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Towards the car-independent workplace: A framework for multimodal and intermodal accessibility analysis of workplace locations

NECTAR Conference Toronto

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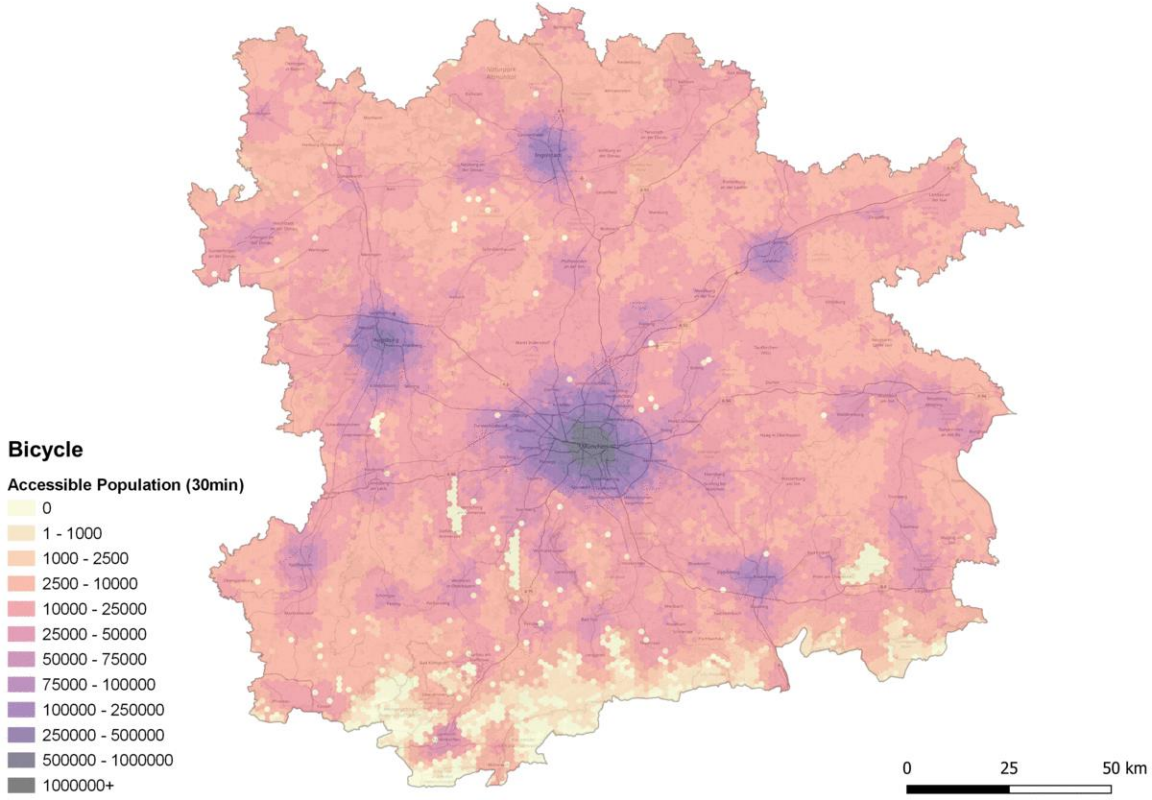
Toronto, July 21, 2022



Fasten your seatbelts and join me on a flight…

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Who's this guy?

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PhD Researcher at Technical University of Munich,

Chair of Urban Structure & Transport Planning (since 2017)

Currently working on: MCube Integration Project SUE (Systemanalysis and Evaluation), EMMA

Main methods & tools: Accessibility Modelling (QGIS, PostGIS, R, Open Trip Planner), Data Analysis & Visualization (R), Survey Design & Analysis (R, LimeSurvey)

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Project context: EMMA's goals

„Development, application, and assessment of a model to optimize the accessibility of workplace locations in terms of multimodal and intermodal mobility"

(1) Identification and quantification of relevant impact factors on workers' mobility behavior

(2) Development of an accessibility model that enables the multimodal and intermodal accessibility analysis of workplace locations

(3) Application of the model in the metropolitan region (regional scale) as well as on a smaller scale on selected cases studies in order to develop and assess scenarios for future development

(4) Contribution to a better understanding of multimodal and intermodal accessibility analysis for workplace location development

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New workplace location – changes in car availability?

