



Locational Optimization As a Stabilizer of Mobility-hub Design

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Designing Locations



What to consider for facility planning

- Stakeholders, activities, and strategies...
- Location is an important factor

Roadside Stations in Japan

- Designated by MLIT
(Ministry of Land, Infrastructure, Transport and Tourism)
- Managed by local governments



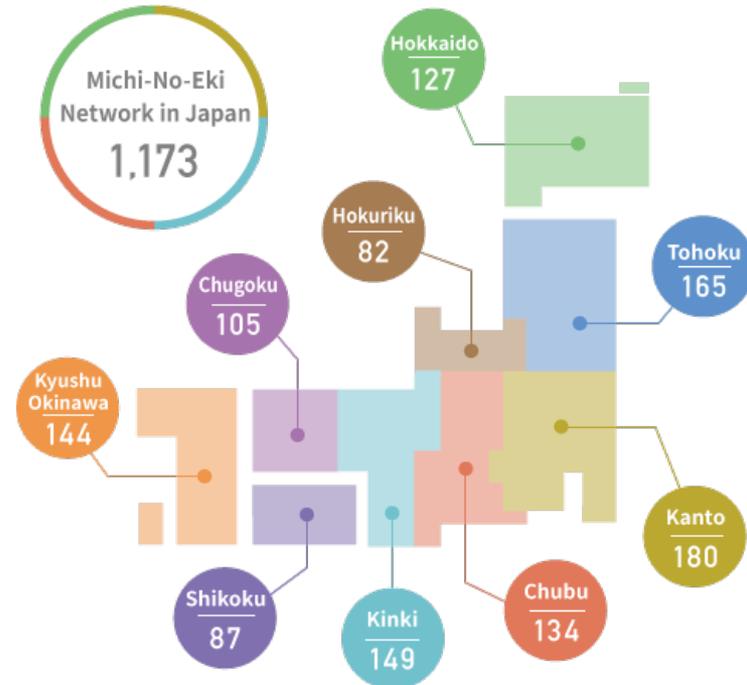
Park & Rest



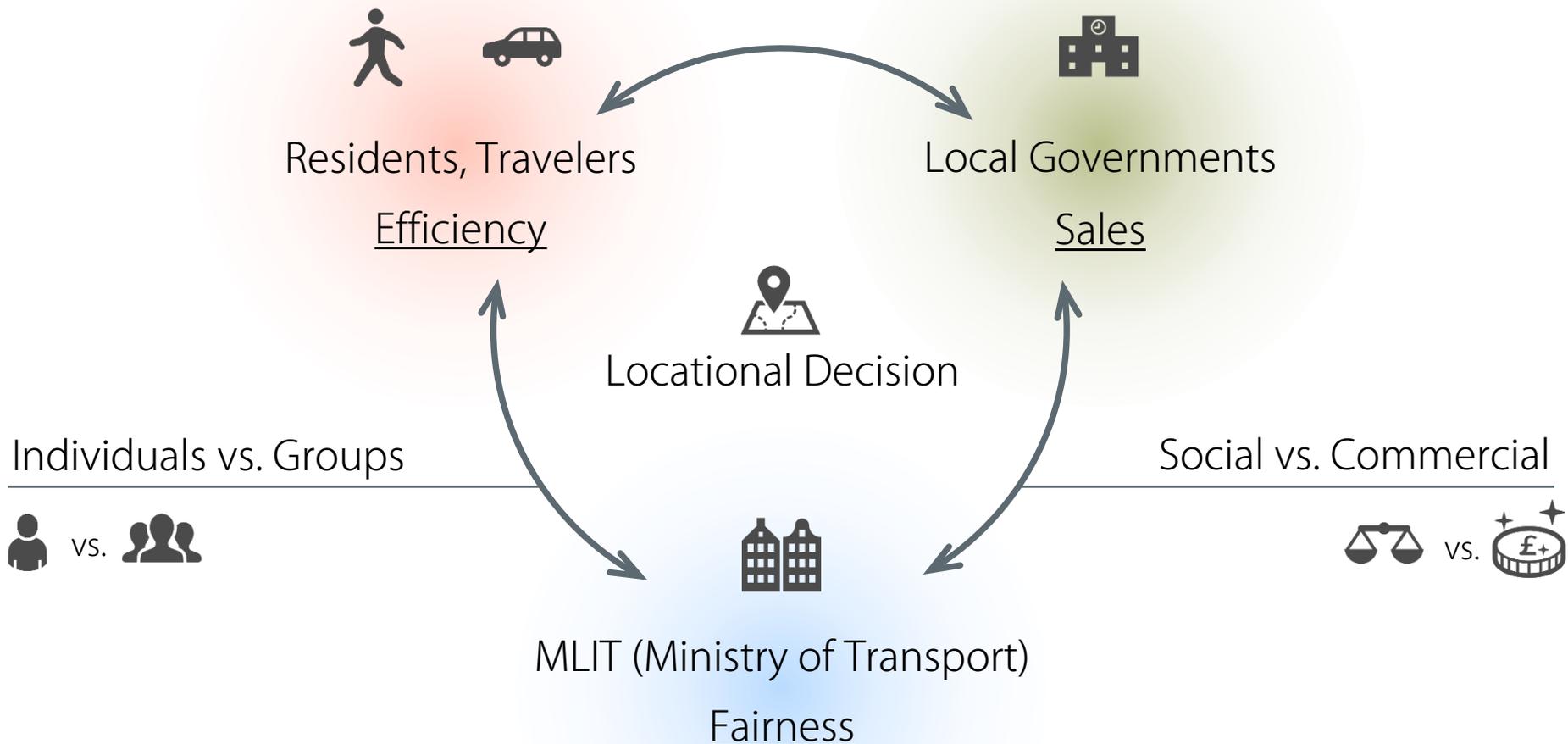
Market



Information



Stakeholders



Best location is different for each stakeholder

Aim of This Talk



Institute of Industrial Science,
The University of Tokyo

As one of the MLIT official projects

