practice Question 4

The correct answer is A.
The development chain is a set of activities and processes associated with new product introduction, which includes

- Product design phase & research;
- Associated capabilities and knowledge;
- Sourcing decisions;
- Production plans.