Pedestrian Modeling: Assessing Pedestrian Impacts of Future Land Use and Transportation Scenarios

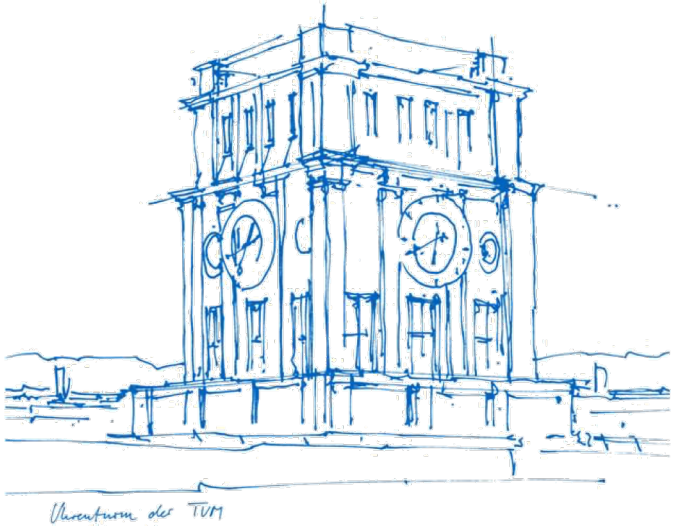
Qin Zhang

Technical University of Munich

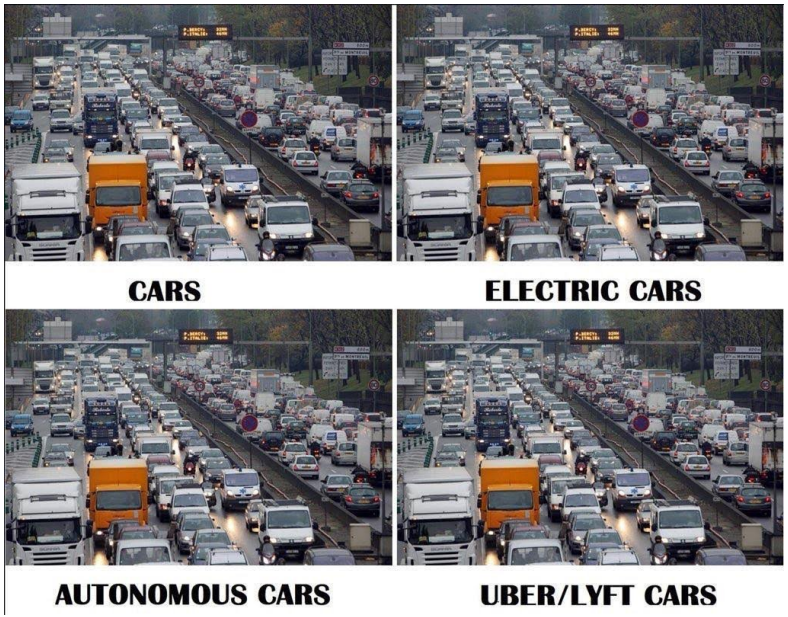
Department of Civil, Geo and Environmental Engineering

Professorship for Modeling Spatial Mobility

MobilLAB final event, 14 Sep 2020



WaaS: Walk as a Solution?



From Twitter

Background

Among 48 large Metropolitan planning organizations (MPOs) in US[1]:

- 38 % did not estimate walking
- 33 % estimated non motorized (walking + bicycling) travel
- 29 % estimated walking

→ Pedestrian travel demands are less represented in the existing transport models. Transport planning and decision-making have often overlooked them.

[1]Singleton et al. 2018. “Making Strides: State of the Practice of Pedestrian Forecasting in Regional Travel Models.”

