
# Transformative Sociology

Combining analytical sociology and agent-based modeling

Johannes Weyer

Venice Workshop in Analytical Sociology
VIU – Nov. 14-17, 2022

Sorry for presenting some slides from 2019 and 2021.
Josef asked me to do this last year …

# Global challenges – risky dependencies

**Multiple crises**

- Climate change
- Digitization
- Global supply chains
- Pandemics
- Ukraine war
- …
- …

**Dependencies**

- Russian oil and gas
- U.S. digital companies
- Chinese suppliers
- Societal solidarity
- Stable world order / shared values
- …
- …

# Strategic sovereignty

- independence
- not isolation

→ societal transformation


Wörner/Schmidt (2022) - acatech

presented 2021

# Societal transformation

social science

external pressure (climate change)

politics

System $t_1$ (present) *

transformation *

System $t_2$ (future) *

poor performance

growing dissatisfaction

?

sustainable

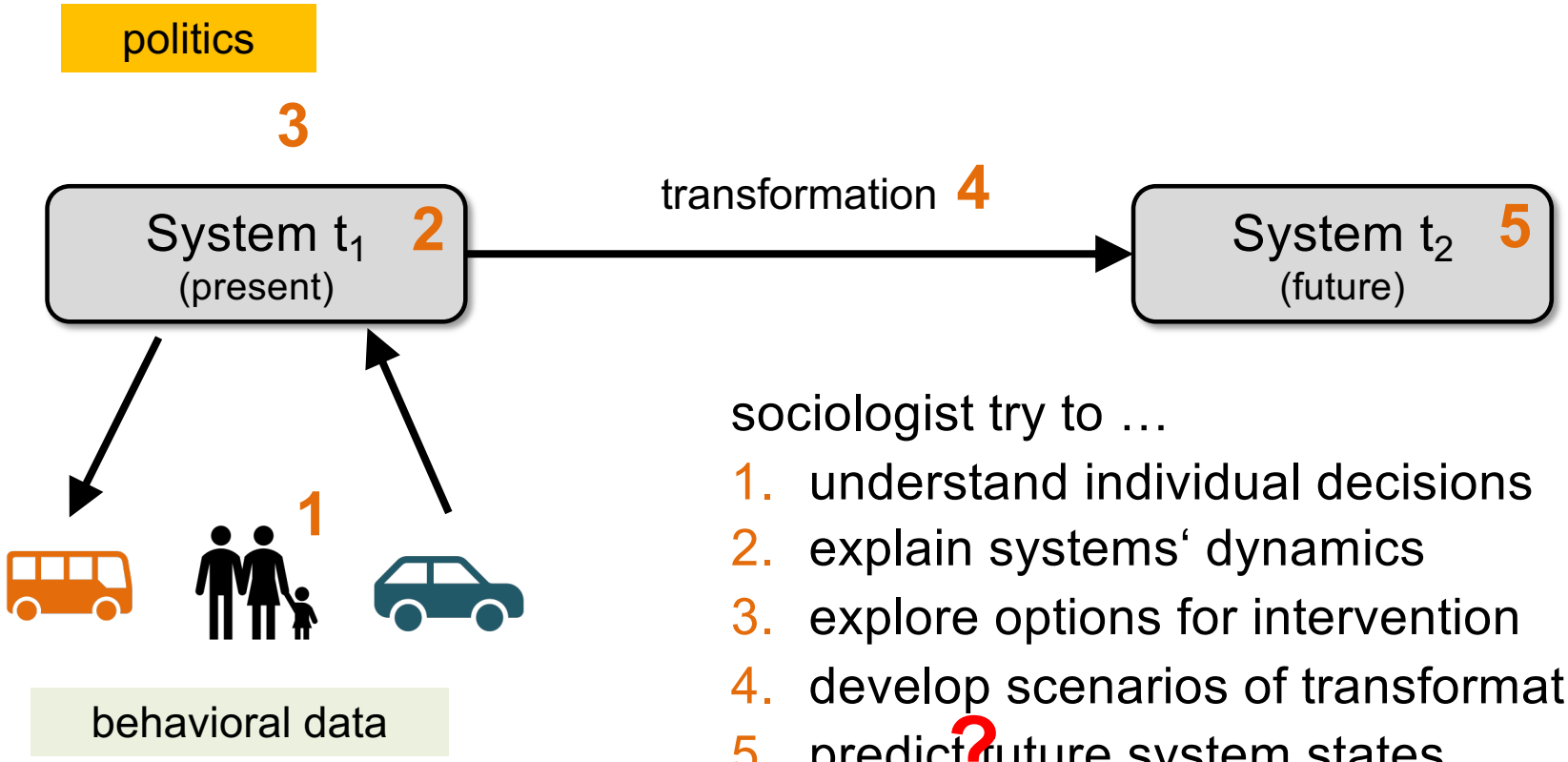
efficient

safe/reliable

socially fair

presented 2021

# Transformative social science




sociologist try to …

1. understand individual decisions
2. explain systems‘ dynamics
3. explore options for intervention
4. develop scenarios of transformation
5. predict future system states ?

# Transformative science

**Transformative sociology**

**normative orientation**

- 17 SDGs
- Sustainability
- Safety
- Resilience

**theoretical basis**

- Analytical sociology
  - Modeling complex systems
- Governance
  - crisis management
  - transformation

**active commitment**

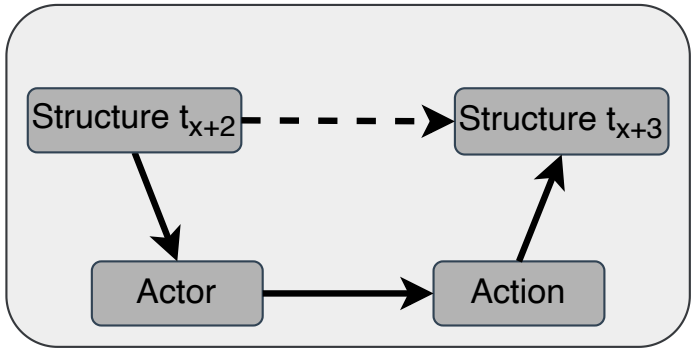
**methods**

# Content

presented 2019 (?)

