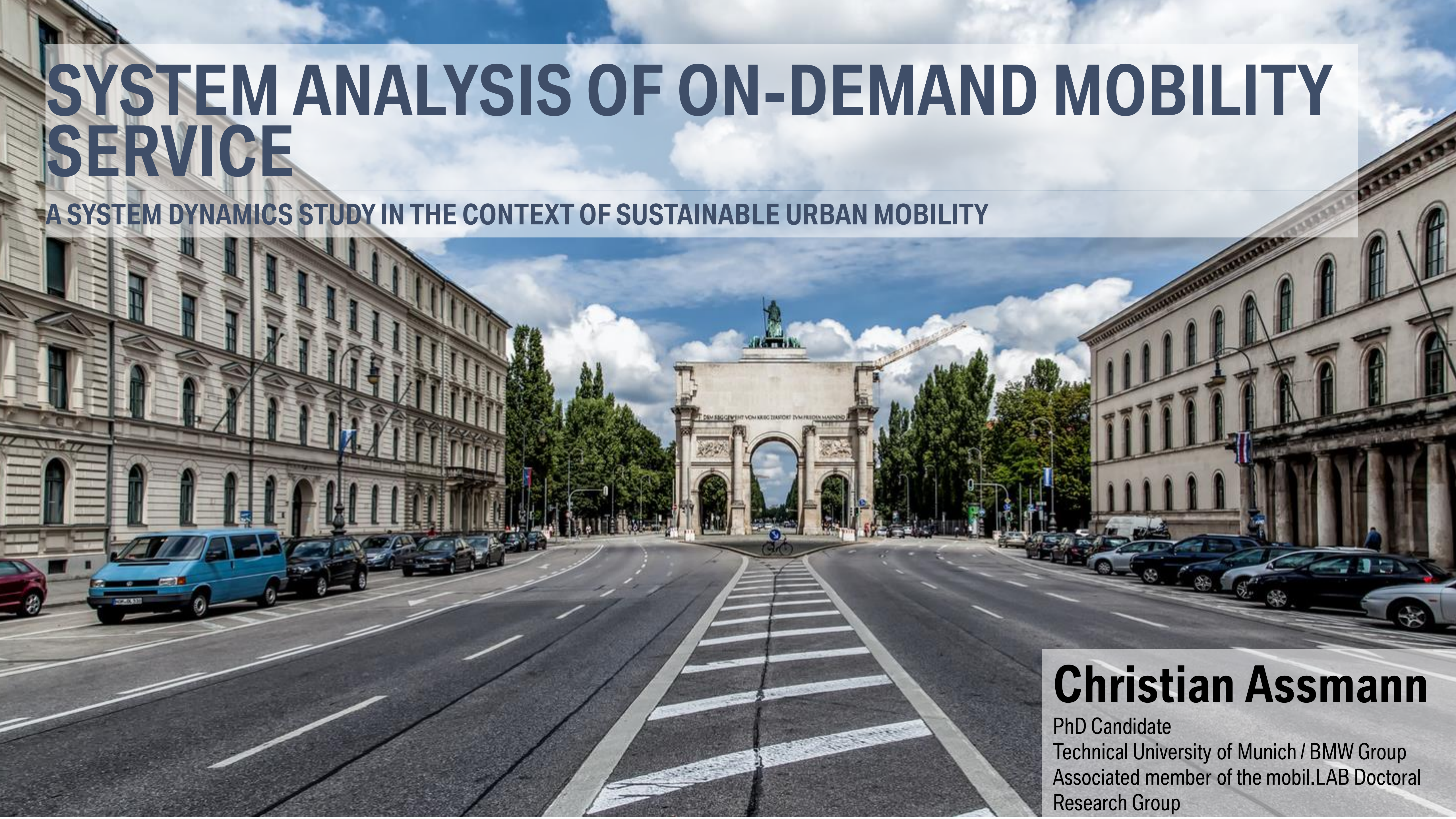
SYSTEM ANALYSIS OF ON-DEMAND MOBILITY SERVICE

A SYSTEM DYNAMICS STUDY IN THE CONTEXT OF SUSTAINABLE URBAN MOBILITY



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VISION OF A MODERN CITY
TRANSFORMATION FROM A CAR CENTRIC- TO A MORE LIVABLE CITY

Uber and Lyft are creating more traffic and congestion instead of reducing it, according to a new report

BI Sean Wolfe, Business Insider
27.07.2018, 17:42

Ride-Hailing Services Add To Traffic Congestion, Study Says

August 1, 2018 · 7:25 AM ET
Heard on Morning Edition

As ride hailing booms in D.C., it's not just eating into the taxi market — it's increasing vehicle trips

Ride-hailing tax revenue for the city grew from about $900,000 in 2015 to $4.5 million by late 2017.