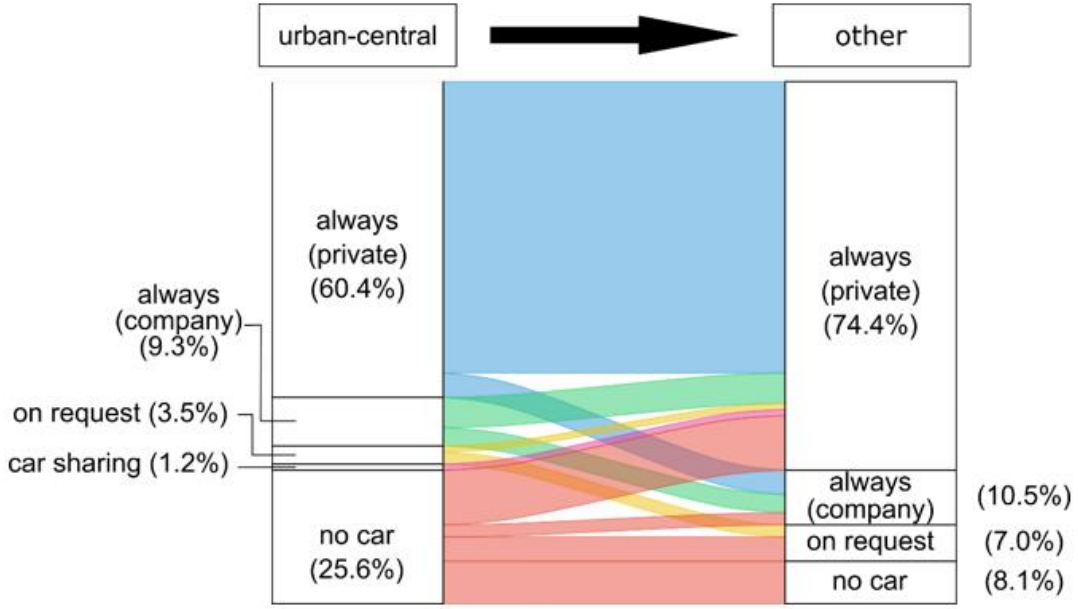

Figure 2: Car Availability - flow from urban-central to other cluster (n=86)

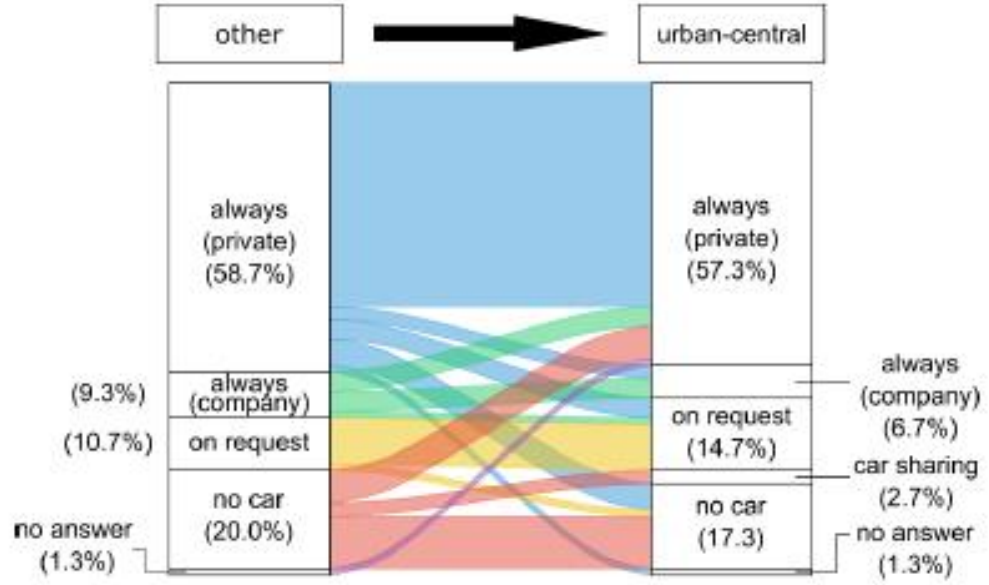

Figure 3: Car Availability - flow from other to urban-central cluster (n=75)

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	Dependent variable			
	Car Availability Increase			
	Estimate	SE	T-statistic	P-value
(Intercept)	-3.834	0.33	-11.629	< 0.001
Age group of worker 18-24 (0,1)	**0.425**	**0.185**	**2.296**	**0.022**
Age group of worker 25-29 (0,1)	**0.56**	**0.138**	**4.05**	**< 0.001**
Age group of worker 30-39 (0,1)[a]				
Age group of worker 40-49 (0,1)	**-0.335**	**0.159**	**-2.116**	**0.034**
Age group of worker 50 and older (0,1)	**-0.686**	**0.231**	**-2.975**	**0.003**
Gender male[a] (1,0)				
Gender female (1,0)	**0.369**	**0.106**	**3.473**	**< 0.001**
Family status single household (0,1)[a]				
Family status DINK (0,1)	**0.585**	**0.159**	**3.675**	**< 0.001**
Family status family (1 working) (0,1)	0.269	0.291	0.925	0.35
Family status family (both working) (0,1)	**0.756**	**0.183**	**4.141**	**< 0.001**
Family status shared flat (0,1)	**0.525**	**0.183**	**2.867**	**0.004**
Family status other (0,1)	**0.838**	**0.272**	**3.079**	**0.002**
Travel time ratio better (1,0)	0.34	0.267	1.272	0.2
Travel time ratio equal (1,0)[a]				
Travel time ratio worse (1,0)	**0.482**	**0.266**	**1.813**	**0.07**
Change in Distance to Work (reduction of 5 km or more) (1,0)	0.186	0.196	0.945	0.34
Change in Distance to Work (reduction between 1 and 5 km) (1,0)	-0.076	0.245	-0.309	0.76
Change in Distance to Work (no sig. change) (1,0)[a]				
Change in Distance to Work (increase between 1 and 5 km) (1,0)	-0.065	0.238	-0.273	0.78
Change in Distance to Work (increase by 5 km or more) (1,0)	**0.405**	**0.193**	**2.1**	**0.036**
Change in Residential Cluster (away from urban-central) (1,0)	**0.27**	**0.152**	**1.771**	**0.077**
Change in Residential Cluster (no change) (1,0)[a]				
Change in Residential Cluster (to urban-central) (1,0)	-0.39	0.245	-1.591	0.11
Change in Workplace Cluster (away from urban-central) (1,0)	**0.683**	**0.175**	**3.9**	**< 0.001**
Change in Workplace Cluster (no change) (1,0)[a]				
Change in Workplace Cluster (to urban-central) (1,0)	0.133	0.212	0.63	0.53
Pseudo-R^2 (Nagelkerke)	0.058			
BIC	2997			

positive	negative
age < 30	age >30
gender: female	
family status: DINK, family with 2 working, shared flat	
travel time ratio: worse	
change in distance to work > +5km	
change in residential cluster: less central	
change in workplace cluster: less central	

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New workplace location – changes in mode choice to work?

