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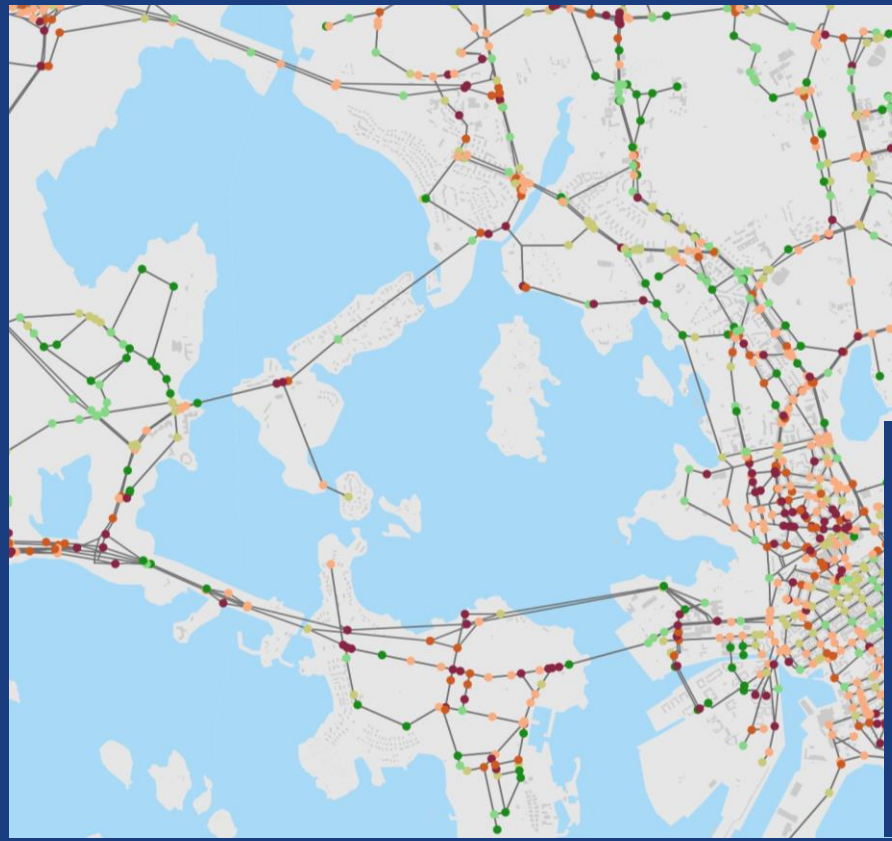

Mobility for Liveable Cities: Shared mobility

Luis Martinez
(with Olga Petrik, Francisco Furtado and Jari Kaupilla)

INTERNATIONAL TRANSPORT ENERGY MODELING (ITEM) WORKSHOP, October, 2017

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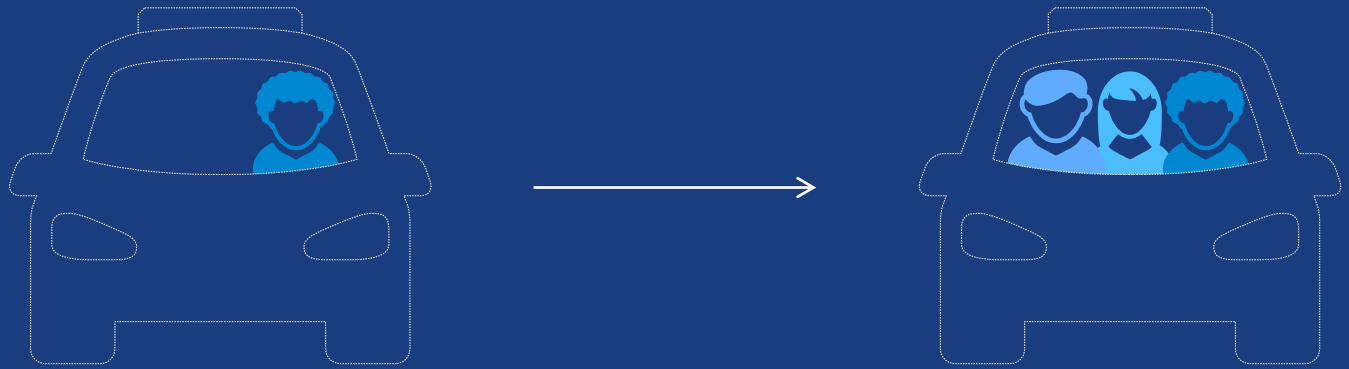
what if?



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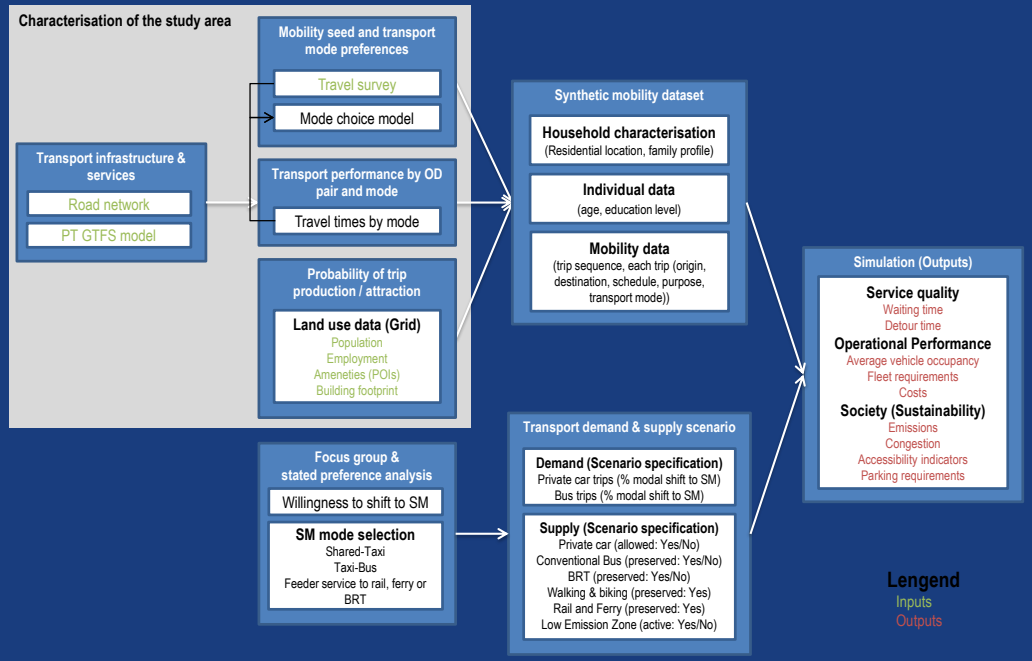
Model Framework