Apr 26, 2018

Exclusiv im Ersten: Mit Vollgas in den Verkehrskollaps

Reportage & Dokumentation

30.07.2018 Reportage & Dokumentation · Das Erste

Deutschlands Städte ersticken im Stau: Immer mehr Pendler, immer mehr Autos, immer mehr Verkehrschaos. Städte und Politiker reden von der Verkehrswende, der Mobilität von morgen. Doch was taugen diese Rezepte gegen den Stau wirklich?

The future of Lyft is more carpooling

By Alison Griswold • June 7, 2018

drivy

Shared mobility, car use and demotorisation: what is the impact of car sharing on European cities and how to foster its development?

Does sharing cars really reduce car use?

June 2017

CARSHARING EROBERT DIE STÄDTE

Aber wie nachhaltig ist der Trend eigentlich?

12. November 2013

Warum nutzen Berliner, Hamburger und Münchner Carsharing? Weil es billig und bequem ist oder die Umwelt schützt?

Nutzen von Carsharing für die Umwelt umstritten

Mieter stellen ihr Carsharing-Fahrzeug von Car2Go wird in einer Wohnstraße ab. Die Daimler-Tochter betreibt in Berlin eine Flotte mit 1200 Pkw.

Jürgen Stüber – 9. Januar 2019

Carsharing-Dienste treten mit dem Anspruch an, ihren Nutzern einen nachhaltigeren Lebensstil zu ermöglichen. Doch das lässt sich nur schwer belegen.

Picture: www.bosch.com

AGENDA

OBJECTIVES AND RESEARCH QUESTIONS

Research Questions

1. What are the effects of future On-Demand Mobility services on traffic, emissions and land use / consumption in the city of Munich?
2. What are the relevant influencing factors for the future development of On-Demand Mobility Services?
3. Under what conditions can On-Demand Mobility services help to improve traffic, emissions and land use / consumption in the city of Munich?

SUSTAINABLE URBAN MOBILITY. OPERATIONALIZATION IN THIS STUDY.

Sustainable urban Mobility

Traffic Flow and Average Speed

- Spatially and temporally aggregated average speed in the study area

$$V_{Avg}(t) = \frac{\sum_{h=1}^{24} \sum_{i=1}^{h_n} V_{hi}}{\sum_{h=1}^{24} n_h}$$

Air pollutants and Greenhouse Gas Emissions

- Emission inventories for carbon dioxide (CO_2), particulate matter (PM) and nitrogen oxides (NOx) based on the mileage of different vehicle classes:

$$EI_{Poll} = \sum_{m=1}^{M} [FL_m * EF_m]$$

Land use and Land Consumption

- Total area for parked vehicles in public spaces (On-Street Parking) in the city of Munich.

$$A\ (t) = C\ (t) * \ Ac\ (t) * \omega$$
$$C\ (t) = f\ \{Fb\ (t)\}$$

V_{Avg} Average Speed
n_h Number of trips per hour
FL Milage
EF Emission factor
C Number of Vehicles
Ac Space per Vehicle
ω Number of Vehicle parking on-street
Fb Vehicle Ownership
A Space
EI_{Poll} Emission inventar

ON-DEMAND MOBILITY.
SEGMENTATION AND TERMINOLOGY.

On-Demand Mobility

	Car Rental	Car Sharing	Car Pooling	Ride Hailing	Ride Pooling	Micro Mobility
Services	➢ Operator-Based ➢ Peer-2-peer	➢ Free-Floating ➢ Station-Based ➢ Peer-2-peer	➢ Car Pooling ➢ Van Pooling	➢ Traditional Taxi ➢ Transport Network Companies (TNC's)	➢ Shared Ride / Taxi ➢ Micro Transit / Smart Shuttle	➢ Bike Sharing ➢ Scooter Sharing ➢ E-Scooter Sharing
Global Service Provider	Sixt, Hertz, AlphaRent, Europcar, AVIS, 神州租车 …	zipcar, enterprise CarShare, TURO …	BlaBlaCar, waze CARPOOL, RIDESCOUT …	Uber, DiDi, FREE NOW, Grab, Sixt, TAXI, lyft …	uberPOOL, lyft, MOIA, CleverShuttle, Grab …	BIRD, lime, voi., emmy, circ, TIER, lyft, Uber …
Local Service Provider	Sixt, Hertz, Alamo, Europcar …	SHARE NOW, Sixt share, TURO, oply, Flinkster, MILES, STATT AUTO …	BlaBlaCar, RideBee …	FREE NOW, Sixt, TAXI, Uber …	CleverShuttle, IsarTiger …	dott, DB, circ, emmy, TIER, lime, JUMP, BIRD …

Days / Hours / Minutes ⟷ Hours / Minutes

ON-DEMAND MOBILITY.
SEGMENTATION AND TERMINOLOGY.

