A Framework For Integrating Pedestrians

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Symposium for the Integration of Land-Use & Transport Models

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Metro

Background

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How do travel models estimate walking?

Among 48 large MPOs in US:

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

Lacking pedestrian built environment measures & small spatial units

Trip-based model sequence

1. **Generation**
2. **Distribution**
3. **Mode choice**
4. **Assignment**

Source: Singleton, P. A., & Clifton, K. J. (2013). Pedestrians in regional travel demand forecasting models: State-of-the-practice.

Why model pedestrians?

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- Pedestrian investments
- Mode shifts
- Greenhouse gas emissions
- Health & safety
- Transit access/egress
- New research opportunities

Incorporating pedestrians

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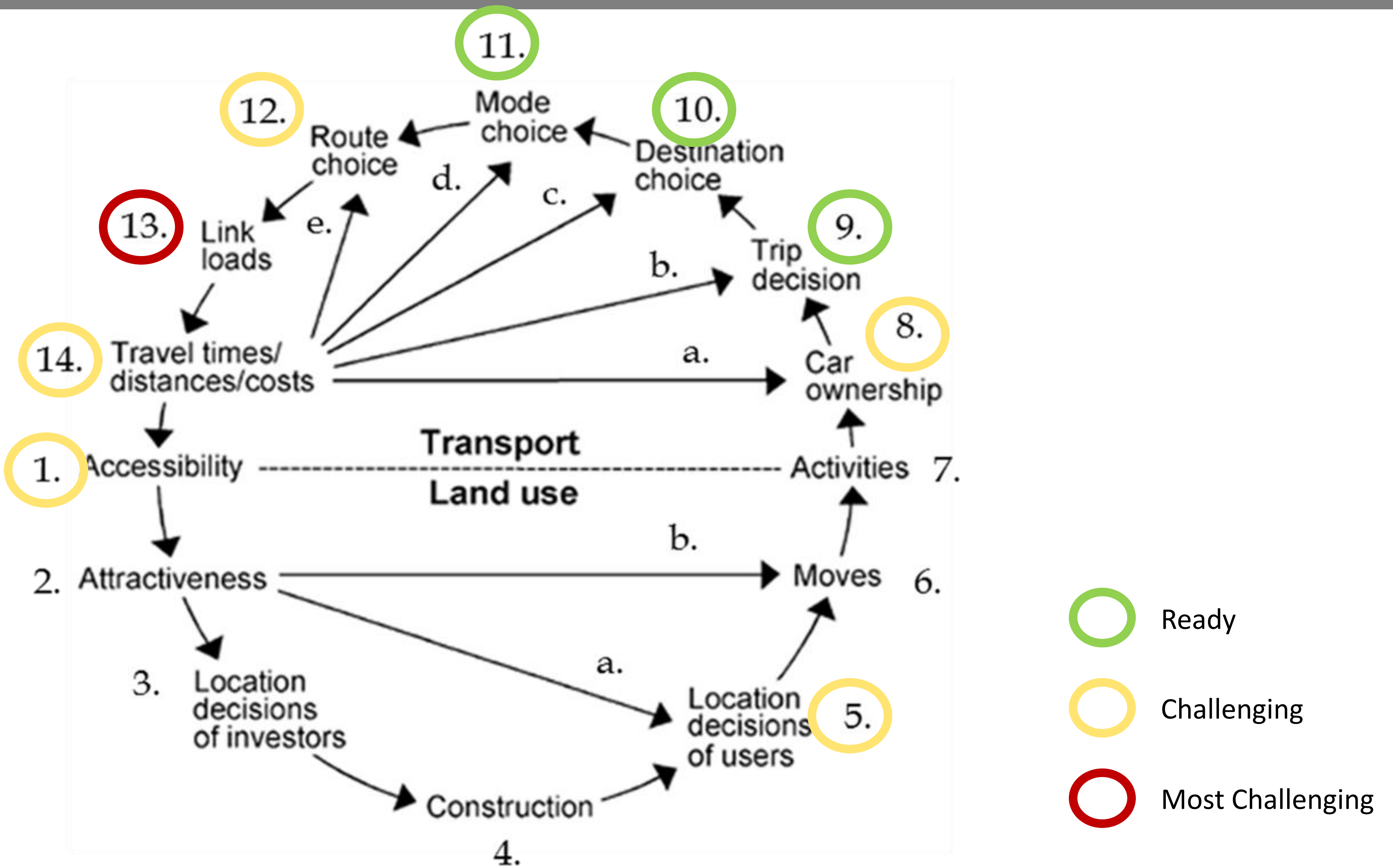