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Synthetic mobility

Method

- Using a mobility survey, the model uses the available information from the original surveyed person to:
  - ✓ Generate a set of persons similar to the interviewee (depending on the survey expansion multiplicative coefficient of the person)
  - ✓ Model the trip chain of each new "virtual person" – preserving the array of trip purposes stated on the survey
  - ✓ Introduce (relatively small) variations in time and in space distance of each trip (keeping all the other attributes of that trip) – which depend of the origin and destination, the trip purpose and mode used for each trip
- The model uses statistical data from the survey to establish constraints and membership functions to determine "virtual origin and destination", attached to the land uses associated with the trip generation of each census track

Synthetic mobility

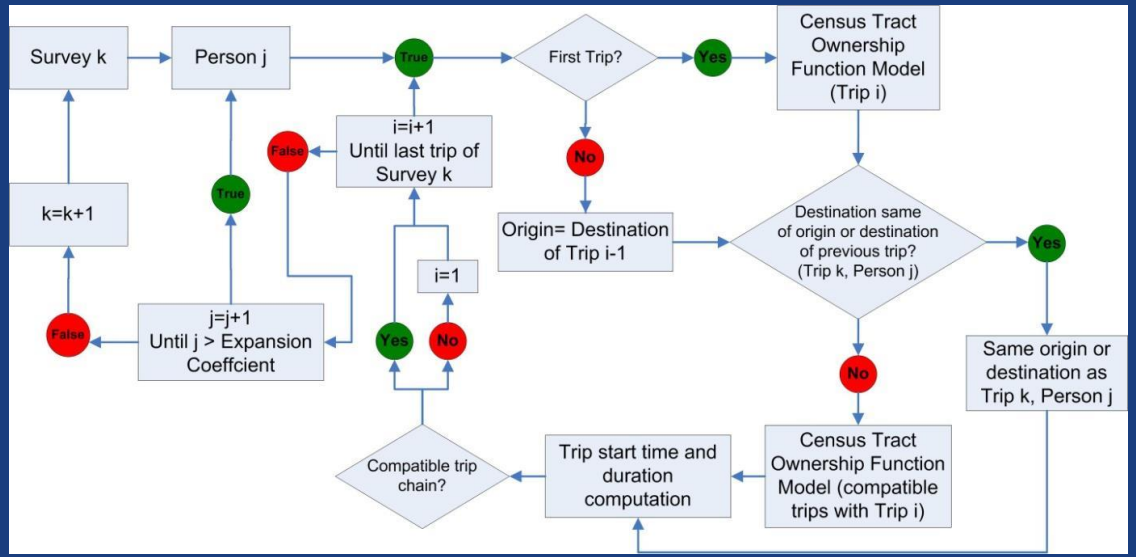
Inputs for the synthetic trips generator

- A mobility survey with geocoded trip ends and characterization of the respondent and each trip that he performs (if possible also including trip purpose) with sample coefficients (sampling rate >0.5%)
- A detailed land use database used as seed for trip generation/attraction functions
- A characterization of the trip generation/attraction rates of land use activities for different times of the day and relation with the purpose of the trip (worker, visitor or other)
- A characterization of the travel times in different transport modes and the number of transfers required in public transport between all the census tracts of the study area

Synthetic mobility

Workflow

- For each trip end location the model calls a ownership function, which determines the trip end location using a Monte Carlo Simulation procedure



Synthetic mobility

Probability of trip origin or destination

- The ownership function is computed for each census tract of the modelling area for each trip. This model is based on a trip generation rate for each type of land use, linked to the trip purpose and the trip departure time
- Based on the land use distribution of each census tract, the model computes a trip generation rate. These generation rates are then corrected by some model correction factors and constraints

Synthetic mobility

Compatibility analysis

- Structural compatibility:
  - ✓ Same trip purpose, trip mode (walking/biking, private car or public transport), trip home based (yes/no), alone (yes/no)
- Time compatibility:
  - ✓ Trip starting time interval (depends of the mode), trip duration ratio (max 25% difference)
- Space compatibility:
  - ✓ Distance between origins and destinations (depends of the trip purpose), trip length ratio (max 25% difference)
- The probability of choice of a given census track as destination of a trip is a function of the similarity of distance to origin (in comparison with that reported in the survey), of the distribution of functional areas aligned with the stated trip purpose along with the distance-compatible census track and of the mode-compatibility

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Mode choice selection

Focus group & stated preference analysis

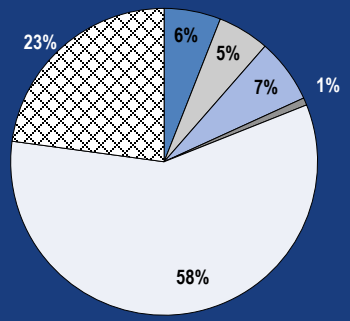
Willingness to shift to SM

SM mode selection

Shared-Taxi
Taxi-Bus
Feeder service to rail, ferry or BRT

Parameter	Estimated value
Alternative specific constant, cycle	-
Alternative specific constant, bus	-1.82
Alternative specific constant, rail	-1.65
Alternative specific constant, car	0
Alternative specific constant, walk	-
Alternative specific constant, shared taxi	0.973
Alternative specific constant, non-motorised modes	-1.95*
Alternative specific constant, PT	-
Shared mode being Taxi-Bus, for car users	-0.425*
Access time, PT	-0.0851**
Access time, shared mobility	-0.106*
Access time, generic (PT and shared mobility)	-
Being a car user, shared mobility	0
Travel cost, car	-0.196*
Travel cost, PT	-0.260
Travel cost, shared mobility	-0.246
Being female, shared mobility	0
Lost time, shared mobility	-0.0539*
Number of transfers, PT	-0.523**
Number of passengers, Shared Taxi	0
Riding alone, Shared Taxi	0.291
Travel time, car	-0.0729*
Travel time, non-motorised modes	-0.0803*
Travel time, PT	-0.0175
Travel time, shared mobility	-0.0910*
Waiting time, PT	-0.0192
Living far from the city centre, shared mobility	-0.948*
Living close to the city centre, shared mobility	0
Living close to the city centre, PT	0
Being below 25 years old, shared mobility	0
Being above 60 years old, bus	1.82*
Being below 25 years old, bus	0.968*
Being below 25 years old, cycle	1.07*
Adjusted rho-squared	0.29
Number of observations	896
Value of time (NZD per hour), car	22.32
Value of time (NZD per hour), PT	4.04
Value of time (NZD per hour), shared mobility	22.20
Correctly predicted choices (full sample), %	59
Value of riding alone (NZD), Shared Taxi	1.18

Note: - not available, * significant at the 95% level; ** significant at the 90% level.