- Locational evaluation of roadside stations regarding multiple criteria
(Project leader: Dr. Kazushi Sano)
- Based on the results of Team IV
(with Mr. Shinichiro Kai, Dr. Ryota Horiguchi, Dr. Kazushi Sano, and Dr. Takashi Oguchi)

Focusing on...

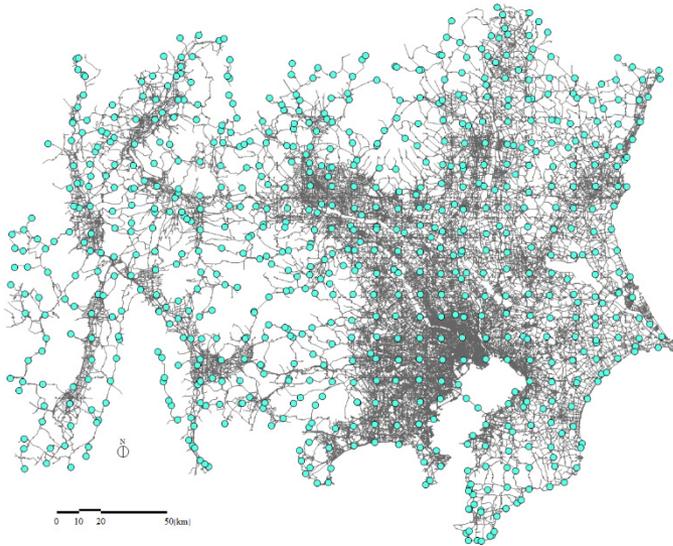
1. How to apply digital tools for locational decision
 - Introduction to “Integer Programming”
2. How to stabilize the deviations between stakeholders
 - Not to decide, but rather to understand

Integer programming

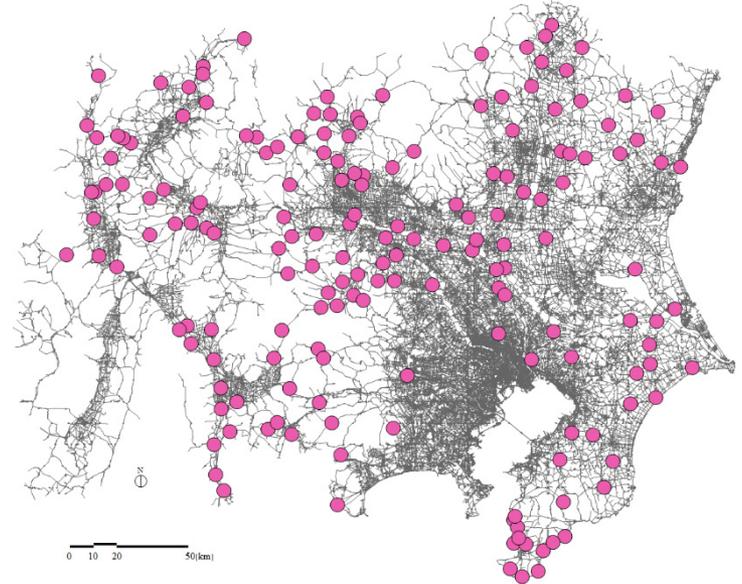
Digital tool for optimization

- 175 out of 735 $\Rightarrow 5.53 \times 10^{173}$ patterns

Candidate sites



Selected Locations (Current sites)