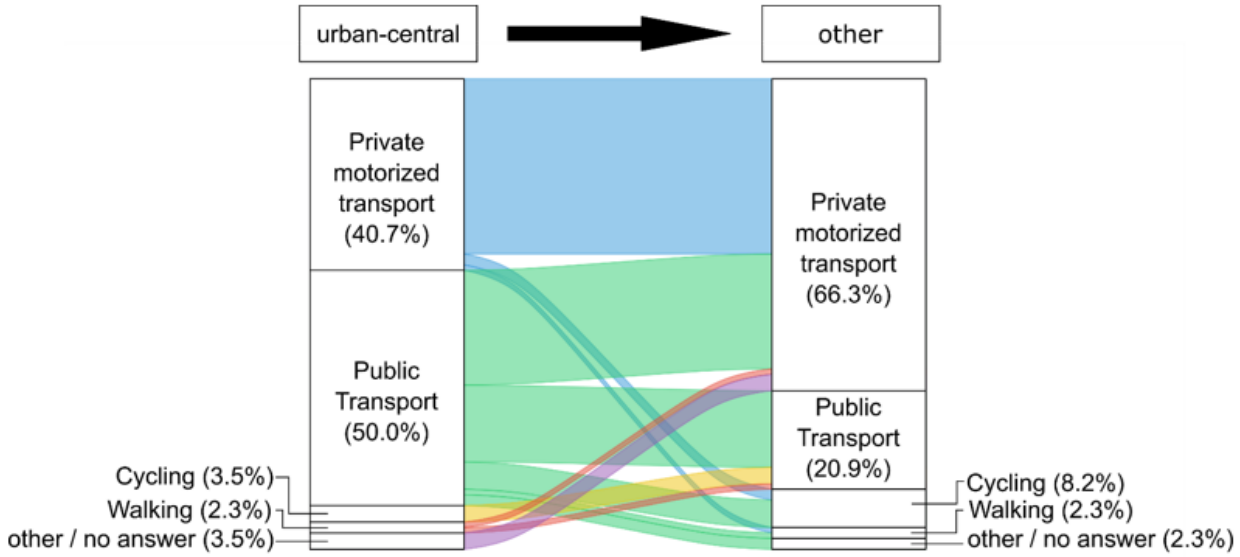

Figure 5: Mode Choice - flow from urban-central to other cluster (n=86)

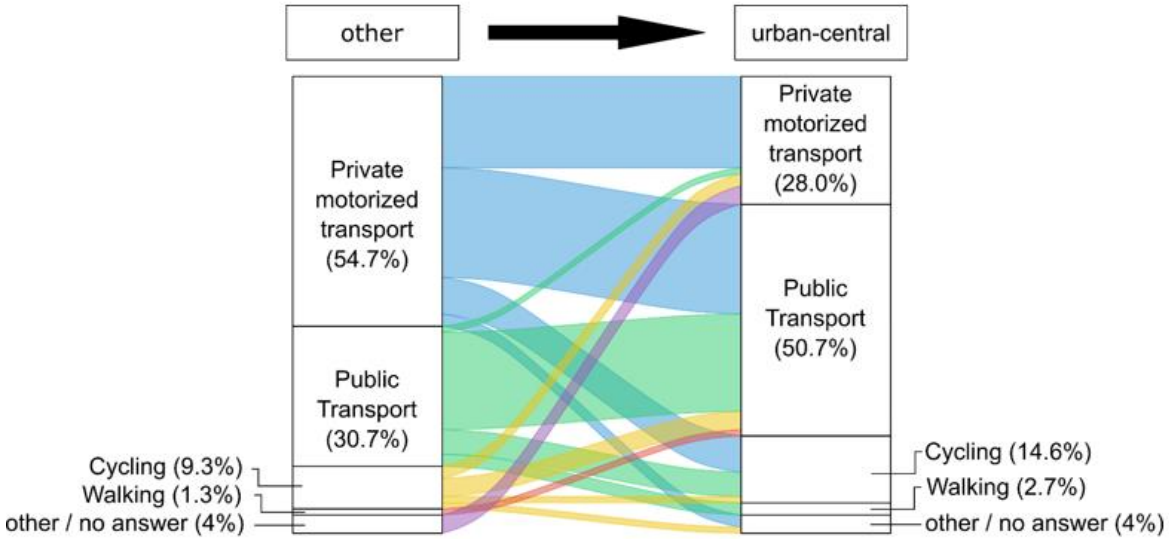

Figure 6: Mode Choice - flow from other to urban-central cluster (n=75)

Statistics

Which factors are positively associated with modal change to driving?