# Basic model of a social system

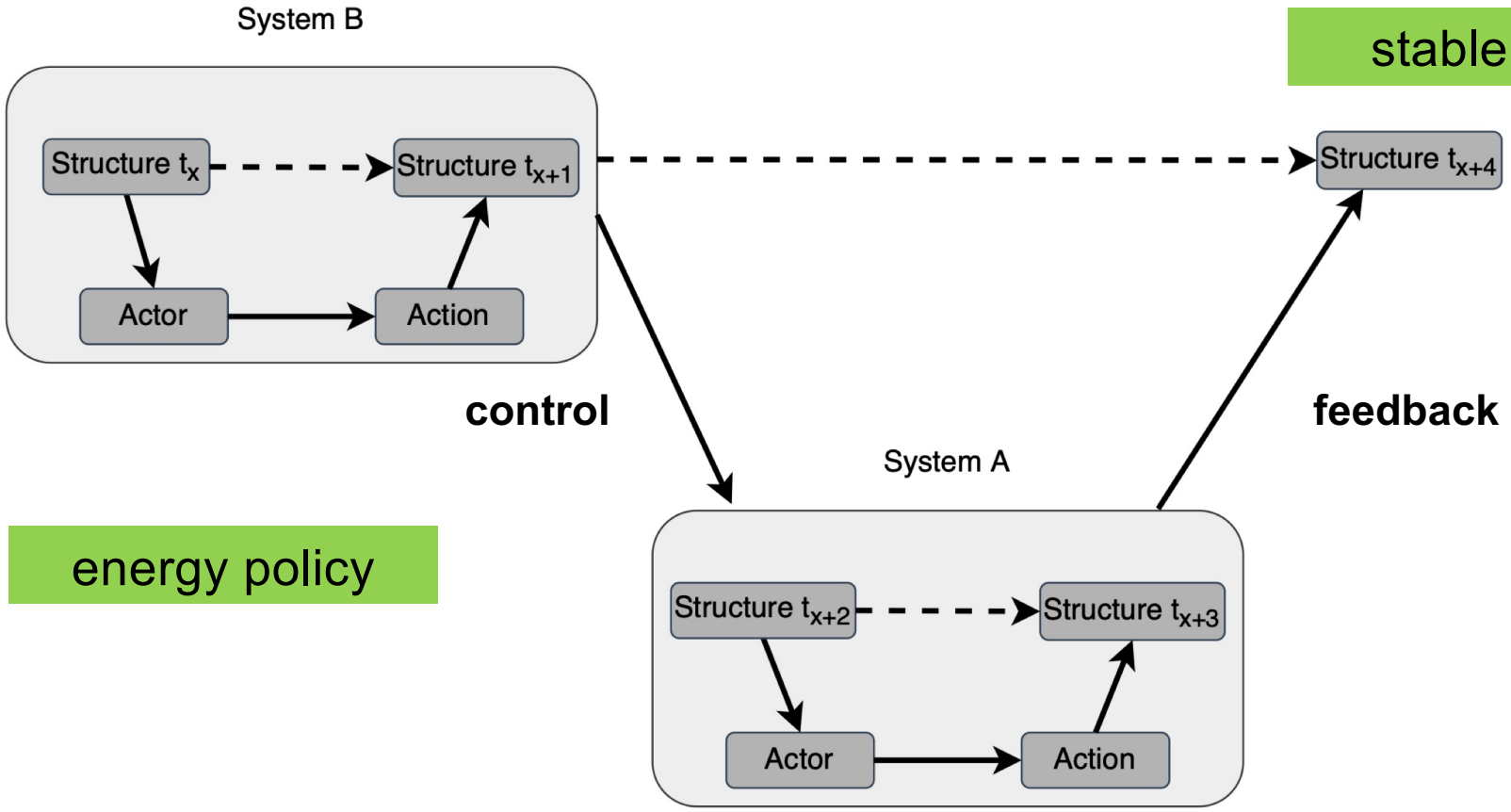
- family
- sports club
- company
- energy system
- global society






Weyer et al. 2015

# Model of multiple social Systems (MmSys)




stable grids

energy policy



Weyer et al. 2015

# Transformative sociology – mixed methods

**Transformative sociology**

**theoretical basis**

- Analytical sociology
- Governance theory
- …

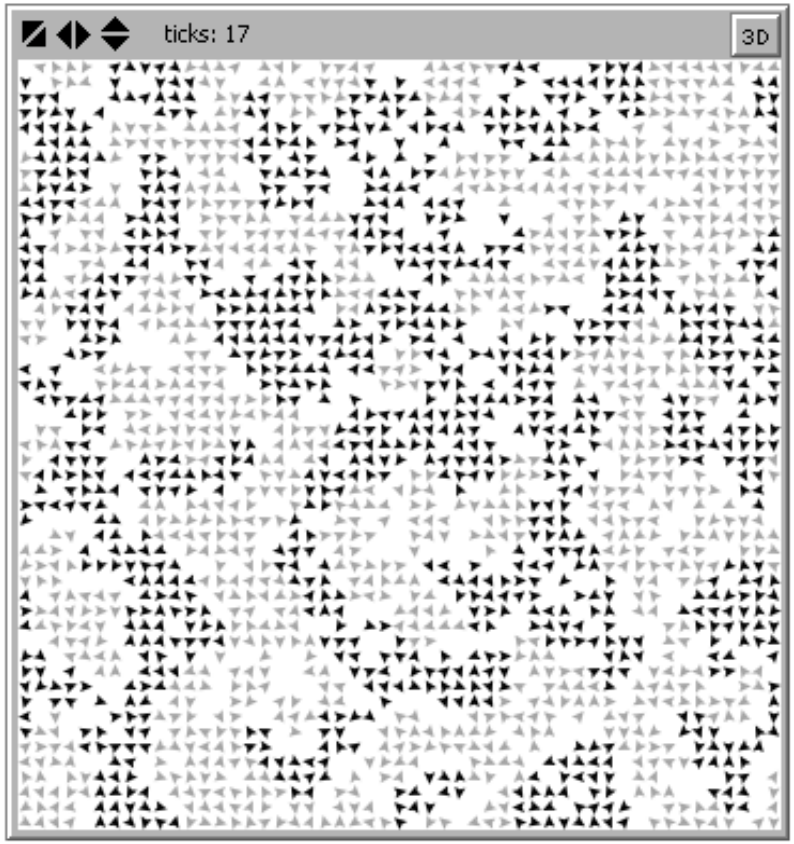
**methods**

- qualitative
- quantitative
- **experimental (ABM)**
- participatory
- …

# Content

# Agent-based modeling (ABM)

- complex systems (artificial societies)
  - macro-micro-macro
  - social mechanism
  - aggregation, system dynamics
- non-linearity
  - surprising outcomes
- heterogeneous agents
  - individual preferences and behavior
- decision-making algorithm
  - action theory (bounded rationality)
- experiments (what-if)
  - scenarios → forecasts
- impact of interventions (governance)




