Shared Autonomous Vehicle System in Residential Suburban Areas

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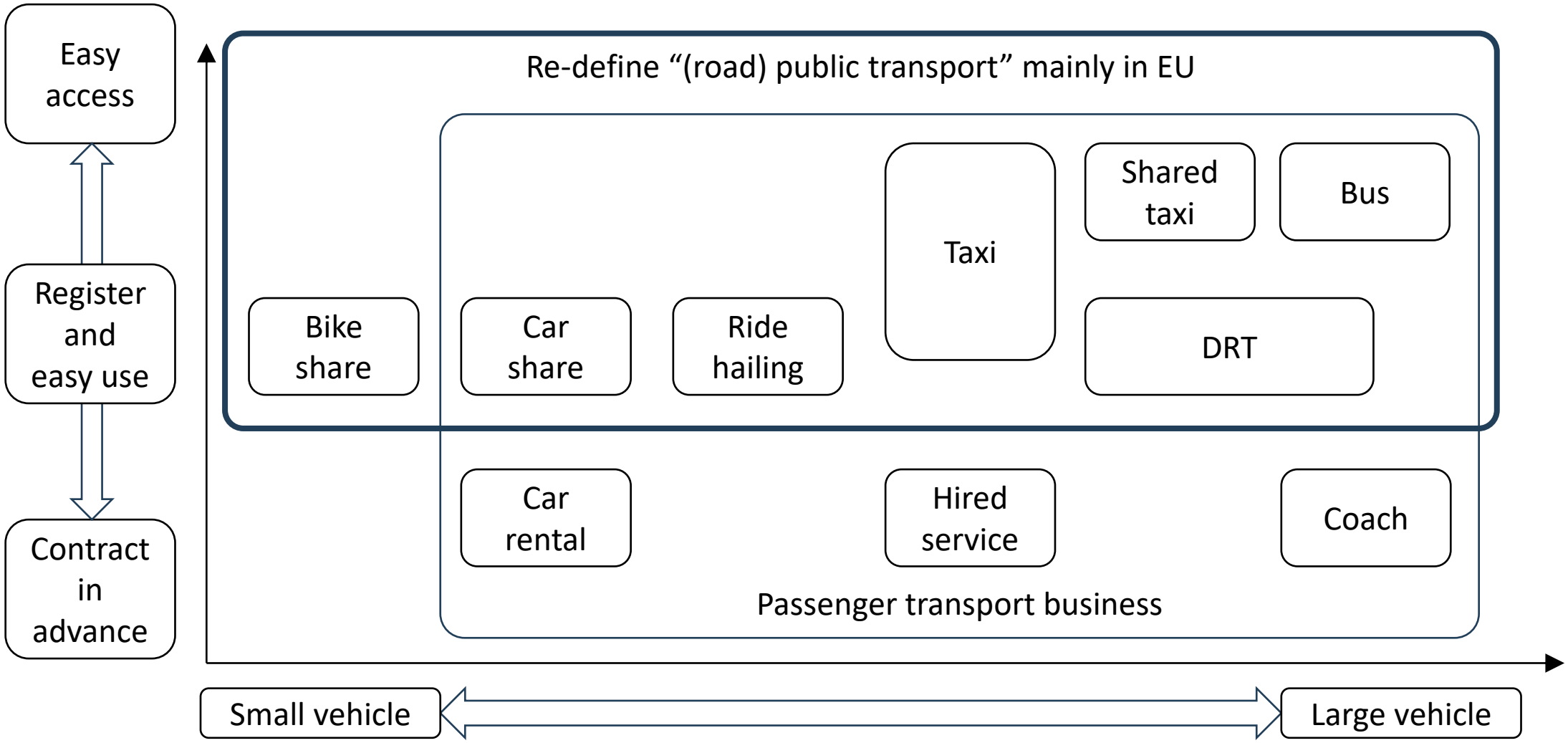
Introduction to Case Study of Smart City

Kasugai City

- https://www.jasca2021.jp/practices/area/japan/#case321

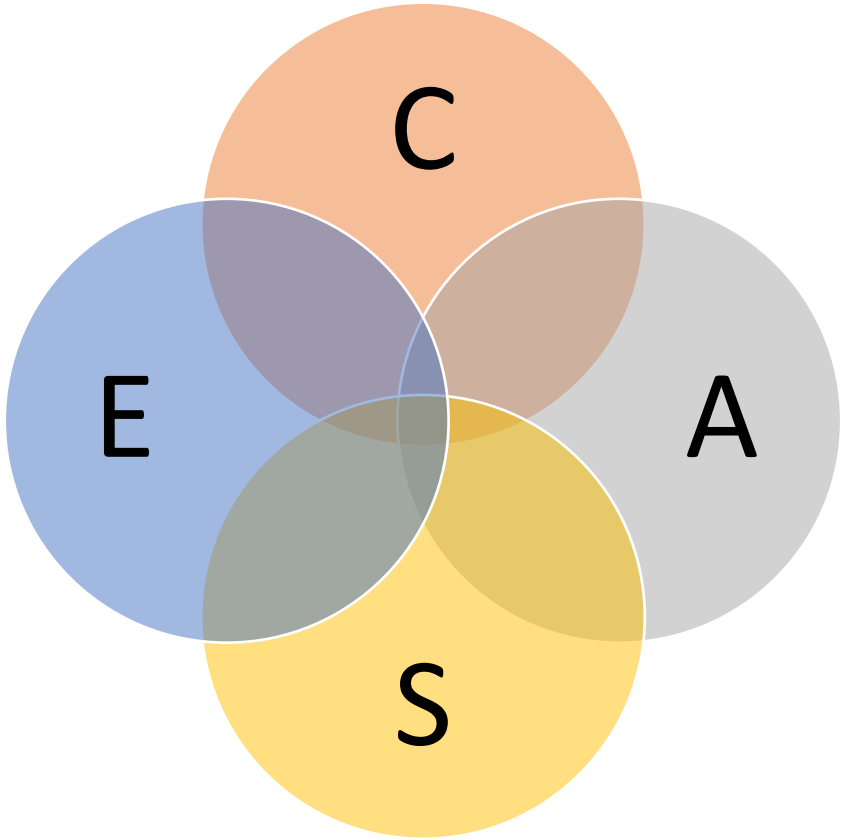
From Public Transport to Transport for Public



Source: Nakamura (2022)