Heckman Selection Model, **selection equation** (on car availability)

	Dependent variable (selection model)			
	Always Car Available (1,0)			
	Estimate	SE	T-statistic	P-value
(Intercept)	**0.734**	**0.112**	**6.559**	**< 0.001**
Age group of worker 18-24 (0,1)	**-0.242**	**0.074**	**-3.254**	**0.001**
Age group of worker 25-29 (0,1)	-0.052	0.055	-0.95	0.34
Age group of worker 30-39 (0,1)[a]				
Age group of worker 40-49 (0,1)	**0.203**	**0.054**	**3.749**	**< 0.001**
Age group of worker 50 and older (0,1)	**0.226**	**0.067**	**3.393**	**< 0.001**
Household income <= 1,500 € (1,0)	**-0.465**	**0.112**	**-4.143**	**< 0.001**
Household income 1,501 € - 2,000 € (1,0)	**-0.255**	**0.088**	**-2.898**	**0.004**
Household income 2,001 € - 2,500 € (1,0)	**-0.171**	**0.083**	**-2.062**	**0.039**
Household income 2,501 € - 3,000 € (1,0)[a]				
Household income 3,001 € - 4,000 € (1,0)	0.006	0.074	0.083	0.93
Household income 4,001 € - 5,000 € (1,0)	0.109	0.078	1.399	0.16
Household income 5,001 € - 6,000 € (1,0)	0.107	0.091	1.186	0.24
Household income >= 6,000 € (1,0)	**0.51**	**0.099**	**5.131**	**< 0.001**
Household income no answer (1,0)	-0.043	0.079	-0.543	0.59
Family status single household (0,1)[a]				
Family status DINK (0,1)	-0.037	0.065	-0.568	0.57
Family status family (1 working) (0,1)	-0.093	0.093	-0.999	0.32
Family status family (both working) (0,1)	0.086	0.073	1.18	0.24
Family status shared flat (0,1)	**-0.298**	**0.07**	**-4.28**	**< 0.001**
Family status other (0,1)	0.046	0.098	0.467	0.64
Travel time ratio (transit/car) <0.5 (0,1)	**0.274**	**0.095**	**2.871**	**0.004**
Travel time ratio (transit/car) 0.5-1 (0,1)	**-0.245**	**0.068**	**-3.612**	**< 0.001**
Travel time ratio (transit/car) 1-1.5 (0,1)	**-0.136**	**0.052**	**-2.608**	**0.009**
Travel time ratio (transit/car) 1.5-2 (0,1)[a]				
Travel time ratio (transit/car) 2-2.5 (0,1)	0.109	0.066	1.637	0.1
Travel time ratio (transit/car) 2.5-3 (0,1)	**0.18**	**0.087**	**2.082**	**0.037**
Travel time ratio (transit/car) >=3 (0,1)	**0.222**	**0.081**	**2.723**	**0.006**
Residence Urban-Decentral (1,0)[a]				
Residence Urban-Central (1,0)	**-0.266**	**0.069**	**-3.846**	**< 0.001**
Residence Peripheral-Rural (1,0)	**0.349**	**0.112**	**3.124**	**0.002**
Residence Urban-Catchment (1,0)	**0.32**	**0.08**	**4.019**	**< 0.001**
Workplace Urban-Decentral (1,0)[a]				
Workplace Urban-Central (1,0)	**-0.248**	**0.082**	**-3.03**	**0.002**
Workplace Peripheral-Rural (1,0)	0.311	0.2	1.552	0.12
Workplace Urban-Catchment (1,0)	-0.082	0.095	-0.857	0.39
N	5079			
Log-likelihood	-2916			
BIC	6088			
Model χ^2	691			
Prob > χ^2	0.000			

[a] Reference category

Statistics

Which factors are positively associated with modal change to driving?

Heckman Selection Model, **outcome equation** (on change to driving)

	Dependent variable (outcome model)			
	Change to driving (1,0)			
	Estimate	SE	T-statistic	P-value
(Intercept)	0.035	0.027	1.296	0.2
Gender male[a] (1,0)				
Gender female (1,0)	**0.026**	**0.012**	**2.222**	**0.026**
Travel time ratio better (1,0)	0.047	0.025	1.831	0.067
Travel time ratio equal (1,0)[a]				
Travel time ratio worse (1,0)	**0.091**	**0.025**	**3622**	**< 0.001**
Change in Distance to Work (reduction of 5 km or more) (1,0)	**0.065**	**0.022**	**3.012**	**0.003**
Change in Distance to Work (reduction between 1 and 5 km) (1,0)	-0.011	0.025	-0.428	0.67
Change in Distance to Work (no sig. change) (1,0)[a]				
Change in Distance to Work (increase between 1 and 5 km) (1,0)	0.044	0.025	1.778	0.076
Change in Distance to Work (increase by 5 km or more) (1,0)	**0.086**	**0.021**	**4.05**	**< 0.001**
Change in Transfers to Work (less transfers) (1,0)	-0.019	0.016	-1.238	0.22
Change in Transfers to Work (no change) (1,0)				
Change in Transfers to Work (more transfers) (1,0)	**0.059**	**0.015**	**3795**	**< 0.001**
Change in Residential Cluster (away from urban-central) (1,0)	**0.061**	**0.019**	**3.253**	**0.001**
Change in Residential Cluster (no change) (1,0)[a]				
Change in Residential Cluster (to urban-central) (1,0)	-0.046	0.027	-1717	0.086
Change in Workplace Cluster (away from urban-central) (1,0)	**0.195**	**0.024**	**8.047**	**< 0.001**
Change in Workplace Cluster (no change) (1,0)[a]				
Change in Workplace Cluster (to urban-central) (1,0)	**-0.08**	**0.026**	**-3058**	**0.002**
N	5079			
ρ	-0.271			
Inverse Mills Ratio (car availability)	-0.093 (SE 0.027, p<0.001)			