Segregation (Schelling 1969)

# Simulation framework

SIMCo
SIMULATION OF THE
GOVERNANCE OF COMPLEX SYSTEMS

→

MATSim
Multi-Agent Transport Simulation

http://ccl.northwestern.edu/netlogo

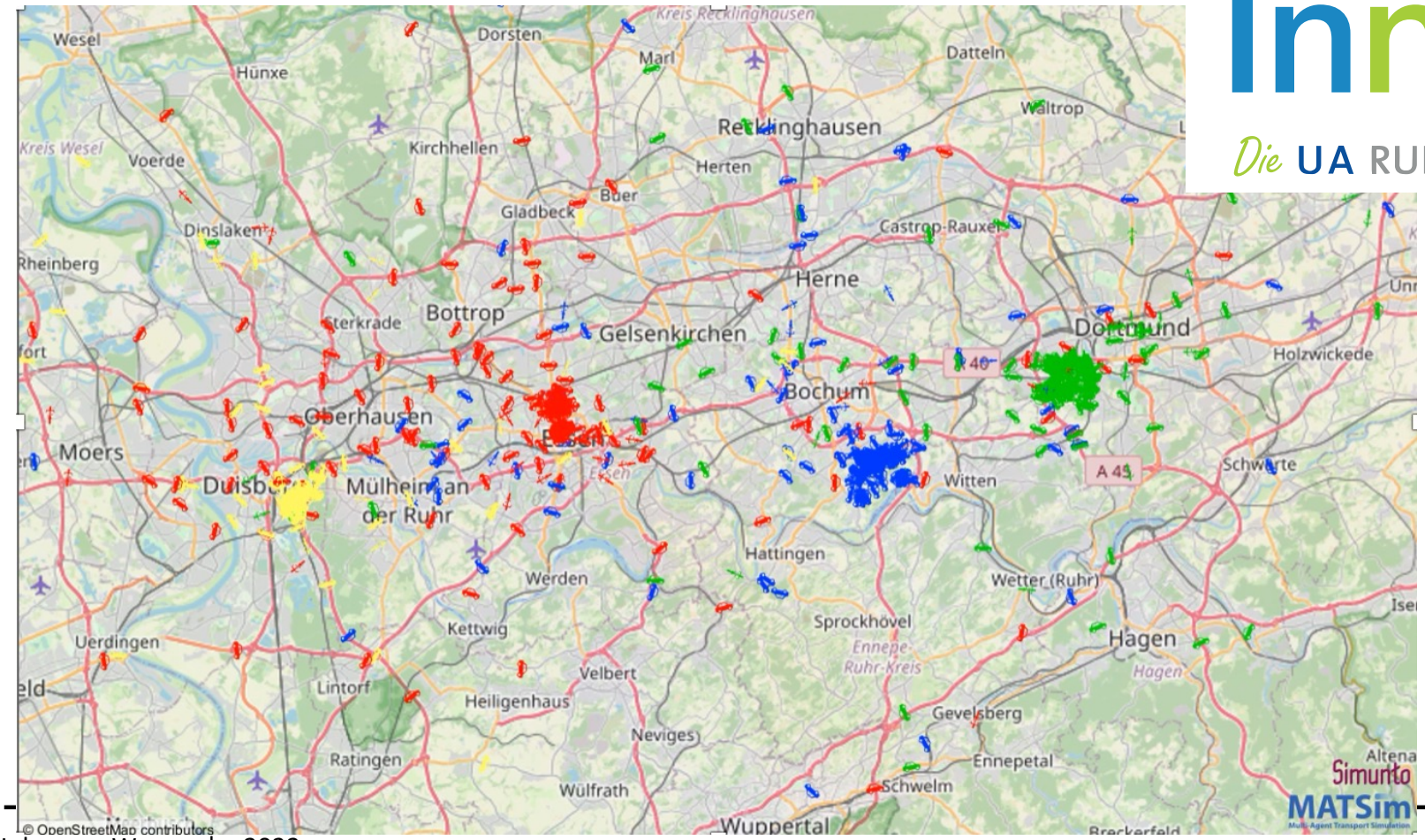
- rooted in analytical sociology
- mobility / energy system
- mobility / energy behavior