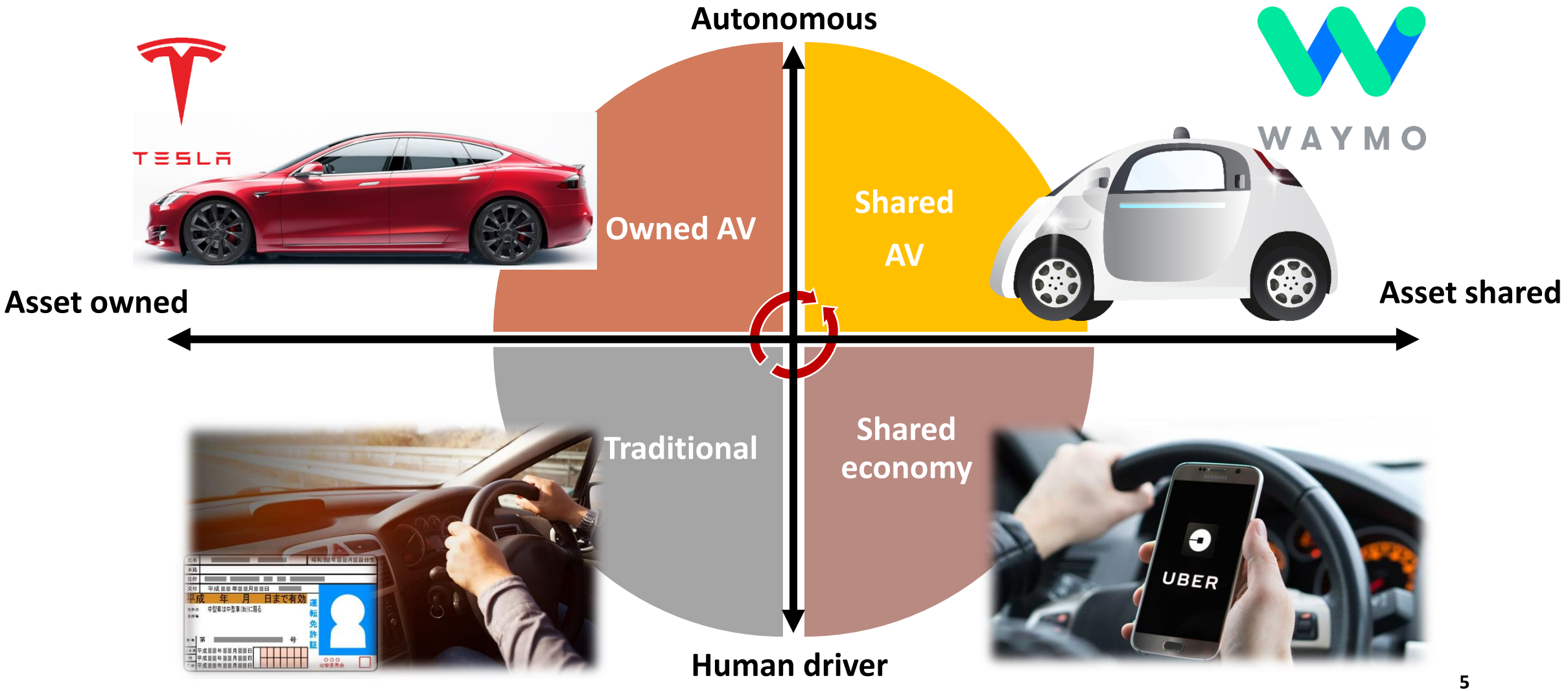
CASE

- Connected
- Autonomous
- Shared
- Electric

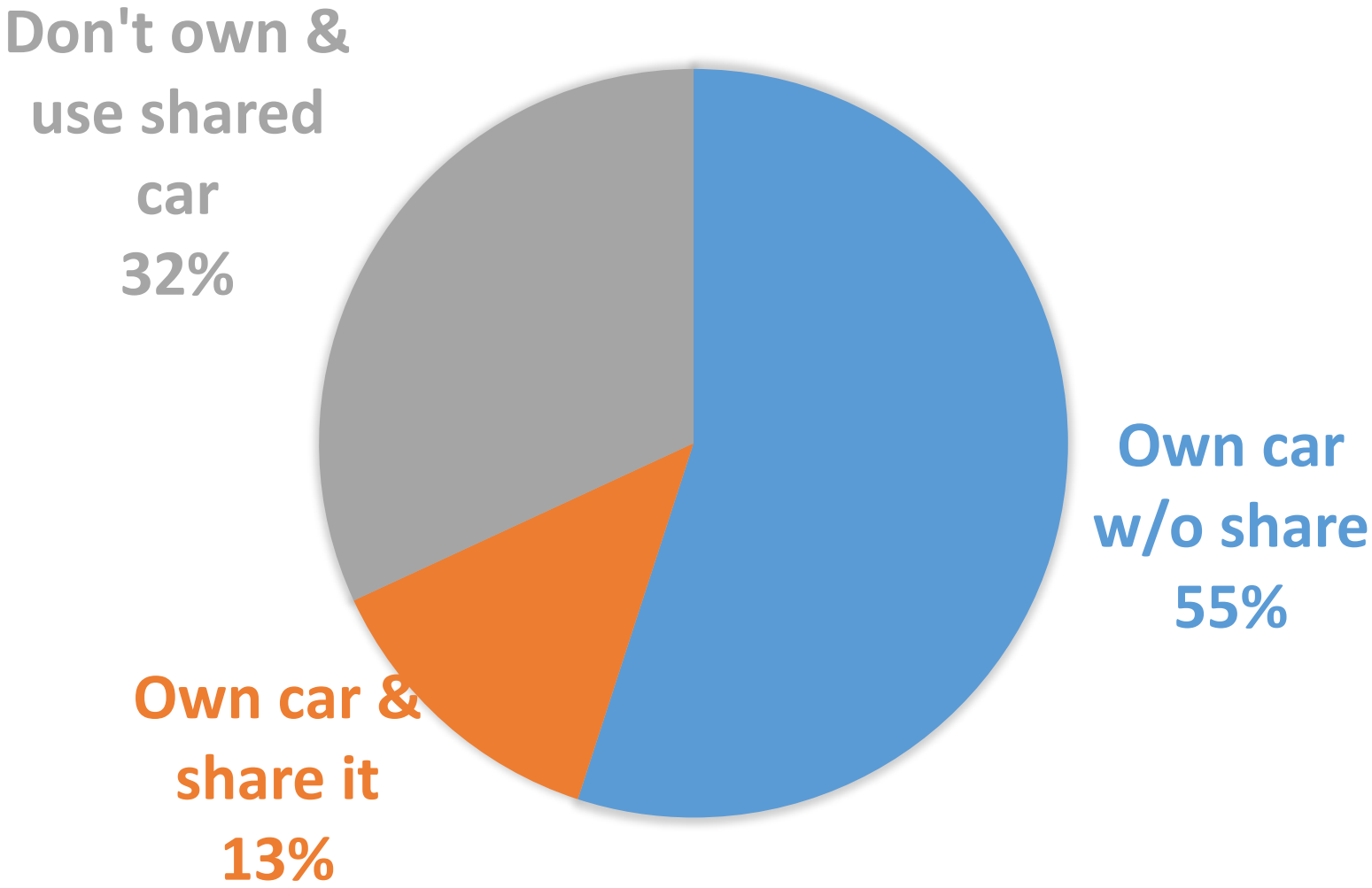


"Connected, Autonomous, Shared, Electric: Each of these has the power to turn our entire industry upside down. But the true revolution is in combining them in a comprehensive, seamless package." by Dr. Dieter Zetsche (Chairman of the Board of Management of Daimler AG)

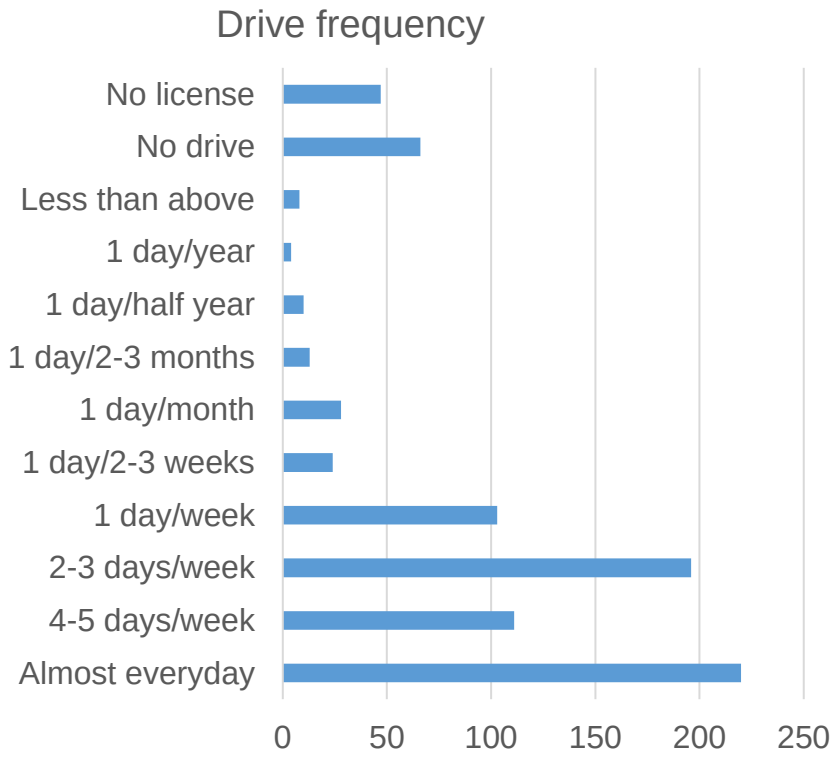
Shared Autonomous Vehicle (SAV)

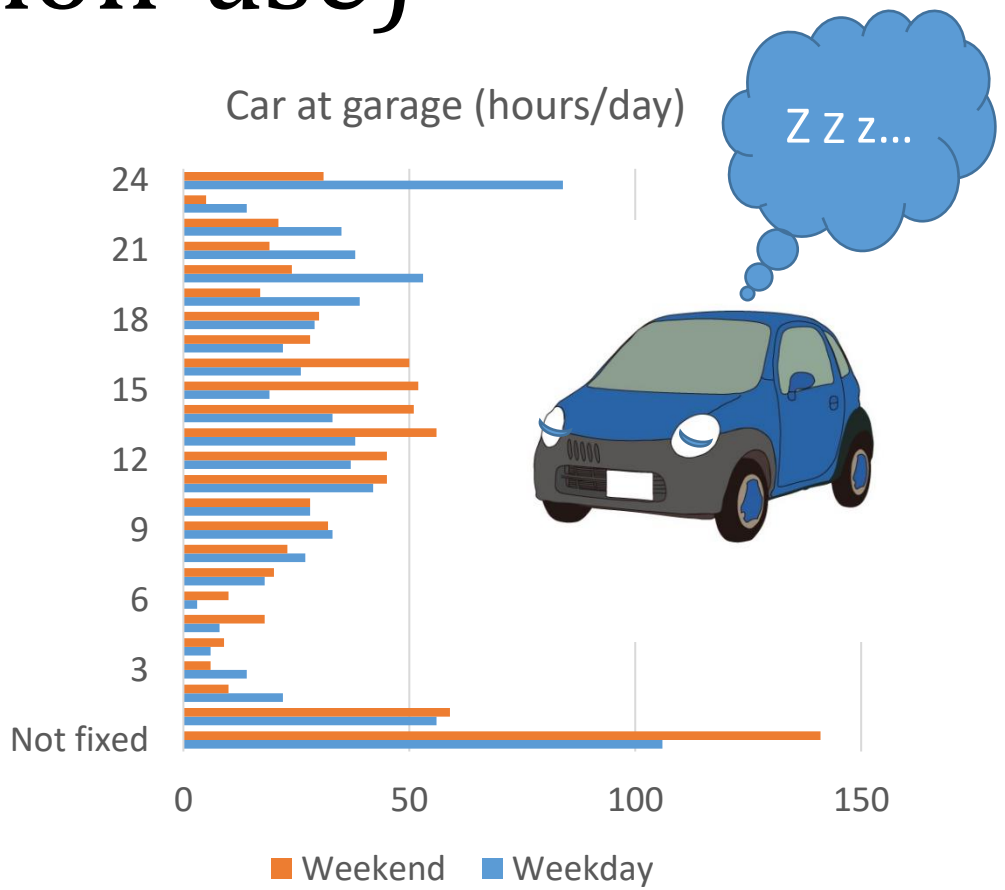


Intention for autonomous vehicle ownership & shared use (N=803)



Current car use (or non-use)





- 14 & 13 hrs. at garage on weekday and weekend on average
- 10% & 14% of households don't use car on weekday and weekend

Motorization, suburbanization and ageing

Automobiles:

- widely spread & increasing
- become daily necessities

→dependency on automobile

Land use:

- population central → suburbs
- suburban sprawl

→inefficient public transit service

Mobility poor at suburban area

Focus

1. combination of P&R and AV in suburbs
   - P&R → offer sustainable mobility service in suburbs
   - mass transportation megacities→ solid fundamental

2. mobility challenged people (aka, transportation poor in Japan)
   - AV → high safety, convenience