[a] Reference category

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Statistics

Which factors are positively associated with modal change to driving?
Heckman Selection Model, **outcome equation:**

positive	negative
gender: female	
travel time ratio: worse	
change in distance to work: reduction by 5km or more	
change in distance to work: increase by 5km or more	
change in transfers to work: more transfers	
change in residential cluster: less central	
change in workplace cluster: less central	**change in workplace cluster: more central**

Summary – What do we learn from this?

- the relocation of the workplace towards a less centralized area is associated positively with an increase in car availability and with a modal shift to driving to work

- a relocation towards a more centralized area is negatively associated with increasing car availability and the modal shift to car commuting

- commuters increase their car availability if they feel they need it for their daily commute but will not decrease it immediately if there is no longer a need to drive to work.

Summary – What do we learn from this?

We emphasize the importance of the accessibility of workplace locations. Some learnings:

- The relocation is an important window of opportunity for behavior change
  → targeted programs should be aimed at new workers of a workplace location
- preventing (future) car ownership is easier than trying to reduce existing cars

- Workplace locations should be planned wisely to avoid car-dependent workplaces and eventually car-dependent workers and families
- Our results emphasize the importance land-use-centric approach for assessing workplace locations, taking into account the accessibility and centrality of the locations
- Good news: if done well, workplace locations can contribute to creating well-working regional systems for living, working, and everything in between

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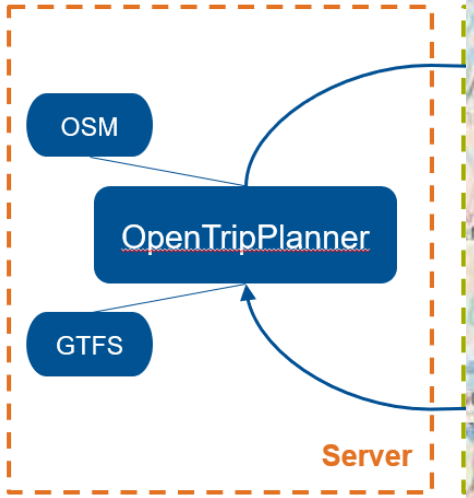
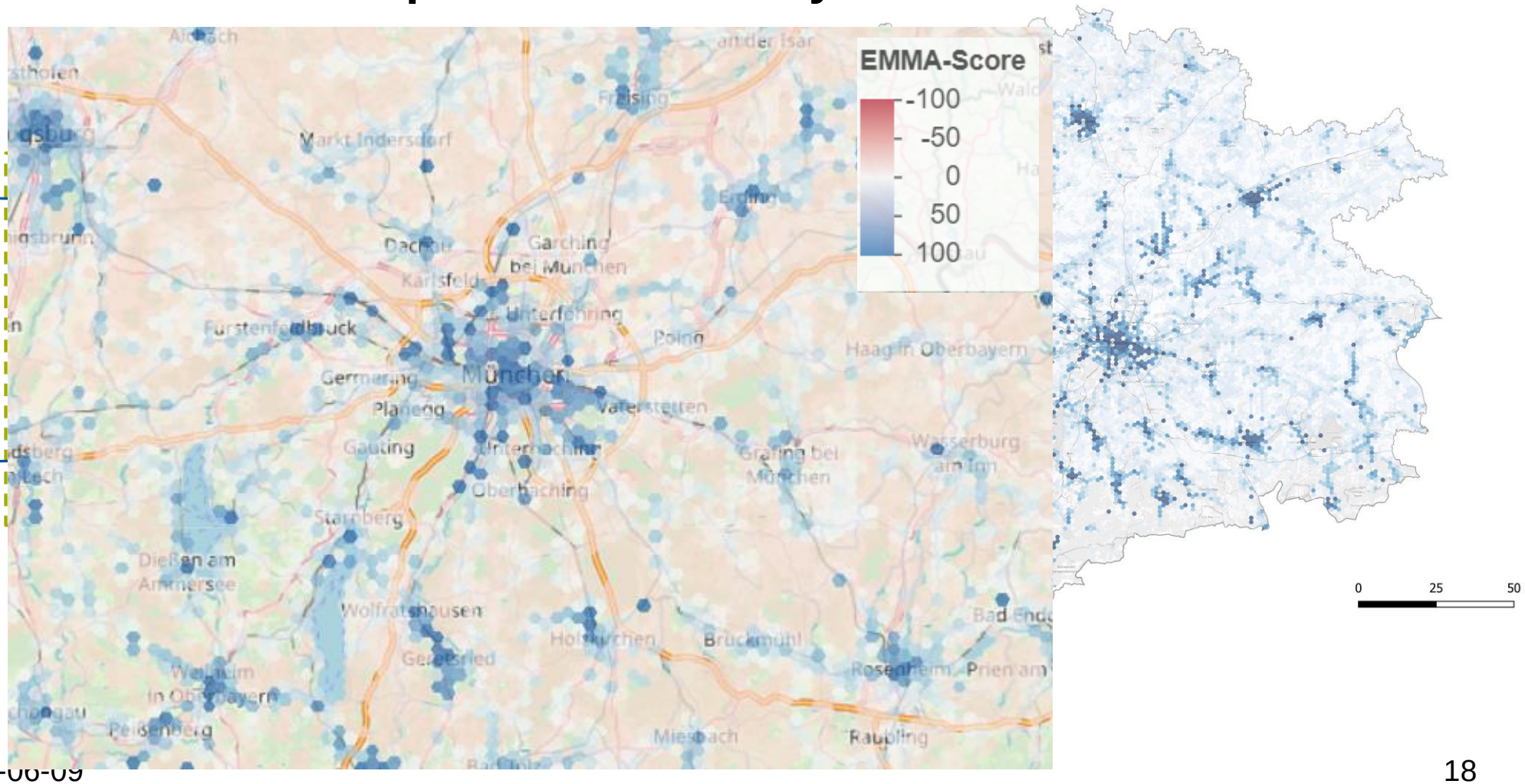
Paper 2: An open-source modelling tool for multimodal and intermodal workplace accessibility analysis