$$x_i = \begin{cases} 1 & \text{if locate at candidate site } i \\ 0 & \text{otherwise} \end{cases}$$

Used GIS Data

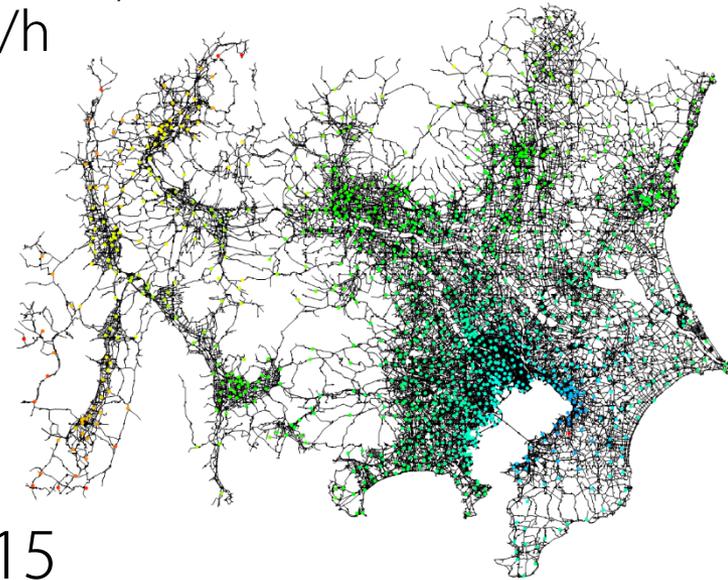


Road network data

- Official digital road network in 2017
 - 245,709 nodes, 358,702 links
- To calculate travel time
 - Highways: 60km/h, arterial roads: 30km/h, normal roads: 15km/h, others : 7.5km/h

Demand Assumptions

- For Neighboring residents :
population census data in 2015
 - 1,324 demand points in total
- For travellers :
Inter-Regional Travel Survey in 2015
 - 139,002 flow patterns in total

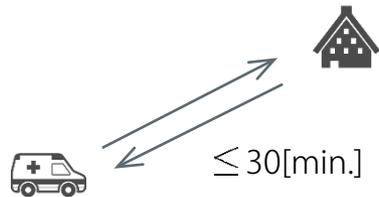
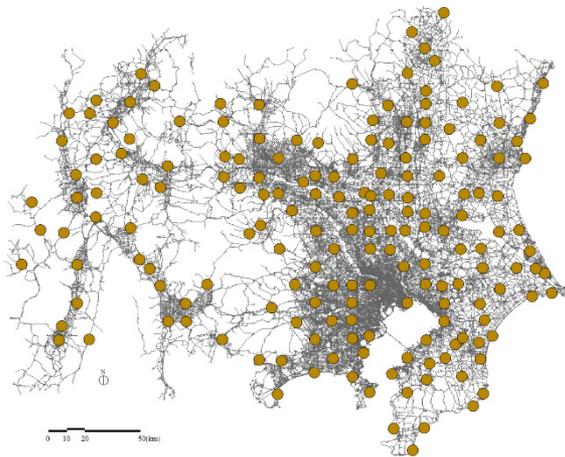


Multiple Criteria

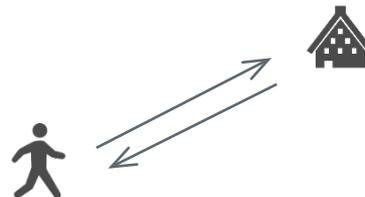
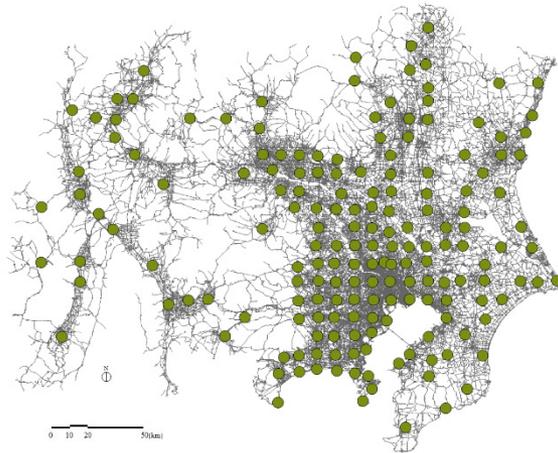
Optimal solution will change

