# A modeling approach for locating logistics platforms for fast parcel delivery in urban areas

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# Outline

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1. Project PLUME

# Context

## Context

- duration : 18 months
- contributor : French Ministry of Ecology, Sustainable Development, Transport and Housing
- partners :
  - **École Nationale Supérieure des Mines de Saint-Étienne** (*graduate school of science and technology* )
  - **Jonction** (*research team specialized in logistics and transport of goods*)
  - **SOGARIS** (*company involved in logistic real estate and associate services*)
  - **Cluster Paca Logistique** (*association which manages projects in logistics in the French region PACA*)

# Context

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- PLUME addresses the come back of urban logistics platforms in the heart of the town
- a real case study : Marseilles, with ARENC

# Location of logistics platforms for an urban use

## From the past ...

limiting the presence of logistics platforms in urban areas:

- urbanistic reasons (regulation rules)
- political reasons (less noise and pollution for inhabitants)
- economical (available surfaces are rare and expensive)

## ... to the future ?

↪ this location, far from the city, is now questioned:

- long vehicle tours
- more traffic pollution
- more traffic congestion
- impossibility to schedule several successive routes

# Our study

## Our study

- given a set of available surfaces in and outside of the city,
- given an average distribution activity of the city,
    - how many logistics platforms have to be built ? where should they be located ? and how should they be sized ?
    - how should be the vehicle fleet of each logistics platform composed of ?
    - what should be the (approximate) daily route of each vehicle ?

$\hookrightarrow$ so that the distribution is performed at optimal performance regarding a set of criteria including economic, environmental and social impacts

# Targets

## Targets

- a field study in Marseilles
- a mathematical model
- a decision-making tool (software)

# Outline

2. Marseilles field survey

# Framework

## Fast parcel deliveries

transport of small goods, volume of 0.10-0.20$m^3$ for an average weight of 30-70kg

## Logistics specialists

$\approx$ 30 companies in Bouches-du-Rhône
$\hookrightarrow$ 12 majors ones: 80% of the market

# Surfaces

## Surfaces

- Bouches-du-Rhône : $\approx$ 95000 $m^2$ (docks + office)
- 2 main areas (outside the city)
- Marseilles : 40 à 50% of the market share of each company
  $\hookrightarrow$ surface dedicated to Marseilles : $\approx$ 45000 $m^2$

# Transport of goods in Marseilles

## Tours (1/2)

- 320 in delivery and 215 in collect (coupling $\approx$ 20%)
- length : from 50 to 180km
- 35 customers per tour
- average weight for a delivery: 100kg
- organization : $\approx$ 1 tour / borough

# Transport of goods in Marseilles

## Tours (2/2)

- vehicles :
  - capacities: 40% $<$3.5t, 40% 7 - 13t, 20% more thant 13t
  - gasoline engines
- many subcontractors : 2/3 of the total number of vehicles
- volume : delivery 1120 T / day, collect 770 T / day
- customers : delivery 12 500, collect 7 000

# Evaluation

## More and more organisational difficulties for planning tours

professionals (later and later) $\neq$ people (earlier and earlier)

## E-business

more and more deliveries : necessity to be close to customers

$\hookrightarrow$ towards several tours per day

$\hookrightarrow$ a platform in Marseilles becomes a necessity

# Outline

3 Modeling approach

# 3 key points in the modelling approach

- criterion to optimize ?
  - economical
  - environmental
  - social
- a lot of actors (different models)
  - local authorities
  - logistics companies
  - customers / inhabitants
- how to evaluate distribution costs

# Criterion to optimize

## 9 criterion

- economical criterion
  - platforms: investment cost (fixed + variable/dock)
  - platforms: operating cost (depends on the number of docks)
  - vehicles: investment cost
  - vehicles: operating cost
- environmental criterion
  - vehicles: pollution
  - plateforms: pollution
- social criterion
  - platform: acceptability by the riparian
  - vehicle: congestion
  - platform: interest in terms of employment

# How to estimate transportation costs ?

- Necessity to deal with costs of entering and leaving the city
  - impact on the location of logistics platforms
- Necessity to deal with the fleet of vehicles
  - cost per km, autonomy (electric engines)
  - implies to manage tours of vehicles
- hypothesis

  $\hookrightarrow$ fixed costs to distribute goods into zones of demand
  - one tour = cost of entering the city + service of *near* zones + cost of leaving the city