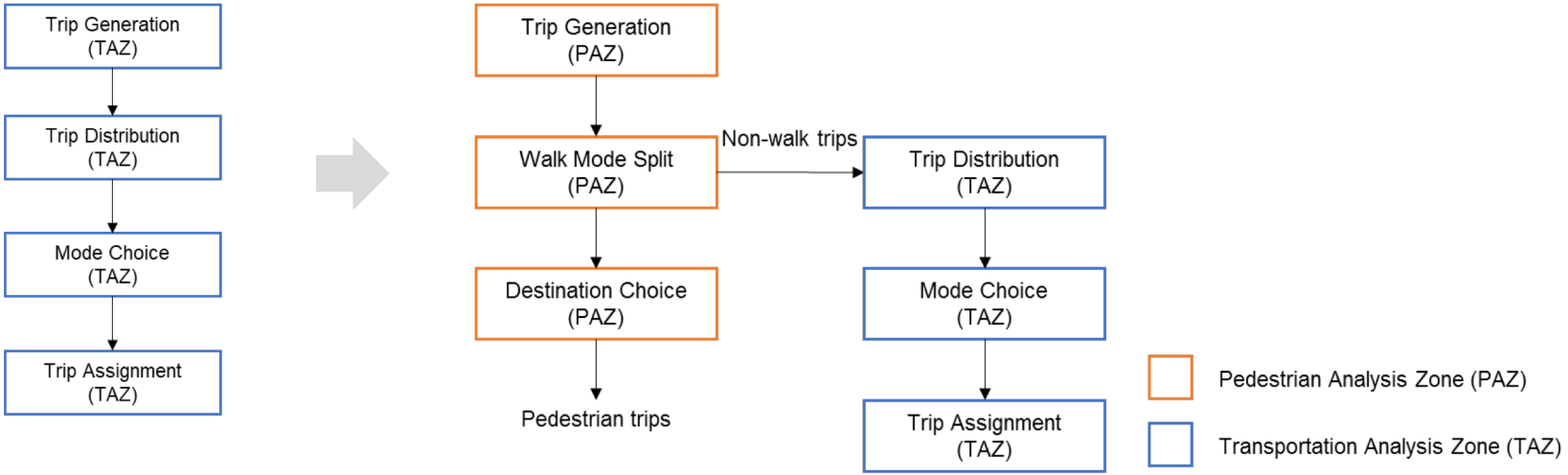
Objective

Incorporate pedestrian modelling with the existing transport model.

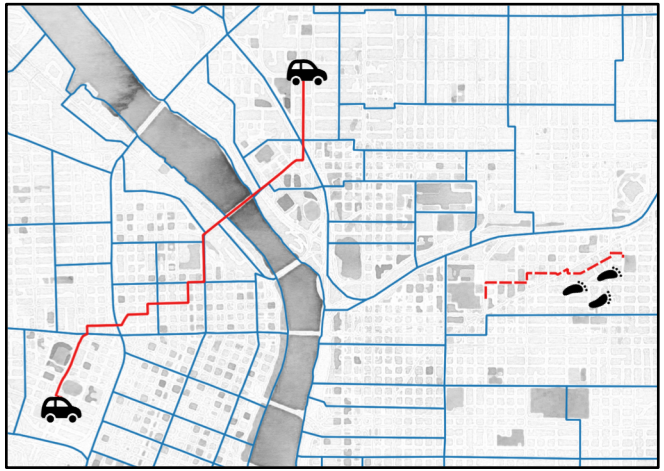
- Pedestrian modeling at small spatial analysis scale
- Better represent pedestrian behavior (pedestrian-related variables)

Existing transport model

New modelling framework

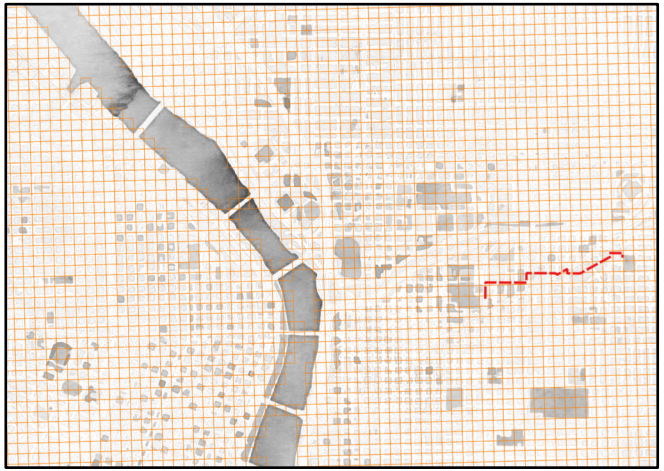


Pedestrian Analysis Zone (PAZ)