- Walk
- Bicycle
- Bus
- Rail
- Car
- Shared Transport

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Shared modes

Shared Taxis

simultaneous ride-sharing

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Taxi-Bus

optimised on-demand bus

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Shared modes specification

Mode	Booking	Access time	Max. waiting time (depending on distance)	Max. total time loss (depending on distance)	Vehicle type
Shared Taxi	Real time	Door-to-door	5 minutes (≤ 3 km), up to 10 minutes (≥ 12 km)	Detour time + waiting time, from 7 minutes (≤3 km), up to 15 minutes (≥12 km)	Minivan of 8 seats rearranged for 6 seats, with easy entry/exit
Taxi-Bus	30 minutes in advance	Boarding and alighting up to 400 m away from door, at points designated in real time	Tolerance of 10 minutes from preferred boarding time	Minimum linear speed from origin to destination (15 km/h)	Minibuses with 8 and 16 seats. No standing places

Shared Taxi

Taxi-Bus

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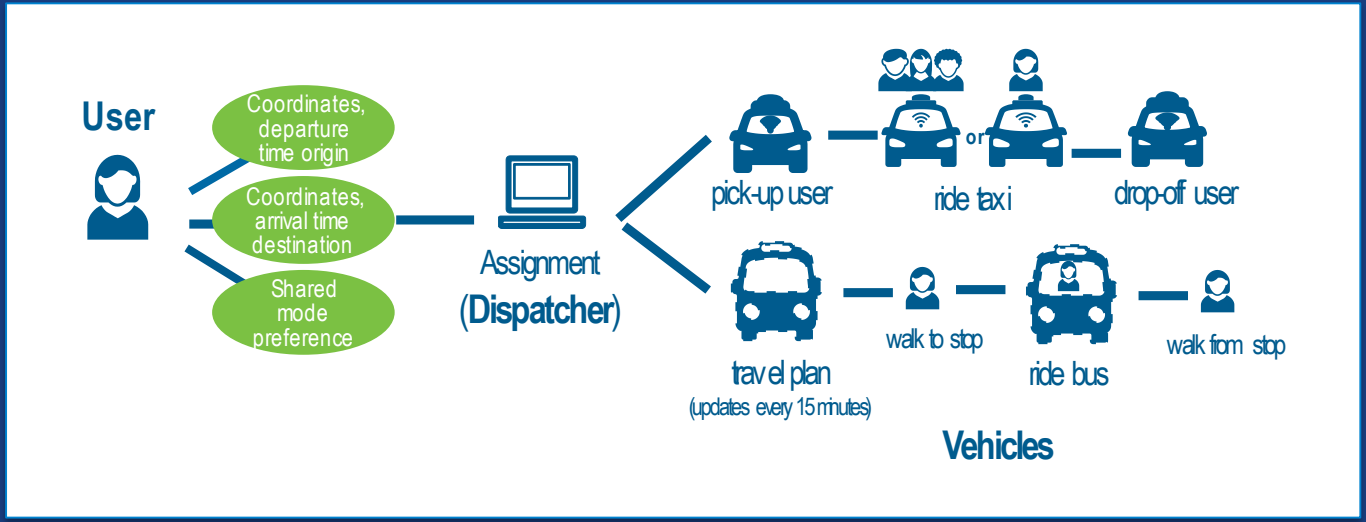
Shared modes workflow



Running the simulation…

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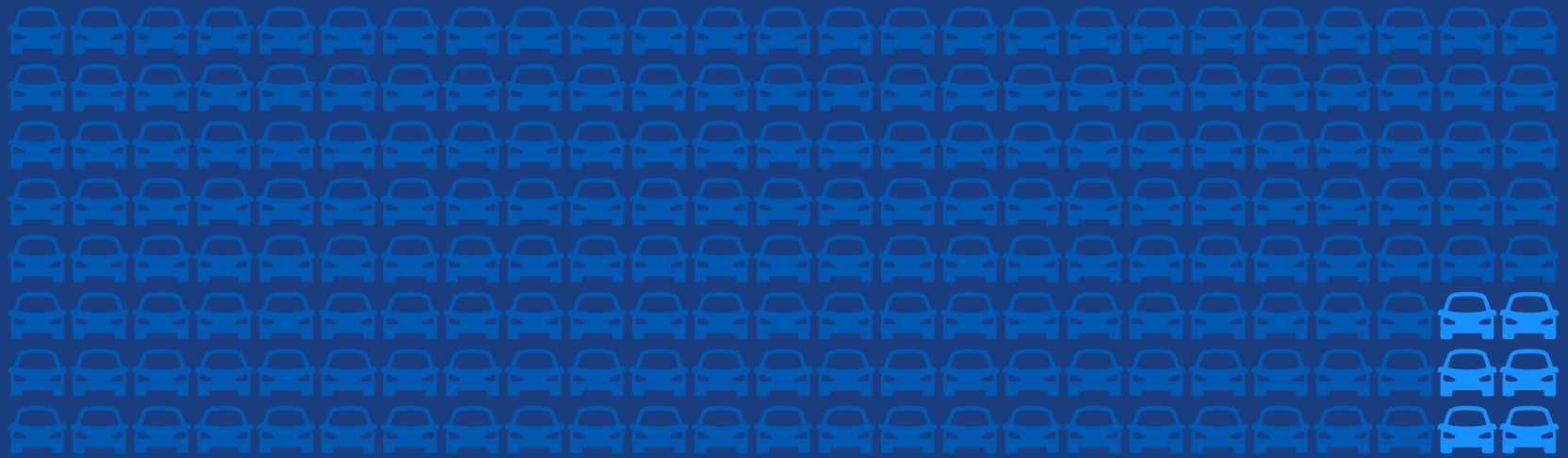
Lisbon