Adelt et al. 2018

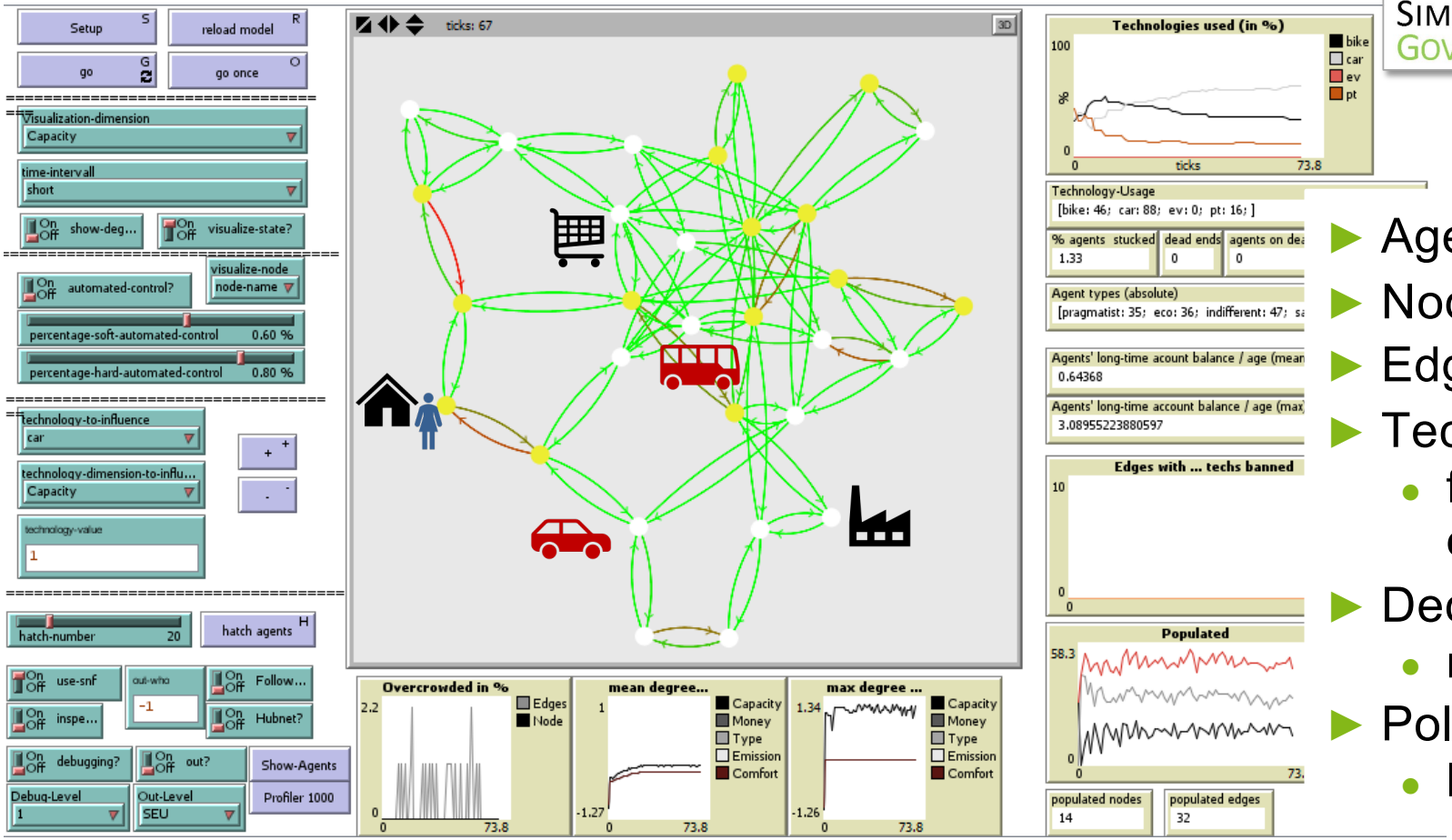
# Mobility in the Ruhr district (MATSim)

InnaMo RUHR
Die UA RUHR macht mobil!




Philipp et al. 2023

# SimCo GUI




- Agents (types)
- Nodes
- Edges
- Technologies
  - fast, cheap, eco-friendly
- Decision rules
  - mode choice
- Politics
  - limits, incentives

# Content

# Experiment 1
# Governance of sustainable transformation

- urban transportation
- modes of governance
  - no control
  - soft control (incentives)
  - strong control (bans)
- abstract model of big city (Dortmund)
- dynamic interventions

presented 2019 (?)

# Sustainable transformation (urban transportation)

| | Mean | | |
|---|---|---|---|
| Governance mode | capacity utilization of edges | pollution on edges (short) | pollution on edges (long) |
| **No control** | 21,4% | 18,0% | 33,3% |
| **Soft control** | **15,8%** | **12,8%** | 24,7% |
| **Strong control** | 19,1% | 15,6% | 28,9% |
| **Combined** | 16,4% | 12,9% | **24,7%** |

Adelt et al. 2018

# Sustainable transformation (urban transportation)

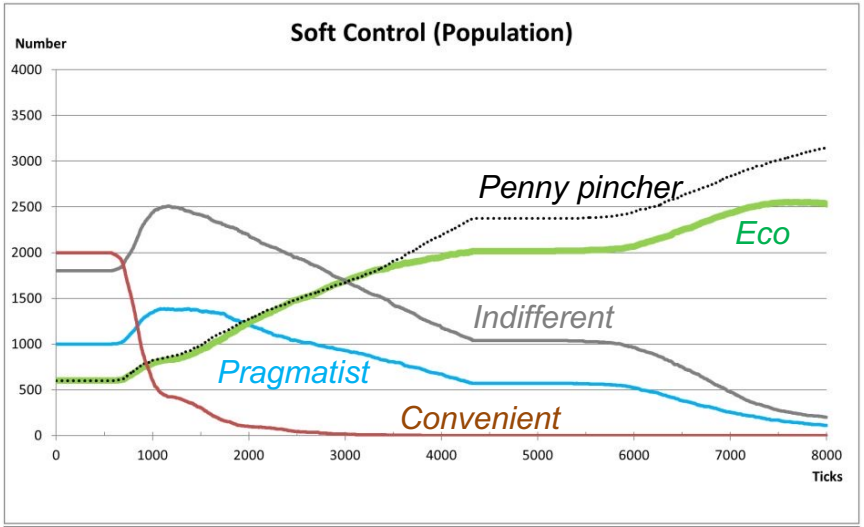
| | Mean | | | Modal share | | |
|---|---|---|---|---|---|---|
| Governance mode | capacity utilization of edges | pollution on edges (short) | pollution on edges (long) | Bike | Car | PT |
| **No control** | 21,4% | 18,0% | 33,3% | 31,6% | 62,5% | 5,9% |
| **Soft control** | **15,8%** | **12,8%** | 24,7% | 46,0% | **37,5%** | **16,5%** |
| **Strong control** | 19,1% | 15,6% | 28,9% | 41,4% | 52,1% | 6,5% |
| **Combined** | 16,4% | 12,9% | **24,7%** | **49,9%** | 39,0% | 11,1% |

