Laboratory of Transportation Engineering (LoTE)

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Assessing the impacts of traffic calming at network level. A multimodal agent-based simulation

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Research Project: Simulation tool for Micromobility to improve Urban Transportation Planning – SIM4MTRAN (project code: T2EDK – 02494, NSRF 2014 -2020)

RSS 2022
8th Road Safety & Simulation International Conference
Road Safety and Digitalization
08-10 June, 2022 • Athens, Greece

Traffic calming

Traffic calming measures intends to reduce sever crashes in urban roads (Yannis et al., 2014)

SAFETY

Traffic calming can be considered as an alternative approach to prioritize the slowest modes (i.e., pedestrian and cyclists) that will lead to a fairer and more efficient allocation of urban space
(Curl et al., 2015)

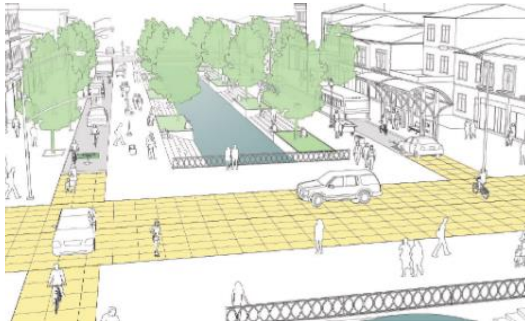
ACCESSIBILITY + LIVEABILITY

Traffic calming = 

?

+ interventions: speed humps, roundabouts, curb extensions, chicanes, raised intersections, median barriers or islands etc.

COMPLIANCE !!



https://globaldesigningcities.org/

Research Objective

More safe ..... Less efficient ???

trade – off ??

What if?

lower speed limits → lower road network capacity → less accessibility of private car → less attractive choice → lower veh*km → less congestion → more efficiency

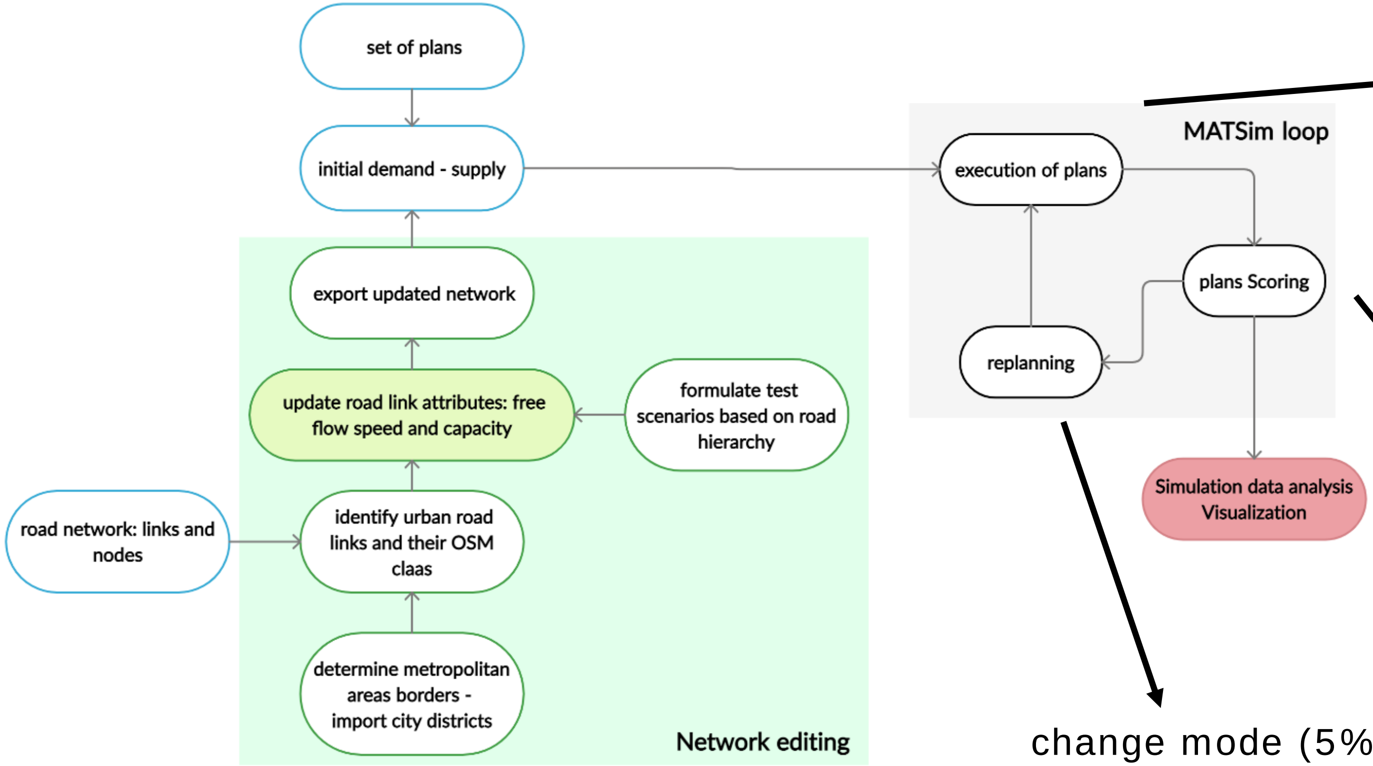
This study aims to test this hypothesis considering a bigger scale, i.e. a metropolitan area

