Intermodality – Key to a More Efficient Urban Transport System?

Laura Gebhardt, Daniel Krajzewicz, Rebekka Oostendorp

German Aerospace Center (DLR) - Institute of Transport Research

Outline

Urban mobility is changing…

New systems of bicycle rental and car sharing are evolving

Growing cities

Services offered by public transport providers are increasingly integrated

Forms of life and work

Demand for quality of life

Smartphones simplify access to traffic information and tickets

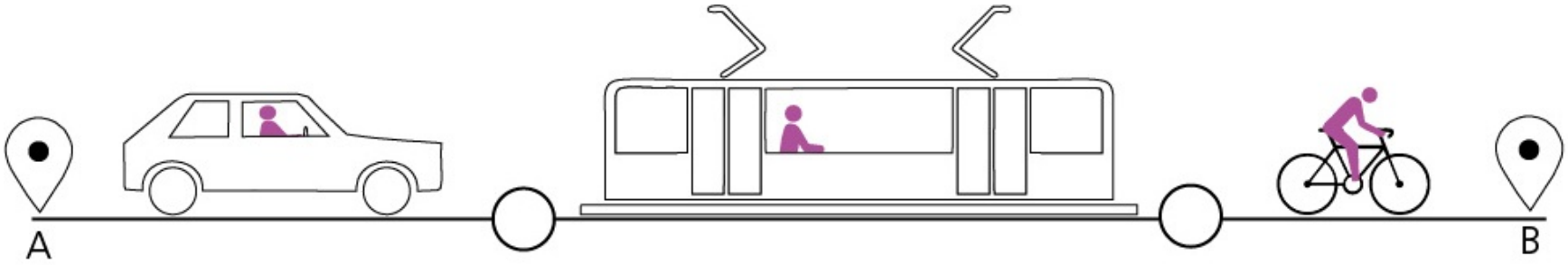
Traffic congestions, emissions and demand for parking space

Flexible usage and combination of different means of transport

Changing role of private cars

DLR

Intermodality
What do we talk about?



Source:authors' own graph 2017

- The flexible usage and combination of different means of transport on a single trip (Chlond 2013; Gebhardt et al. 2016)

- Is being discussed as a key to a more efficient urban transport system.
  - optimizing mobility towards matching personal wishes in terms of costs, time...
  - friendlier to the environment and healthier, because of less cars, congestions, emissions and less parking space needed... (Dacko & Spaltholz 2014)

- Essential component of the European Union's Common Transport Policy for sustainable mobility (EC 1997)

Approach & Methodology

- Thin empirical basis; most of the studies refer to long distance traffic (Ubbels &Palmer 2013; Van der Hoeven et al. 2013) , only a few deal with intermodality in everyday mobility (Dacko & Spalteholz 2014; Köhler & Heinrichs 2014)
- This presentation will show some results from the Urban Mobility Project (DLR)
- **Research Questions**
  - Which means of transport do people in Berlin use and combine when they travel to work?
  - What are the differences between monomodal and intermodal trips with regard to accessibilities, emissions, personal energy consumption and price?
  - What is the correlation between intermodal mobility and the characteristics of urban spaces and infrastructures?
- **Methodology**
  - Empirical studies in Berlin (quantitative and qualitative)
  - Performance evaluation of mono- and intermodal trips

Intermodality
Survey design – Berlin

- **Different spatial categories** (PLR's clustered in terms of mobility and urban fabric)
  - 1. decentralized neighbourhoods
  - 2. urban neighbourhoods
  - 3. well-connected neighbourhoods
- **Survey approach**
  - Representative sample concerning age and gender for each planning area (PLR)
  - Online questionnaire
- **Survey topics**
  - (Intermodal) mobility behaviour
  - Intermodal behaviour ↔ spatial structures
  - Users' perspective (e.g. requirements)
- **Responses**
  - 1,098 participants

Source: Urban Mobility Project, DLR 2016, n = 1.09

Intermodal combinations especially on trips to work or education

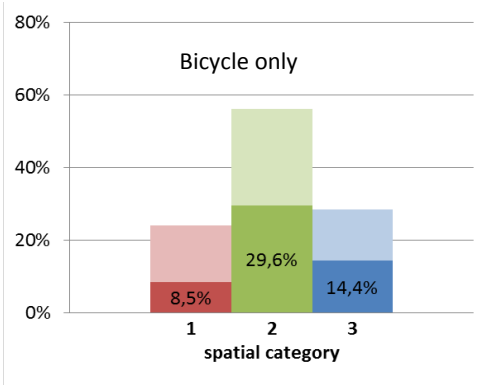
- One third (30.8%) of respondents stated that they combine different modes of transport on their trips to work or education on a daily basis

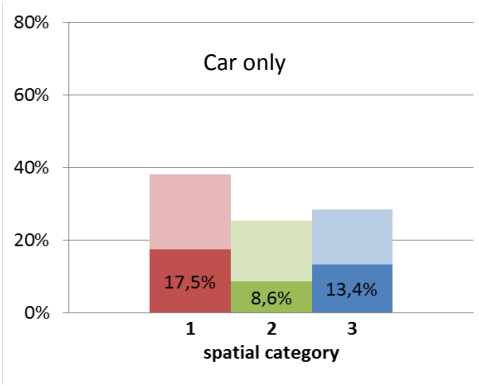
Table 1: Share of persons doing intermodal trips with a certain frequency, differentiated by trip purposes

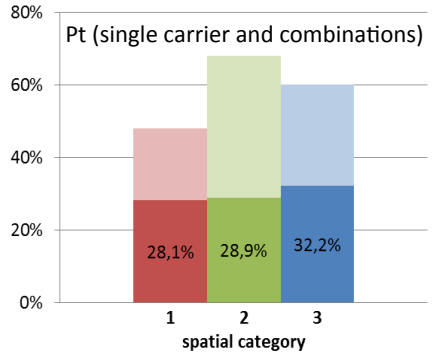
Trip purposes	Daily intermodal	Less than daily intermodal	Never intermodal
Work / education	**30.8%**	27. 4%	41.7%
Recreational	16.2%	64.8%	19.0%
Work related	8.2%	64.6%	28.2%
Shopping	7.5%	56.6%	35.9%
Personal business	7.3%	39.4%	52.5%
Pick up and bring people	3.7%	46.7%	49.6%
Transport of goods and material	2.6%	44.4%	53.0%

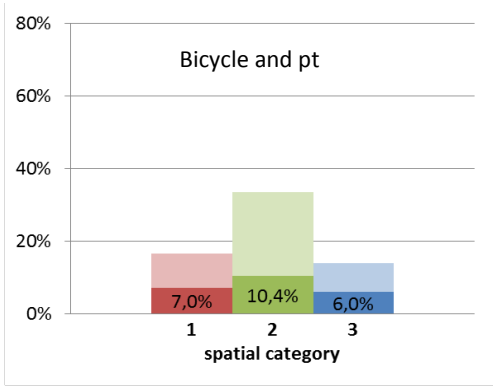
Source: Urban Mobility Project, DLR 2016, n = 1.098