- Every criterion seems appropriate

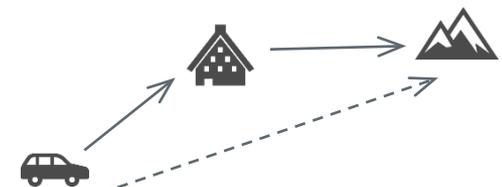
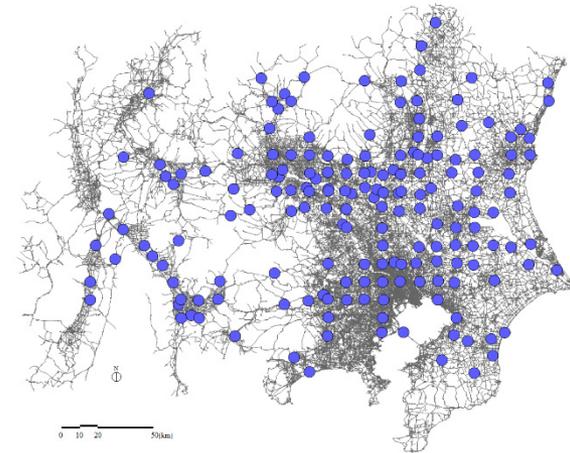
(A) max. the number of neighboring residents within 30 minutes



(B) min. the average access time of neighboring residents



(C) min. the average detouring time of traveling people

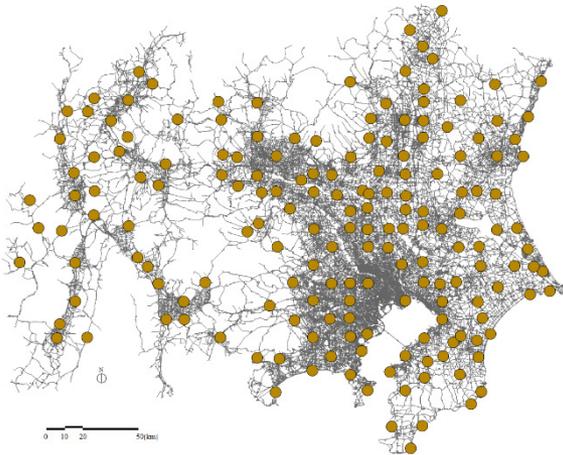


Multiple Criteria

Optimal solution will change

- Every criterion seems appropriate

(A) max. the number of neighboring residents within 30 minutes

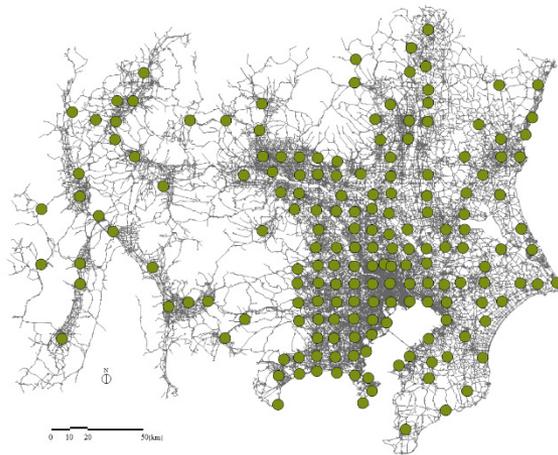


(A) coverage : 98.58[%]

(B) access time : 18.92[min.]

(C) detouring time : 3.57[min.]