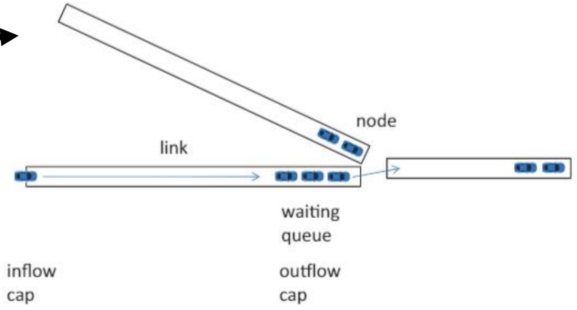
And compliance ?? It is factor related to the road design which is taken into account

Methodology

a new network editing
tool developed in python

MATSim
Multi-Agent Transport Simulation



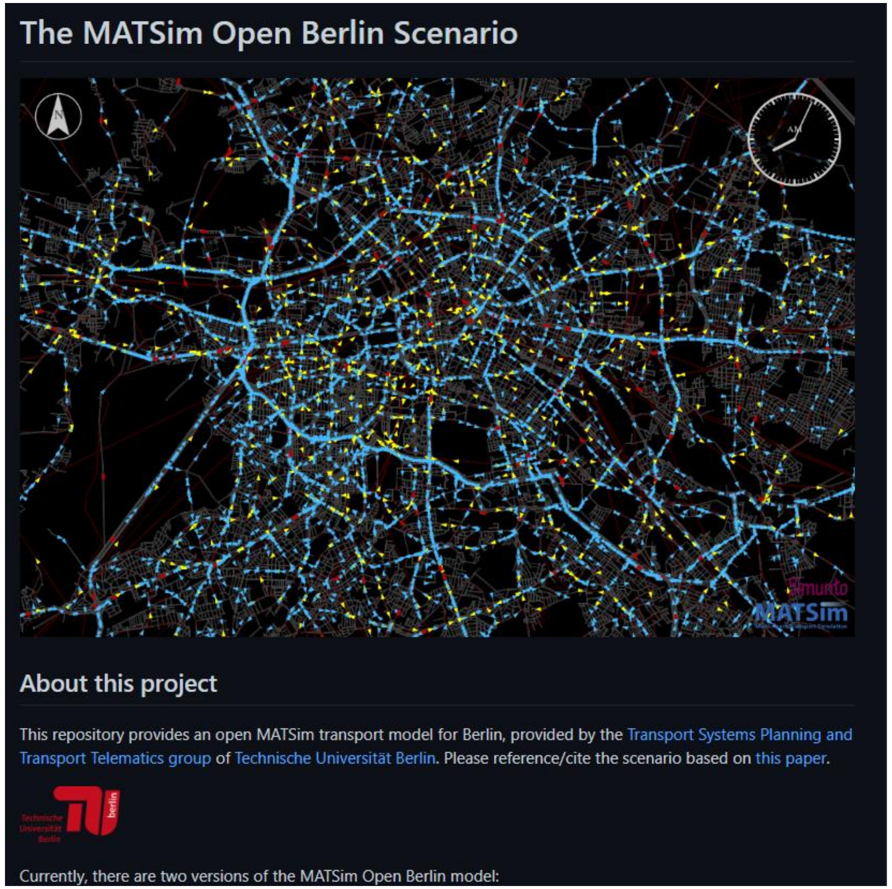


Queue – based
traffic simulation

based on time +
distance (=cost)

change mode (5%)
change route (5%)
modify departure time (5%)

The Open-Berlin Scenario



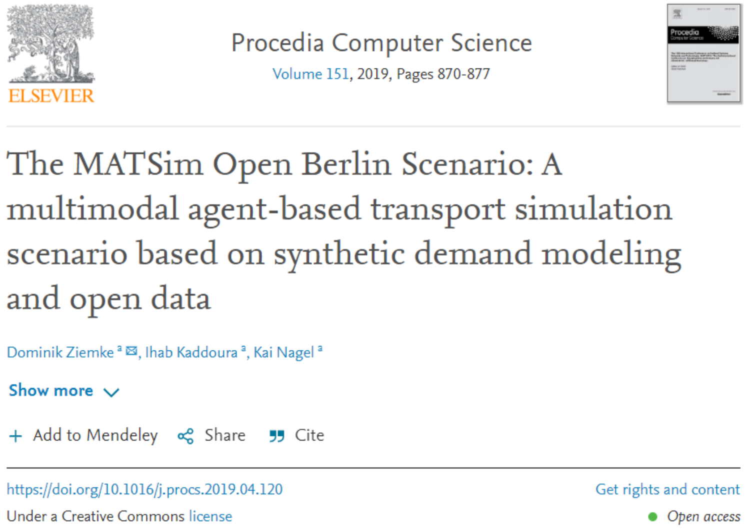
The MATSim Open Berlin Scenario

About this project

This repository provides an open MATSim transport model for Berlin, provided by the Transport Systems Planning and Transport Telematics group of Technische Universität Berlin. Please reference/cite the scenario based on this paper.

Currently, there are two versions of the MATSim Open Berlin model:

https://github.com/matsim-scenarios/matsim-berlin



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The MATSim Open Berlin Scenario: A multimodal agent-based transport simulation scenario based on synthetic demand modeling and open data

Dominik Ziemke [a], Ihab Kaddoura [a], Kai Nagel [a]

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73689 nodes and 159039 single-direction links
+ public transport network

Available modes: car, bicycle, walking, motorcycle, freight and public transport modes.

1% of all adult people living in the states of Berlin and Brandenburg

Scenario formulation (1)

	Speed limits in km/h		
OSM class	**Scenario 1**	**Scenario 2**	**Scenario 3**
motorway	130	130	130
motorway_link	130	130	130
trunk	90	90	90
trunk_link	90	90	90
primary	70	70	50
primary_link	70	70	50
secondary	70	50	30
tertiary	50	30	30
residential	50	30	15
living street	30	15	15
unclassified	30	15	15

$$uf_i = ulim_j * c$$

$$c_i = \frac{ulim_j * cf_j * w * (l_i * kjam)}{ulim_j * cf_j + w} = \frac{ulim_j * cf_j * 13.5 * (l_i * 125)}{ulim_j * cf_j + 125}$$

where:

c_i: road capacity of link i in veh/h;

w: wave speed in km/h – assumed fixed to 13.5 km/h;

$kjam$: congestion density per lane of link i in veh/km – assumed fixed to 125 veh/km;