TAZ – transport analysis zone

+ Homogeneous traffic activities
- Not sensitive to walking trips
- Too many intrazonal trips



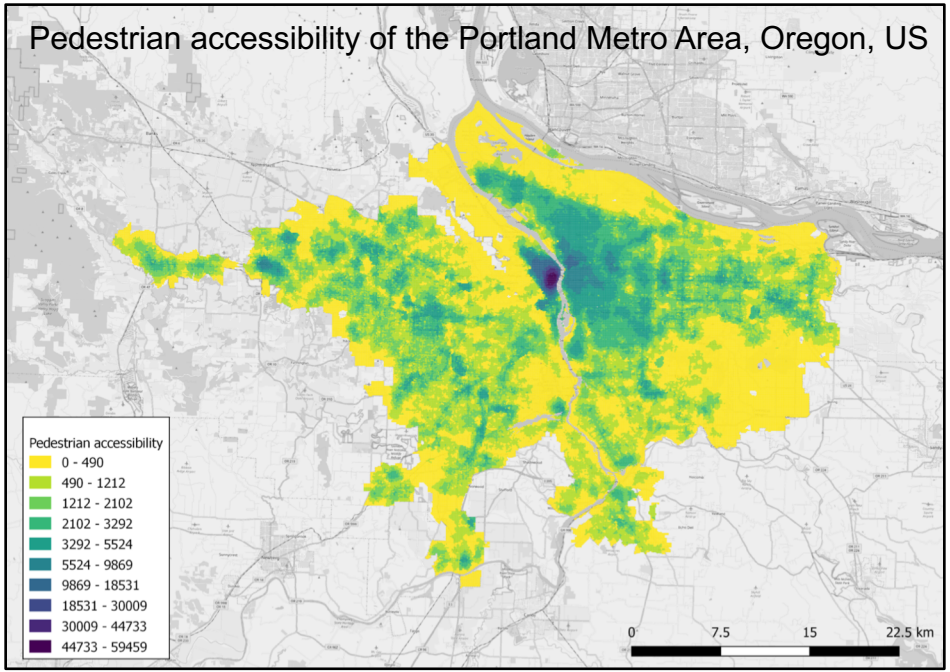
PAZ – 80 * 80 m grid cell

+ Sensitive to walking trips
- Millions of analysis zones
- Need of fine socio-economic data