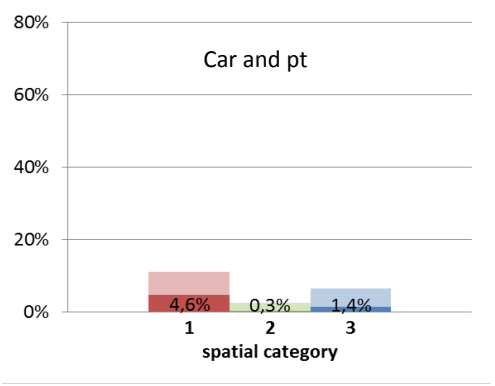
Shares of mode and mode combinations on trips to work differ between the spatial categories





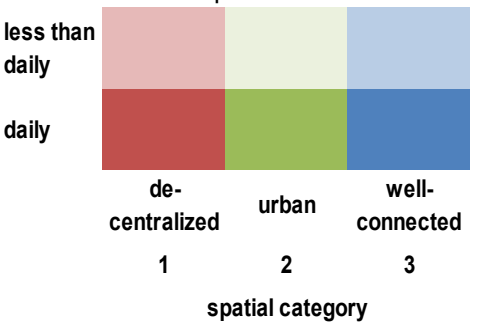






Legend:

Share of persons using a certain mode choice on trips to work



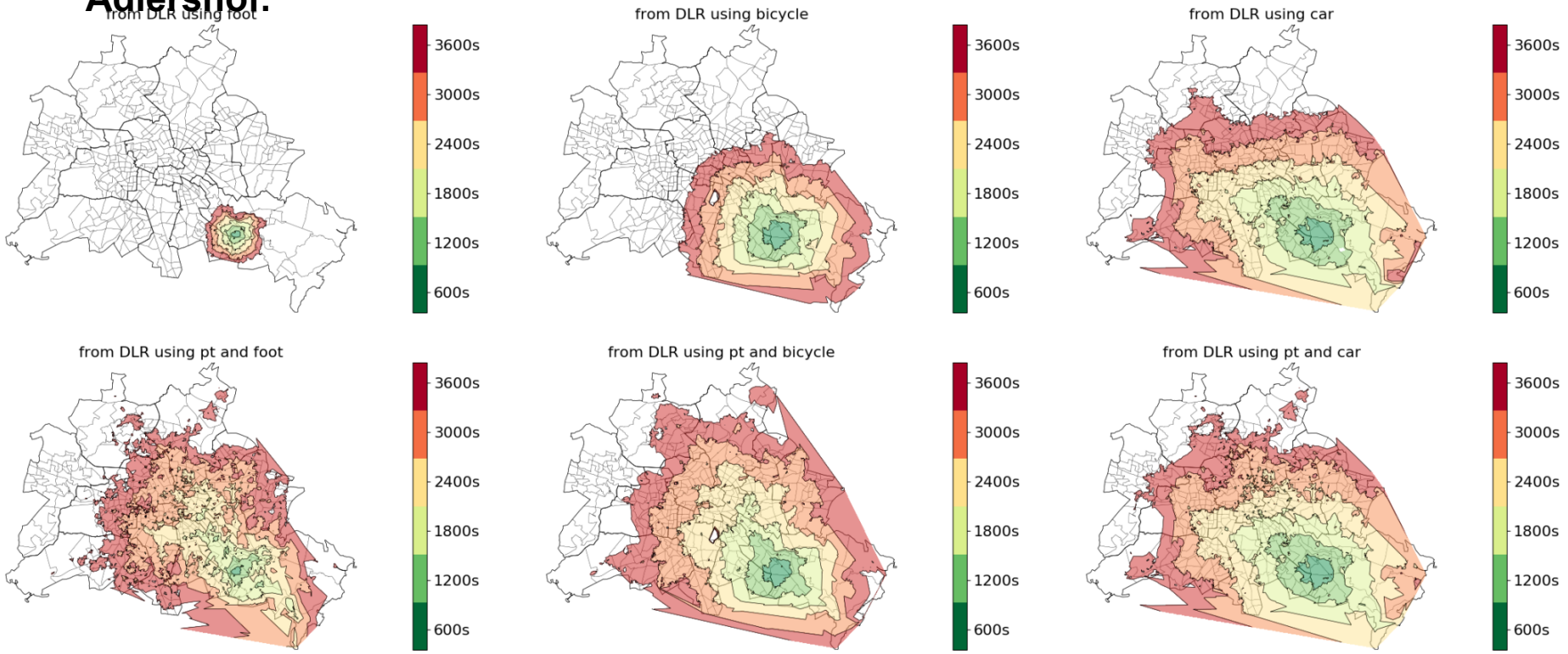
Source: Urban Mobility Project, DLR 2016, n = 1.09

Outline

Performance Evaluation of combining different modes of transport

- „Contour Accessibility Measures“ are used.
- They describe how many activity locations can be approached within a given time.

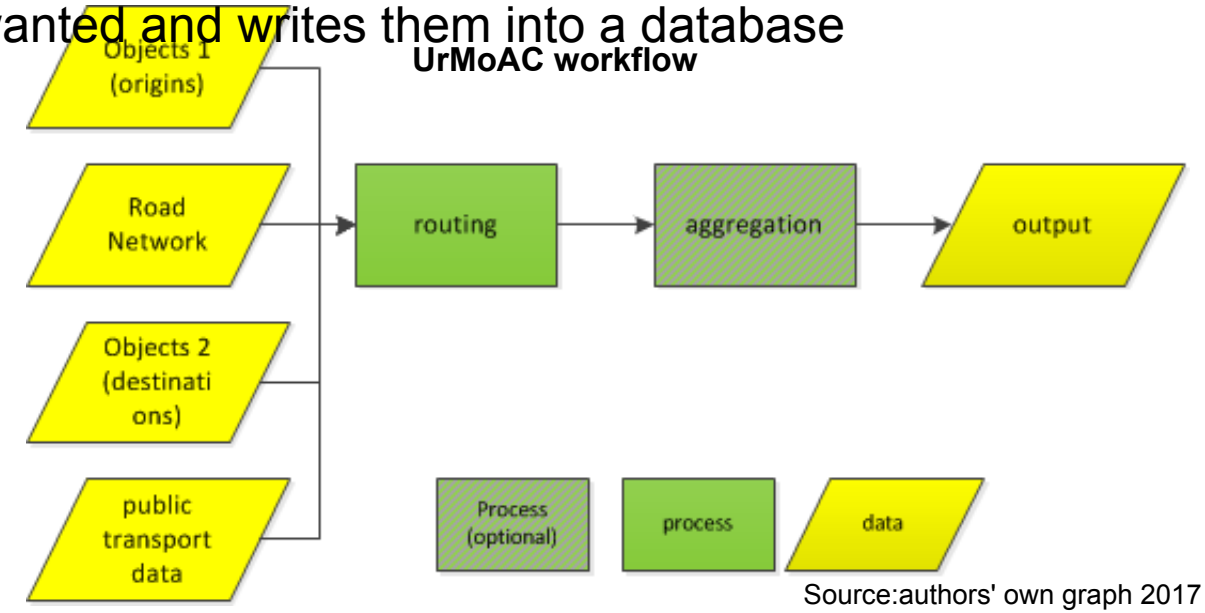
Figures: Number of work places accessible from the DLR site in Berlin, Adlershof.