Adapted from: Wegener and Fürst, 1999

Incorporating pedestrians

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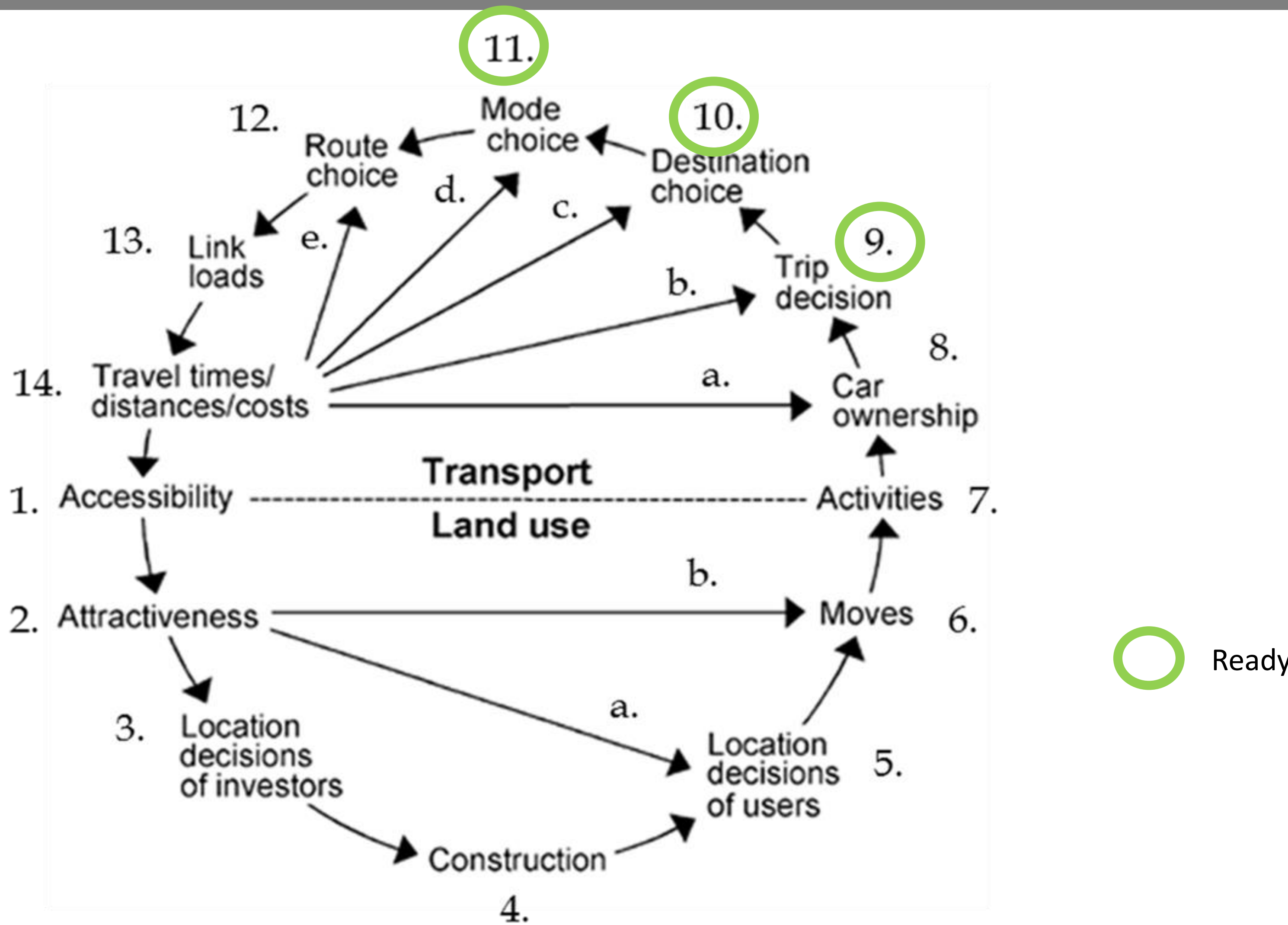
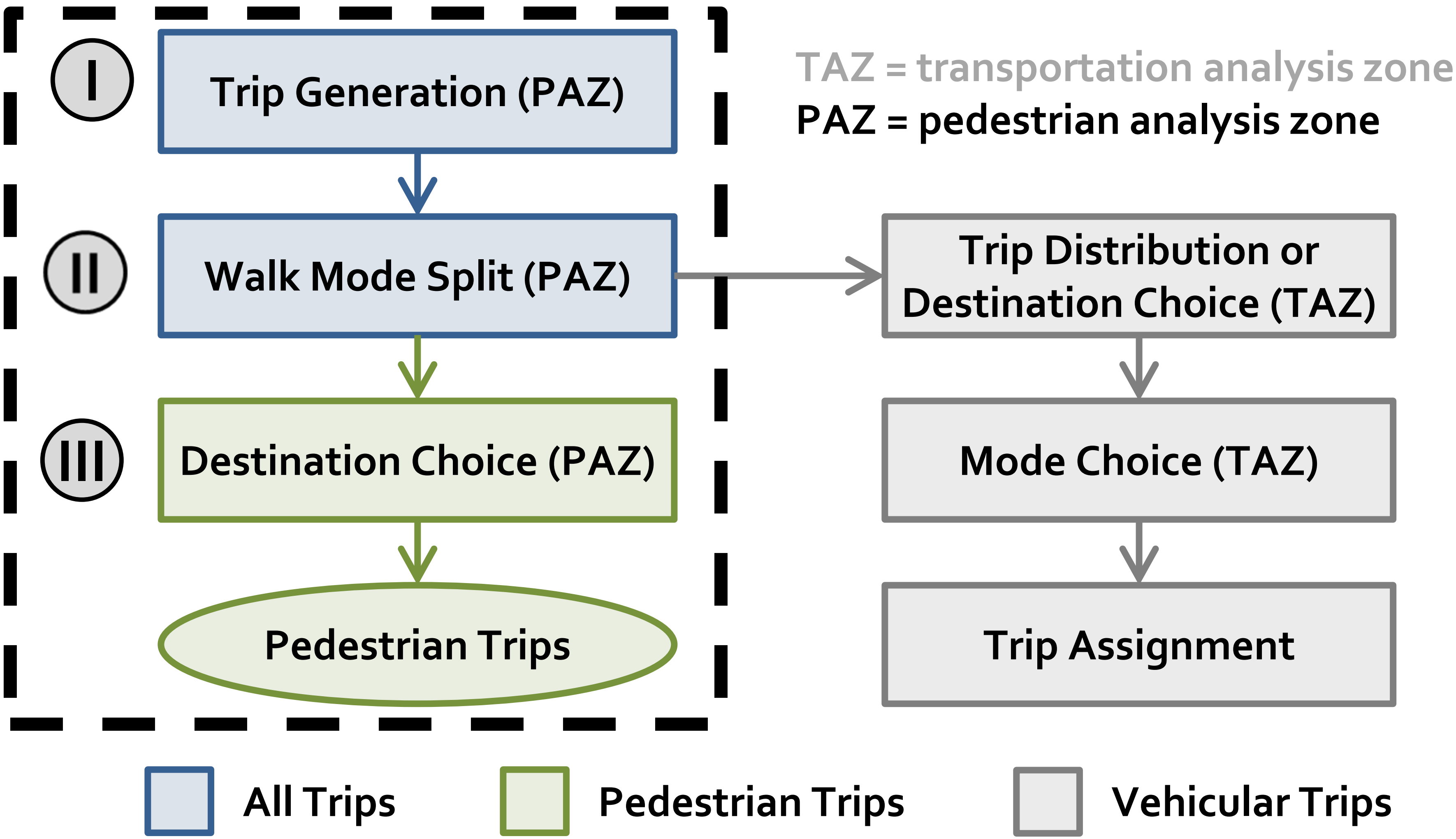