Proposed SAV System

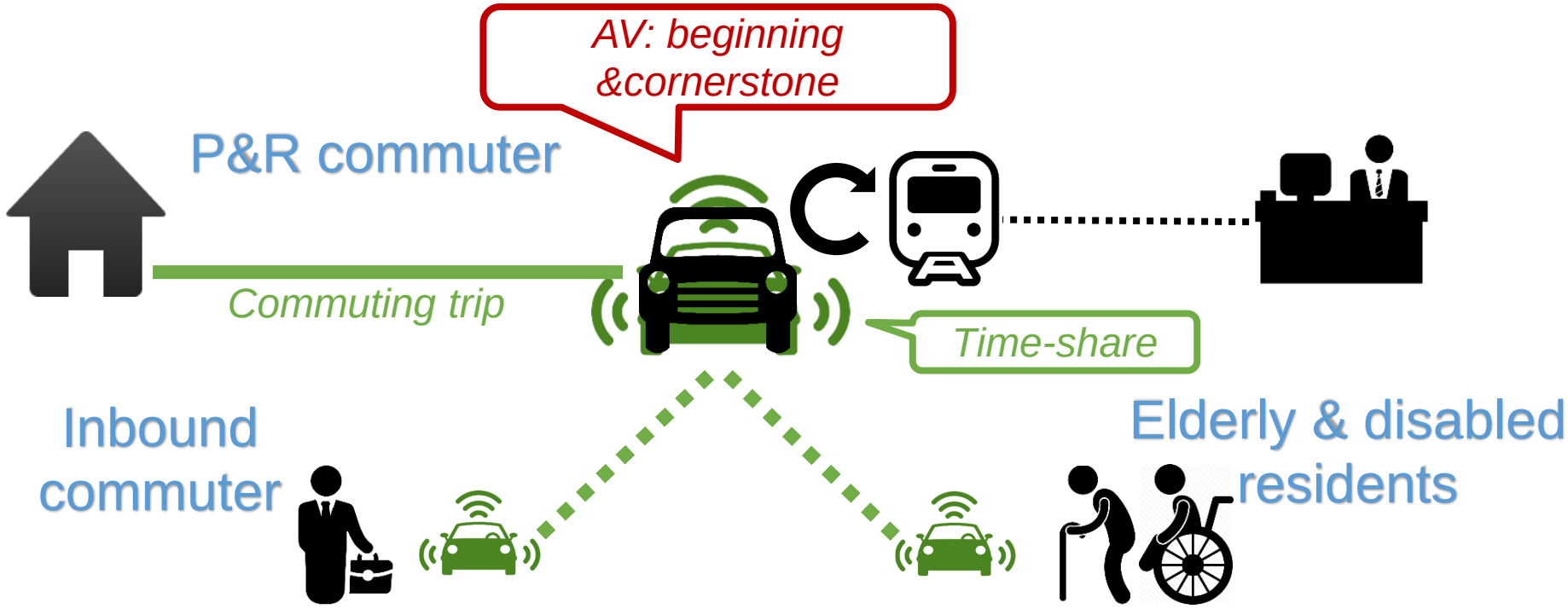
3 Groups:

1. Park & Ride commuter
   - Transfer at selected stations
   - Depart out of target areas
   - Access mode private vehicle
2. Inbound commuter
   - Destination within target areas
   - Egress mode private vehicle
3. Elderly & disabled residents
   - Residents within target areas
   - Mobility difficulties
   - Age over 70

How to find supply/demand?

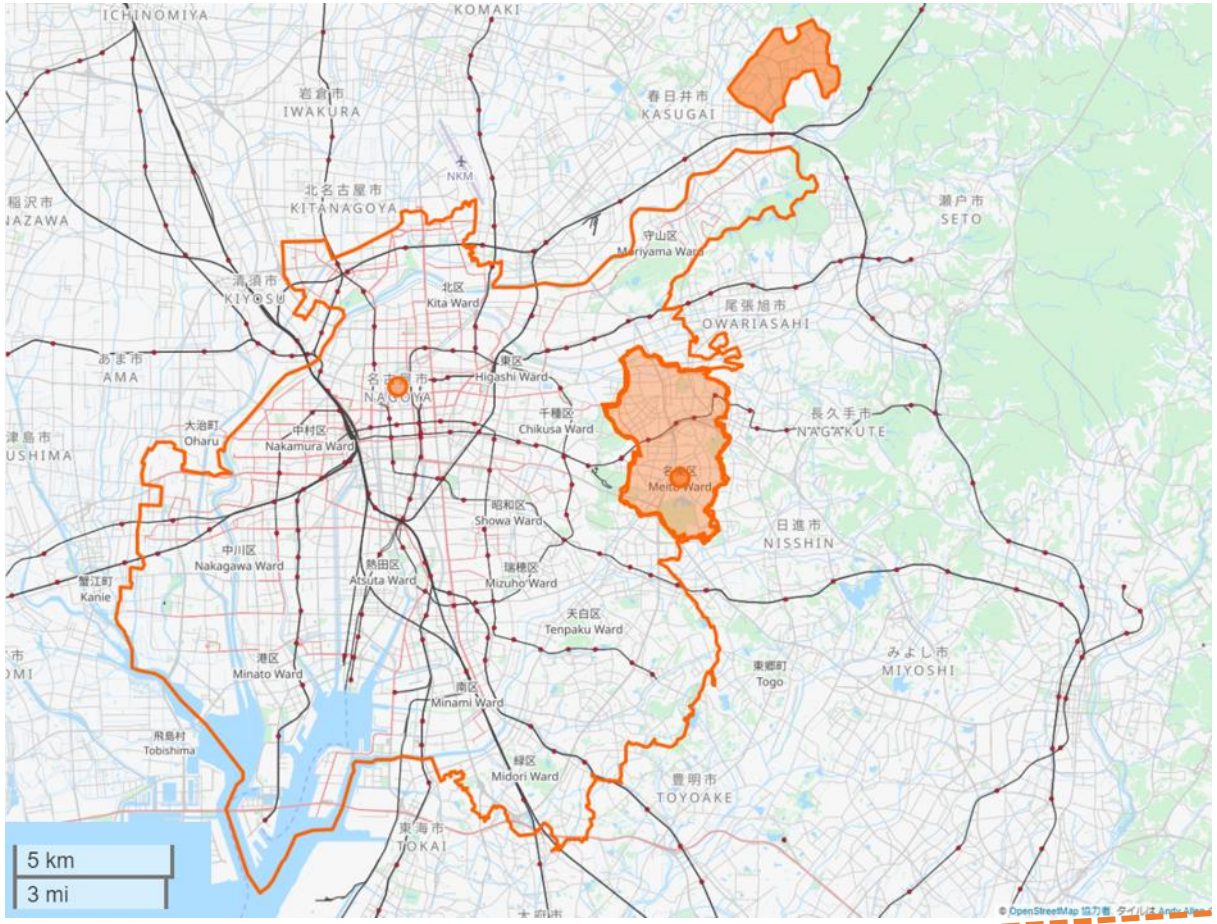
Supply

Proposed SAV System



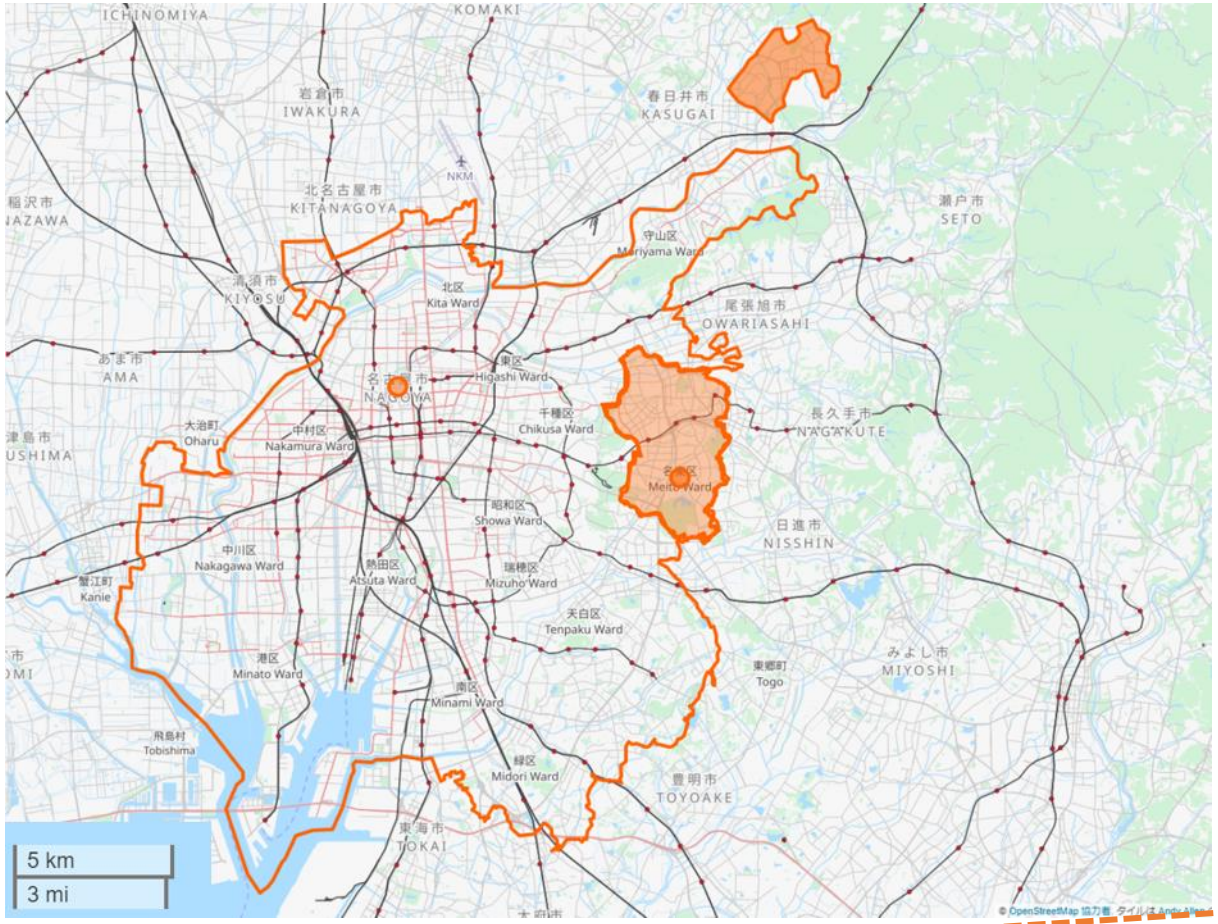
Study cases


Nagoya Metropolitan Area
Japan
Wakkanai
Nayoro
Abashiri
Kushiro
Tomakomai
Hakodate
Aomori
Akita
Miyako
Sendai
Niigata
Iwaki
Suzu
Kanazawa
Numata
Tokyo
Hamamatsu
Osaka
Matsue
Hiroshima
Fukuoka
Uwajima
Goto
Yatsushiro
Kagoshima
Busan
Vladivostok
Jixi
Suifenhe
Yanji
Gangneung
100 km
100 mi