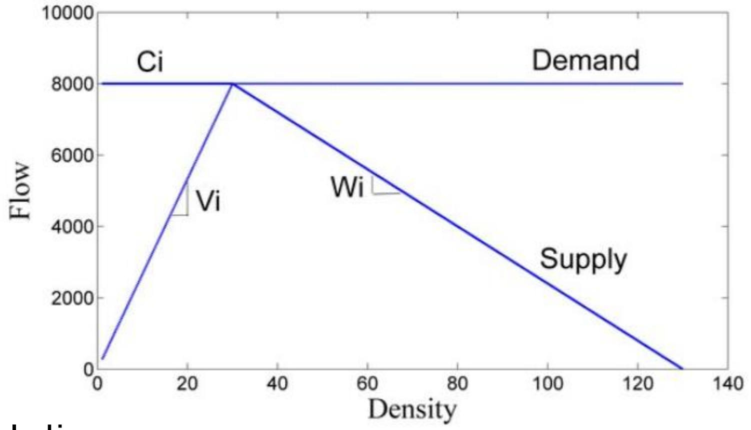
$u_{f,i}$: free flow speed of link i in km/h;

$ulim_j$: speed limit of OSM class j

cf_j: compliance rate of OSM class j;

l_i: number of traffic lanes in link i.

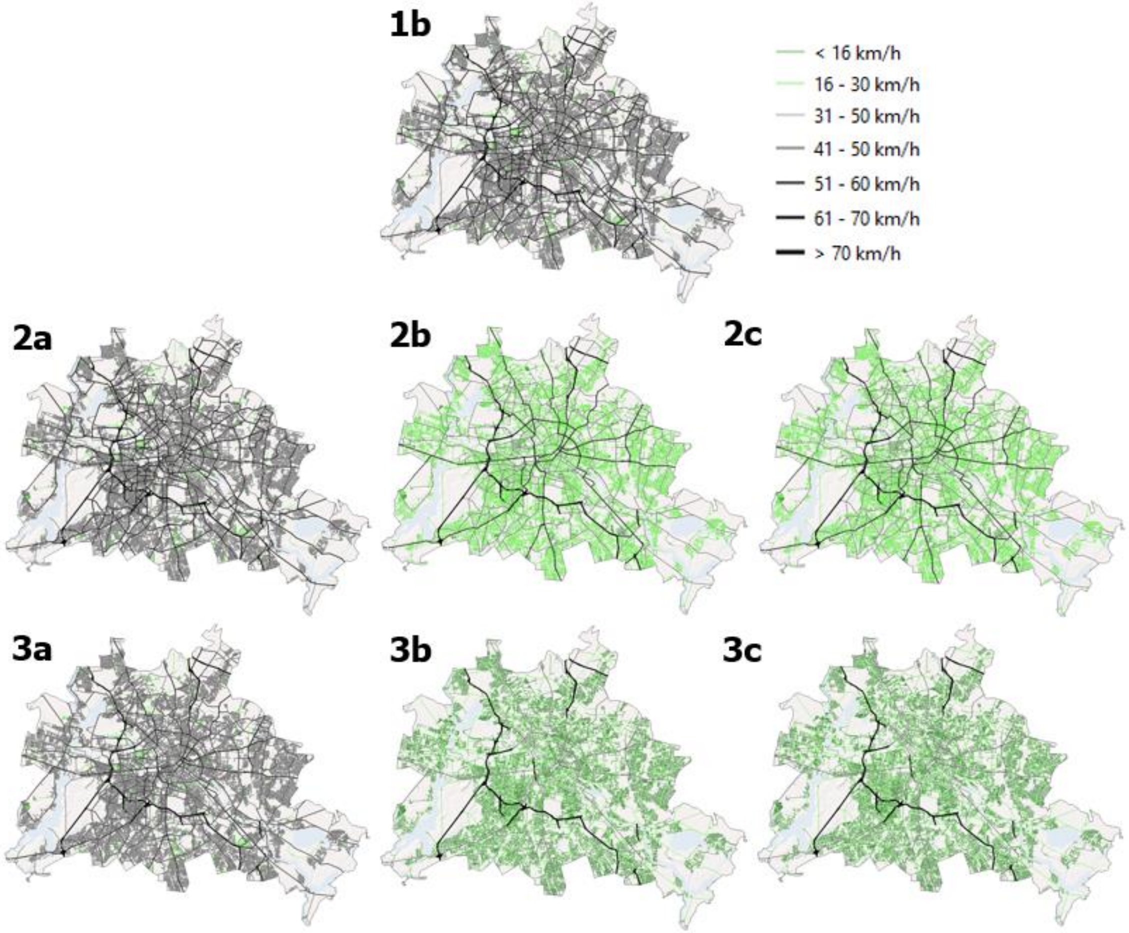
	Compliance rate
Scenario a	A 10% decrease in speed limit reflects to 2.5 km/h in mean speed. The compliance rate is calculated accordingly
Scenario b	The free flow speed is equal to the speed limit. The compliance rate is equal to 1.
Scenario c	In urban roads with speed limit lower than or equal to 30 km/h, the compliance rate is equal to 0.9. In other roads, the compliance rate is equal to 1.