Source: Urban Mobility Project, DLR 201

Intermodality
Performance Evaluation

- Accessibility measures are computed using a tool developed within the project
  - ➢„UrMo AccessibilityComputer“ (UrMoAC) (Krajzewicz & Heinrichs 2016)
- The tool reads sources and destinations as well as a multimodal road network from a database
- It computes shortest routes between sources and destinations
- It aggregates the results if wanted and writes them into a database
- Different options can be set, such as limits (time, distance)
- The tool was extended to model intermodal routes (mode combinations), including entrainment restrictions



Source:authors' own graph 2017

Intermodality
Performance Evaluation

- For our investigations, contour measures were computed as follows:
- Starting in the center of each of the PLRs the survey was performed within
- Collecting all work places over time

➢ Modes:
  - walking
  - biking
  - using a private vehicle
  - public transport + walking
  - public transport + biking (including entrainment in metros and city rail)
  - public transport + private vehicle

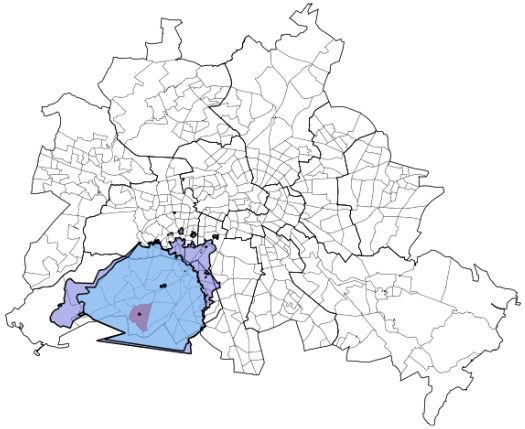
Table 2: Values used for computing the indicators

Transport mode	Max. speed	CO_2	Personal energy consumption	Price
Walking	5km/h	0g/km	280kcal/h	0€/km
Cycling	12km/h	0g/km	300kcal/h	0€/km
Motorized individual traffic	loaded from SUMO	150g/km	85kcal/h	0.45€/km
Public transport	as scheduled	75g/km	170kcal/h	0.95€/trip

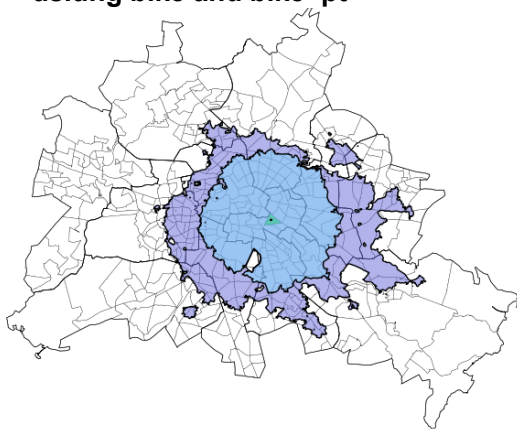
Source:Umweltbundesamt 2010; ADAC 2013; Krajzewicz et al. 2014

Intermodality - Performance Evaluation
Bike vs. Bike & public transport in different spatial categories

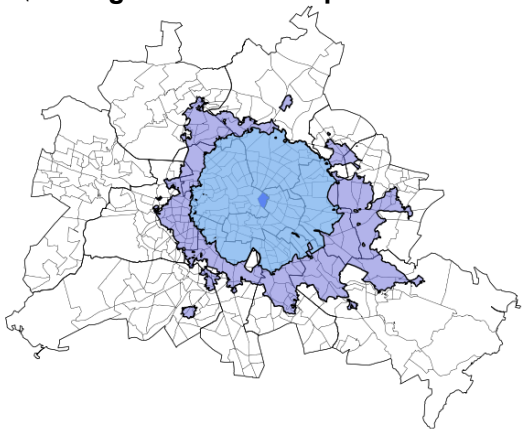
PLR 172 from Category 1
(decentralized neighbourhoods)
usiung bike and bike+pt



PLR 44 from Category 2
(urban neighbourhoods)
usiung bike and bike+pt

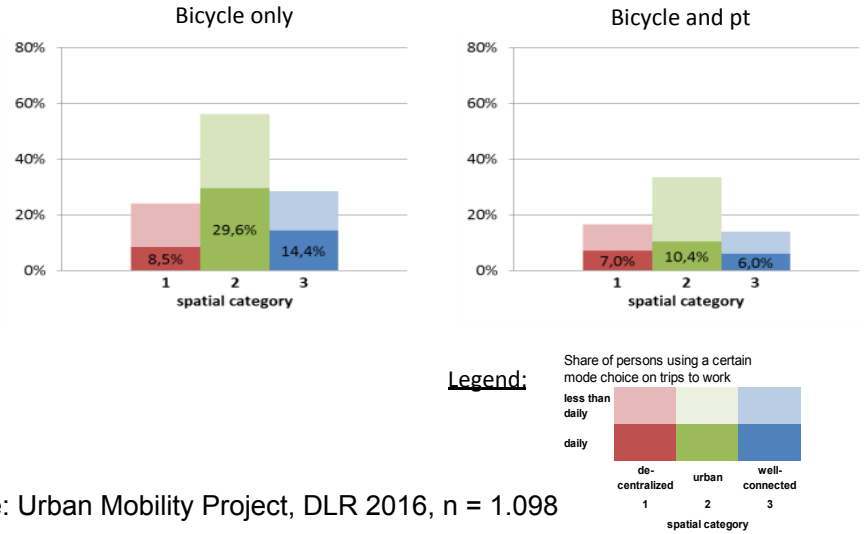


PLR 11 from Category 3
(well-connected neighbourhoods)
usiung bike and bike+pt



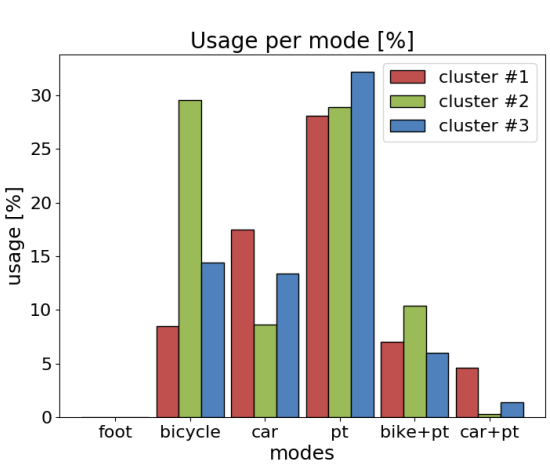
- Accessible area within one hour using the bike or the combination public transport+bike is much bigger in urban and well-connected neighbourhoods compared to decentralized neighbourhoods