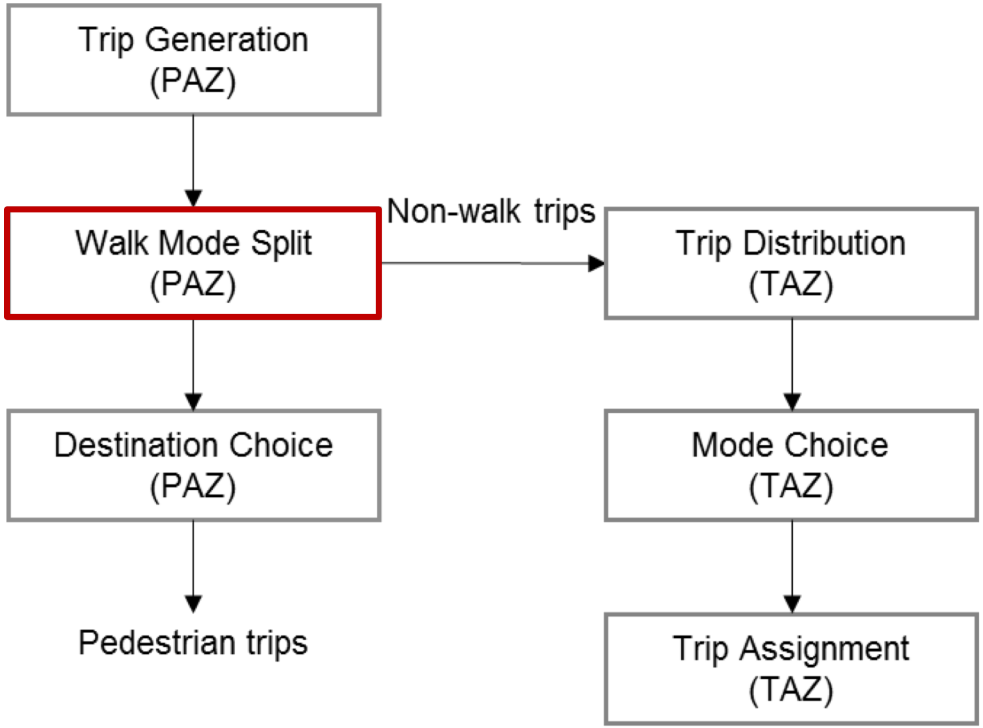
Pedestrian Accessibility

Activity density within an 800-meter pedestrian catchment area:

- **Activity density** = number of non-industrial jobs + number of population
- **Pedestrian catchment area** is calculated based on network distance



Pedestrian modelling framework



Walk Mode Split | Methodology

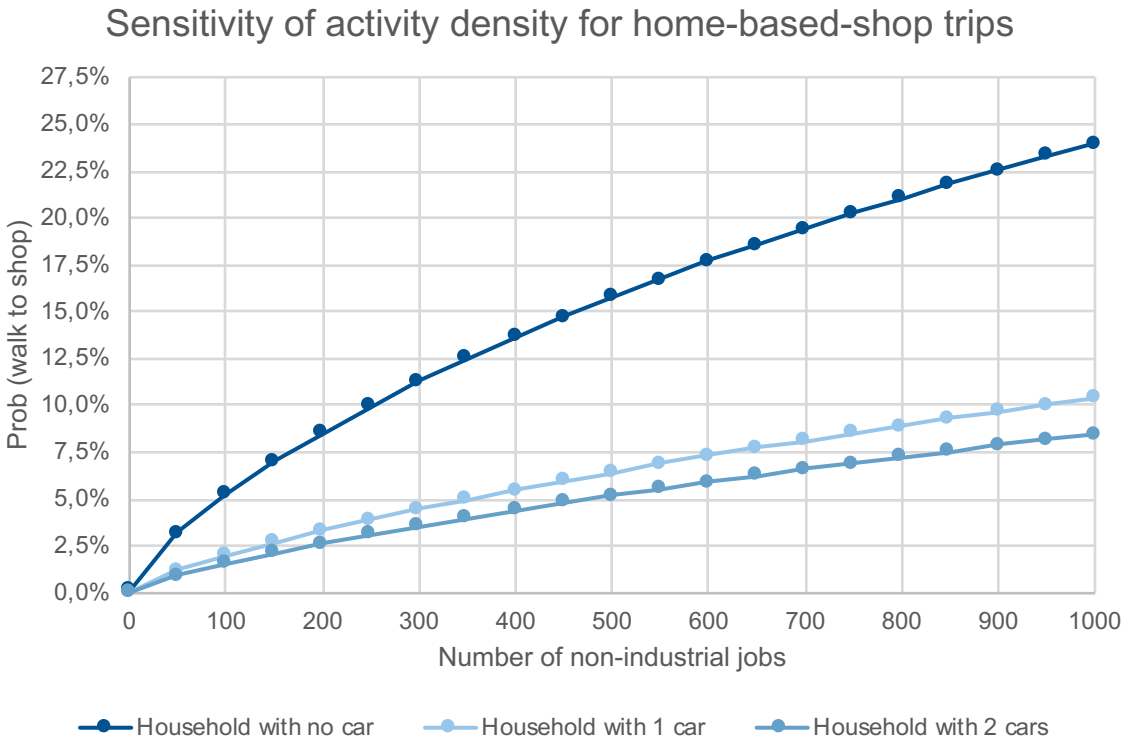
- **Data source:** Oregon Household Activity Survey data 2011 (90% sample)
- **Method:** binary logit model