Scenario: 24 hours

number of cars required to provide the same trips as before:

3%

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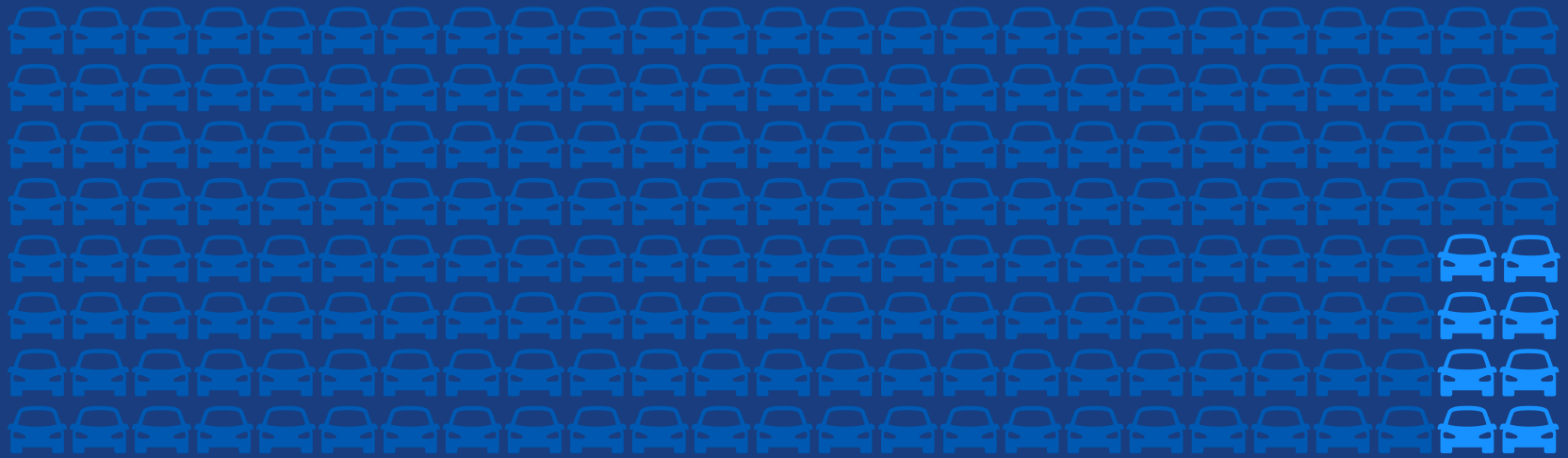
Helsinki



Scenario: 24 hours

number of cars required to provide the same trips as before: **4%**

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Impacts (best scenario)

-62%

(Lisbon)

-34%

(Helsinki)

CO_2 emissions

OECD

24hrs.

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CO_2 /inhabitant (base year)

3.5

(Lisbon)

2.5

(Helsinki)

OECD

24hrs.

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CO_2 /inhabitant (best scenario)

1.6

(Lisbon)

1.8

(Helsinki)

OECD

24hrs.