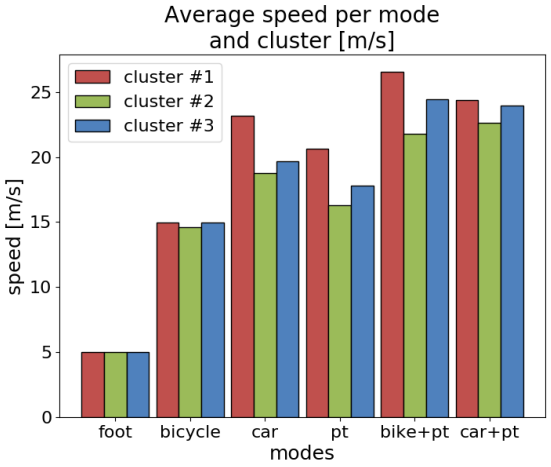
- Empirical data show that people in urban neighbourhoods are well aware of these advantages and behave accordingly.

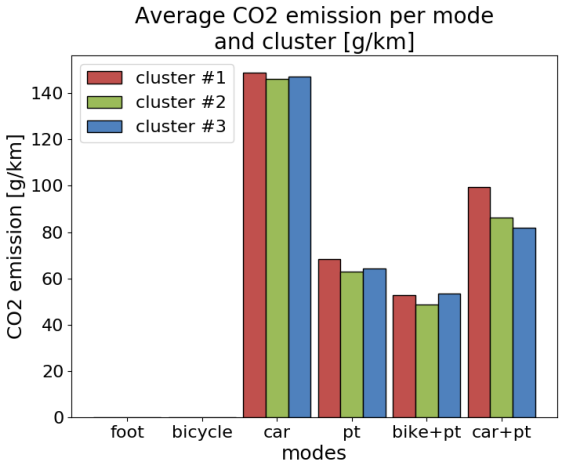


Source: Urban Mobility Project, DLR 2016, n = 1.098

Intermodality
Performance Evaluation



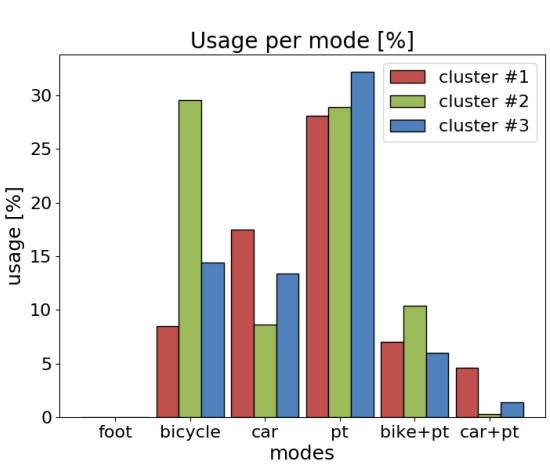


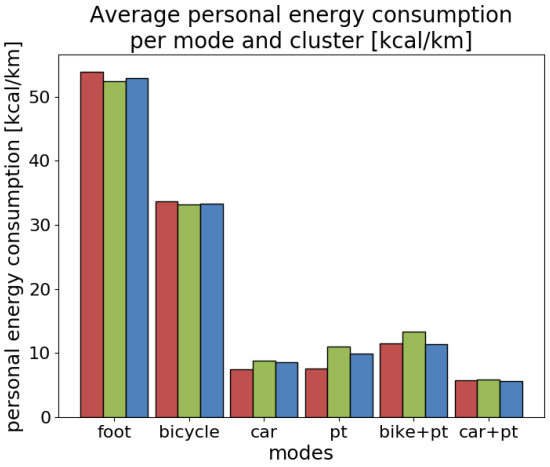


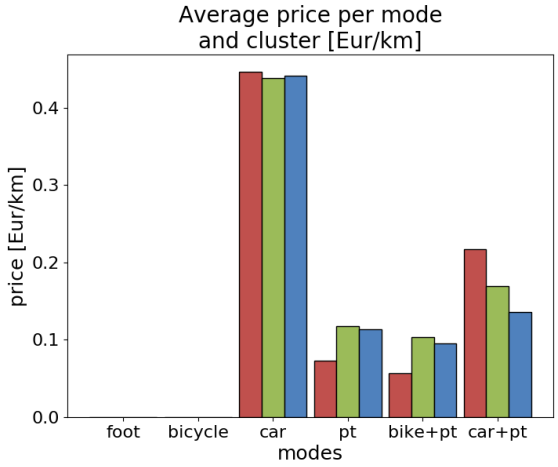
Source: UrMoAC calculations, DLR 2016

- High usage of cars in decentralized areas; high usage of bikes in urban areas
- Speed & usage of cars decrease in areas of category 2 and 3 (lack of parking space, congestions, speed limits…)
- Average speed of the combination of bike & public transport outperforms the car in all three spatial categories
- Active modes and the combination of bike & public transport produce the smallest amount of CO2 – while the car unsurprisingly emits the most.

Intermodality
Performance Evaluation







Source: UrMoAC calculations, DLR 2016

- Unsurprisingly being active (walking or using a bike) benefits your health the most.
- Furthermore walking and using a bike are the least expensive ways to get from A to B.
- In contrast the car is by far the most expensive mode in every cluster and driving around in a car burns the least calories.

Summary

Empirical findings:

- People combine different means of transport on their trips to work or education
  - especially different means of public transport and occasionally they combine bike and public transport
- There is a link between the combination of different means of transport and spatial structures

Performance evaluation:

- Accessibility-based quantification of monomodal and intermodal trips in terms of speed / CO2 emissions / personal energy consumption and price

→Allowing a direct comparison of these modes using concrete, multi-criterial measures.

→**Performance evaluation – findings:**

- The combination of bike + public transport outperforms the usage of a private car in terms of travel time (accessibility), CO2 emissions and price especially in urban and well-connected neighbourhoods.