$$P_i(walk) = f(person\ characteristic, built\ environment\ attribute)$$

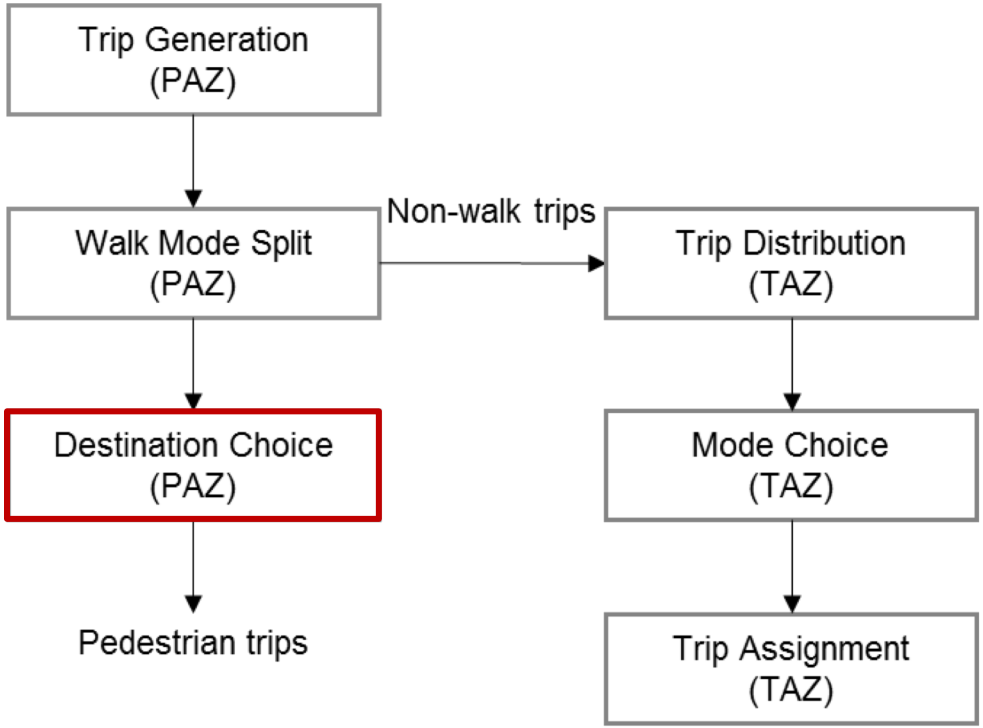
Walk Mode Split | Model results

	Home-based purposes			Non-home-based purposes		
	Estimate	Pr(>|z|)		Estimate	Pr(>|z|)	
(intercept)	-8.392	0.000	***	-7.411	0.000	***
Income category 2				-0.205	0.261	
Income category 3				0.222	0.046	*
Income category 4			.	0.448	0.000	***
Number of vehicle (0)	1.001	0.000	***	1.375	0.000	***
Number of vehicle (2)	-0.226	0.002	**	-0.898	0.000	***
Number of vehicle (2+)	-0.394	0.000	***	-0.963	0.000	***
Number of children (1)	-0.554	0.000	***			
Number of children (2)	-0.574	0.000	***			
Number of children (2+)	-0.718	0.000	***			
Child (Yes)			***	-0.162	0.039	*
log(pedestrian accessibility)	0.754	0.000	***	0.686	0.000	***
HBShop	1.029	0.000	***			
HBOther	1.046	0.000	***			
HBRecreation	1.566	0.000	***			
NHBWork				-0.362	0.000	***
Log-Likelihood:	-4189			-2624		
McFadden R^2:	13.5%			22.8%		