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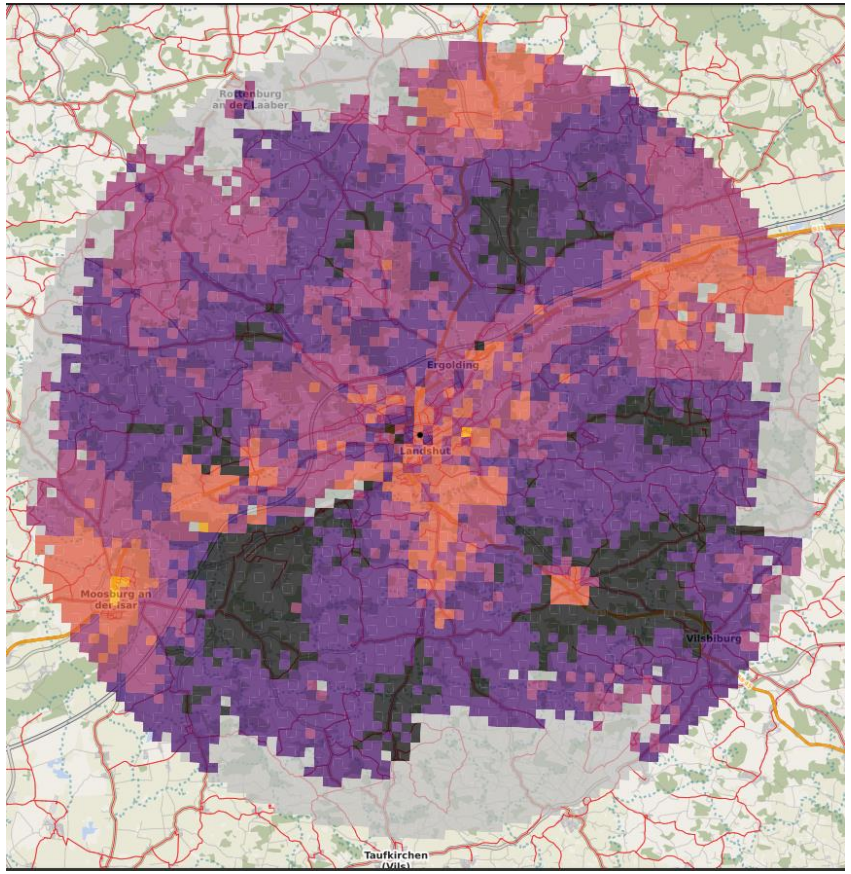
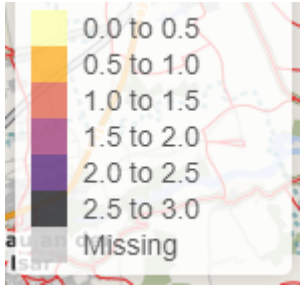
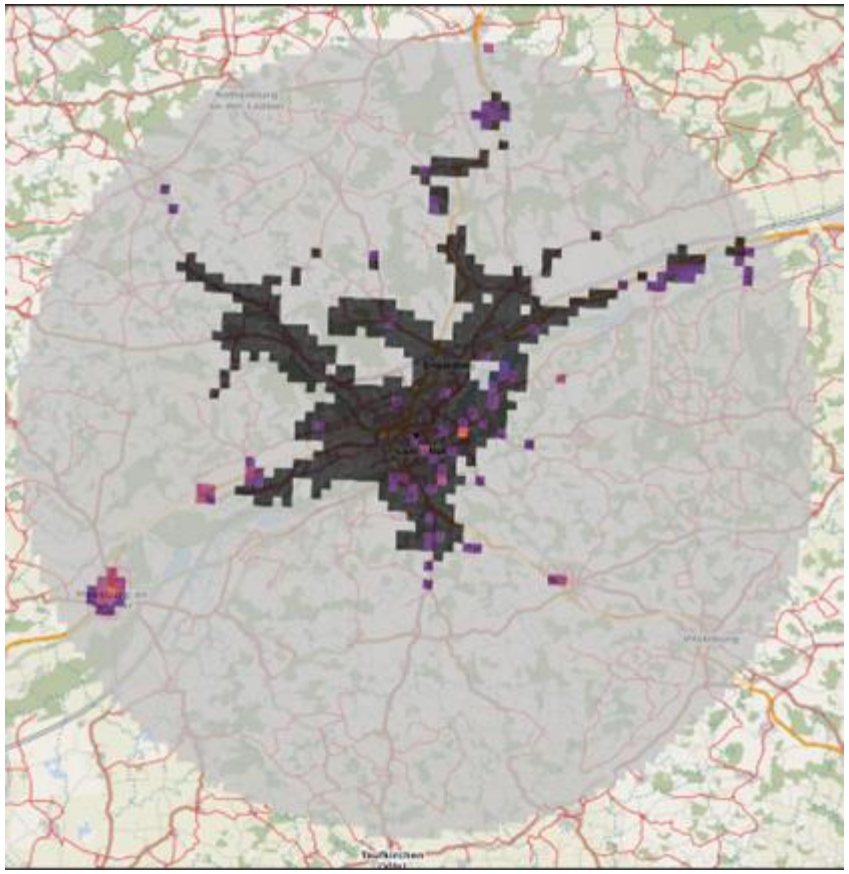
Paper 3: Modelling multimodal and intermodal accessibility scenarios for workplace locations