Factors affecting outcome

Current modal share

Public transport quality

Density of the area

Trip patterns


eliminate
all street parking


PARKING

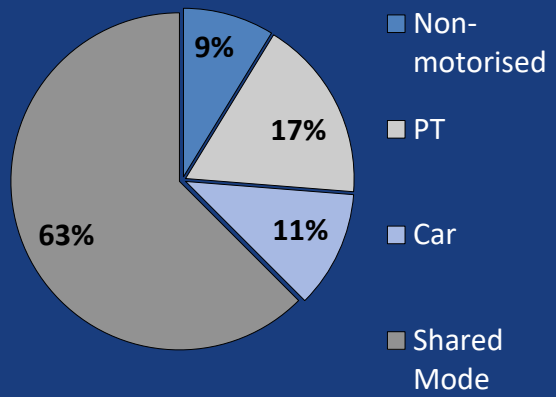

PARKING

Understanding user preferences

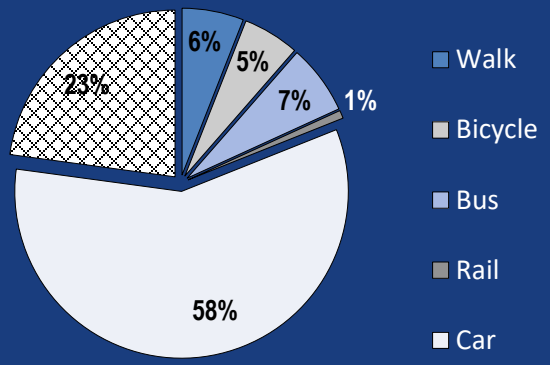
Focus group for each city

Stated preference survey

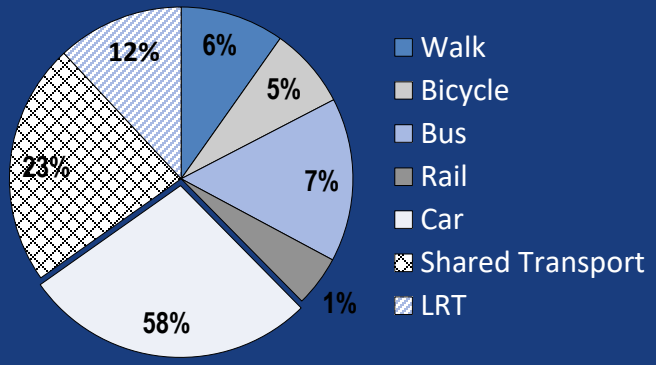
Shared mode in stated preference survey



Helsinki

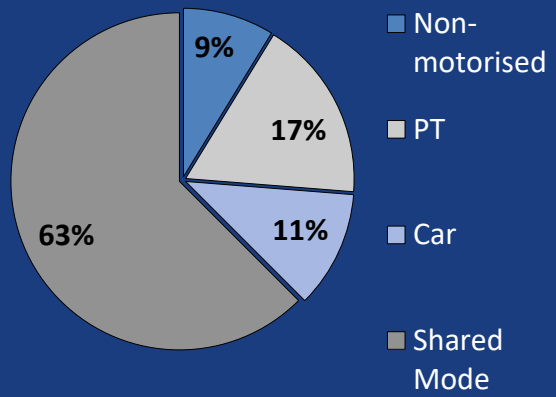


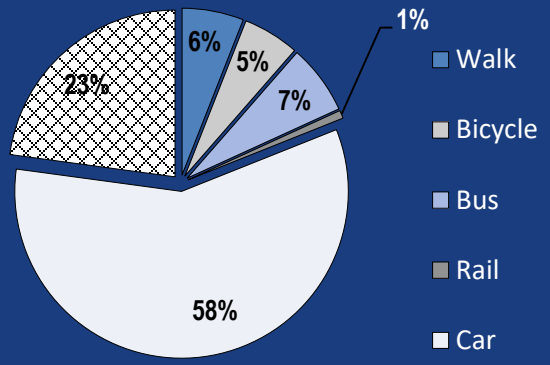
Auckland

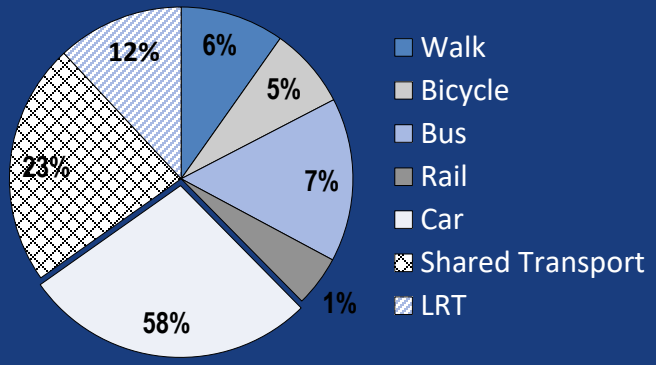


Dublin

Car mode in stated preference survey







Helsinki (41%) Auckland (87%) Dublin (65%)

Other observations

- Importance of having services across the entire area – and feeder service to mass transit
- Willing to share vehicles rather with more than fewer travellers
- Early adopters: residents living far from the city centre, regular PT users young and people above 55 years
- Price important factor for all respondents
  - Waiting, access and travel time, number of transfers and comfort
- One third of respondents that own a car stated they would sell one of more cars if shared mobility services were available

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CO2 emissions (20% cars replaced)

-19%*

(Lisbon)

-4%

(Helsinki)

* Estimation

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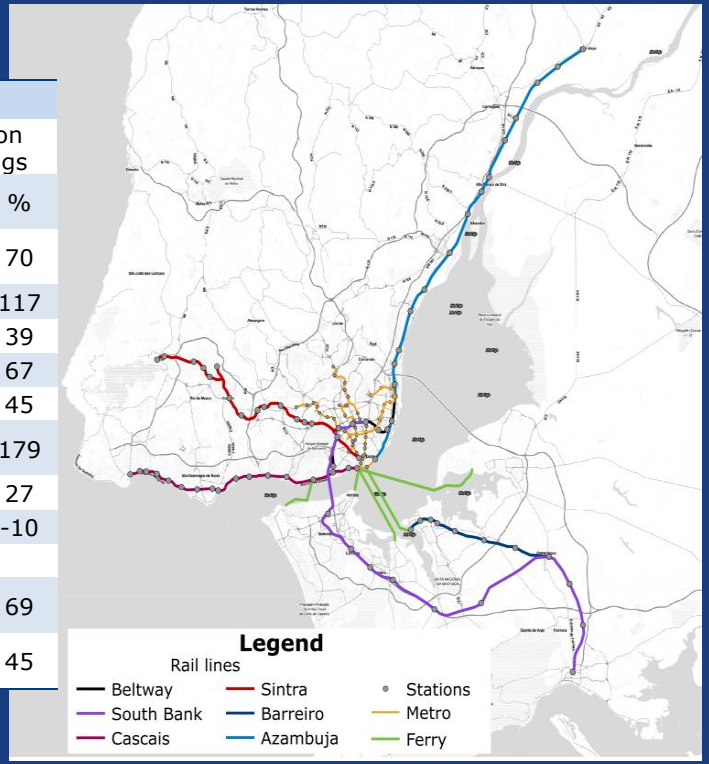
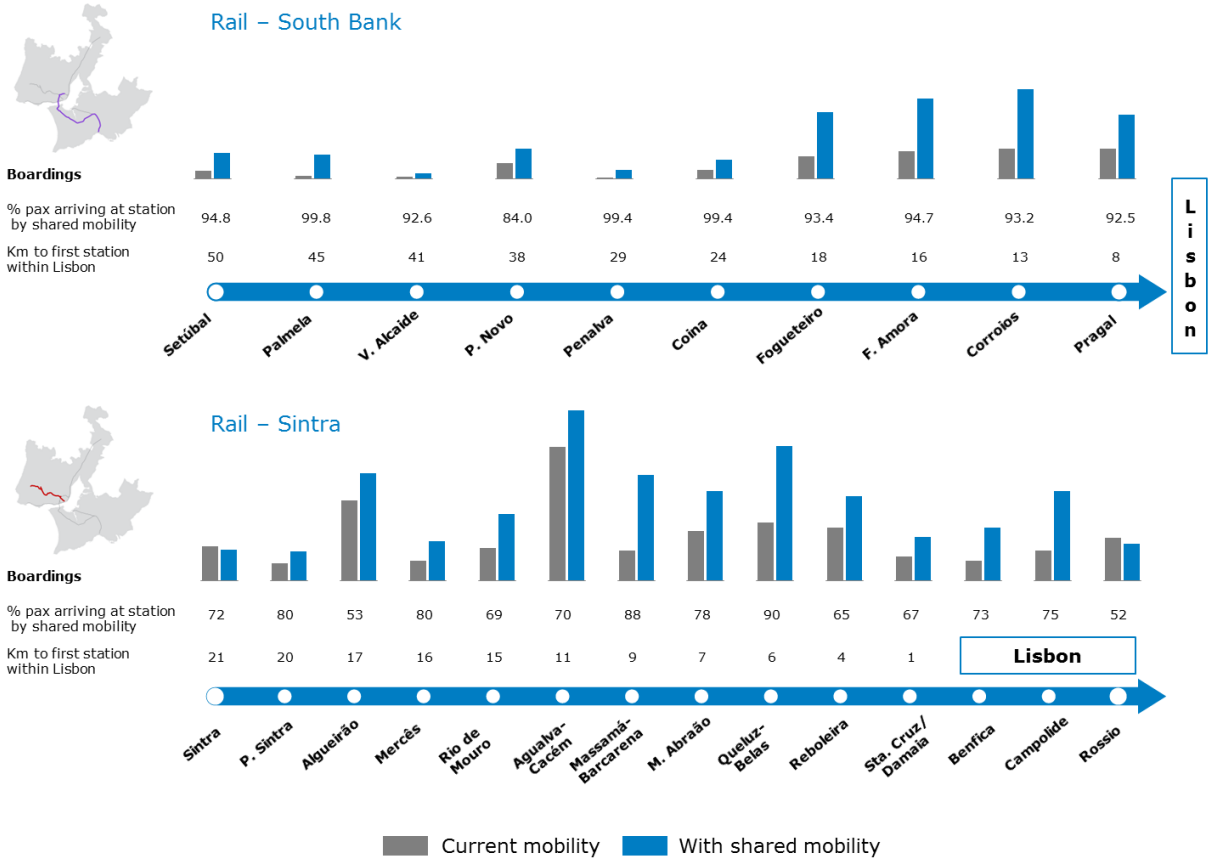
24hrs.