Outlook

- **UrMoAC** is still relatively simple and **should be extended**
- Using accessibility measures **does not take into account the users´ preferences** and their options to use certain means of transport
  - → Investigation of the differences between “real mobility behaviour” and what UrMoAC shows as the “best choice”
  - → **More analyses**
  - → **Qualitative interviews** with intermodal users
  - …

- **More information:**
  - Webpage Urban Mobility project: www.urmo.info
  - UrMoAC: Krajzewicz, Daniel und Heinrichs, Dirk (2016) *UrMo Accessibility Computer - A tool for computing contour accessibility measures.* In: SIMUL 2016, The Eighth International Conference on Advances in System Simulation.

Questions

- How can we make sure the user will understand the benefits of intermodality?
- How can we promote intermodality to a wider public and communicate the benefits?

- How do we want to define walking in the context of an intermodal trip?
  - Can walking be defined as an “independent mode of transport” ?
  - Does the combination of using public transport & walking can be described as an intermodal trip?
  - How does a survey question needs to be designed in order to reflect that?

Thank you for your Attention!

Laura Gebhardt
German Aerospace Center (DLR)
Institute of Transport Research
Rutherfordstr. 2
12489 Berlin
www.dlr.de/vf/en

Phone:+49 30 67055-629
Fax:+49 30 67055-283

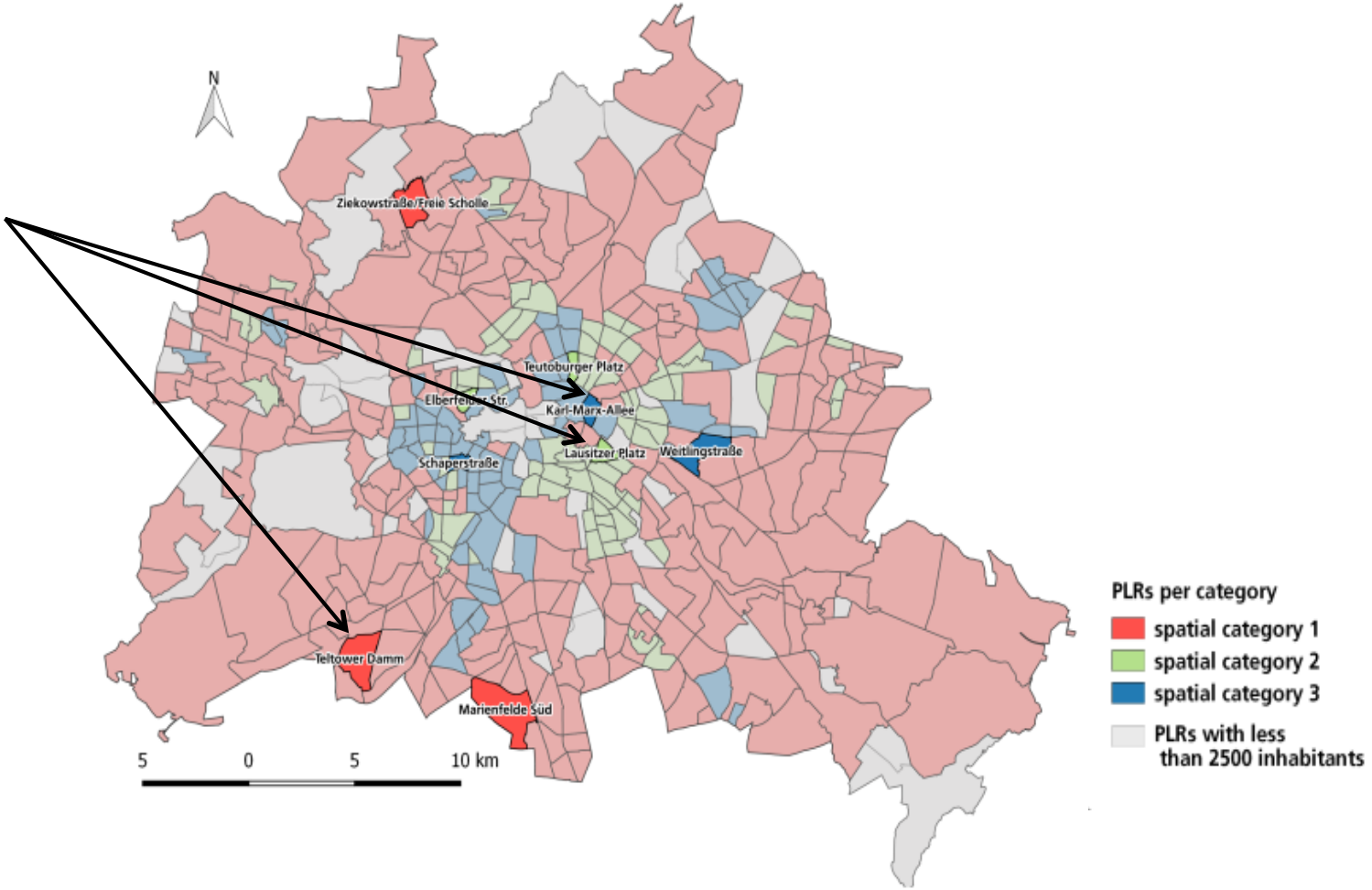
www.urmo.info

References

- Chlond, B. (2013): Multimodalität und Intermodalität. In: Nicht weniger unterwegs, sondern intelligenter? Neue Mobilitätskonzepte, p.271-293.
- Dacko, S. G. & Spalteholz, C. (2014): Upgrading the city: Enabling intermodal travel behaviour. In: Technological Forecasting and Social Change 89, p.222-235.EC 1997
- Gebhardt, L.; Krajzewicz, D.; Oostendorp, R.; Goletz, M.; Greger, K.; Klötzke, M.; Wagner, P. & Heinrichs, D. (2016): Intermodal urban mobility: users, uses, and use cases. 6th Transport Research Arena. Transportation Research Procedia, Volume 14, p.1183-1192.
- Köhler, K. & Heinrichs, M. (2014): Das Elektronische Wegetagebuch – Chancen und Herausforderungen einer Automatisierten Wegeerfassung Intermodaler Wege. In: Schelewsky, M.; Jonuschat, H.; Bock, B. & Stephan, K. (Hrsg.): Smartphones unterstützen die Mobilitätsforschung. Neue Einblicke in das Mobilitätsverhalten durch Wege-Tracking. Wiesbaden, p.25-46.
- Krajzewicz, D.; Hausberger, S.; Wagner, P.; Behrisch, M. & Krumnow, M. (2014): Second Generation of Pollutant Emission Models for SUMO. In: SUMO2014 - Second SUMO User Conference, Berlin, 15th -16th May.
- Krajzewicz, D. & Heinrichs, D. (2016): UrMo Accessibility Computer - A tool for computing contour accessibility measures. In: SIMUL 2016, 8thInternational Conference on Advances in System Simulation, p.56-60.
- Ubbels, B.; Palmer, D. (2013): Conceptual framework: key intermodality factors. City HUB project. http://www.cityhub.imet.gr/Portals/0/D2%202_Conceptual%20framework_key%20intermodality%20factors%20(2).pdf (19.10.2016).
- Umweltbundesamt (2010): CO_2-Emissionsminderung im Verkehr in Deutschland. https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/3773.pdf (20.02.2017).
- Van der Hoeven, F. ; Van Nes, Ak. & Van der Spek, S. (2013): NODES. State of the Art. Available at: http://www.nodes-interchanges.eu/documents/2014/05/nodes_wp2_d2-3_final-3.pdf (19.02.2016).