intermodal vs. car

travel time ratios





public transport vs. car

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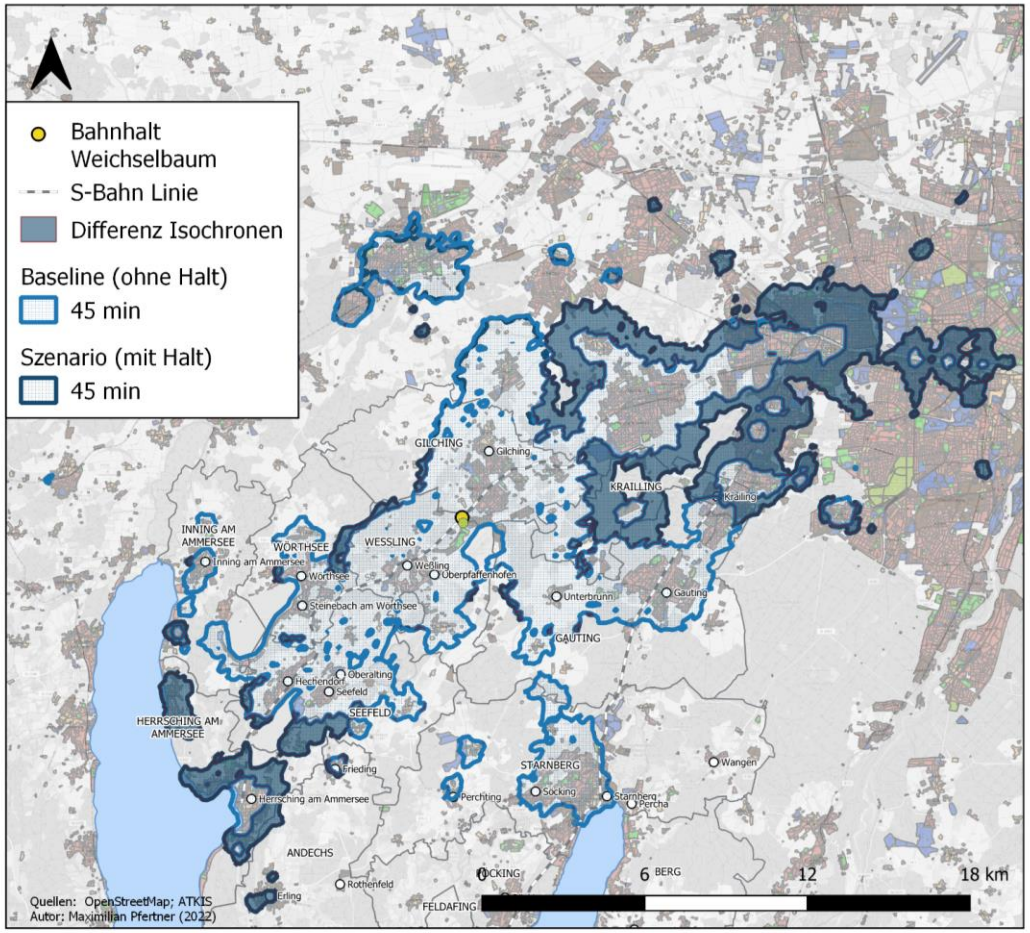
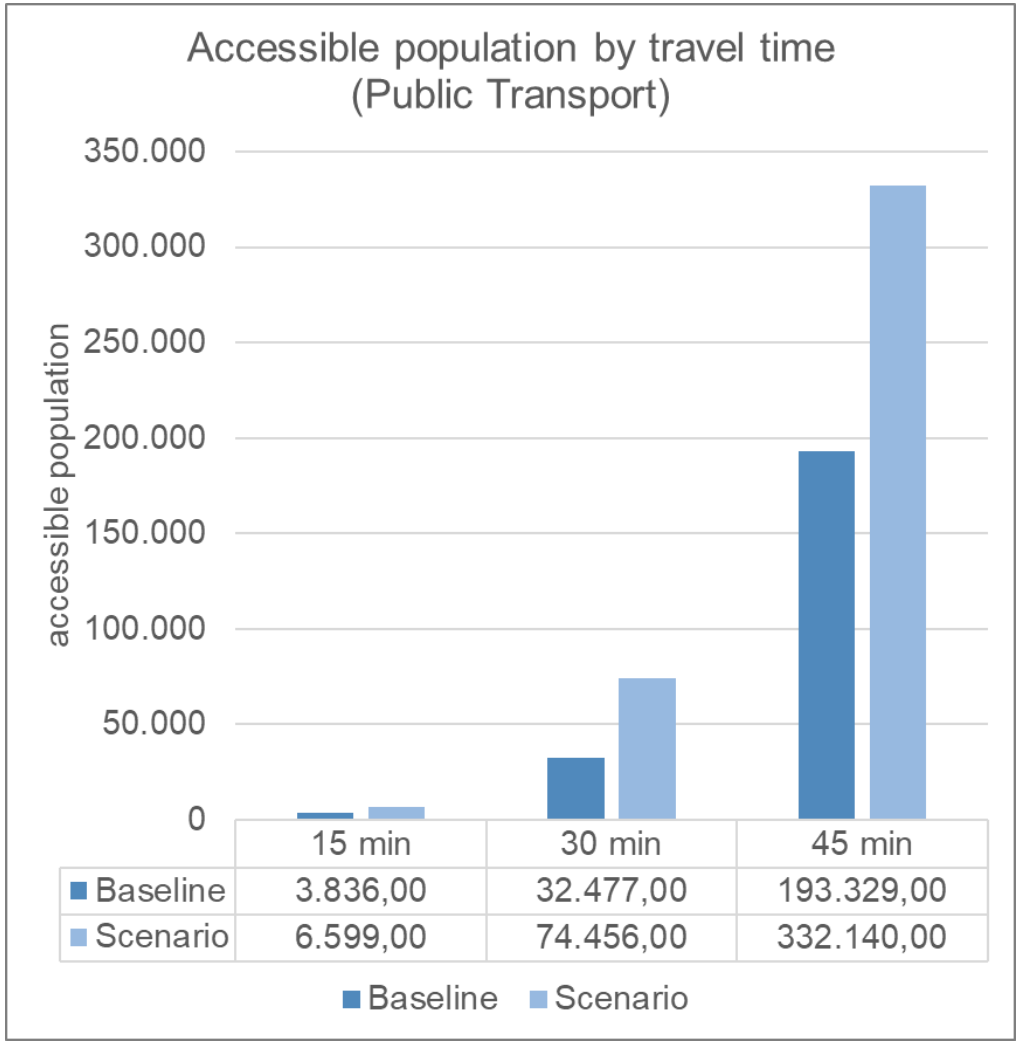
Paper 3: Modelling multimodal and intermodal accessibility scenarios for workplace locations