# Extract of a mathematical model: constraints (1/2)

$$w_l \leq q_l \cdot u_l \qquad \forall l \in L \qquad (1)$$

$$\sum_{l \in L} \sum_{v \in V} x_{lvd} = 1 \qquad \forall d \in D \qquad (2)$$

$$\sum_{l \in L} \sum_{d \in D} z^{\alpha}_{lvd} \leq 1 \qquad \forall v \in V \qquad (3)$$

$$\sum_{l \in L} \sum_{d \in D} x_{lvd} \leq \mathcal{M} \cdot \sum_{l \in L} \sum_{d \in D} z^{\alpha}_{lvd} \qquad \forall v \in V \qquad (4)$$

$$\sum_{l \in L} \sum_{d \in D} z^{\beta}_{lvd} \leq 1 \qquad \forall v \in V \qquad (5)$$

$$\sum_{l \in L} \sum_{d \in D} x_{lvd} \leq \mathcal{M} \cdot \sum_{l \in L} \sum_{d \in D} z^{\beta}_{lvd} \qquad \forall v \in V \qquad (6)$$

$$z^{\alpha}_{lvd} + z^{\beta}_{lvd} \leq x_{lvd} \qquad \forall l \in L \ \forall v \in V \ \forall d \in D \qquad (7)$$

$$\sum_{l \in L} x_{lvd} + \sum_{l \in L} x_{lvd'} \leq 1 \qquad \forall v \in V \ \forall d \in D \ \forall d' \in \bar{D}_d \qquad (8)$$

$$\sum_{l \in L} \sum_{d \in D} \left( z^{\alpha}_{lvd} M_{ld} + z^{\beta}_{lvd} M_{ld} + x_{lvd} \mathrm{dist}_d \right) \leq a^{\mathrm{dist}}_v \qquad \forall v \in V \qquad (9)$$

$$\sum_{l \in L} \sum_{d \in D} \left( z^{\alpha}_{lvd} T_{vld} + z^{\beta}_{lvd} T_{vld} + x_{lvd} S_{vd} \right) \leq \min(a^{\mathrm{tps}}_v, T_{\max}) \qquad \forall v \in V \qquad (10)$$

avec: $\mathcal{M} \geq \mathrm{card}\,\{D\}$

# Extract of a mathematical model: constraints (2/2)

$$\sum_{l \in L} x_{lvd} \leq J_{vd} \qquad \forall v \in V \; \forall d \in D \qquad (11)$$

$$\sum_{l \in L} \sum_{d \in D} x_{lvd} \cdot \gamma_d \leq b_v \qquad \forall v \in V \qquad (12)$$

$$\sum_{v \in V} \sum_{d \in D} x_{lvd} \cdot \gamma_d \leq \Theta \cdot w_l \qquad \forall l \in L \qquad (13)$$

$$u_l \in \{0, 1\} \qquad \forall l \in L \qquad (14)$$

$$w_l \in \mathcal{N} \qquad \forall l \in L \qquad (15)$$

$$x_{vd} \in \{0, 1\} \qquad \forall v \in V, \forall d \in D \qquad (16)$$

$$z^{\alpha}_{lvd} \in \{0, 1\} \qquad \forall l \in L, \forall v \in V, \forall d \in D \qquad (17)$$

$$z^{\beta}_{lvd} \in \{0, 1\} \qquad \forall l \in L, \forall v \in V, \forall d \in D \qquad (18)$$

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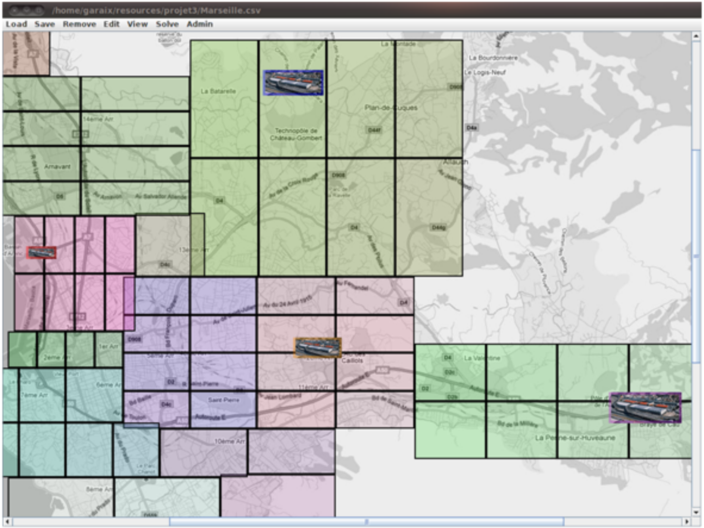
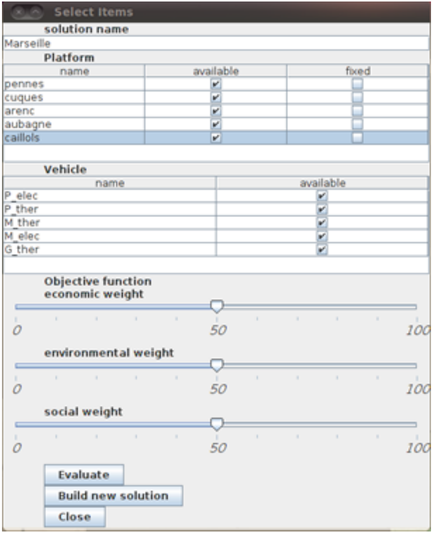
4 Screenshots of the decision-making tool

# Screenshot: instance



# Screenshot: optimization tool



# Screenshot: solution