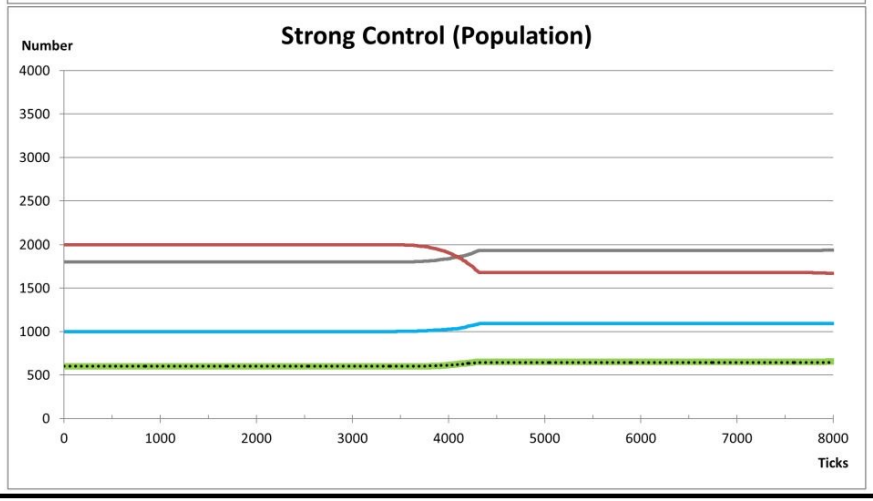
Adelt et al. 2018

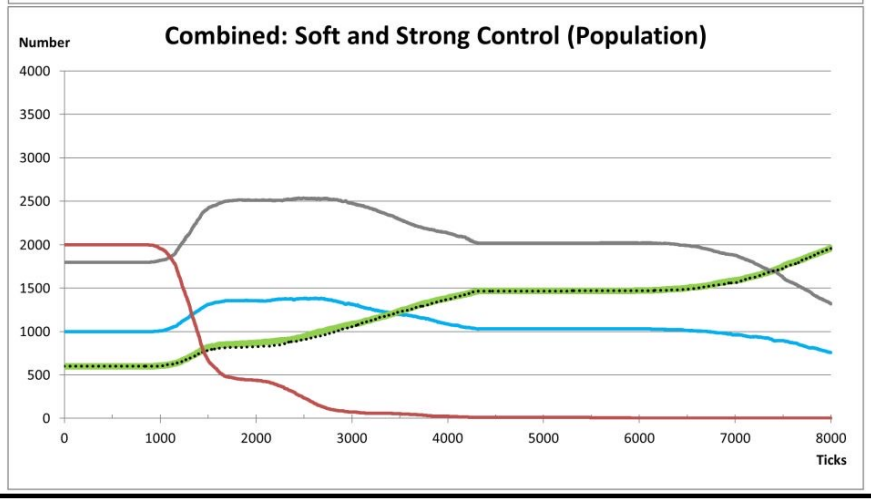
# Sustainable transformation (agent types)



SIMCo
SIMULATION OF THE GOVERNANCE OF COMPLEX SYSTEMS



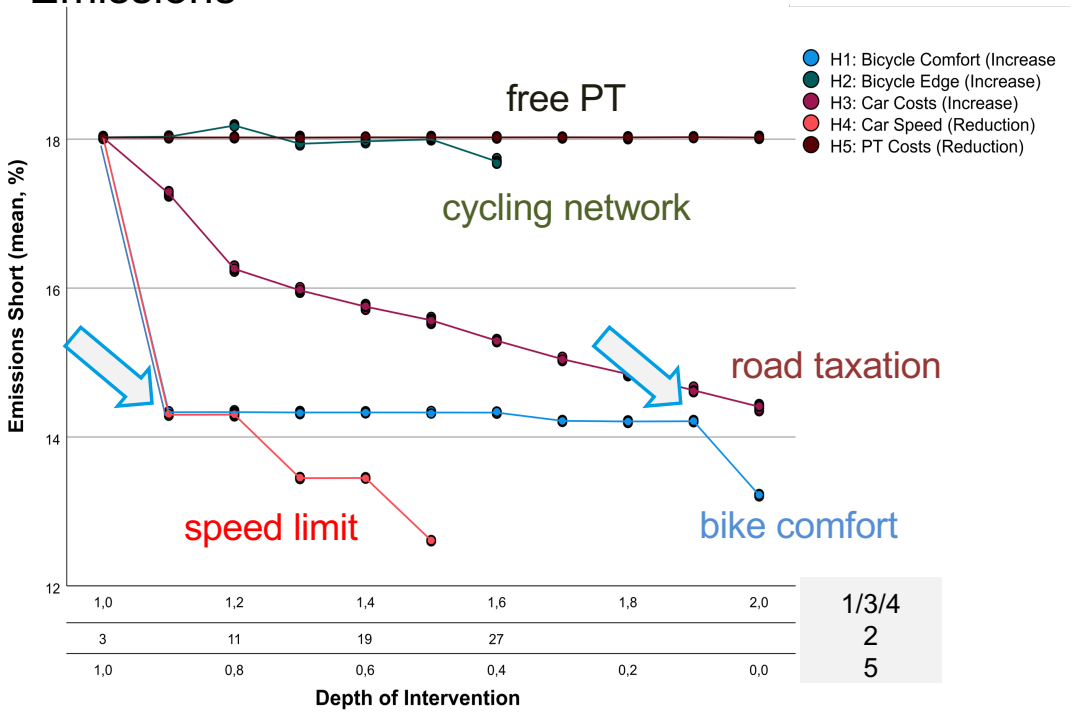

Adelt et al. 2018

# Experiment 2
# Political regulation

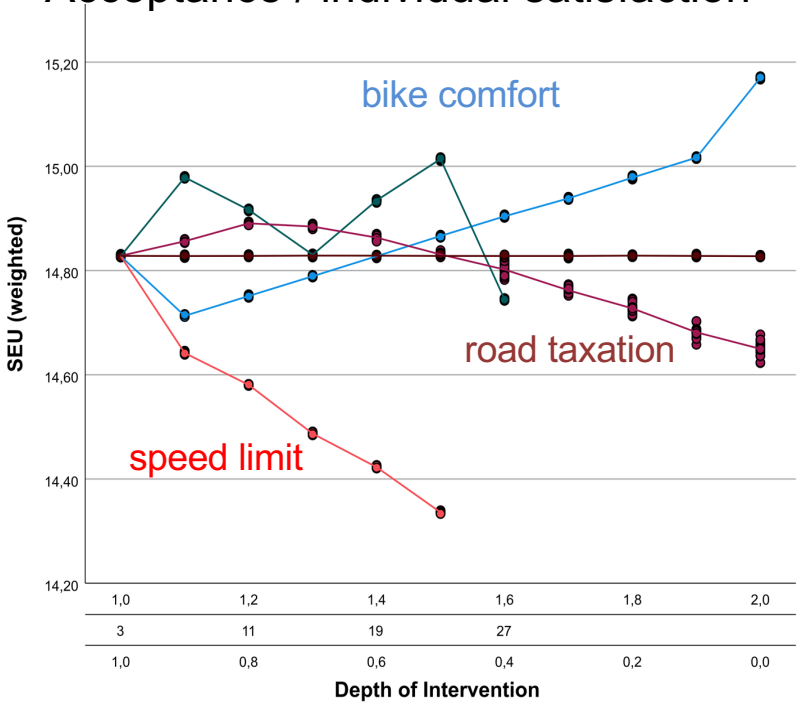
- urban transportation
- political regulation
  - five **realistic scenarios** (not combined)
- abstract model of big city (Dortmund)
- **static** interventions
  - fixed parameters

# Political regulation of urban transportation (static interventions)

## Emissions




## Acceptance / individual satisfaction






Philipp/Adelt 2018

# Experiment 3
# Political regulation

- urban transportation
- political regulation
  - various scenarios (**combined**)
- **Ruhr model (MATSim/SimCo)**
  - **university population**
- static interventions
  - fixed parameters

InnaMo RUHR
Die UA RUHR macht mobil!