Walk Mode Split | Sensitivity analysis

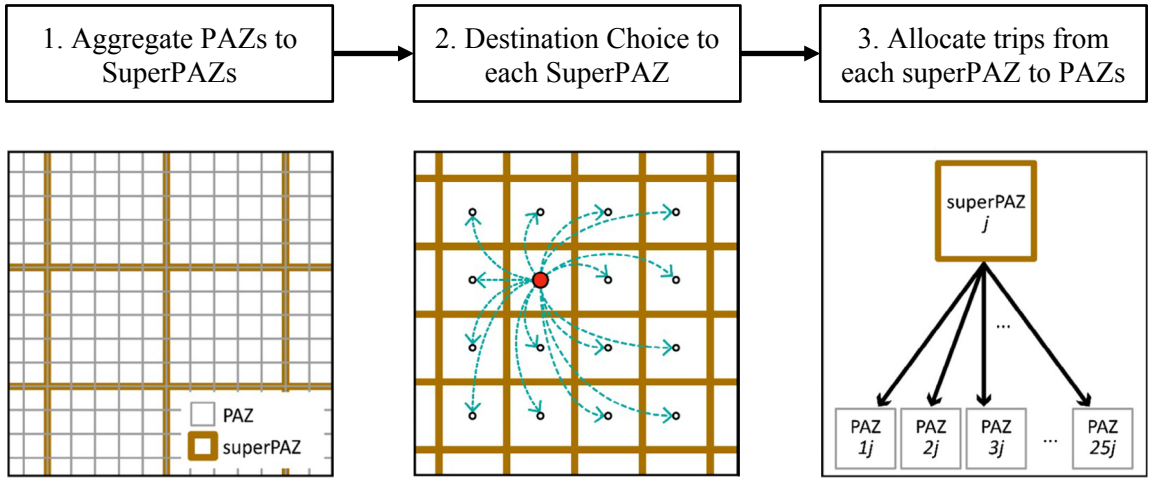


Pedestrian modelling framework



Walk Trip Destination Choice | Methodology

- **Data source:** Oregon Household Activity Survey data 2011 (90% sample)
- **Method:** Multinomial logit model
- **Spatial unit:** superPAZ and PAZ

