## Facility Location and Layout

**1. Facility:** a separate unit of production or service. It interacts with other facilities and/or companies.

 **Examples:**

1. Complete production unit,

2. Warehouse,

3. Distribution center. Factories (e.g. shoe, shirt, suit) of a brand → distribution center → retailers

This is a possible structure of a supply chain.

**2. Layout:** positioning units and/or machines internal the facility

**3. Facility management:** decision on the location of the facility and its layout.

**4. Selection on the location of the facility.**

The decision is twofold: territory/state/country and site

**4.1 Decision No. 1: territory**

**Important factors**

| Nearness of markets | Water | Local regulations |
|---|---|---|
| Nearness of raw material | Available labor | Climate |
| Available transportation options: highway, train, airport, ship | Taxation and financial support | Fire and police protection |
| Electric power | Labor laws | Community attitude |

**Example.** Steel factory needs :

1. Iron ore.

2. Coal.

3. Water.

Iron and coal is huge quantity bulk. Their cheapest transportation is ship.

**Factors which must be present:** labor, energy supply, water, and protection.

**Cost effecting factors:** nearness of market and raw material, transportation options, taxation and financial support, and labor.

**Business environment:** labor laws, local regulations, stability of taxation, and community attitude.

**Fixed cost:** investment (building and technology) and initial support (e.g. area)

**Variable cost:** transportation and labor.

**Most frequent objective function:** minimization of transportation cost.

**Other objective functions.** Fixed cost and variable cost must be connected by discounting factor.


## 5.2 Measuring distances

Textbook solution: - long distance: Euclidean distance ($l_2$) $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

-short distance: rectilinear (Manhattan, $l_1$) $|x_1 - x_2| + |y_1 - y_2|$


Real solution: - exact distance based on map

-measured time

-transportation tariff


## 5.3 The location of a single facility in a city having rectangular street system

**STEP 1.** Order the "x" coordinates. Determine the interval where no more than half of the transportations is left and right.

**STEP 2.** Order the "y" coordinates. Determine the interval where no more than half of the transportations is left and right.

## 5.4 Public sector location problems

**Emergency services:** maximal distance is to be minimized. E.g. first aid must reach all accidents within 15 minutes.


**Example.**

| x | y | transp. | x | y | transp. | x | y | transp. |
|---|---|---|---|---|---|---|---|---|
| 22.5 | 5.5 | 10 | 29.0 | 25.0 | 3 | 32.5 | 25.0 | 1 |
| 26.5 | 9.5 | 10 | 30.0 | 25.0 | 1 | 33.0 | 25.0 | 1 |
| 29.5 | 14.0 | 5 | 29.5 | 24.5 | 1 | 32.5 | 24.5 | 1 |
| 28.5 | 24.0 | 3 | 32.0 | 24.5 | 3 | 16.0 | 36.5 | 5 |
| 28.5 | 24.5 | 1 | 32.0 | 25.0 | 1 | 18.0 | 37.5 | 4 |

## 5.5 Multi-facility location

**Constraints:**

1. Assignment of demands to facilities
2. Facility capacity constraint
3. Technical constraints
4. Objective function: weighted sum of the transportation cost and invested amount.