# Scoring function (adapted)

**Scoring MATSim** **75%** ? **Individual utility** **25%**

$$S_{plan} = \underbrace{\sum_{q=0}^{N-1} S_{act,q}}_{\text{activity}} + \underbrace{\sum_{q=0}^{N-1} S_{trav,mode(q)}}_{\text{trip}} \quad + \quad SEU\,(H_i) = \sum_{j=1}^{n} p_{ij} * U(O)_j$$

**Scoring activity**

$$S_{act,q} = S_{dur,q} + S_{wait,q} + S_{late.ar,q} + S_{earl.dp,q} + S_{sort.dur,q}$$

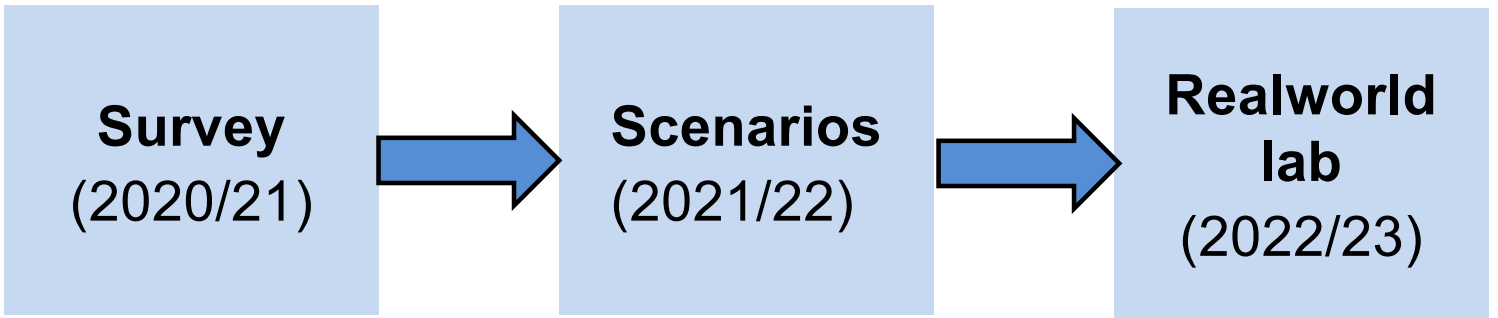
**Scoring trip**

$$S_{trav,q} = C_{mode(q)} + \beta_{trav,mode(q)} * t_{trav,q} + \beta_m * \Delta m_q + \left(\beta_{d,mode(q)} + \beta_m * \gamma_{d,mode(q)}\right) * d_{trav,q} + \beta_{transfer} * x_{transfer,q}$$

# Concept of an integrated, sustainable mobility for the University Alliance Ruhr

InnaMo RUHR
Die UA RUHR macht mobil!

Change of mobility patterns?



presented 2021

# Actor types (cluster analysis)

* data collected via questionnaire
(slider 0-10, sum: min 30, max 40)

* individual preferences (survey)
→ mobility behavior
→ reaction to incentives

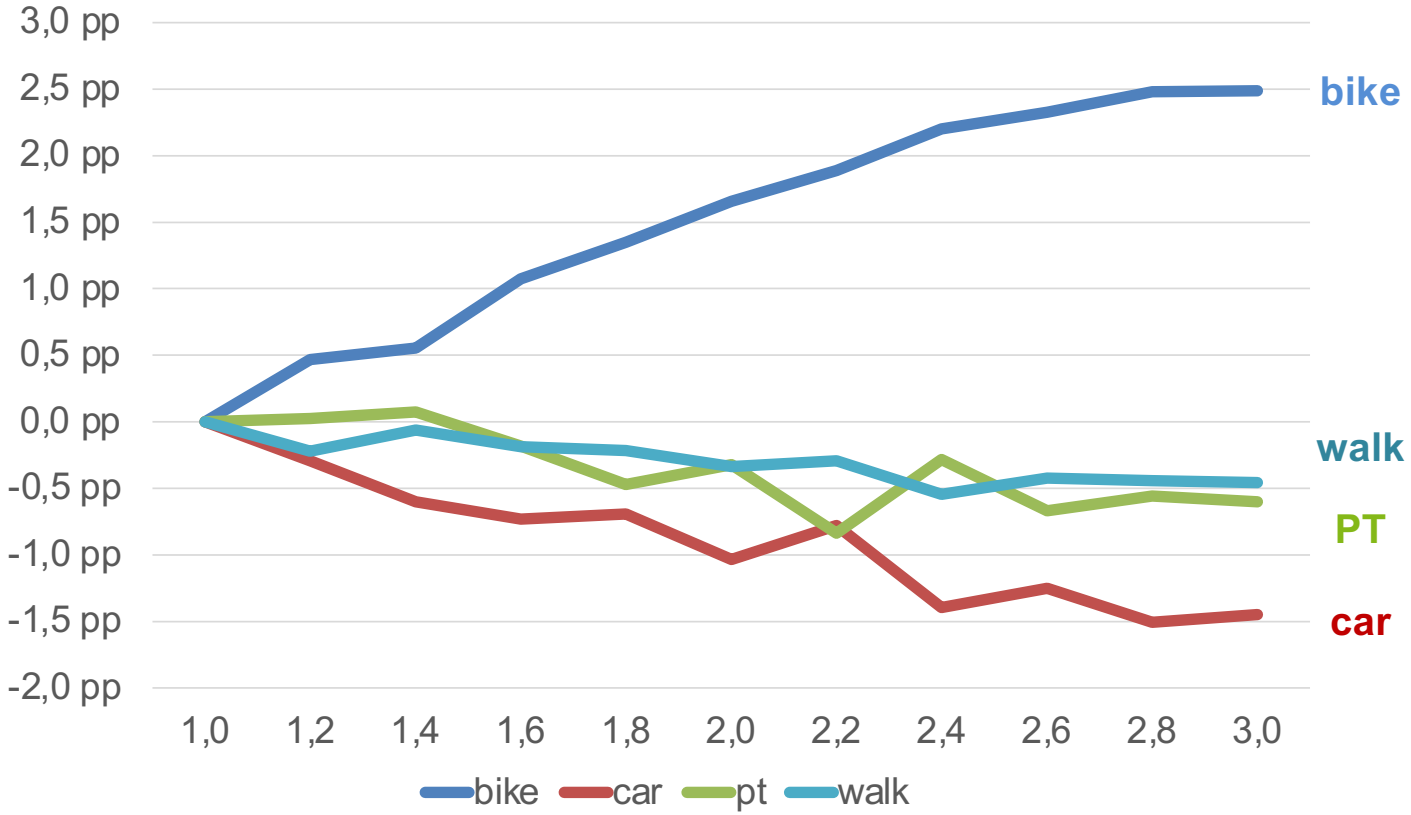
| Characteristics | *Outlier* | 1 | 2 | 3 | 4 | 5 | Mean (all) |
|---|---|---|---|---|---|---|---|
| fast | *0,9* | -1,6 | -0,8 | 1,0 | 0,8 | 0,8 | 7,8 |
| cheap | *0,5* | -0,6 | 0,5 | 0,9 | -3,1 | 1,4 | 6,3 |
| eco-friendly | *-0,2* | 1,7 | 0,9 | -2,2 | -2,1 | 2,1 | 5,9 |
| comfortable | *1,4* | -1,6 | 0,8 | 0,3 | 2,8 | -2,2 | 4,7 |
| safe | *1,3* | 1,7 | 0,2 | -0,6 | 1,4 | -2,7 | 6,2 |
| reliable | *-7,1* | 0,5 | -1,9 | 0,8 | 0,5 | 0,5 | 8,1 |
| percentage | *0,2* | 19,3 | 23,4 | 26,0 | 14,8 | 16,2 | 100,0 |
| | | Risc averse ecologicals | Indifferent | Efficient/ pragmatic | Comfort-oriented | Ecological savers | |
| | | bike/PT | !!? | !!? | car | bike/PT | |