ICHINOMIYA
KOMAKI
IWAKURA
KASUGAI
KITANAGOYA
SETO
KIYOSU
Moriyama Ward
Kita Ward
OWARIASAHI
AMA
Higashi Ward
NAGOYA
Chikusa Ward
Oharu
Nakamura Ward
NAGAKUTE
Meito Ward
Showa Ward
NISSHIN
Nakagawa Ward
Atsuta Ward
Mizuho Ward
Kanie
Tenpaku Ward
Minato Ward
Togo
MIYOSHI
Minami Ward
Tobishima
Midori Ward
TOYOAKE
TOKAI
5 km
3 mi

Study cases


Nagoya Metropolitan Area
Japan
Wakkanai
Nayoro
Abashiri
Kushiro
Tomakomai
Hakodate
Aomori
Akita
Miyako
Sendai
Iwaki
Niigata
Numata
Kanazawa
Suzu
Tokyo
Hamamatsu
Osaka
Matsue
Hiroshima
Fukuoka
Uwajima
Goto
Yatsushiro
Kagoshima
Busan
Gangneung
Vladivostok
Yanji
Jixi
Suifenhe
100 km
100 mi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Minami Ward
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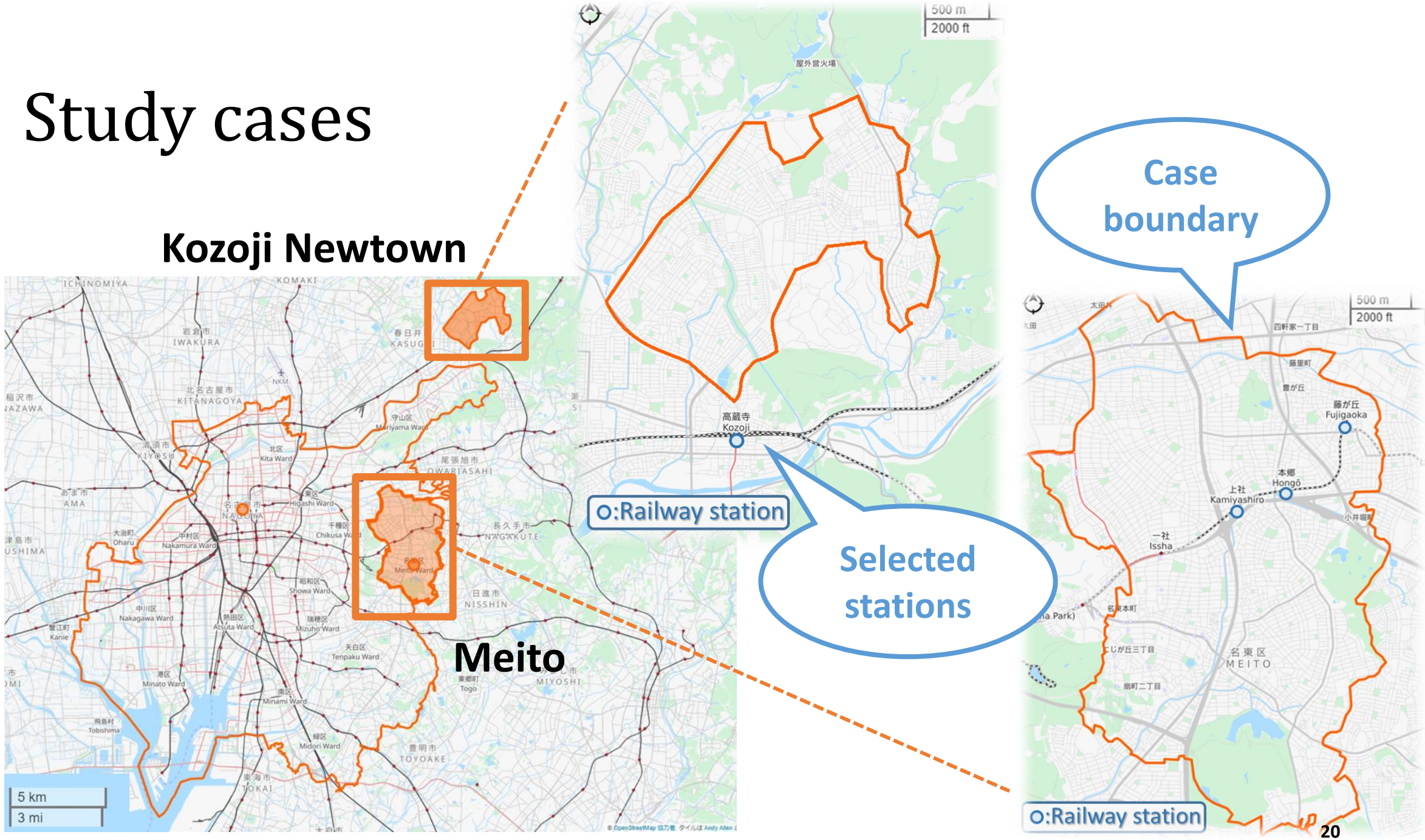
MIYOSHI
TOYOAKE
TOKAI
Oharu
Kanie
5 km
3 mi

Study cases


Kozoji Newtown
Meito
Case boundary
Selected stations
O:Railway station
O:Railway station
高蔵寺
Kozoji
Fujigaoka
Hongō
Kamiyashiro
Issha
名東区
MEITO
500 m
2000 ft
5 km
3 mi

Simulation

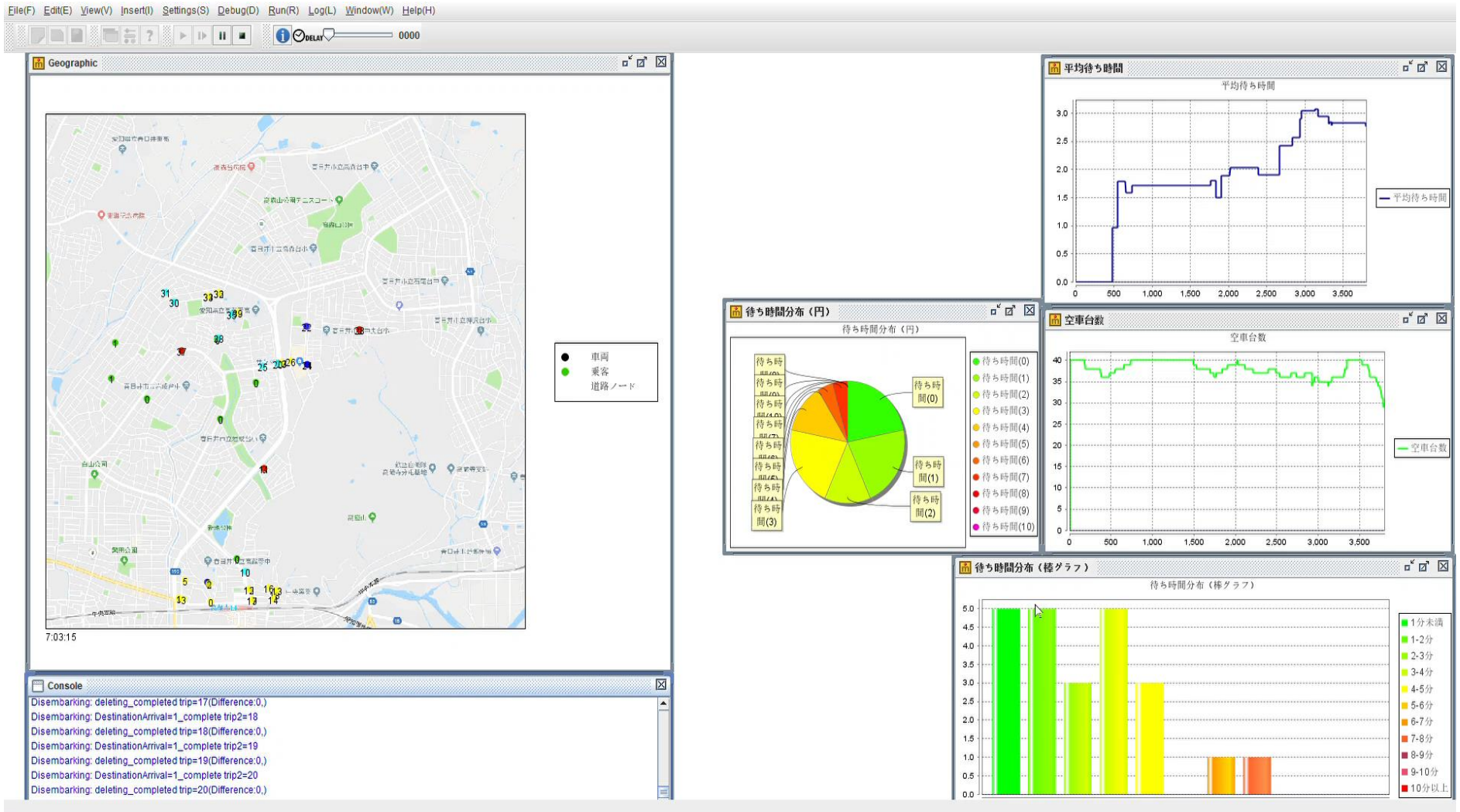
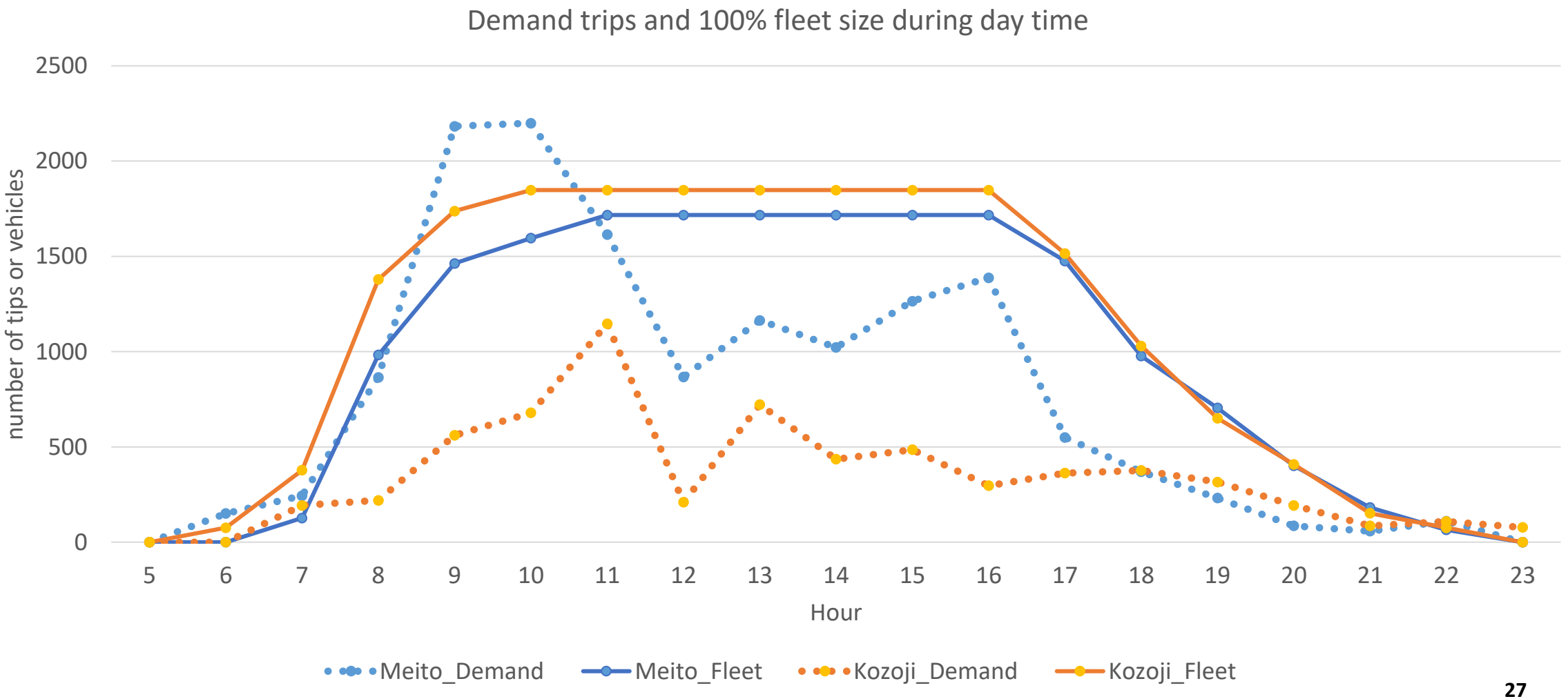