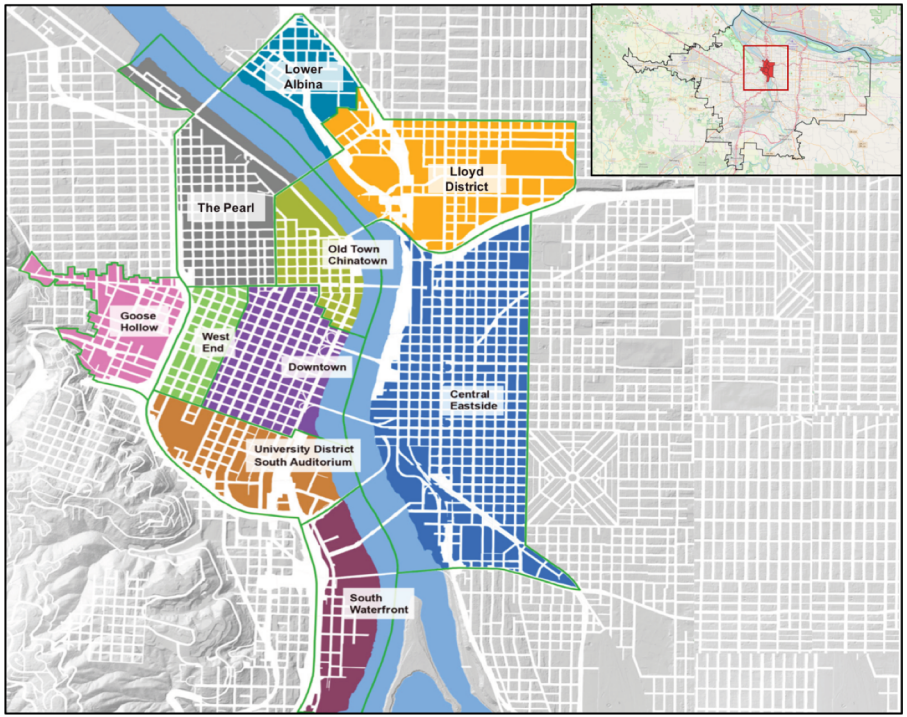


$$Prob(dest.) = f\ (network\ distance, pedestrian\ supports\ and\ barriers)$$

Walk Trip Destination Choice | Model results

	HBWork			HBShop			HBRecreation		
	Estimate	sd	Pr(>|z|)	Estimate	sd	Pr(>|z|)	Estimate	sd	Pr(>|z|)
Intrazonal (Yes)	0.71	0.19	0.00	-0.95	0.16	0.00	0.18	0.12	0.14
Distance on major road	-1.58	0.10	0.00	-2.26	0.15	0.00	-2.26	0.10	0.00
Distance on residential road	-1.48	0.13	0.00	-2.37	0.12	0.00	-1.99	0.11	0.00
Size term (ln)									
Service jobs (#)	0.41	0.05	0.00				0.10	0.03	0.00
Retail jobs (#)				0.95	0.04	0.00			
Finance jobs (#)	0.32	0.05	0.00						
Government jobs (#)									
All other non-industrial jobs (#)									
Households (#)							-0.04	0.04	0.33
Share of industrial jobs	-1.04	0.55	0.06	-1.36	0.43	0.00			
Mean slope	-0.19	0.07	0.01	-0.38	0.07	0.00	-0.15	0.04	0.00
Freeway in zone (Yes)				-0.32	0.18	0.08	-0.36	0.22	0.09
Park (Yes)							0.68	0.11	0.00
Null model Log-Likelihood:	-1618			-3574			-3412		
Final model Log-Likelihood:	-936			-1564			-1883		
Mc'Fadden pseudo R2	40.47%			55.93%			44.50%		

Model Application: Portland Central City 2035 Plan



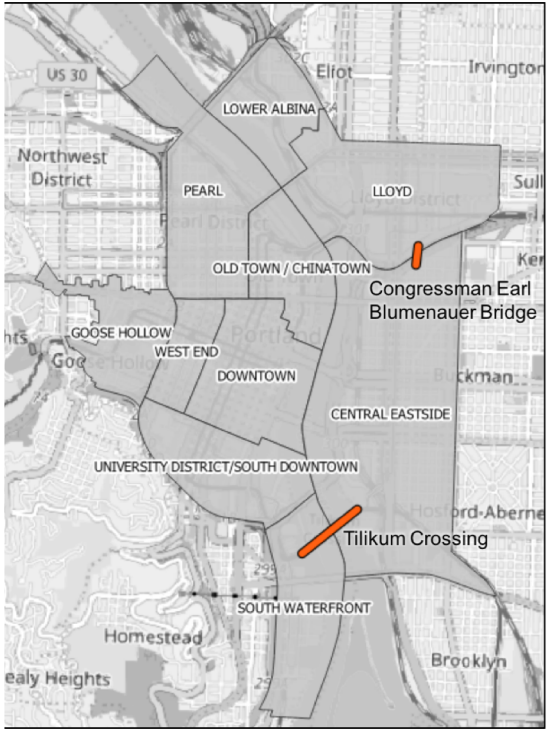
Household

23,100 → 60,300 (+161%)

Employment

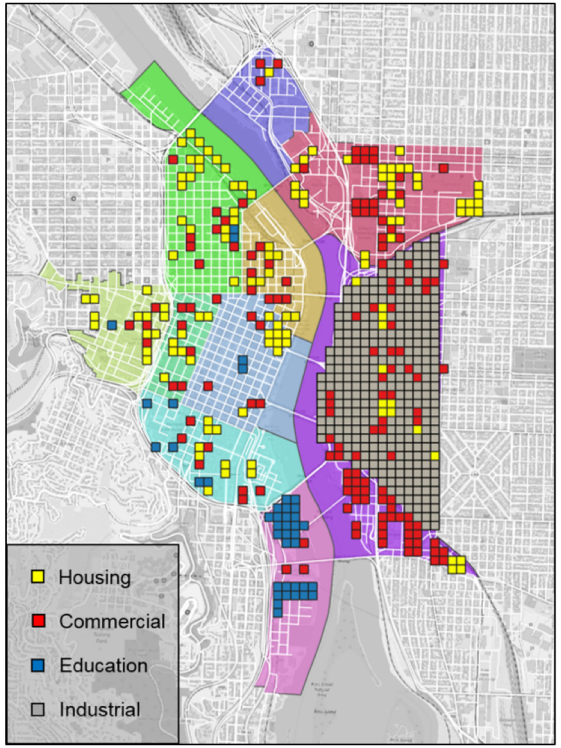
123,800 → 174,000 (+41%)