Weyer 2022

# Raising bike comfort

## Changes in mode choice, compared to base scenario




**Combination**

- bike comfort
- car costs

→ stronger effect



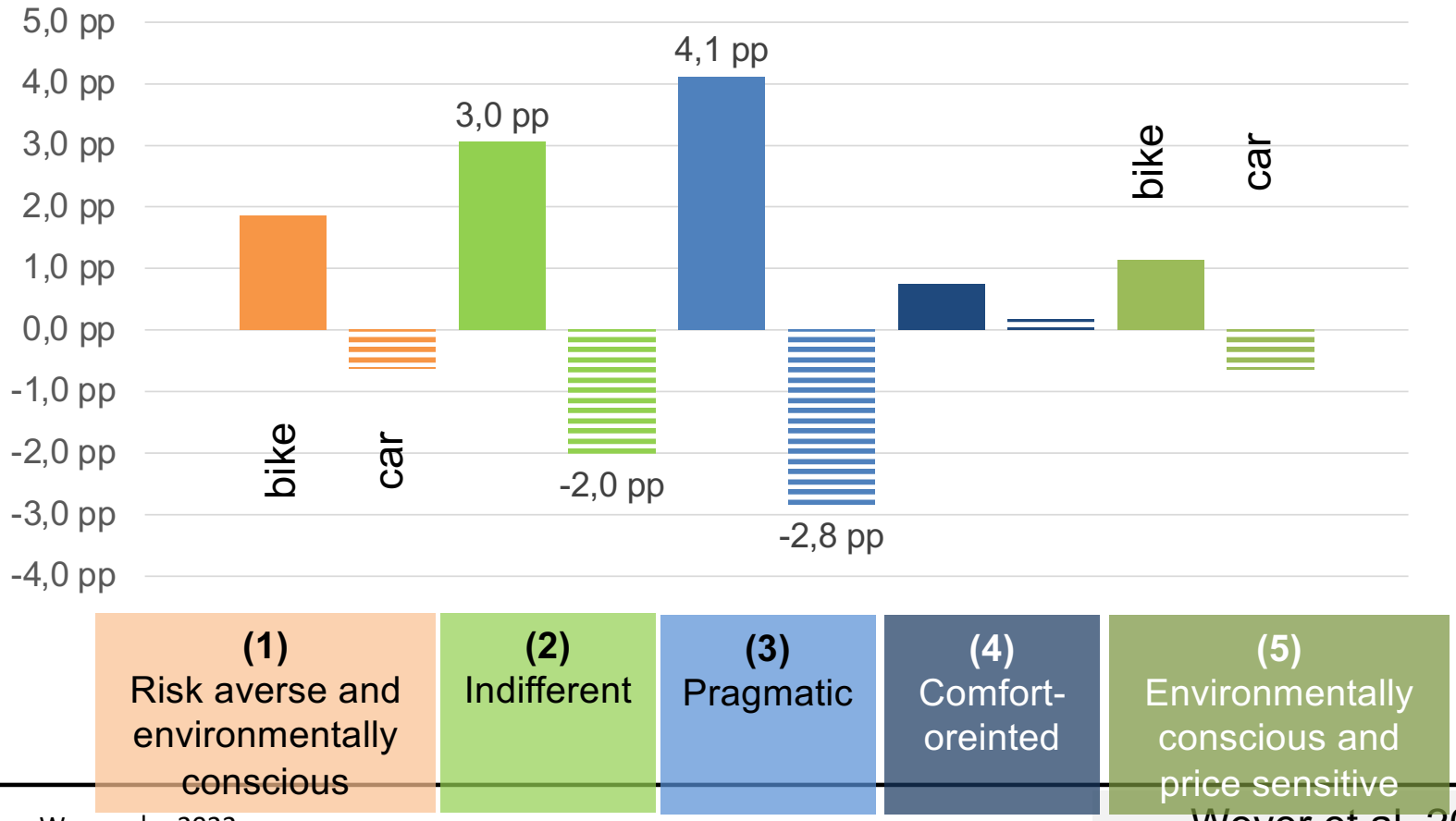
Weyer et al. 2023

# Realworld lab “bicycle station“ (TU Dortmund)


**Oliver Krischer**
(Secretary of Transportation, North Rhine-Westfalia)

TU Dortmund
Oct. 5, 2022

# Raising bike comfort – agent types




Weyer et al. 2023

# Content

# Transformative sociology

**Transformative sociology**

**normative orientation**

**theoretical basis**

- Analytical sociology
- Agent-based modeling

**methods**

**active commitment**

Keuschnigg/Lovsjö/Hedström, 2018: Analytical sociology and computational social science. In: *Journal of Computational Social Science* 1: 3-14.