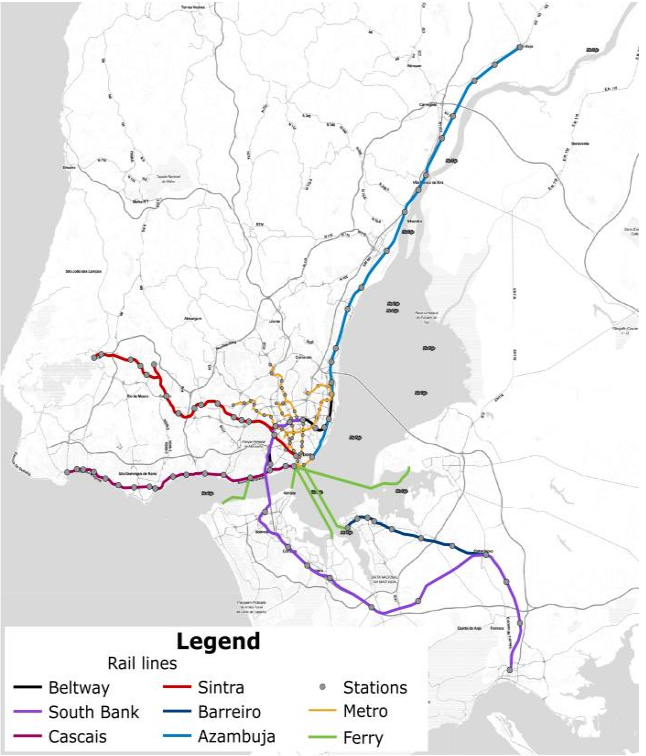
Increase in metro and rail ridership (Lisbon)

High capacity line or system	Reference case				Shared mobility					
		Access modes (%)				Access modes (%)			Variation boardings	
	Boardings	Private Car	Bus	Walk	Boardings	Taxi-Bus	Shared Taxi	Walk	Absolute	%
Rail - Azambuja	33 142	5.8	39.6	54.6	56 315	57.6	17.9	24.5	23 173	70
Rail - Barreiro	8 926	3.9	60.2	35.9	19 360	63.3	22.3	14.4	10 434	117
Rail - Cascais	75 291	2.6	44.8	52.6	104 992	60.0	12.1	27.9	29 701	39
Rail - Sintra	88 167	3.2	32.0	64.8	147 270	57.5	12.8	29.7	59 103	67
Rail - Beltway	11 034	4.4	25.3	70.3	15 945	53.8	16.4	29.8	4 911	45
Rail - South Bank	19 901	5.3	36.7	58.0	55 444	79.6	13.9	6.5	35 543	179
Metro	261 570	5.0	31.0	63.9	331 760	44.4	11.9	43.7	70 190	27
Ferry	12 745	8.5	32.0	59.5	11 424	61.2	19.8	19.0	-1 321	-10
Sub-total rail	236 461	3.9	38.1	58.0	399 326	62.1	15.0	22.8	162 865	69
Total	510 776	4.4	36.5	59.1	742 510	59.8	14.8	25.4	231 734	45