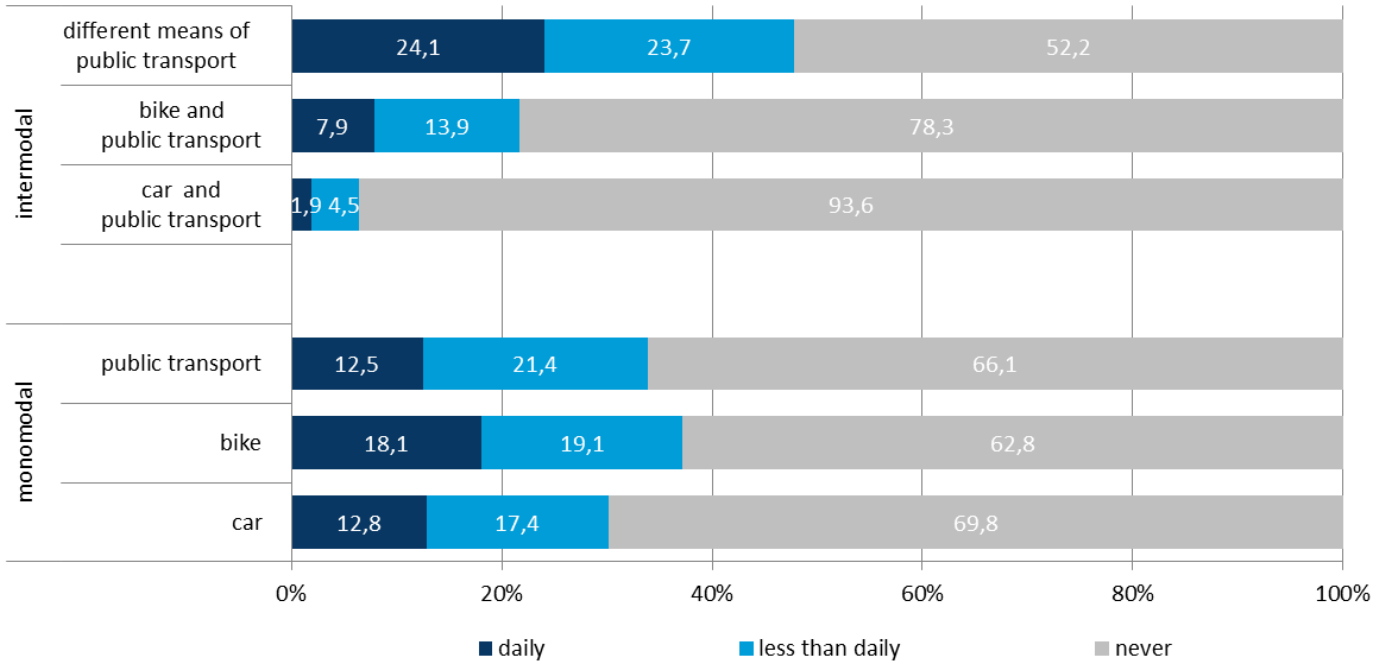
Survey in different spatial categories

- Clustered in terms of mobility access and urban fabric



Source: Urban Mobility Project, DLR 2016, n = 1.09

Frequency of intermodal and monomodal use of means of transport on the way to work or education



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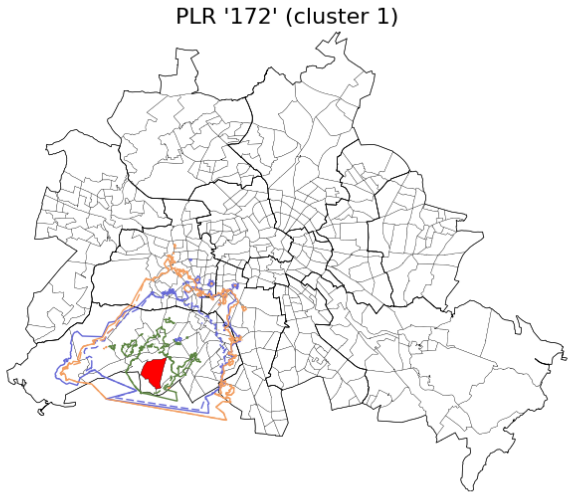
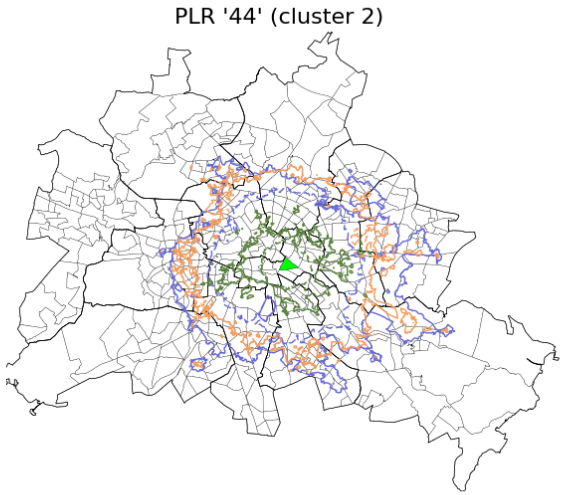
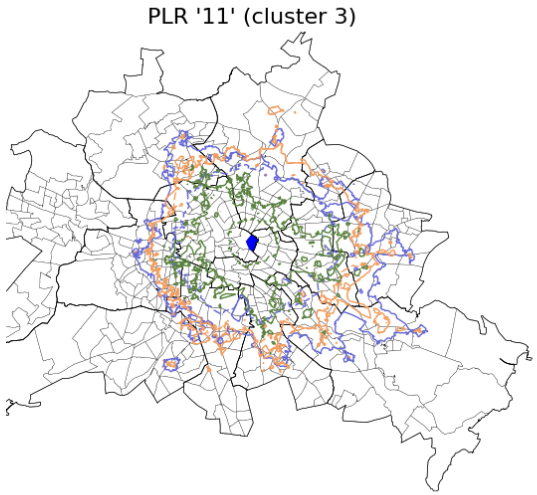
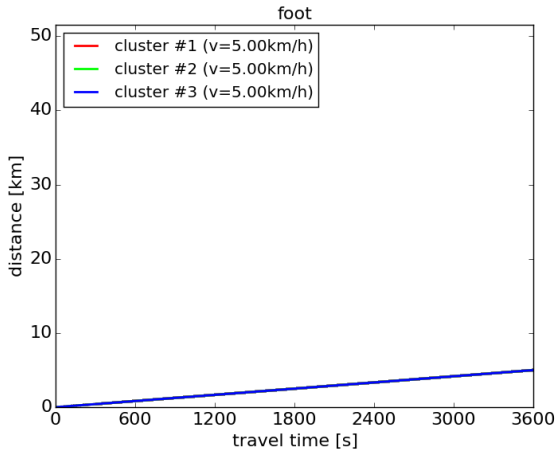
Intermodality
Performance Evaluation

