

Team Working Activity on the Location Planning Problem

Let us consider an Italian production company aiming at launching a new product on the market. Focusing in particular on the market of Northern Italy, the managers have estimated that the main areas where this product can be purchased are associated with the following cities: Torino, Savona, Genova, Milano, Brescia, Piacenza, Bologna and Padova. After a detailed analysis of the possible places where to install the production plants for this new type of product, the managers have identified 4 possible locations, in the industrial areas of Torino, Genova, Milano and Bologna.

To estimate the main parameters of the problem, the company has considered one generic year of activity. For the activation of the production plants (including rent costs for the areas and costs of the equipment), the following annual costs have been estimated: 70000€ for Torino, 90000€ for Genova, 100000€ for Milano and 90000€ for Bologna.

Since the products will be delivered in 20' containers, each one transported by one truck, the transportation cost can be computed by considering the traveling cost of trucks, which is estimated as 0.45 [€/km]. The distances [km] among the cited cities are reported in the following table.

	Torino	Savona	Genova	Milano	Brescia	Piacenza	Bologna	Padova
Torino	30	140	180	140	230	180	330	370
Genova	180	50	20	145	230	150	300	370
Milano	140	180	145	40	100	75	215	250
Bologna	330	340	300	215	205	155	30	120

The demand of the customers has been estimated in terms of number of 20' containers required by each demand point in one year. The following estimates have been provided by the company: 600 containers for Torino, 200 containers for Savona, 500 containers for Genova, 700 containers for Milano, 250 containers for Brescia, 300 containers for Piacenza, 350 containers for Bologna and 250 containers for Padova.

On the basis of the dimensions of the areas where production plants would be installed and depending on the available production equipment, the capacity of these plants have been estimated. In particular, the maximum number of 20' containers that can be produced by the plant in Torino is equal to 1600, for Genova it is 1400, for Milano 1700 and for Bologna 1500.

The company is interested to decide where to locate the production plants (among the 4 possible locations, in the industrial areas of Torino, Genova, Milano and Bologna).

1. Write the mathematical programming formulation for this model (with data with their values, decision variables, objective function and constraints).
2. Implement this model: how many production plants are activated in the optimal solution? What is the optimal total annual cost?
3. Consider a case in which the company wants to activate 3 production plants. How does the formulation change in this case? What is the optimal total annual cost in this case?
4. Consider the case in which the company, in addition to the demand already described, delivers also the products in 30' feet containers, for which the annual demand is 200 containers for Torino, 50 containers for Savona, 150 containers for Genova, 200 containers for Milano, 50 containers for Brescia, 100 containers for Piacenza, 100 containers for Bologna and 50 containers for Padova. The traveling cost of trucks is in this case equal to 0.6 [€/km]. Write the mathematical programming formulation for this model (with data with their values, decision variables, objective function and constraints) which includes products delivered in 20' and 30' containers and implement this model: how many production plants are activated in the optimal solution? What is the optimal total annual cost?