(B) min. the average access time of neighboring residents

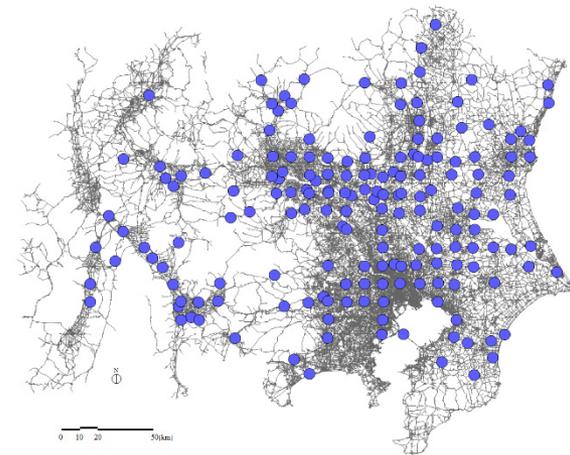


(A) coverage : 95.93[%]

(B) access time : 15.81[min.]

(C) detouring time : 2.43[min.]

(C) min. the average detouring time of traveling people

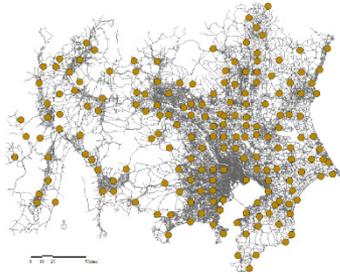


(A) coverage : 83.89[%]

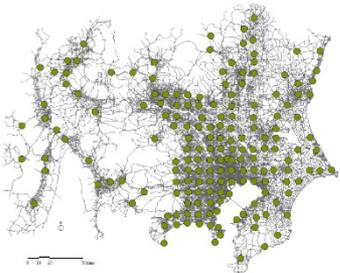
(B) access time : 20.85[min.]

(C) detouring time : 1.33[min.]

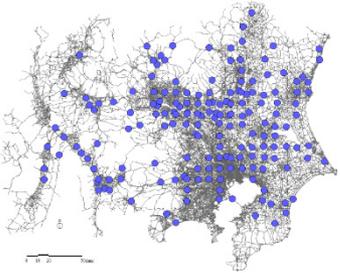
Multi-objective Optimization



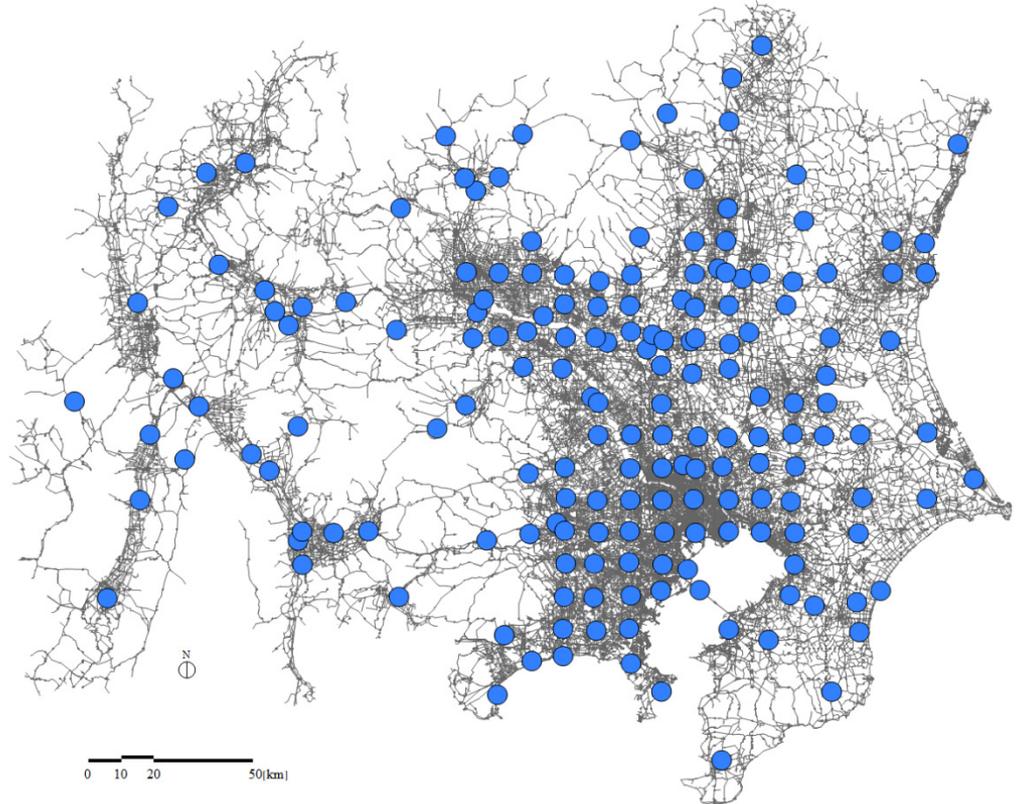
(A) coverage : 98.58[%]



(B) access time : 15.81[min.]