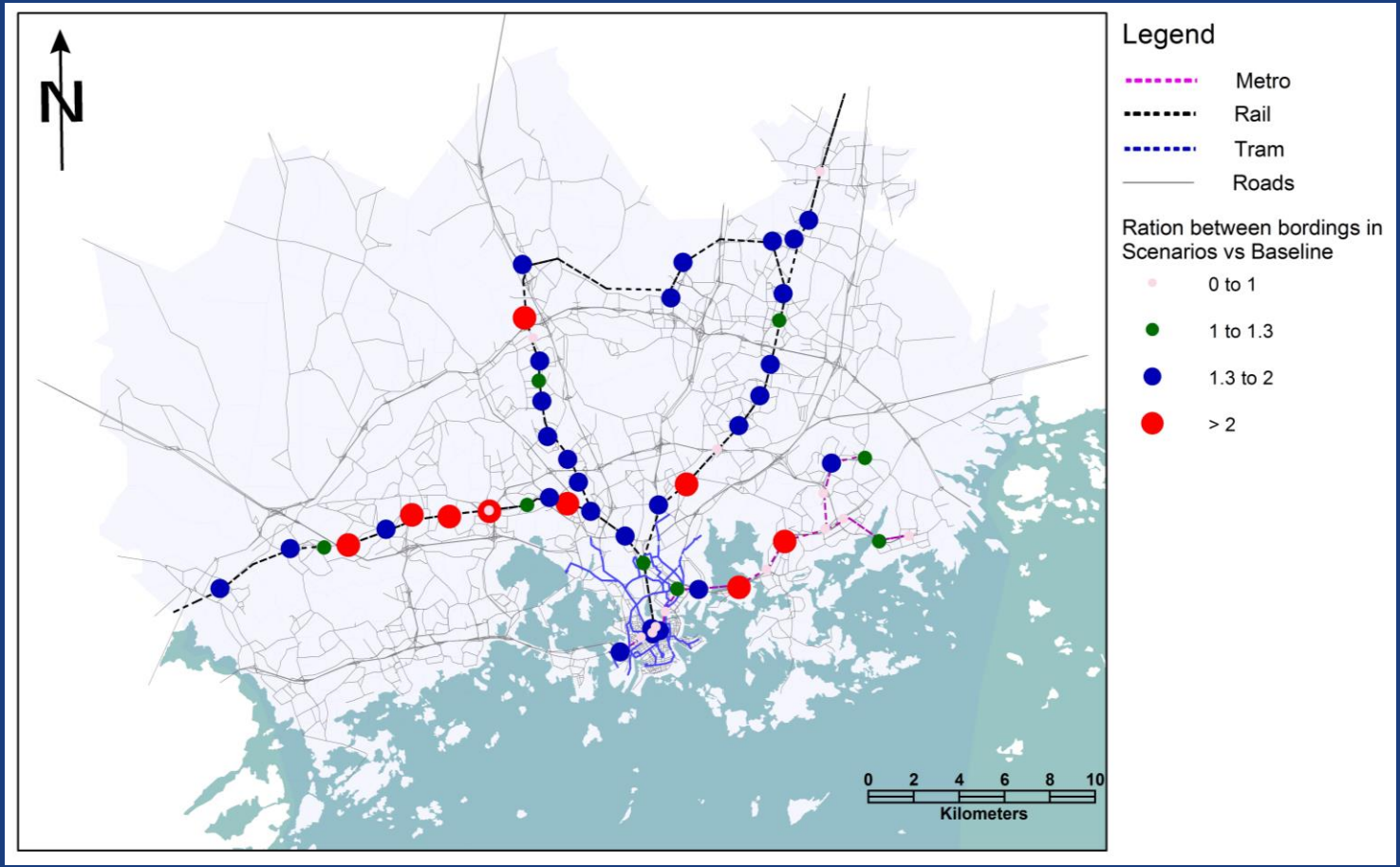


Increase in metro and rail ridership (Lisbon)

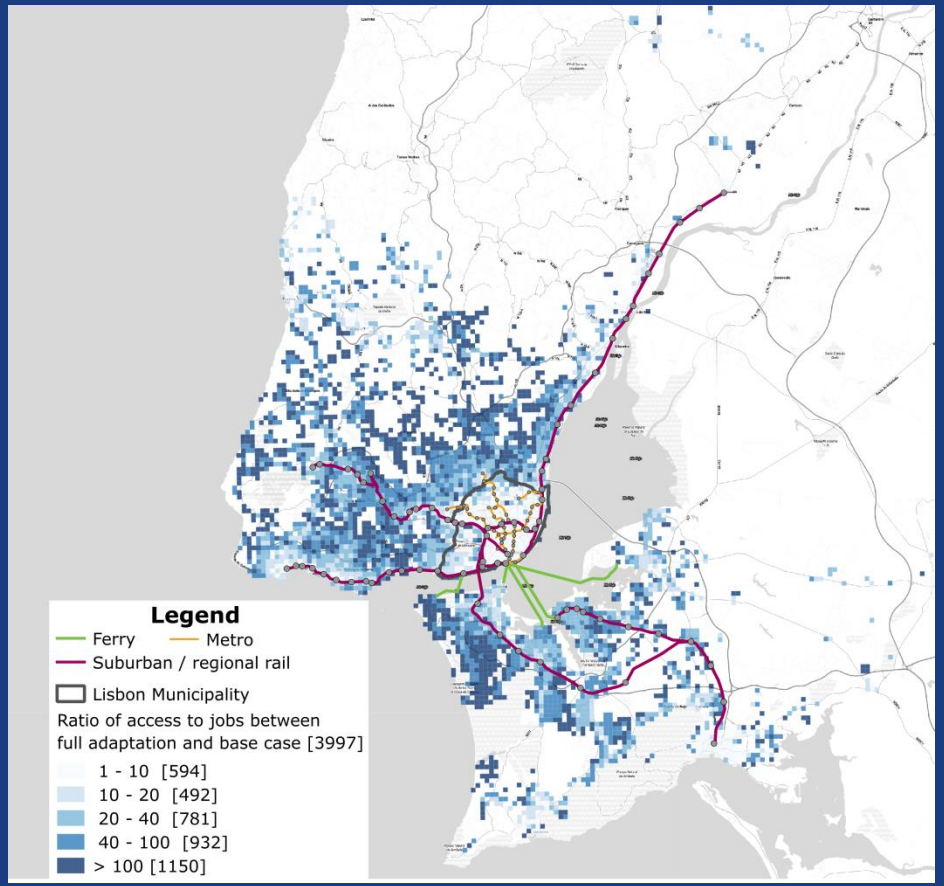




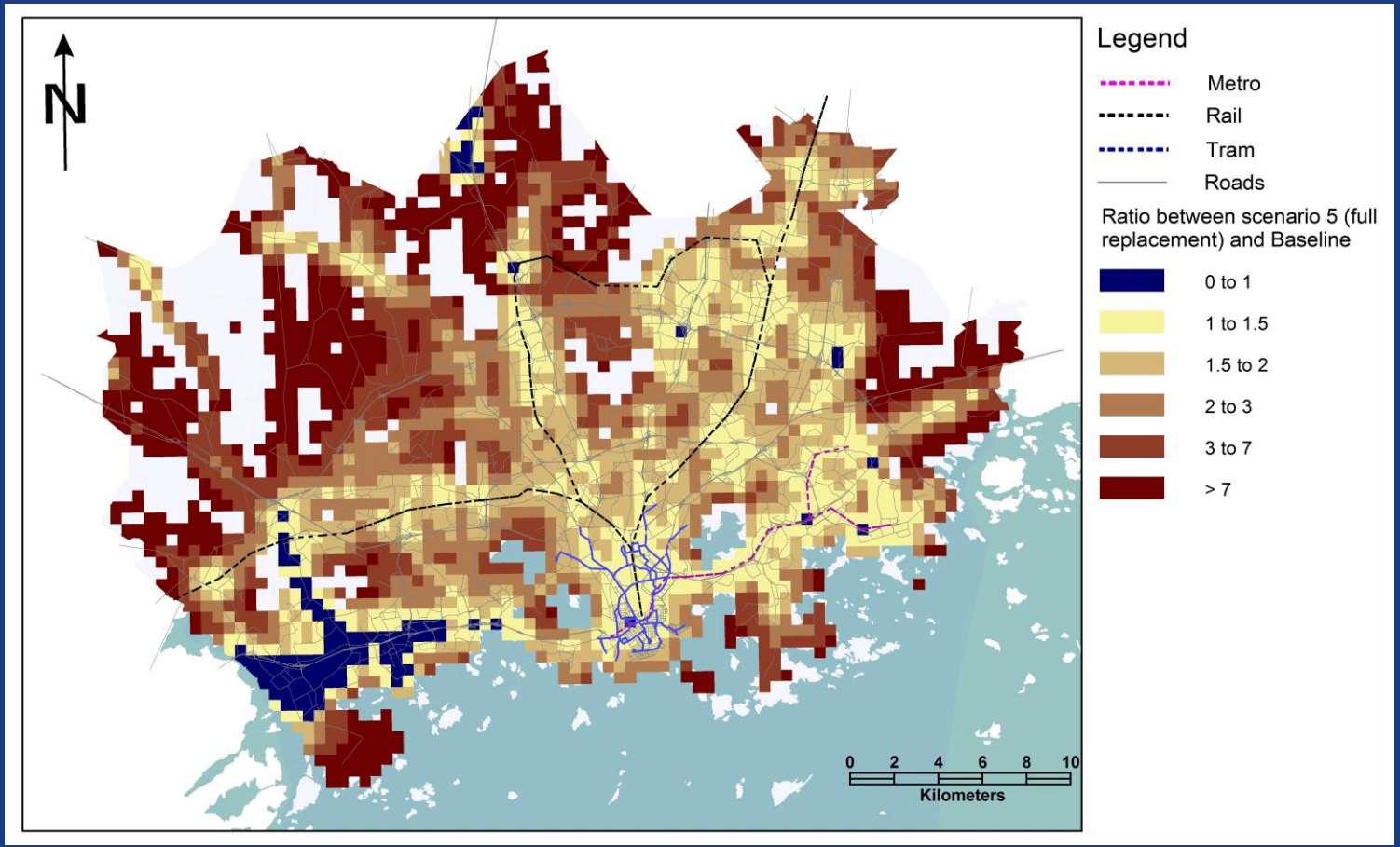
Increase in metro and rail ridership (Helsinki)



