

## Transportation Service Network Design of the SE company

The SE company is specialized in the production of electric plugs. They have factories in several eastern European countries and several regions of China. They also have several distribution hubs worldwide located in several regions of India and China, several South America countries and several western European countries.

Thus, they want to setup a distribution logistic network to send their products from their factories to their distribution hubs. The transport is done by third party logistics transporters. SE has only to pay the prices provided by the transporters. Thus, the use case here is from SE as the client point of view. For this, they ask your consulting company specialized in Logistics consulting and Operations Research to help them to design that network.

After several interviews done in the SE company, the information you have are as follows:

- For the sake of simplicity, you have been told to assume without loss of generality that you have only one type of electric plugs to carry and they are all packed in pallets. A pallet is considered here as the basic logistics unit. All the costs expressed below are per unit of pallet.
- Two transport modes are available: trucks and/or boats.
- Each truck can transport N9 pallets. For the boat, there are two kinds of containers: the small ones can carry N11 pallets each and the big one can carry N22 pallets each.
- Two kinds of routes are available:
  - Ground routes: only trucks are used from factories to distributions hubs.
  - Maritime routes are divided into 3 sections: from factories to ports (ground route), ports to ports, and ports to distribution hubs (ground route).

On the followings, origins and destinations can be either factories, distribution hubs or maritime ports.

- **Truck costs:**
  - Unit cost per pallet using truck  $CTP_{od}$ : this is the cost paid to carry one pallet from origin  $o$  to destination  $d$ .
  - Unit cost per truck  $CT_{od}$ : this is the cost paid when a truck is used to carry one or N9 pallets from origin  $o$  to destination  $d$ .
- **Boat costs:**
  - Unit cost per container  $CBN11_{od}$ : this is the cost paid when a small container is used to carry one to N11 pallets from origin  $o$  to destination  $d$ .
  - Unit cost per container  $CBN22_{od}$ : this is the cost paid when a big container is used to carry one to N22 pallets from origin  $o$  to destination  $d$ .
  - Unit cost per pallet using boat  $CBP_{od}$ : this is the cost paid to carry one pallet from origin  $o$  to destination  $d$ . This cost is paid only if pallet is sent separately from containers.
  - Customs costs: we consider two kind of costs:
    - Fixed costs  $CBFC_{od}$ : this is the customs cost paid as soon as there is a transport of pallets from origin  $o$  to destination  $d$ .
    - Variable costs per pallet  $CBPC_{od}$ : this is the customs cost paid to carry one pallet from origin  $o$  to destination  $d$ .
- Each factory has production  $P_f$  and each distribution hub has demand  $D_h$ .

The objective is to build an optimized service network to transport with minimum costs the electric plugs from factories to distribution hubs. A mathematical model is asked only here, no solving is to be done.

As for the logistics hub location problem, our team leader gives you the following advices:

**Advice0:** Draw the two available transportation routes, ground and maritime.

**Advice1:** Start modelling the ground route problem first.

**Advice2:** Add the model for the maritime routes.