Triangular fundamental diagram

Scenario formulation (2)

Free flow speed



Speed limit

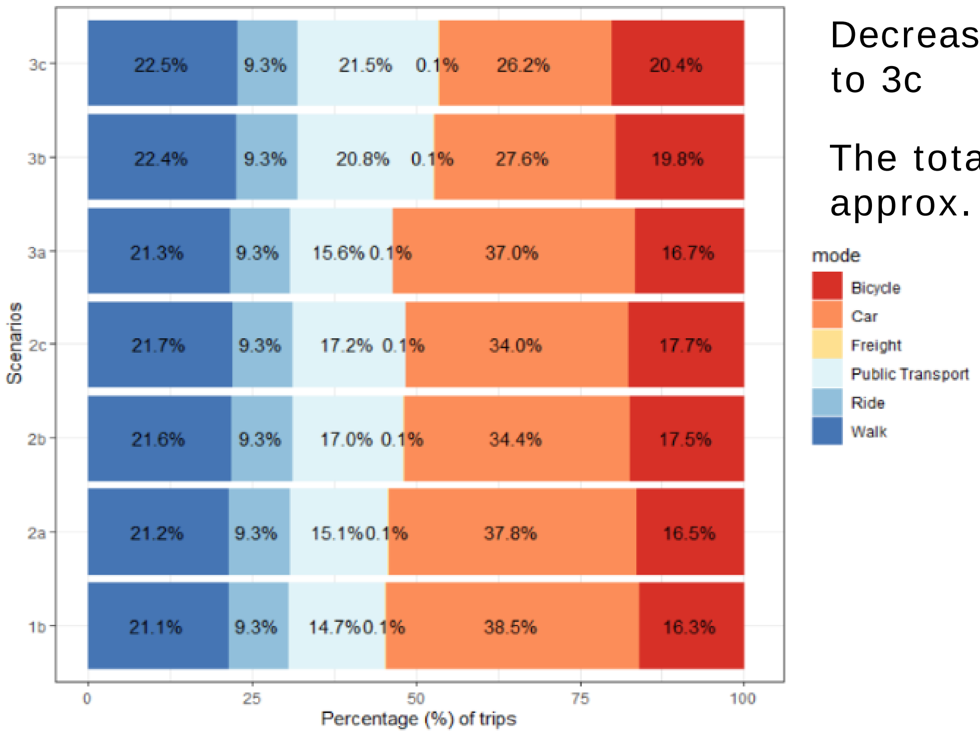
Compliance rate

Scenario 1 (base)