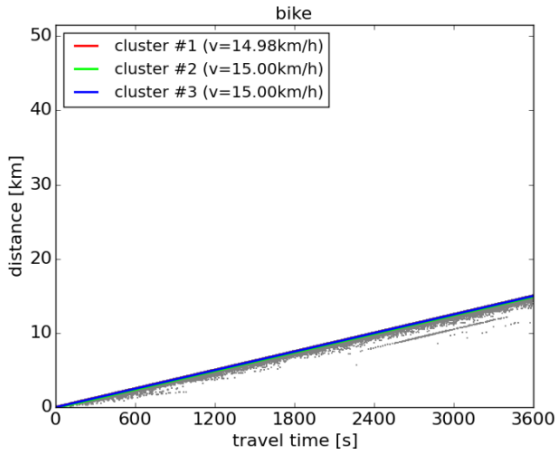


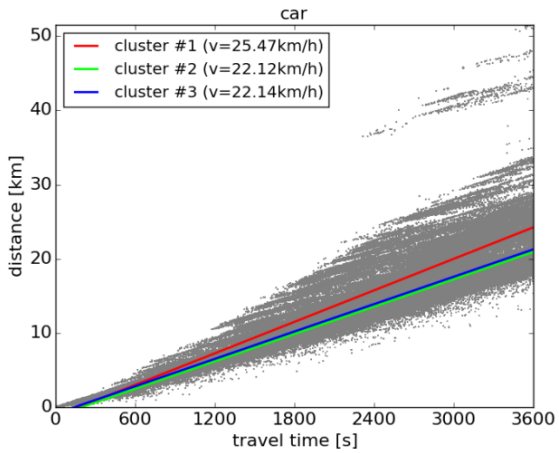


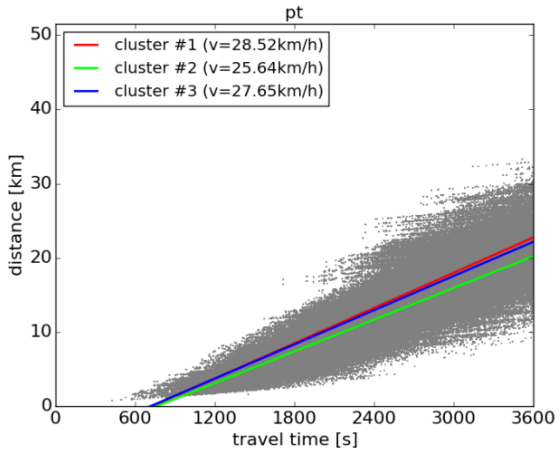


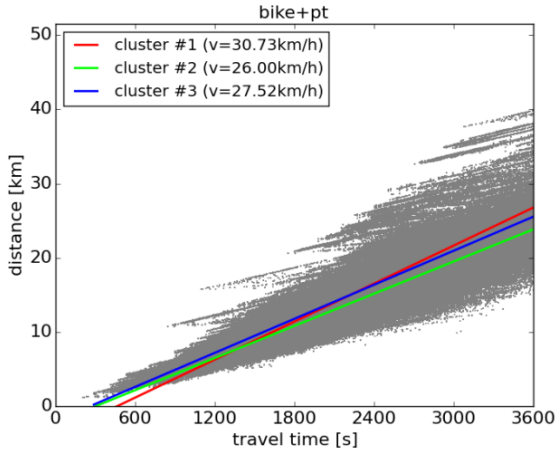
Performance Overview
distance per mode (combination)