Increased access (Lisbon)



Increased access (Helsinki)

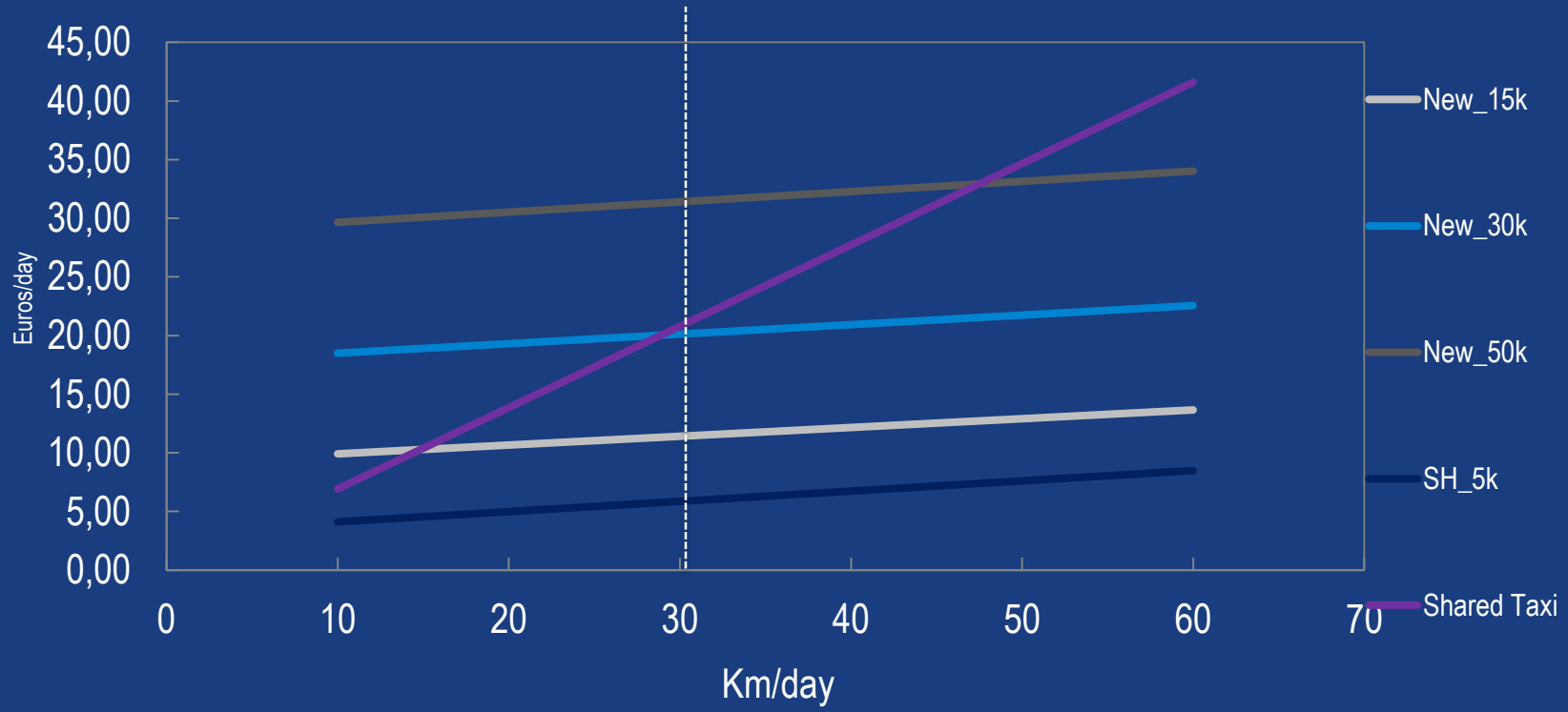


Costs/price – Helsinki Metropolitan Area

Scenarios	Price per km (EUR/km) for end users				
	Shared Taxi	Taxi bus	Average Taxi trip	Average PT user	PT operator without Subsidy
Inside ring road I	0.69	0.20	2.37	0.21	0.35
All cars and buses	0.65	0.19			
20% car trips + bus feeder	0.79	0.20			

Price/Cost in Helsinki Metropolitan Area

Total commuting cost per day and km of car ownership vs Shared Taxi



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Recommendations

Enable shared mobility as part of policy package

Introduce at a sufficient scale

Feed to mass transit

Target potential early adopters (car users)

Ensure line and station capacity

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Transition

Land use policies

Economic instruments

Infrastructure/service measures

Regulatory policies

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Thank you!

Luis Martinez
T +33 (0) 1 85 55 45 48
E luis.martinez@itf-oecd.org

Postal address
2 rue Andre Pascal
75775 Paris Cedex 16

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