Scenarios 2

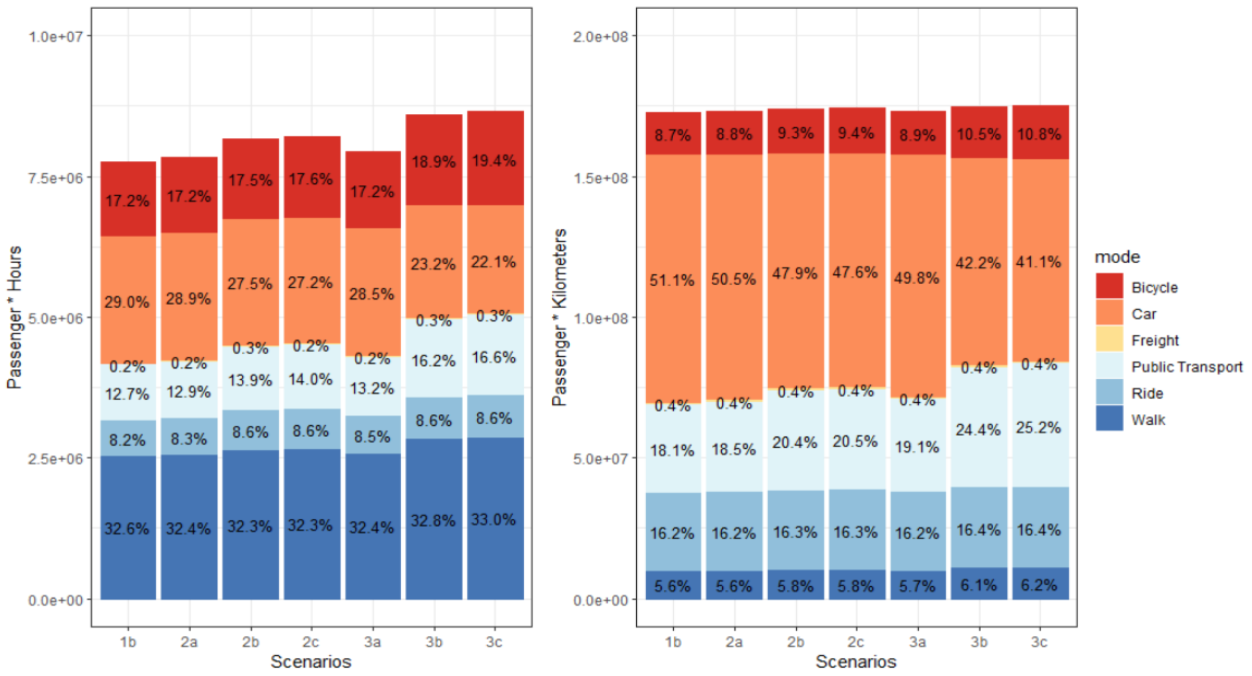
Scenarios 3

Results – Modal split



Decrease of 275500 passenger hours (-15%) with private car from 1b to 3c

The total distance travelled by public transport modes increased by approx. 14% in scenario 2b and 2c and by 40% in scenario 3b and 3c