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Framework

1. Introduction
    1. Motivation
    2. System boundaries
    3. Structure of this thesis
2. State of the Art / Conceptual Framework
    1. Planning workplace locations in the Munich Metropolitan Region
    2. Car-dependency in the context of workplace locations
    3. Accessibility planning
    4. Accessibility of workplace locations
    5. Multimodal and intermodal mobility behavior
3. Research design
    1. Research questions & Hypotheses
    2. Statistical analysis of a quasi-longitudinal survey
    3. Model development and application on the regional scale
    4. Detailed analysis of workplace locations in the region
4. *Paper 1:* Workplace Relocation and its Association with Car Availability and Commuting Mode Choice
5. *Paper 2:* An open-source modeling tool for multimodal and intermodal workplace accessibility analysis
6. *Paper 3:* Modelling multimodal and intermodal accessibility scenarios for workplace locations
7. Synthesis & Discussion
    1. Evaluation of the chosen methodology
    2. Reflections on the implementation to practice
    3. Discussion in the broader societal context
        - COVID-19 pandemic
        - "New Work"
        - "Zeitenwende" – energy costs, global politics, …
8. Conclusions and Outlook

PhDone?


HOW'S THE WRITING GOING, CECILIA?
UH, IT'S GOING OK.
ARE YOU ALMOST FINISHED?
NO.
DO YOU KNOW WHEN YOU'LL BE FINISHED?
NO.
I MEAN, IF I SUDDENLY GET INSPIRED AND KNOW EXACTLY WHAT TO WRITE, I SHOULD BE DONE IN NO TIME.
OTHERWISE, IT MIGHT TAKE FOREVER.
SO SOMEWHERE BETWEEN NOW AND FOREVER IS YOUR BEST ESTIMATE?
IT'S A BOUNDED PROBLEM.
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„just write it down“

Open tasks (knowing when to stop…)

- ☐ Finish (95%) + submit paper 2 and get it accepted
- ☐ Write (content 90%, text 10%) paper 3 and submit (in a good state)
- ☐ Write framework draft (start with introduction)
- ☐ Get feedback from supervisors on draft
- ☐ Finalize framework
- ☐ Submit
- ☐ Defend
- ☐ Celebrate

Thanks for your attention! Questions for you…

- Framework – „towards the car-independent workplace“ – does it make sense?
- Framework – what do you think about the role of workplace accessibility in the current societal context?
- Recommendations for policy implications – am I free to suggest utopian ideas?