



# Mathematics for Supply Chain

## Exam : 2024-2025

### Msc Supply Chain & Purchasing Management

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#### Abstract

This exam is composed of several exercises and case studies. For the evaluation, a great importance will be given to the writing of your answers, *i.e.* a good answer without justification will give you only very few points. To do this, depending on the nature of the question, you should give the following details

- **confidence interval** : you will specify the law on which the construction of your confidence interval is based by specifying the context
- **test of hypothesis** : you will formulate the hypotheses  $H_0$  and  $H_1$ , the nature of the test as well as the test statistic used and its law. Unless explicitly mentioned, you can conclude by constructing a confidence interval or by calculating the  $p$ -value  $p$ .

Finally, you will write your study on the medium of your choice (paper, word, open office, pages, ...) and you will deposit your work on the Dropbox provided for this purpose **in pdf format**.

**Remark:** excel files will contain all the calculations made to obtain the results. Care should be taken to present the calculations in the excel file.

**Due date : January the 31<sup>st</sup>, 2025, a dropbox is available on Brightspace.**

# 1 Exercises

The four exercises in this section are independent. Please provide detailed answers to each exercise.

## Exercise 1

A bottled water distributor wants to determine whether the mean amount of water contained in 1-gallon bottles purchased from a nationally known water bottling company is actually 1 gallon. You know from the water bottling company specifications that the standard deviation of the amount of water is 0.03

gallon. You select a random sample of 55 bottles, and the mean amount of water per 1-gallon bottle is 0.997 gallon.

1. Let  $\mu$  be the population mean. Determine the null hypothesis,  $H_0$ , and the alternative hypothesis,  $H_1$ .
2. What is the value of  $Z_{stats}$  and the associated critical value for a level of significance  $\alpha$  equal to 0.05?
3. What is the conclusion of the test?
4. Compute the  $p$ -value and conclude.
5. Construct a 95% confidence interval estimate of the population mean amount of water per 1-gallon bottle.
6. Compare the conclusion using the confidence interval and the one with the previous question. What can you say?

## Exercise 2

An insurance company states that it settles 85% of all life insurance claims within 30 days. A consumer group asks the state insurance commission to investigate. In a sample of 250 life insurance claims, 203 were settled within 30 days.

1. Test whether the true proportion of all life insurance claims made to this company that are settled within 30 days is less than 85% , at the 5% level of significance.
2. Compute the observed significance of the test, *i.e.* the  $p$ -value.

### Exercise 3

A company wants to compare the performance of two delivery systems in order to determine the best system to guarantee the best customer satisfaction and the long-term future of the delivery company.

To this end, 200 customers were surveyed (100 different customers per delivery system), who provided a satisfaction score ranging from 0 to 100 according to various criteria.

The results of this survey can be found in the file **Delivery Systems**.

Use a statistical study to determine whether one delivery system guarantees higher customer satisfaction than another. Conclusions will be taken with a 5% error rate

You will take care to present the tests carried out and the various steps that led to your conclusion.

### Exercise 4

A new production line has been deployed in a factory belonging to a group specializing in the manufacture of Christmas decorations. To determine the efficiency of the new line, we measured the production time required to make 1,000 Christmas ornaments on the old production line and the new line assigned to the same employees (it is assumed that the employees work with the same efficiency).

The production times (in seconds for one decoration) for these 1,000 decorations are reported in the file **Decoration**. Can we say that the new production line effectively reduces the production time for these Christmas decorations? Conclusions will be taken with a 5% error rate

You will take care to present the tests carried out and the various steps that led to your conclusion.

## 2 Case Study

In this case study, we propose to work with Apple's quarterly sales data (Q1 2015 to Q1 2024), and more specifically, the company's turnover. This data can be found in the file **Apple**<sup>1</sup>.

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<sup>1</sup>The data were extracted from the following website: <https://fr.statista.com/statistiques/524755/apple-chiffre-d-affaires-monde-par-region/>

Your aim is to use the statistical tools presented in class to carry out a small statistical analysis.

For example, you can try to answer the following questions:

- Are sales significantly different between Japan and the Rest of Asia-Pacific?
- Same question between Europe and China and its regions?
- Can we say that overall sales are different from one region of the world to another?
- On a global scale, are sales increasing from one quarter to the next one?
- Is it true to say that Apple's sales over the last ten years have exceeded \$5.5 billion in Japan?

Another question: graph the data and describe the different graphs obtained. In your opinion, what do the peaks correspond to? What time of year does the first quarter correspond to? Try to explain to global trend in the observed graphs.

Feel free to perform any other statistical analysis you feel is relevant.