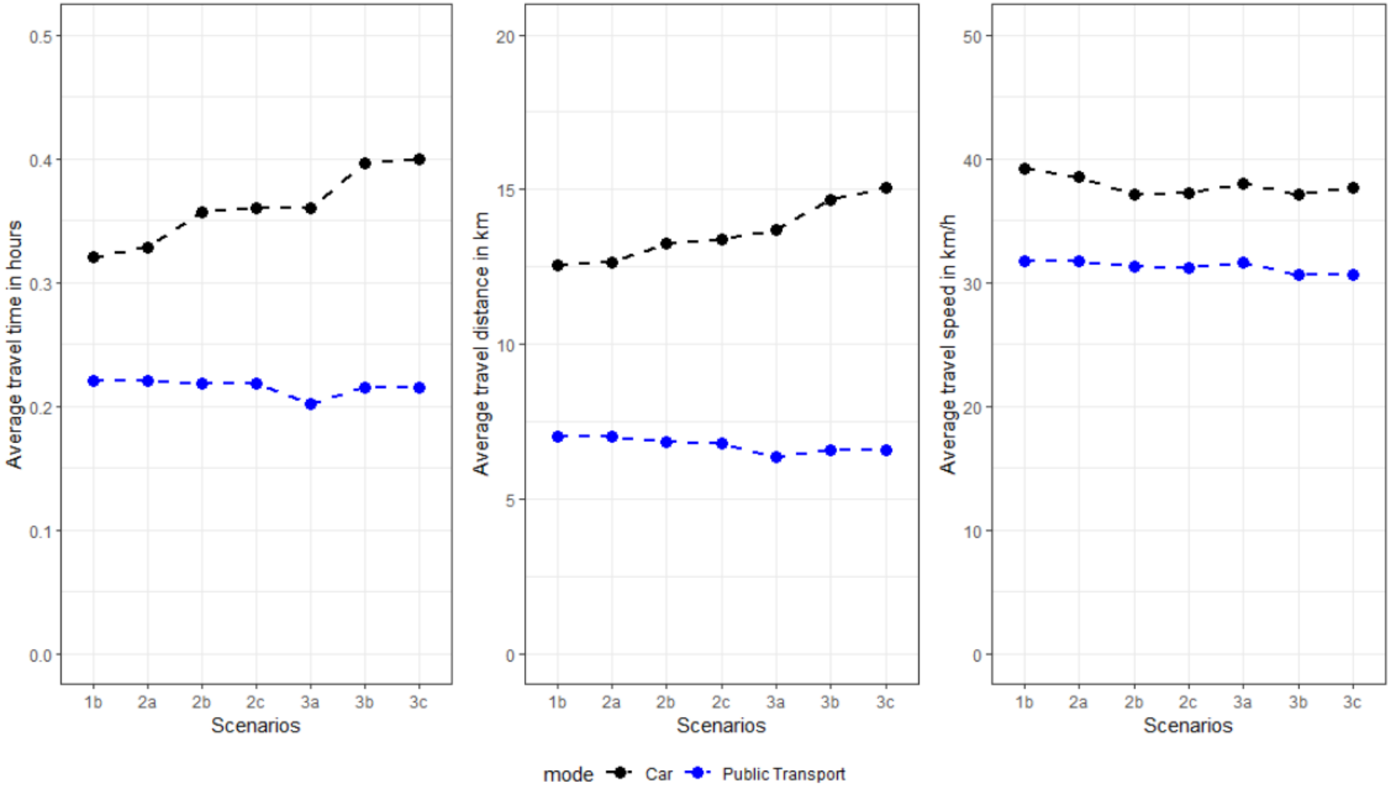
The share of bicycle trips rise from 16.3% in scenario 1b to 20.4% in scenario 3

Results – Congestion points

Afternoon peak hour

3c

Results – Average numbers



Private car: increase of travel distance by 2.11 km

Public transport: decrease of travel distances by 6.1%

Conclusions

- The study results show that the reduction of speed limits in Berlin leads to higher usage of public transport modes.
- the increased usage of public transport leads to a noticeable reduction of passenger car kilometers and consequently congestion points at peak hours.
- Individuals started travelling with private cars for longer distances, following motorways and private roads, where speeds remained constant.
- Although the speed limits were reduced in inner urban roads, the decrease of average travel speed using private car was not so high.
- Scenarios with low compliance rate have no difference in results compared to base scenario. Interventions in the road environment can ensure higher compliance.

Limitations

- Public transport operations were fully reliable in all simulation scenarios. Unreliability (increase of waiting time) adds disutility, so less attractive…

- Walking and bicycle trips were not simulated; they performed utilizing teleportation algorithm.

- Additional environmental factors (e.g. CO_2 emissions, air pollution, consumed energy etc.) were not examined in this study. Yet, the simulation data are rich to estimate these.

- And finally, what is the impact of better safety? … in mode and route choice??

$$S_{trav,q} = C_{m(q)} + \beta_{trav,m(q)} * t_{trav,q} + \left(\beta_{d,m(q)} + \beta_{cost,m(q)} * \gamma_{d,m(q)}\right) * \sum l_i + \boldsymbol{\beta_{psafe,m(q)}} \frac{\sum \boldsymbol{psafe_{i,m(q)}} * \boldsymbol{l_i}}{\sum \boldsymbol{l_i}}$$

where:

$S_{trav,q}$: sum of all travel (dis)utilities of trip q;

l_i: length of link i;

$psafe_i$: perceived safety of link i;

a new scoring function based on time + distance + safety

Or: $+\boldsymbol{\beta_{psafe,m(q)}} * \boldsymbol{min(psafe_{i,m(q)})}$

Thank your for your attention