Figure 5. Interface of agent-based simulation (source: artisoc)

P&R combined SAV system

- Background
- Objective
- Simulation
- Results
- Conclusion and limitation

Results
—Demand and supply during daytime



Results —Operation Ratio

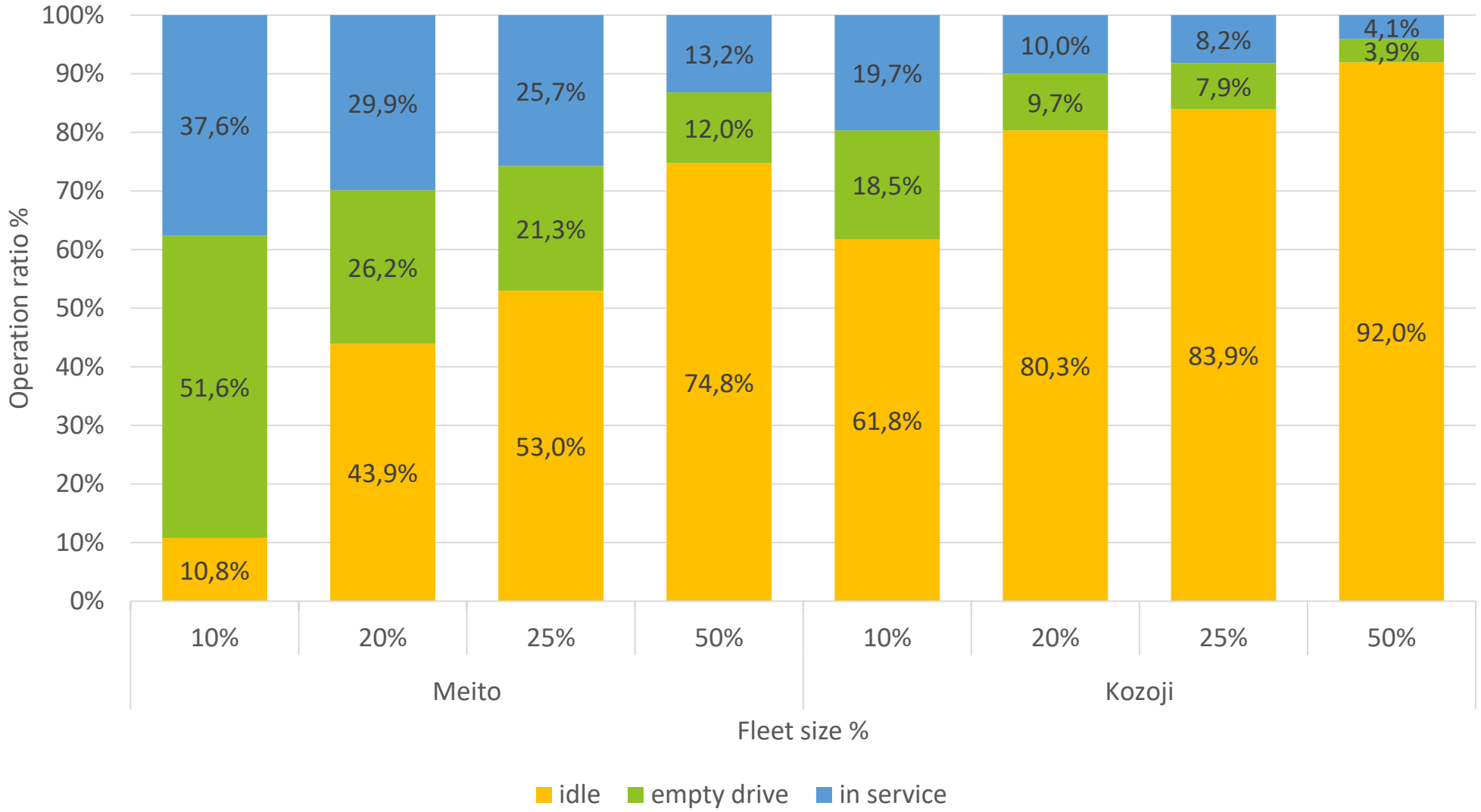


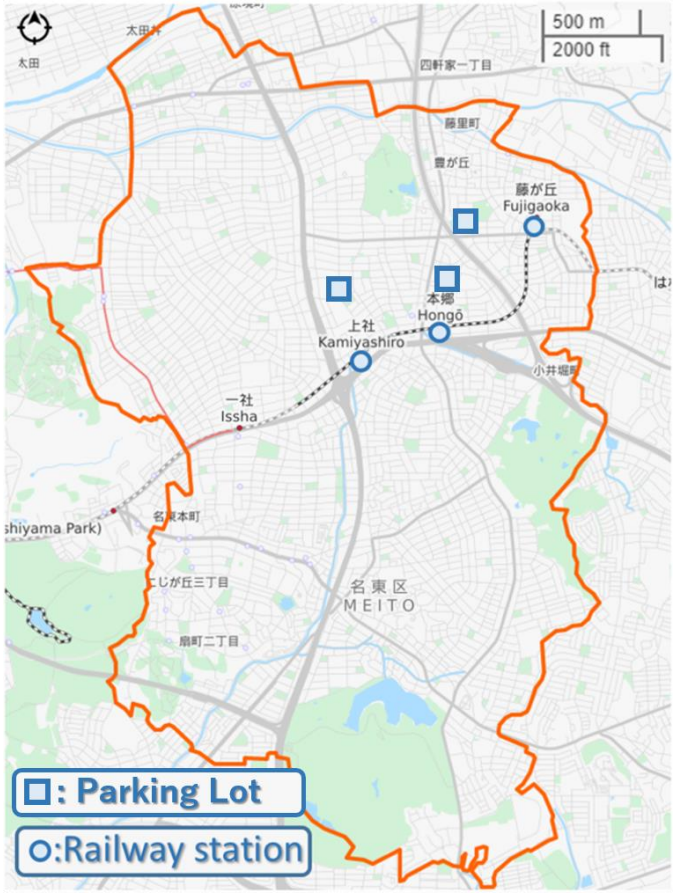
Figure. Operation ratio of Meito's various fleets

Ride-sharing Electric Autonomous Vehicle System

- Background
- Objective
- System & Study cases
- Simulation
- Results and conclusion