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Days / Hours / Minutes ⟷ Hours / Minutes

AGENDA

METHODS.
RESEARCH DESIGN.

Literature-
Review

- Orientation in the research field / state of the art.
- Identification of applied methods.
- Market analysis of existing services in Munich.

Explorative - Qualitative
Expert Study

- Consideration of different stakeholders / perspectives.
- Identification of relevant parameters / system variables.

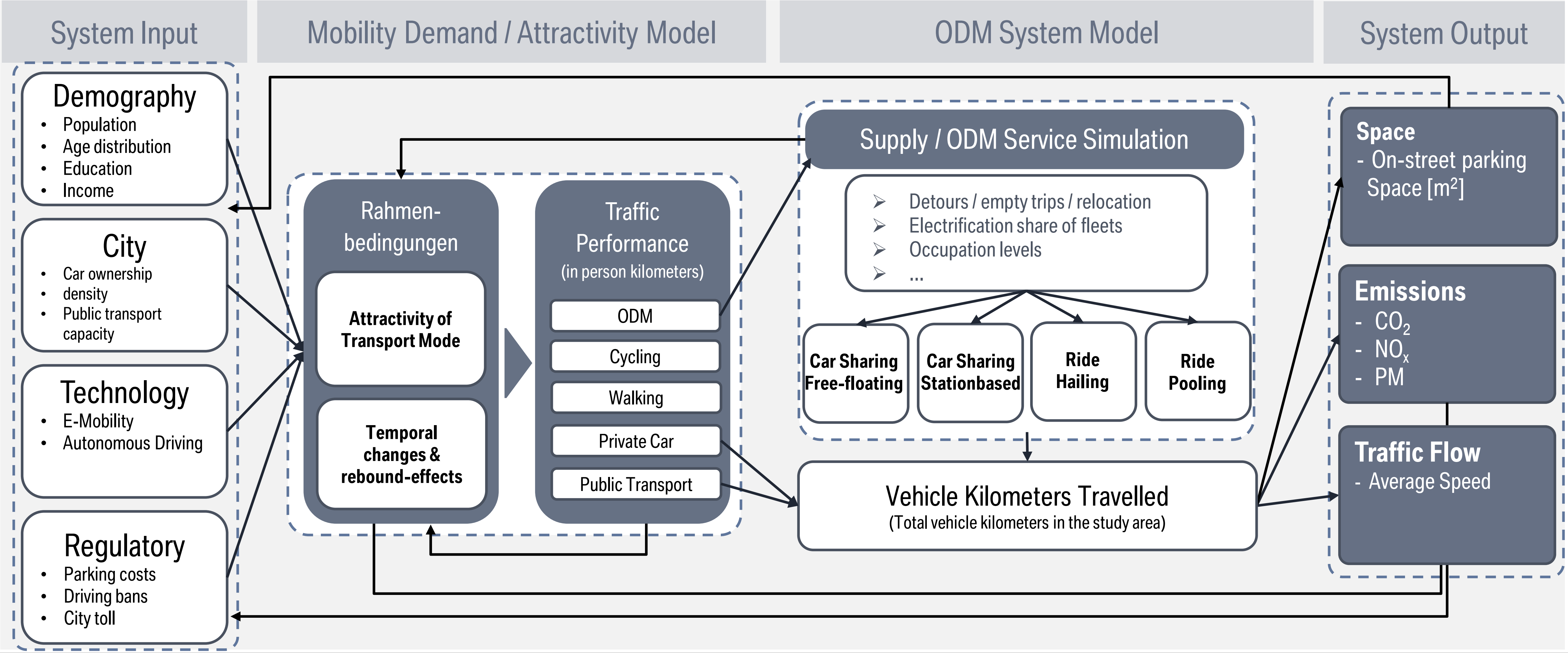
Qualitative and Quantitative System Model
System Thinking / System Dynamics

- Identification of the variables and their dependencies
- Use of causal loop diagrams (CLD's) and stock and flow diagrams (SFD's) to identify the mechanisms in the system
- Quantitative system modeling on the basis of suitable data inputs and relevant future scenarios
- Software: PowerSim (System Dynamics)

Preparation and Interpretation
of the Results

- Evaluation and interpretation
- Identification of different levers
- Formulation of recommendations for action

HIGH-LEVEL SYSTEM MODEL OVERVIEW. ODM SYSTEM.