Model Application: Portland Central City 2035 Plan



Model Application: Portland Central City 2035 Plan

District	A: 2010 Total walk trips	B: 2035 with growth Total walk trips	C: 2035 with growth and bridges difference to B (% Change)
CENTRAL EASTSIDE	3,290	16,043 (+388%)	+1.1%
DOWNTOWN	24,085	48,140 (+100%)	0.0%
GOOSE HOLLOW	6,745	10,077 (+49%)	0.0%
LLOYD	4,717	23,650 (+401%)	+0.2%
LOWER ALBINA	158	701 (+343%)	0.0%
OLD TOWN / CHINATOWN	5,540	8,931 (+61%)	0.0%
PEARL	10,794	25,103 (+133%)	0.0%
SOUTH WATERFRONT	704	8,594 (+1121%)	+0.4%
UNIVERSITY DISTRICT/ SOUTH DOWNTOWN	7,593	17,551 (+131%)	+0.1%
WEST END	10,657	21,018 (+97%)	0.0%
Sum	***74,283***	***179,807 (142%)***	***+0.2%***



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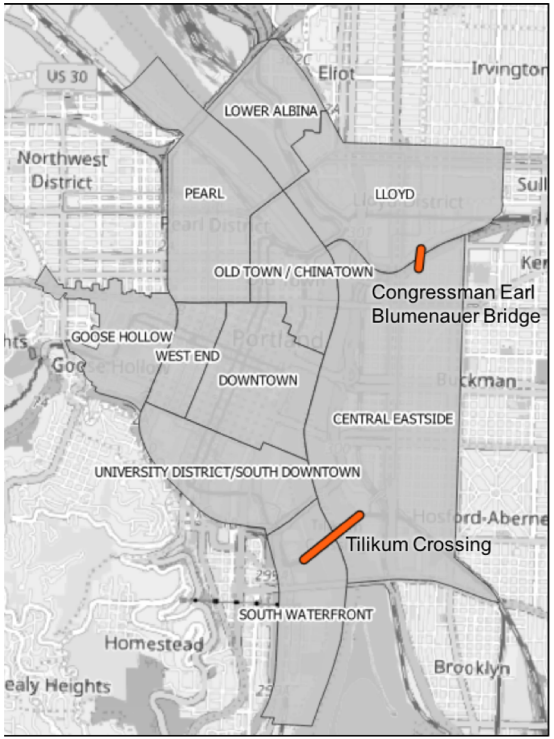

Conclusion

- Contribution
  - One of the first practical planning tool for pedestrian demand estimation at fine spatial scale
  - Better understanding of the effectiveness of various demographic policies and infrastructure planning on promoting more walk trips.

- On progress further works
  - Link the pedestrian modelling to health model for health impact analysis, crash risk exposure, pollutant exposure
  - Feedback health impacts of walking into land use model for estimating life expectancy

Thank you for your listening!

Qin Zhang

MobilLAB final event, 14 Sep 2020

Model Application: Portland Central City 2035 Plan

District	Total households			Total employment		
	2010	2035	Change in %	2010	2035	Change in %
Central Eastside	900	7900	+778%	17000	25000	+47%
Downtown	1600	4600	+188%	48200	55200	+15%
Goose Hollow	3900	4900	+26%	5300	7300	+38%
Lloyd	1000	9000	+800%	16800	25800	+54%
Lower Albina	100	300	+200%	2100	2300	+10%
Old Town	1900	3900	+105%	5200	8200	+58%
Pearl	5600	11600	+107%	10700	14700	+37%
South Waterfront	1100	5100	+364%	1200	11200	+833%
University District	3200	6200	+94%	10400	14400	+38%
West End	3800	6800	+79%	6900	9900	+43%
Sum	*23100*	*60300*	*+161%*	*123800*	*174000*	*+41%*