Study Cases
—Charging Scenario 1: base case

Meito



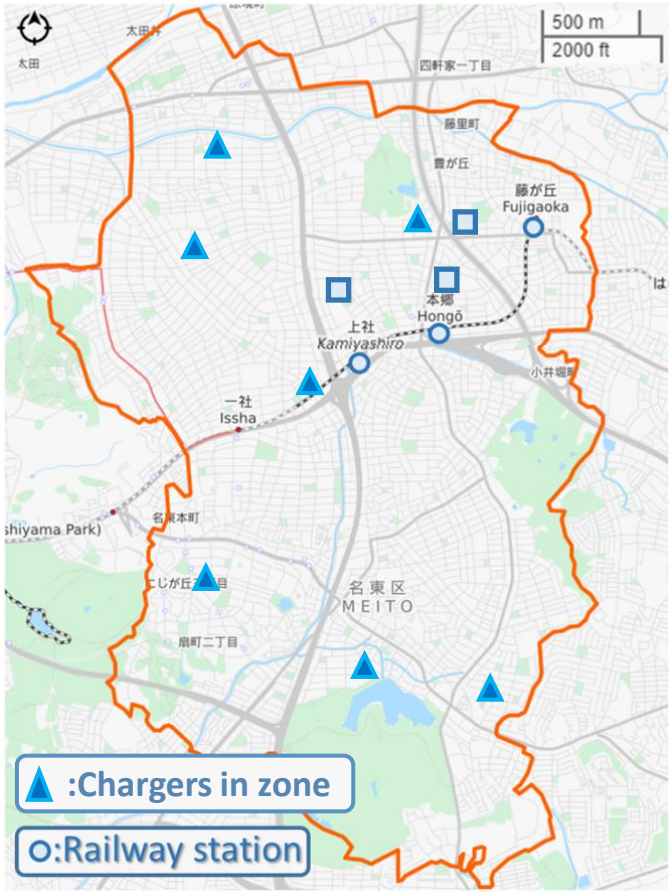
3 chargers

Kozoji-Newtown

2 chargers

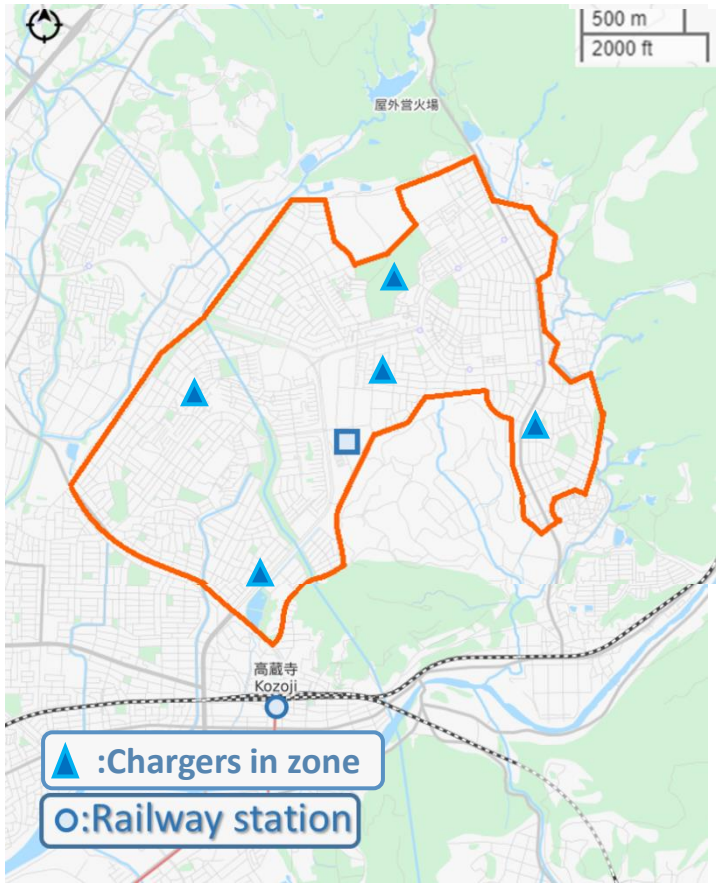
Study Cases
—Charging Scenario 2: additional chargers