(C) detouring time : 1.33[min.]



(A) coverage : 94.70[%]

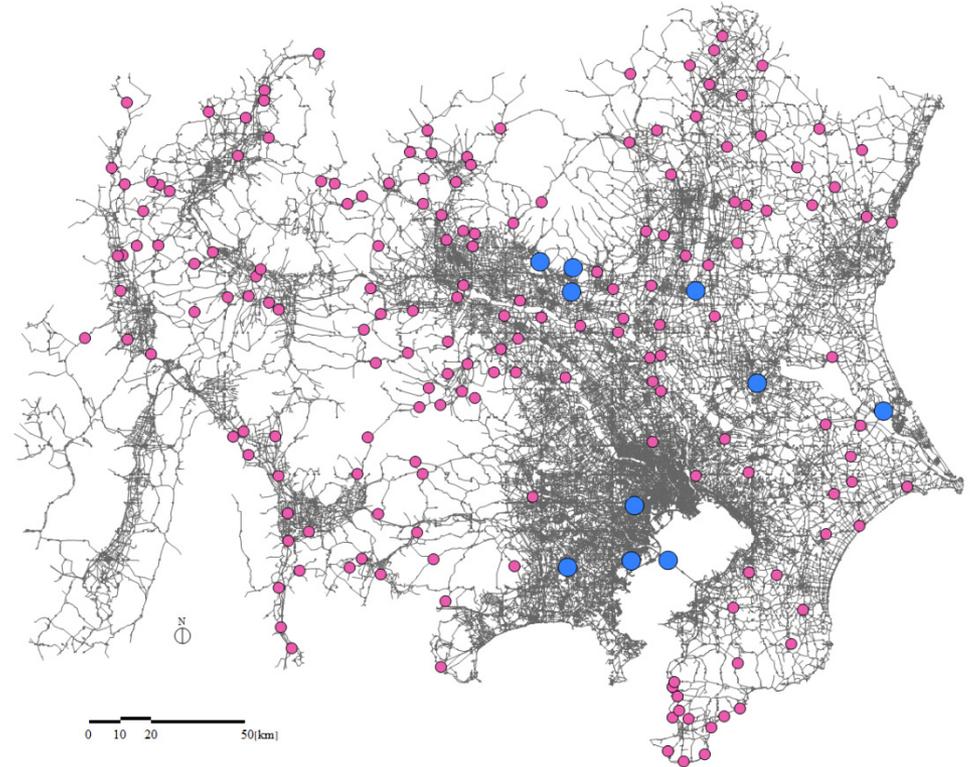
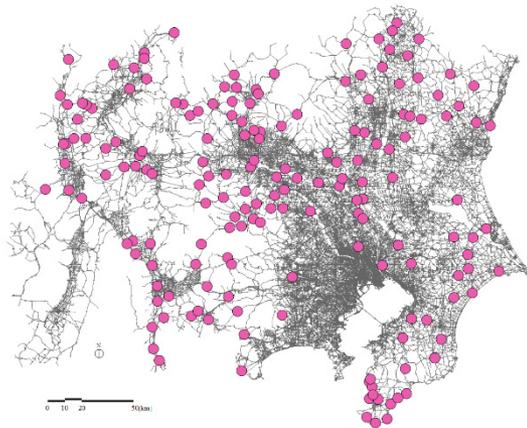
(B) access time : 16.64[min.]

(C) detouring time : 1.40[min.]

Additional New Facilities

Additional new facilities (from Social viewpoint)

Current sites (Commercial viewpoint)



(A) coverage : 42.82[%]
(B) access time : 35.62[min.]
(C) detouring time : 5.55[min.]

(A) coverage : 67.79[%]
(B) access time : 26.75[min.]
(C) detouring time : 2.93[min.]

As a Stabilizer of...



Deviation between different perspectives

- Evaluating the sensitivity of objective values
- Multi-objective optimization

Deviation between social vs. commercial viewpoints

- Additional new facilities can reduce a gap
- Mathematical method to calculate the optimal subsidy

Deviation between stakeholders

- Optimization is a “tool” for better understanding



Thank you.

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