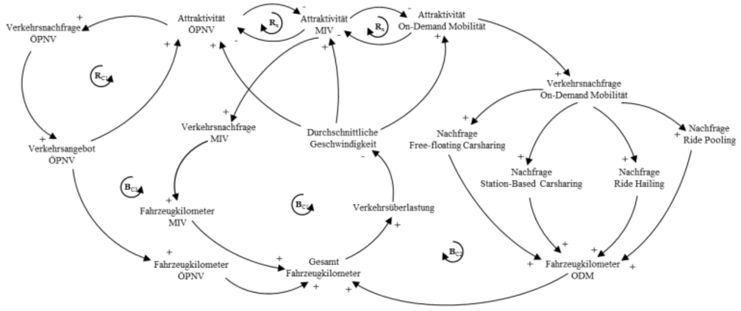


AGENDA

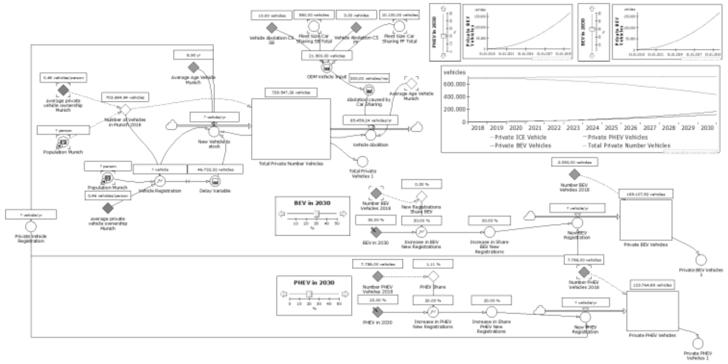
SYSTEM MODEL RESULTS – EMISSIONS.