Meito



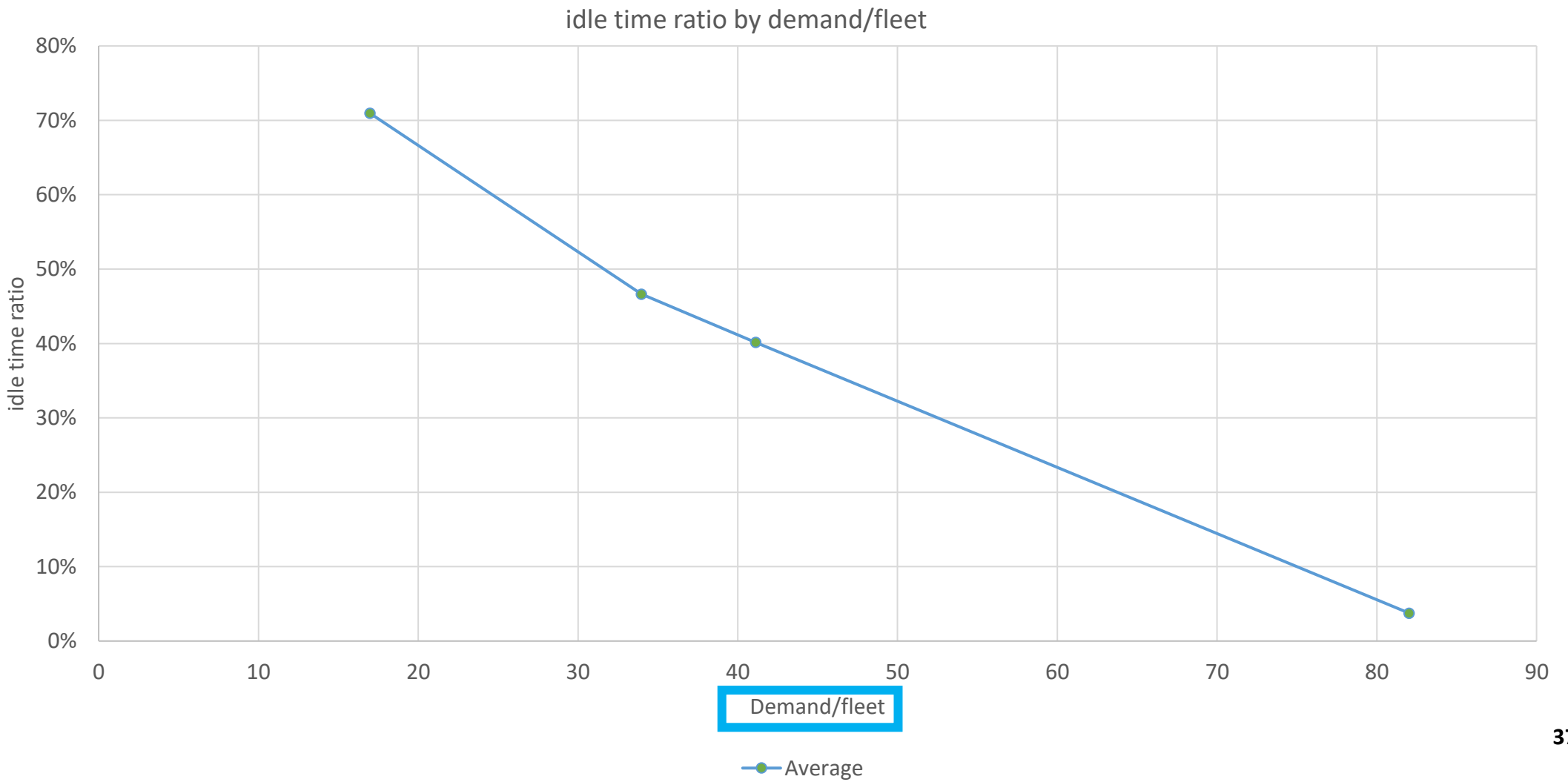
10 chargers

Kozoji-Newtown

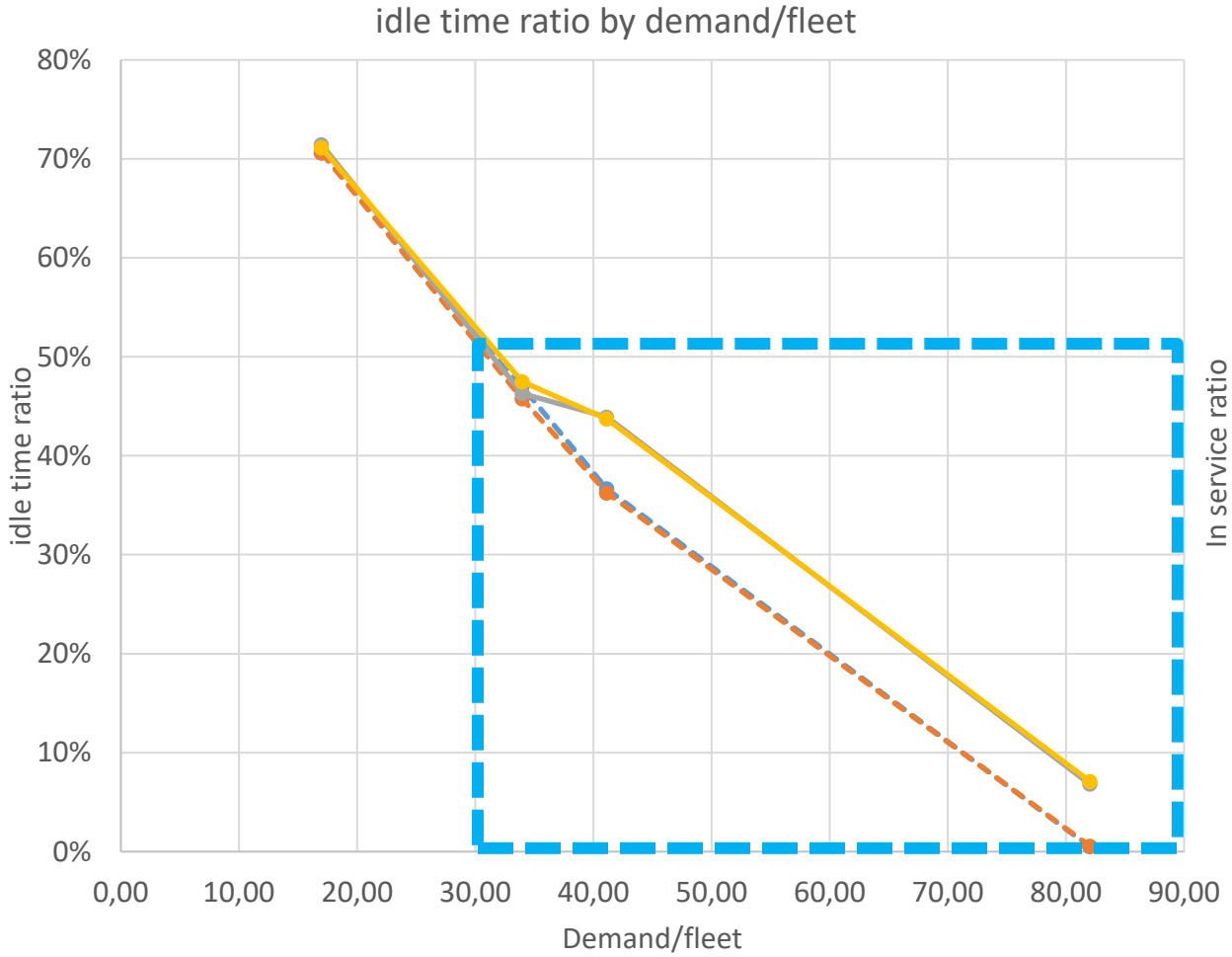


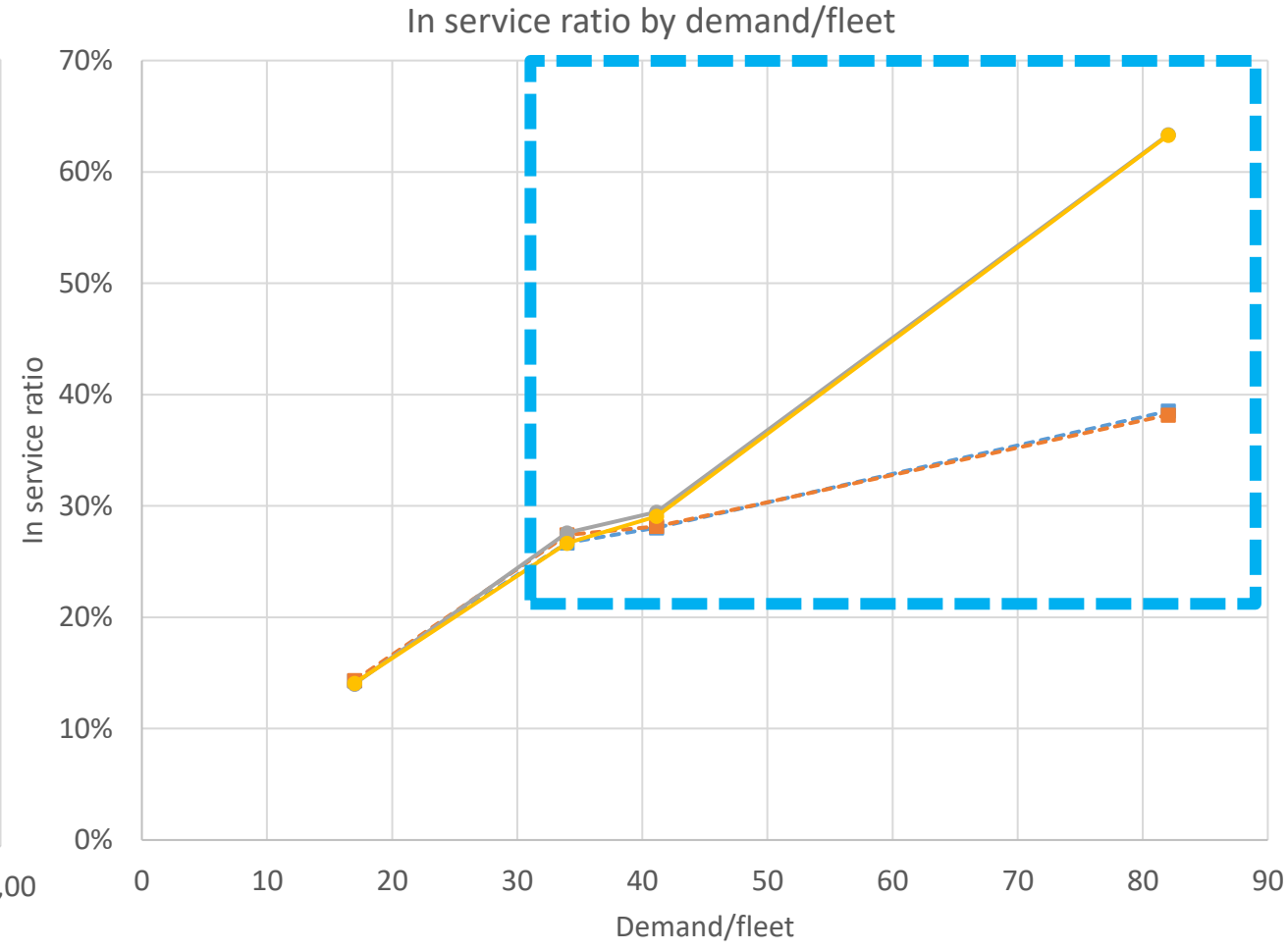
6 chargers

Results: Idle ratio by demand per vehicle

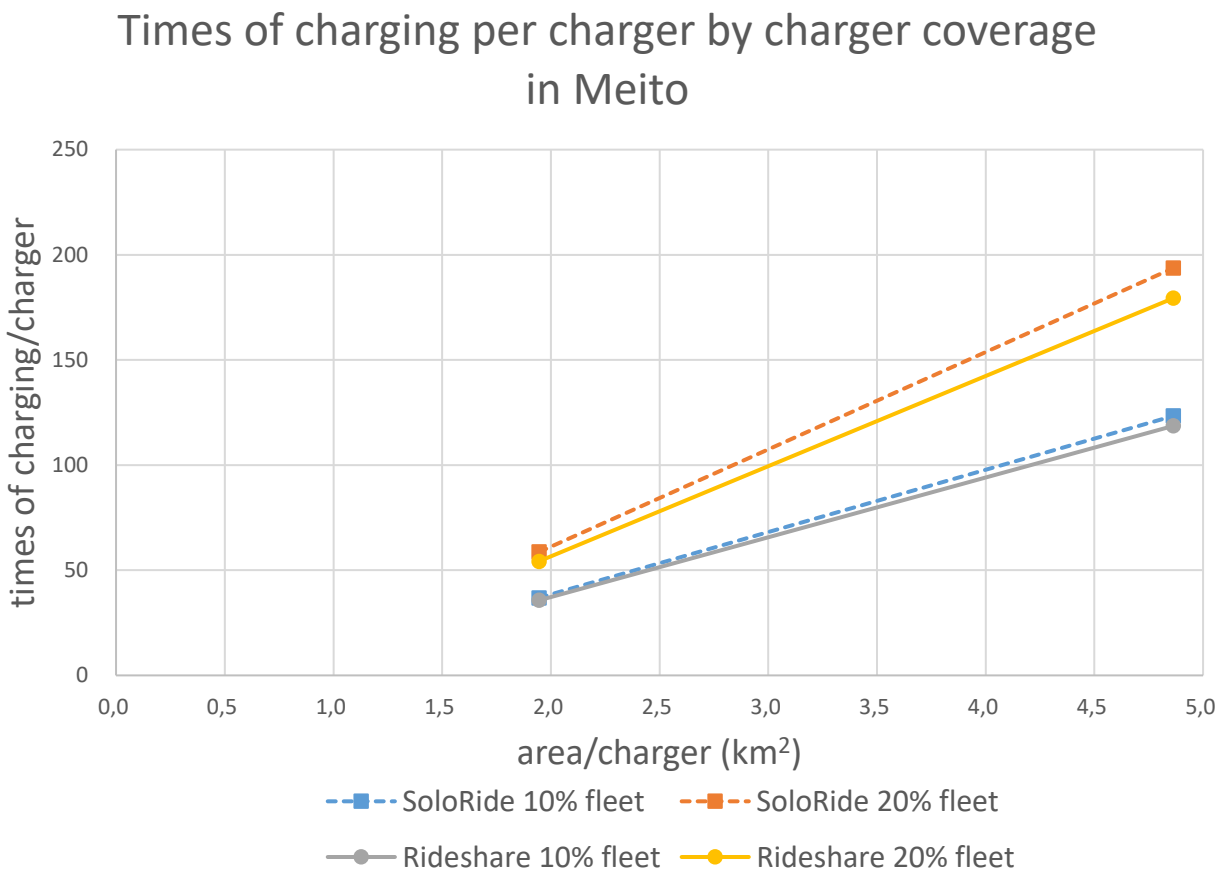


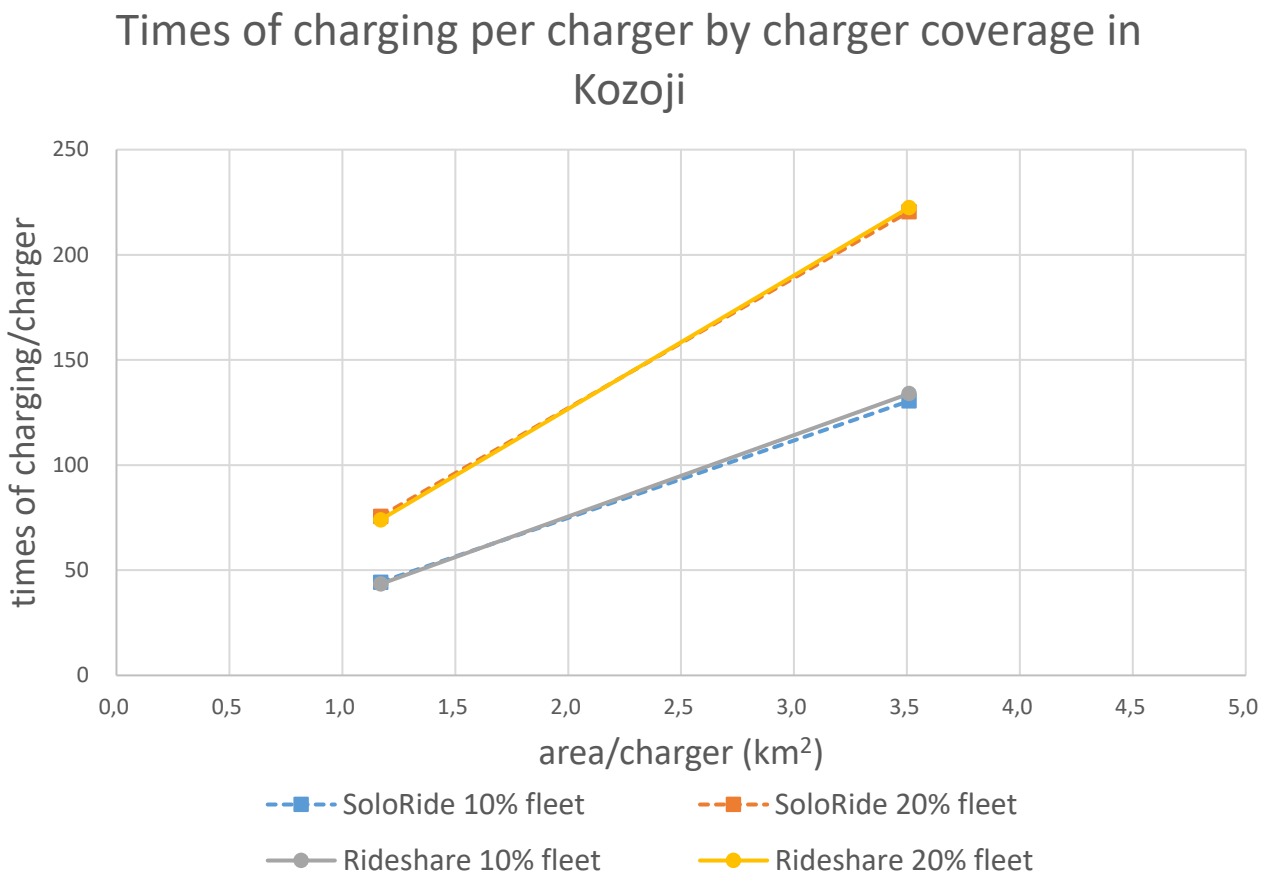
Results: idle, utilized time ratio



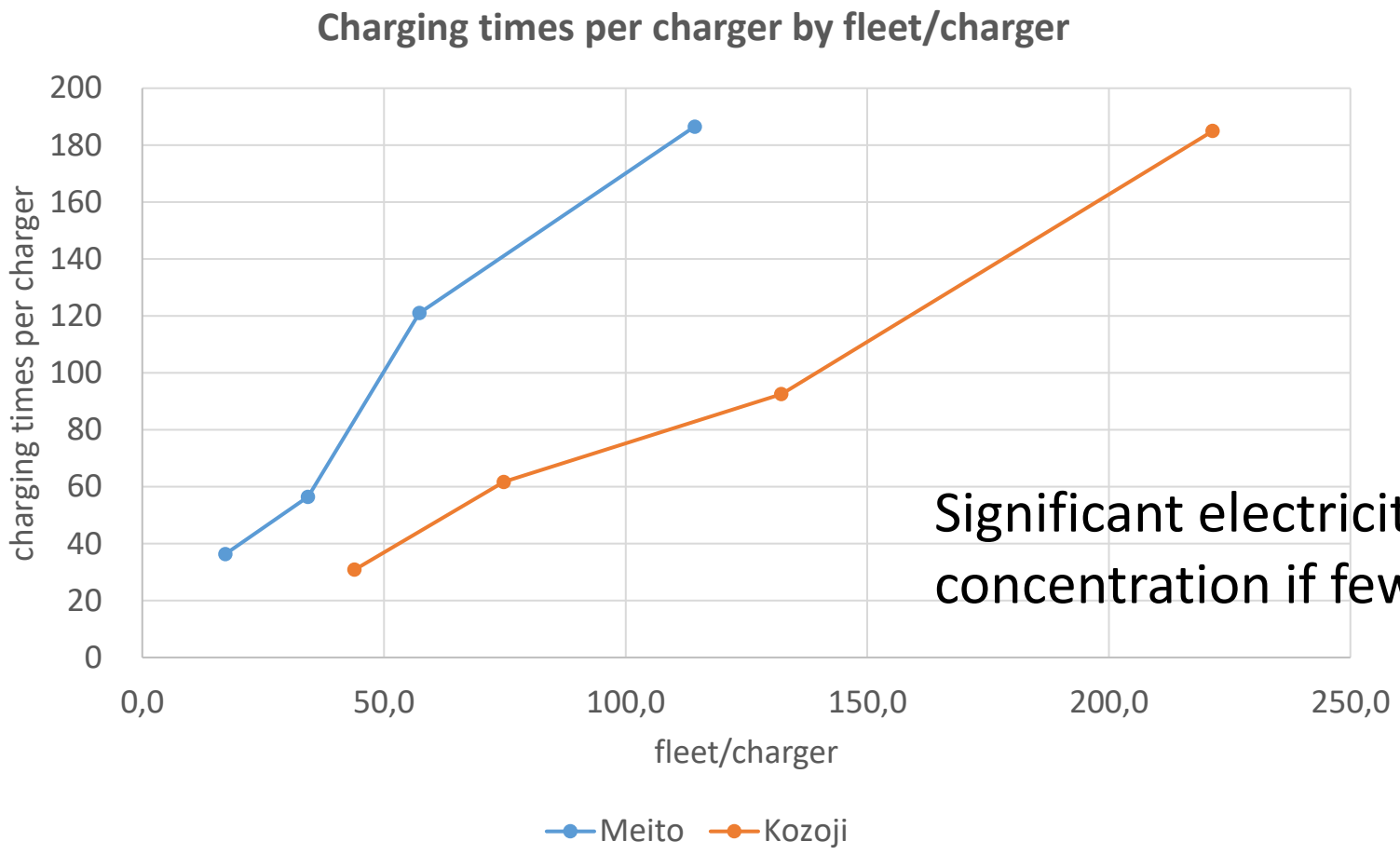


Results: times of charging by charger coverage



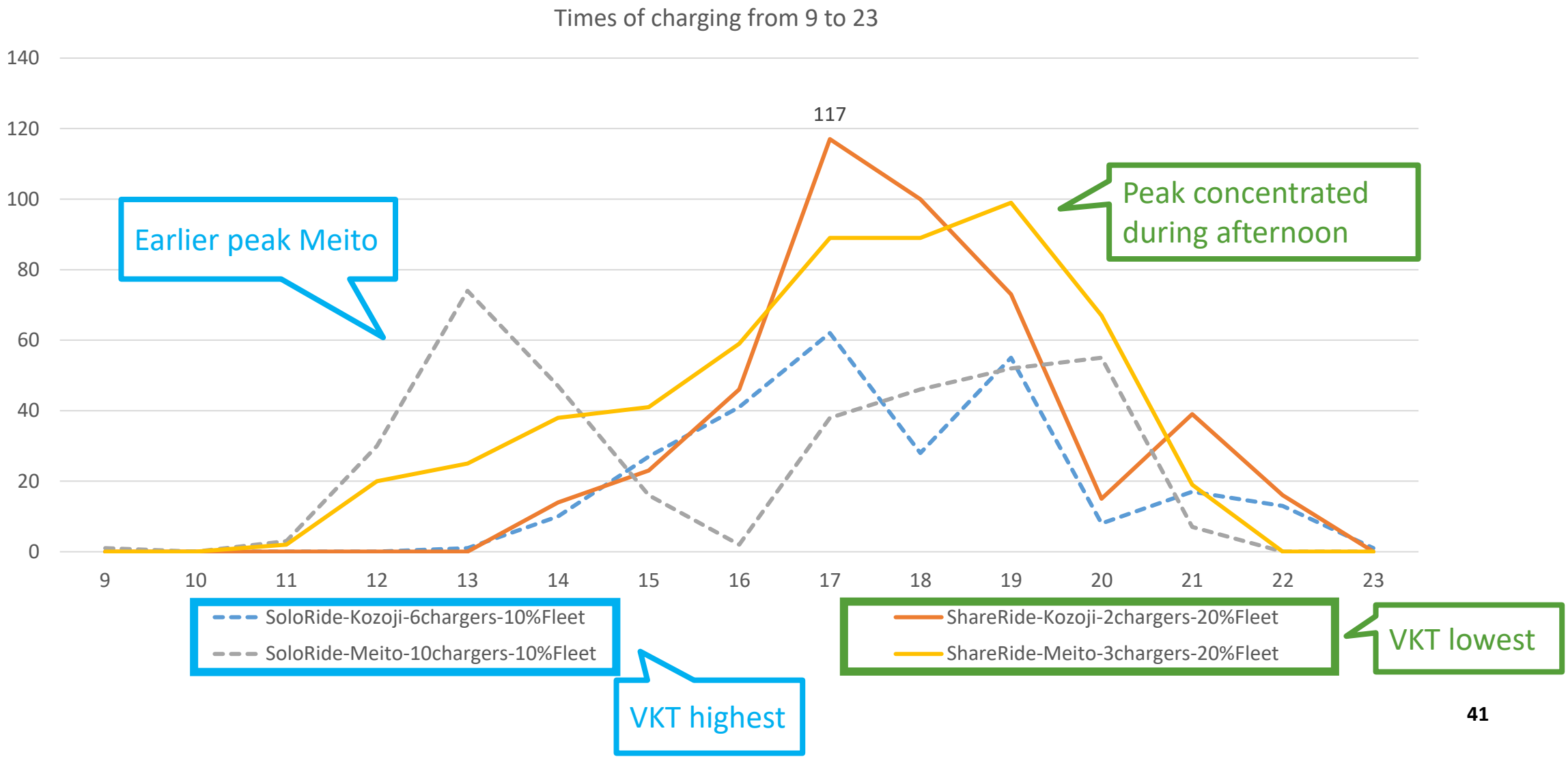


Results: times of charging by charger coverage fleet/charger



Significant electricity demand concentration if fewer charging spots

Results: charging performance



Conclusion —P&R SAV system: case & implication

- **Meito**: 20% to 25% fleet, about 400 vehicles, can provide a quick response service for over 10000
  - average wait time: about 2 min;

- **Kozoji Newtown**: fewer than 400 shared AVs can perform more than 6000 trips, with wait time:
  - approximately 95% of trips → less than 6 min,
  - all trips → approximately 1 min as an average

Conclusion —SAEV system: overall

- The **proposed system is capable** of providing users with an acceptable service in two cases.

- **Potential correlations**:
  - **demand per vehicle**
    - the higher demand per vehicle, the higher completed trips/vehicle·hour
    - ratio of utilized time increases while idle time decreases
    - VKT also rises
  - **charger coverage**
    - Times of charging per charger increase with higher charger coverage
    - Electricity demand concentration