Seniorprofessur

NaMo

Nachhaltige Mobilität

2022-2025

# Individual public transport

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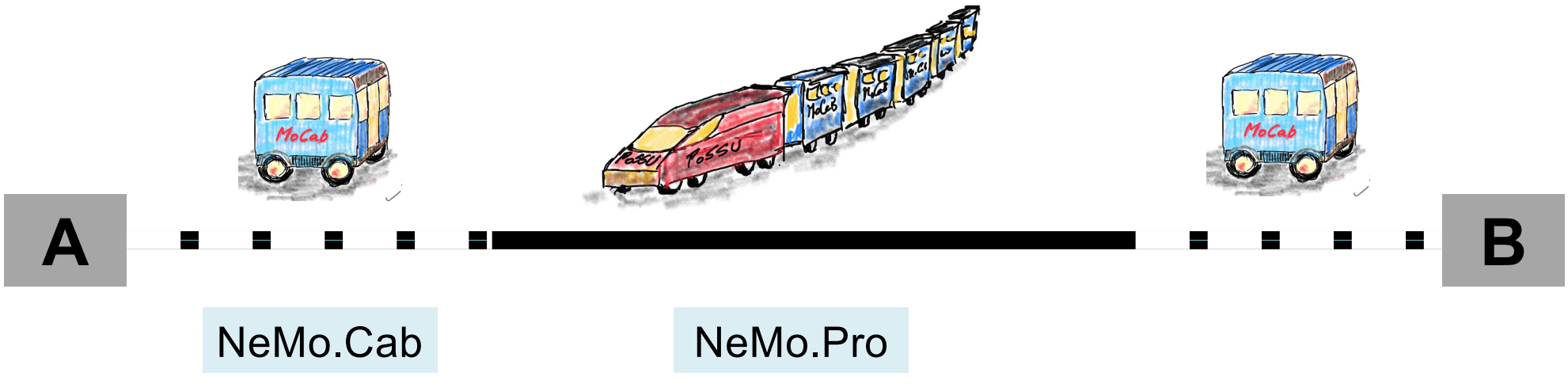
**NeMo.bil**




NeMo.Cab

NeMo.Pro

**NeMo.bil** will only run with input from social sciences!

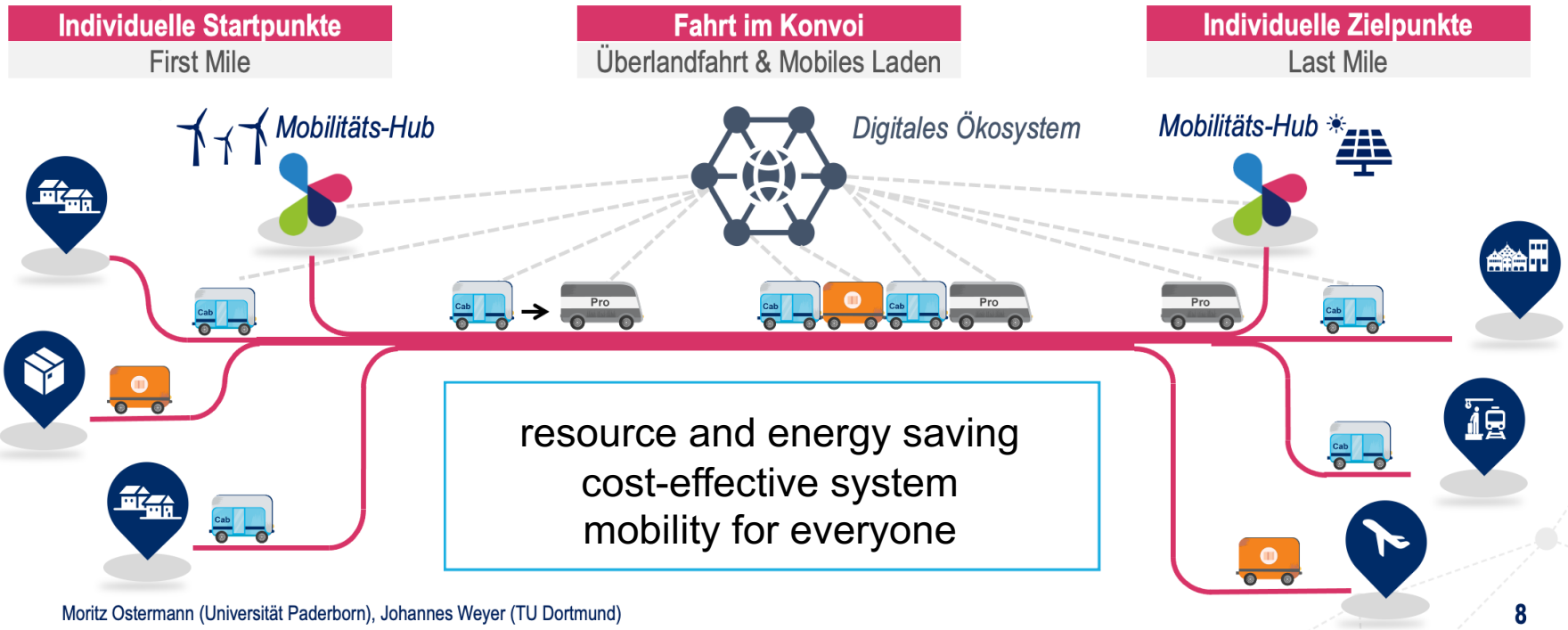
→ Mobility behaviour / willingness to change

→ Governance of complex sociotechnical systems

UNIVERSITÄT PADERBORN

technische universität dortmund

## NeMo.bil Konzept




Ostermann et al. 2023 (→ nemo-paderborn.de)

# Thanks for your attention!

Web sfs.sowi.tu-dortmund.de/ts

YouTube channel “Techniksoziologie Dortmund”
→ www.youtube.com/channel/UCHZaqFTl9uiN785G72XnQzg
→ https://cutt.ly/ahWayXC

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