Qualitative & Quantitative System Modelling

Development of a Causal-Loop-Diagram



Development of a Stock-and-Flow-Diagram



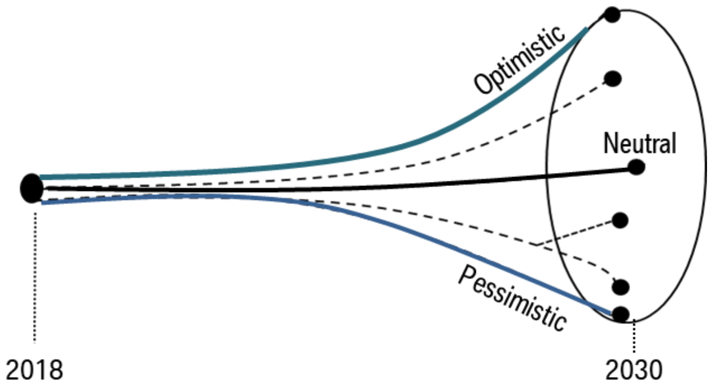
Quantitative Scenario-Analysis

Application of three Future Scenarios

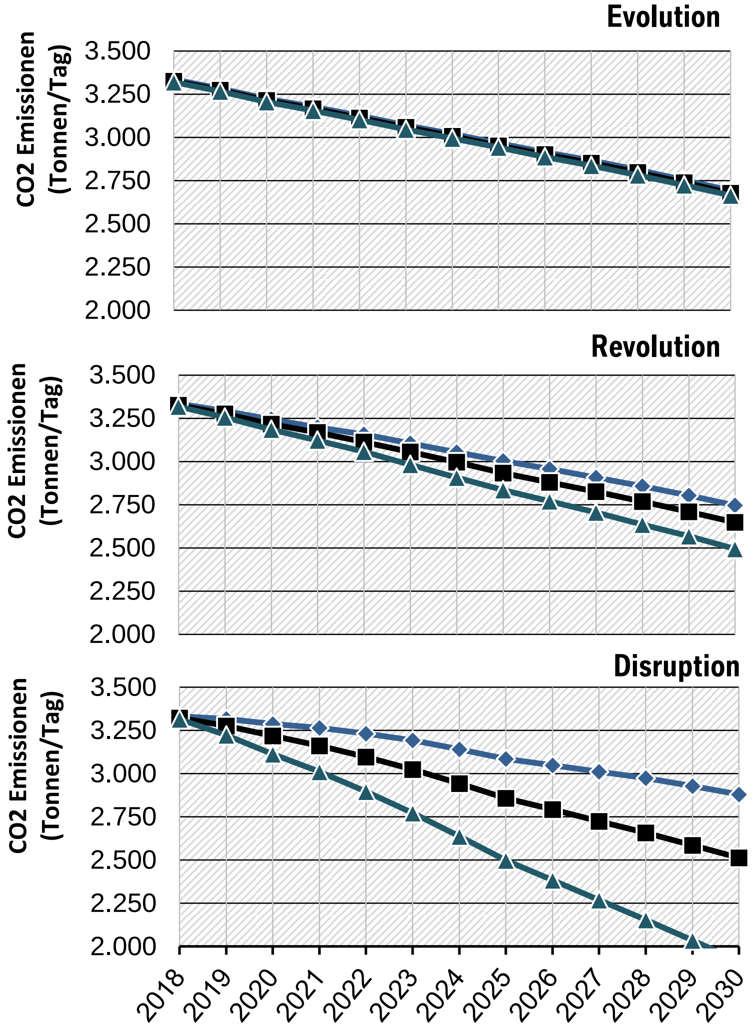
- ➢ Evolution / Revolution / Disruption

Variation of different Variables

- ➢ Substitution / Modal Shifts
- ➢ Additional kilometer effort ODM
  (detours, empty trips, relocation and service trips)
- ➢ Electrification of ODM vehicles
  (forecast share of BEV / PHEV in vehicle fleets)
- ➢ Impact of ODM on vehicle ownership
  (abolition of cars by using ODM services)



Scenario Results



RESULTS

Traffic

- Shifts / Substitution Effects of public transport, bicycle and pedestrian traffic
- Relocation, maintenance trips and service trips
- Empty trips between
- Higher occupancy rates than private Cars, even if the realization of “high” occupancy rates is problematic

In the scenarios examined, **ODM generally does not lead to any traffic reduction**

Improvement of the overall traffic impact only **under highly optimistic assumptions**

Emissions

- An increase in motorized traffic leads to increased emissions of air pollutants and greenhouse gas emissions
- Improved engine / exhaust technology leads to a significant reduction in NOx, PM and CO2 emissions
- High proportion of electrification ODM vehicles

The impact of ODM on emissions **depends largely on substitution effects, the share of electrified vehicles** and the corresponding mileage.

Space – On-Street Parking

- ODM vehicles are mainly parked in the public inner-city area
- Positive impact on private car ownership (different vehicle abolition rates simulated)
- Generally positive effect (strong supportive effect through regulation of private Cars)

In the scenarios examined, **ODM leads to a reduction of the required parking space**

AGENDA

RECOMMENDATIONS FOR ACTION / LIMITATIONS OF THE STUDY

Recommendations

Emissions

- Increase in the proportion of electrification in ODM vehicle fleets (100% electrification of ODM fleets if possible)

Traffic

The underlying substitution effects/ shifts in the modal share have a strong impact on the model results.

- ODM Service characteristics close to Private Car (through suitable service characteristics)
- Regulation of the Private Car (e.g. through road pricing, or parking space management) in order to influence the attractiveness of the Private Car Usage and to support a mobility behavior change towards ODM.
- Differentiation in price between ODM and public transport is necessary in order to reduce substitution effects between public transport and ODM.

Space

- Examination of whether ODM vehicle fleets can partly also be parked on off-street parking areas in order to reduce land use in public spaces.

Limitations of the Study

General limitations of the work

- Difficult to compare the literature: large differences regarding the sustainability impacts (e.g. impact of Car Sharing FF on car ownership 0.3 - 17.0 vehicles (Hülsmann et al. (Share), 2018), Firnkorn et al., 2012)) .
- Expert interviews, in some cases, strongly influenced by their own subjective / expectations. A clear differentiation between realized effects and possible potential is necessary.
- Changes in mobility behavior / adoption of services due to current market penetration cannot be fully mapped

Limitations System Model

- Data basis (e.g. MiD; 2017 - household survey of residents of the city of Munich).
- Validation of system interrelationships (especially quantification of soft system elements).
- Validation of the assumptions / input variables.
- Unclear model usage (black box).
- Spatially aggregated model (large spatial differences to be expected in some cases).

THANK YOU FOR YOUR ATTENTION!

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https://www.bgu.tum.de/sv/startseite/

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