Case study 2

Supply chain management

KedgePAC is a leading manufacturer of heat pump systems (“Pompe A Chaleur” in french). KedgePAC introduced its new “PAK” air-conditioning system a year ago, and it has been a great success on the market. Customers have praised the system for its design, efficiency, reliability, and price. Orders for the PAK system have grown rapidly. However, the success of the PAK system has created serious logistical problems for KedgePAC, who now want to find some way of delivering the PAK system to customers on time, while simultaneously reducing inventory and transport costs.

The PAK system supply chain.

KedgePAC manufactures the PAK systems at its two production plants in Marseille and Paris. The Marseille plant has a monthly production capacity of 13,000 units and Paris a capacity of 10,000 PAKs per month.

PAK's national sales are made from its Bordeaux warehouse, which is directly supplied by the two plants in Marseille and Paris. To benefit from economies of scale in transport, shipments are scheduled once a month. KedgePAC holds stocks in both factories and in the Bordeaux warehouse.

Transport and storage costs.

The fixed and variable unit shipping costs of a PAK system from factory to warehouse are shown in the following table.

	Fixed cost per shipment	**Variable cost per unit**
From Marseille	5000 €	2 €
From Paris	3000 €	4 €

The monthly cost of storage in the factories is €5 per unit, and in the Bordeaux warehouse €10.

Demand and stocks of PAK systems.

KedgePAC asked its marketing department to forecast demand for PAK systems over the next two months. The marketing department forecasts 15,000 units in April and 25,000 in May.

Estimated stocks of PAKs in Bordeaux are 5,000, in Marseille 2,000 and in Paris 1,000.

The KedgePAC problem.

KedgePAC wants to determine the number of PAK units to be manufactured each month in the group's two factories, and the number of units to be shipped to the warehouse each month from these factories, to minimize total transport (shipping) and storage costs.

The optimization model.

To meet KedgePAC's expectations, you will need to build an integer linear programming model of the problem of minimizing total transportation and storage costs during the months of April (index "a") and May (index "m") and implement it in Excel (using the solver).

To build the optimization model, you will use the following decision variables:

- X_{Ma} and X_{Mm}: The quantity of PAK to be produced at the Marseille plant in April and May respectively.
- X_{Pa} and X_{Pm}: Quantity of PAK to be produced at the Paris plant, in April and May respectively.
- Z_{Ma} and Z_{Mm}: Quantity of PAK to be shipped from the Marseille plant to the Bordeaux warehouse, in April and May respectively.
- Z_{Pa} and Z_{Pm}: The quantity of PAK to be shipped from the Paris plant to the Bordeaux warehouse, in April and May respectively.
- Y_{Ma} and Y_{Mm}: The binary decision to ship PAK from the Marseille plant to the Bordeaux warehouse, in April and May respectively.
- Y_{Pa} and Y_{Pm}: The binary decision to ship PAK from the Paris plant to the Bordeaux warehouse, in April and May respectively.

You will also need to use the following state variables:

- S_{Ma} and S_{Mm} : The quantity of PAK stored at the Marseille plant in April and May respectively.
- S_{Pa} and S_{Pm}: The quantity of PAK stored at the Paris plant in April and May respectively.
- S_{Ba} and S_{Bm}: The quantity of PAK stored at the Bordeaux wharehouse in April and May respectively.

Instructions:

- The case must be carried out by groups of no more than 4 students.
- Due date is Friday March, 22.
- Documents to be submitted are:
  - A report with the mathematical formulation and the optimal solution,
  - an Excel file with the solved problem.
- Send by email frederic.babonneau@kedgebs.com