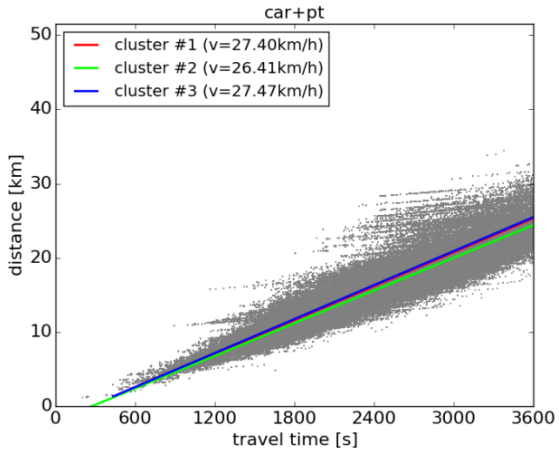


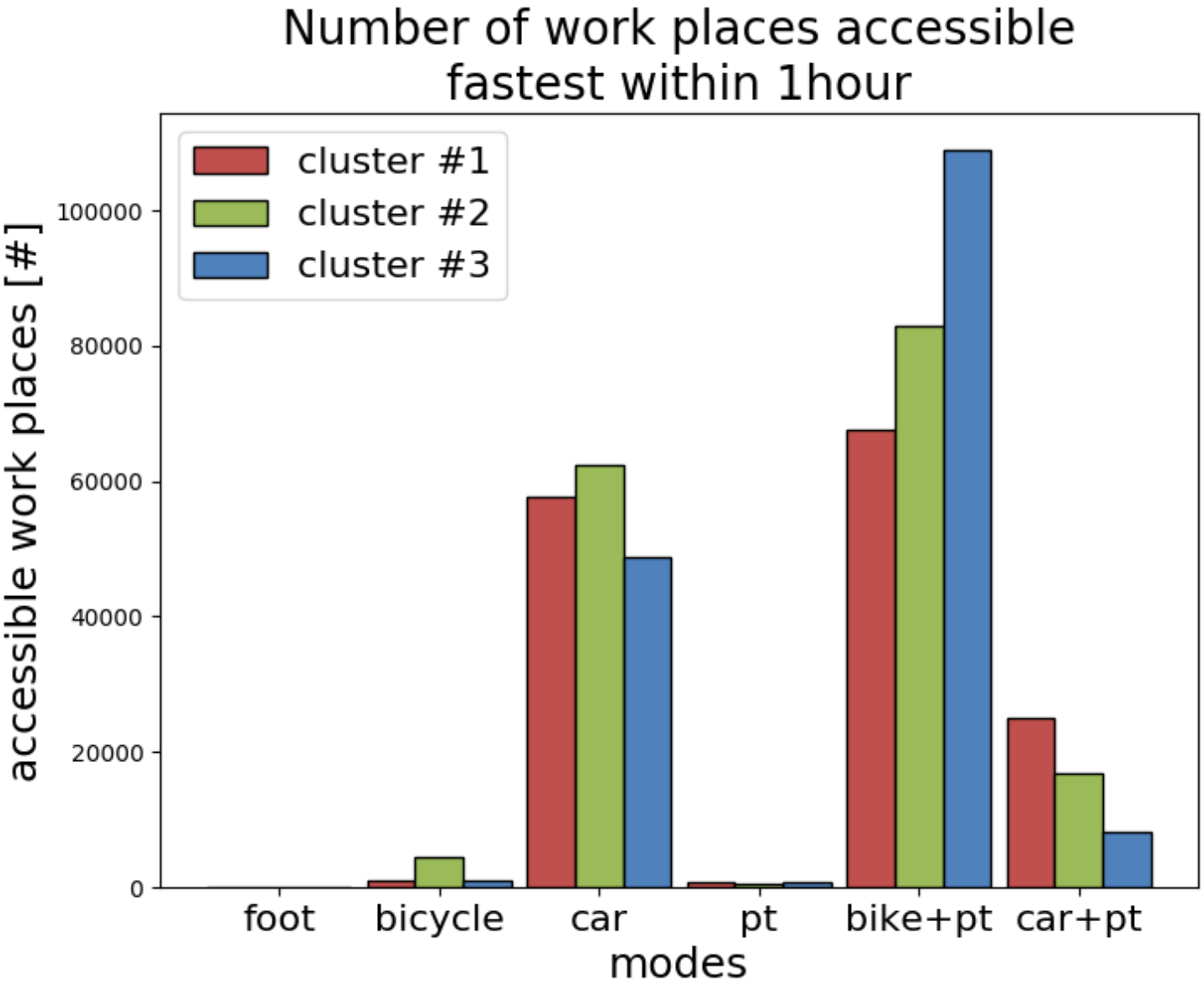


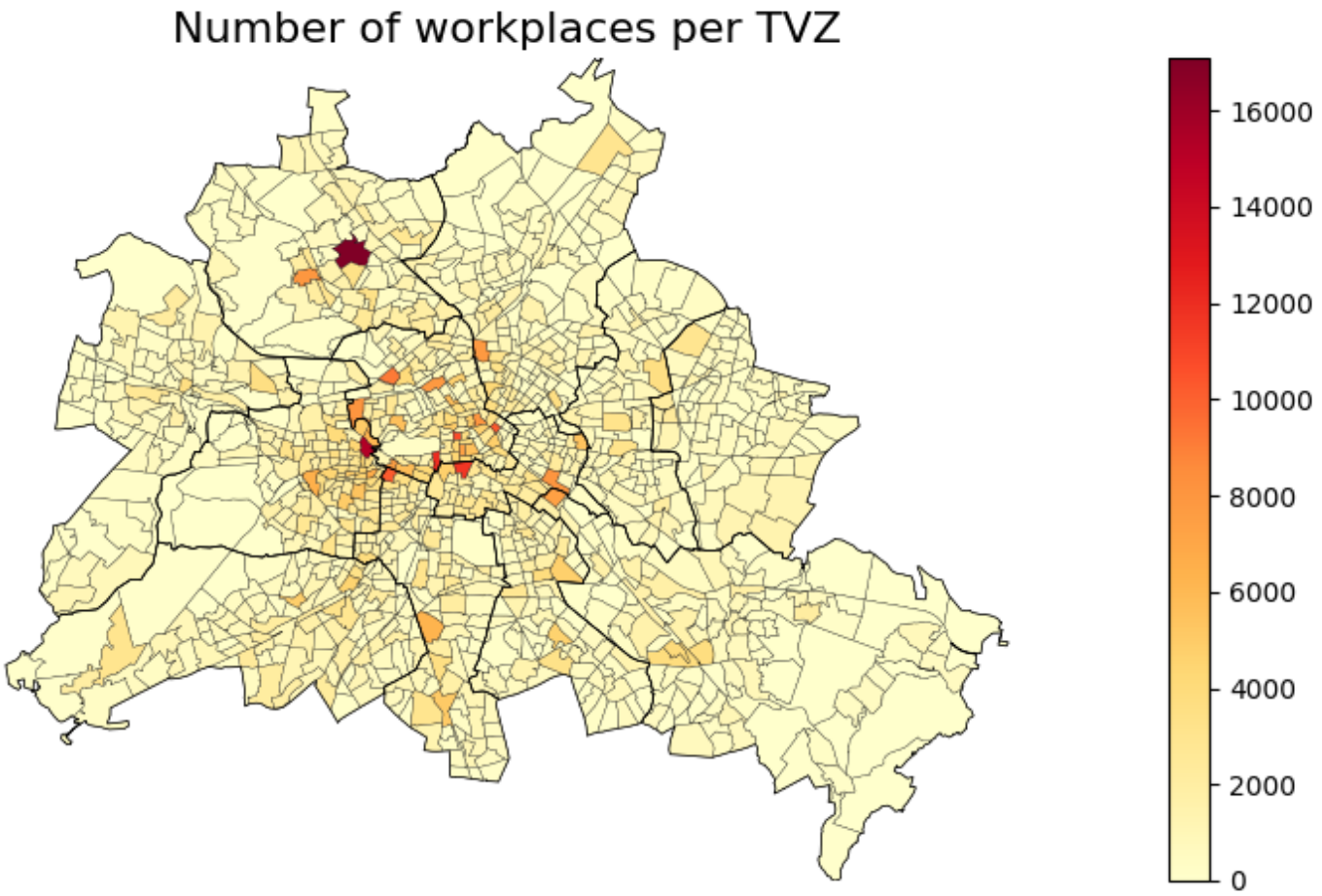









Number of work places accessible fastest within 1hour
cluster #1
cluster #2
cluster #3
accessible work places [#]
100000
80000
60000
40000
20000
0
foot
bicycle
car
pt
bike+pt
car+pt
modes


Number of workplaces per TVZ
16000
14000
12000
10000
8000
6000
4000
2000
0