Adapted from: Wegener and Fürst, 1999

New MoPeD method



Contributions

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- Nests within current structure but can be used alone
- Pedestrian scale analysis (PAZs)
- Pedestrian-relevant variables (PIE)
- One of the first studies to examine pedestrian destination choice in demand modeling framework
- Highlights policy relevant variables: distance, size, pedestrian supports & barriers

Pedestrian analysis zones

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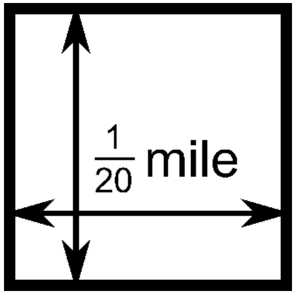

264 feet = 80 m ≈ 1 minute walk

Metro: ~2,000 TAZs → ~1.5 million PAZs

TAZs

PAZs

Home-based work trip productions

Pedestrian environment

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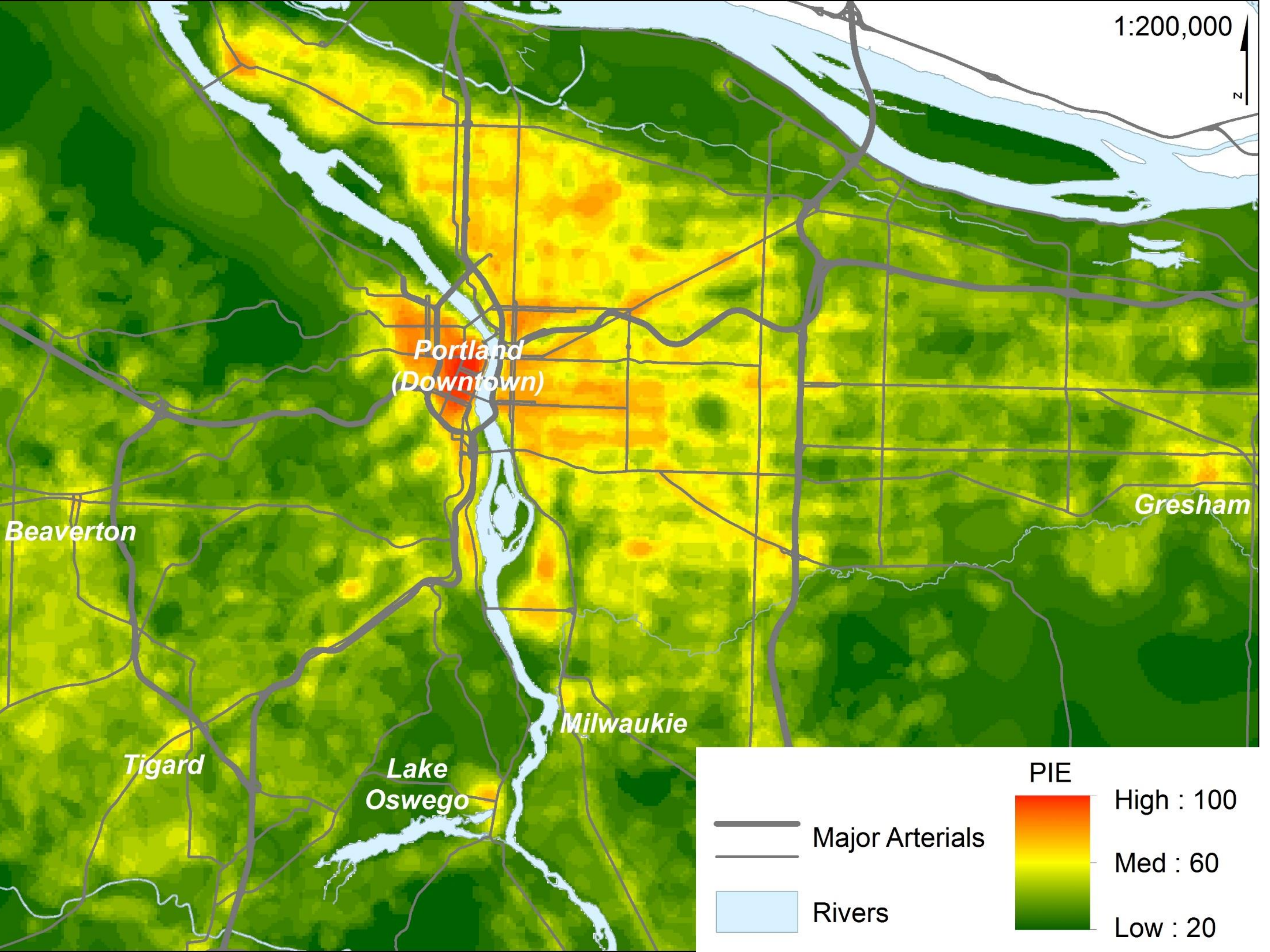
Pedestrian Index of the Environment (PIE)

20–100 score = calibrated ∑(6 dimensions)

- People & job density
- Transit access
- Urban living infrastructure
- Block size
- Sidewalk extent
- Comfortable facilities

ULI = Urban Living Infrastructure: pedestrian-friendly shopping and service destinations used in daily life.



1:200,000
N
Portland
(Downtown)
Beaverton
Gresham
Milwaukie
Tigard
Lake
Oswego
Major Arterials
Rivers
PIE
High : 100
Med : 60
Low : 20

I Trip Generation

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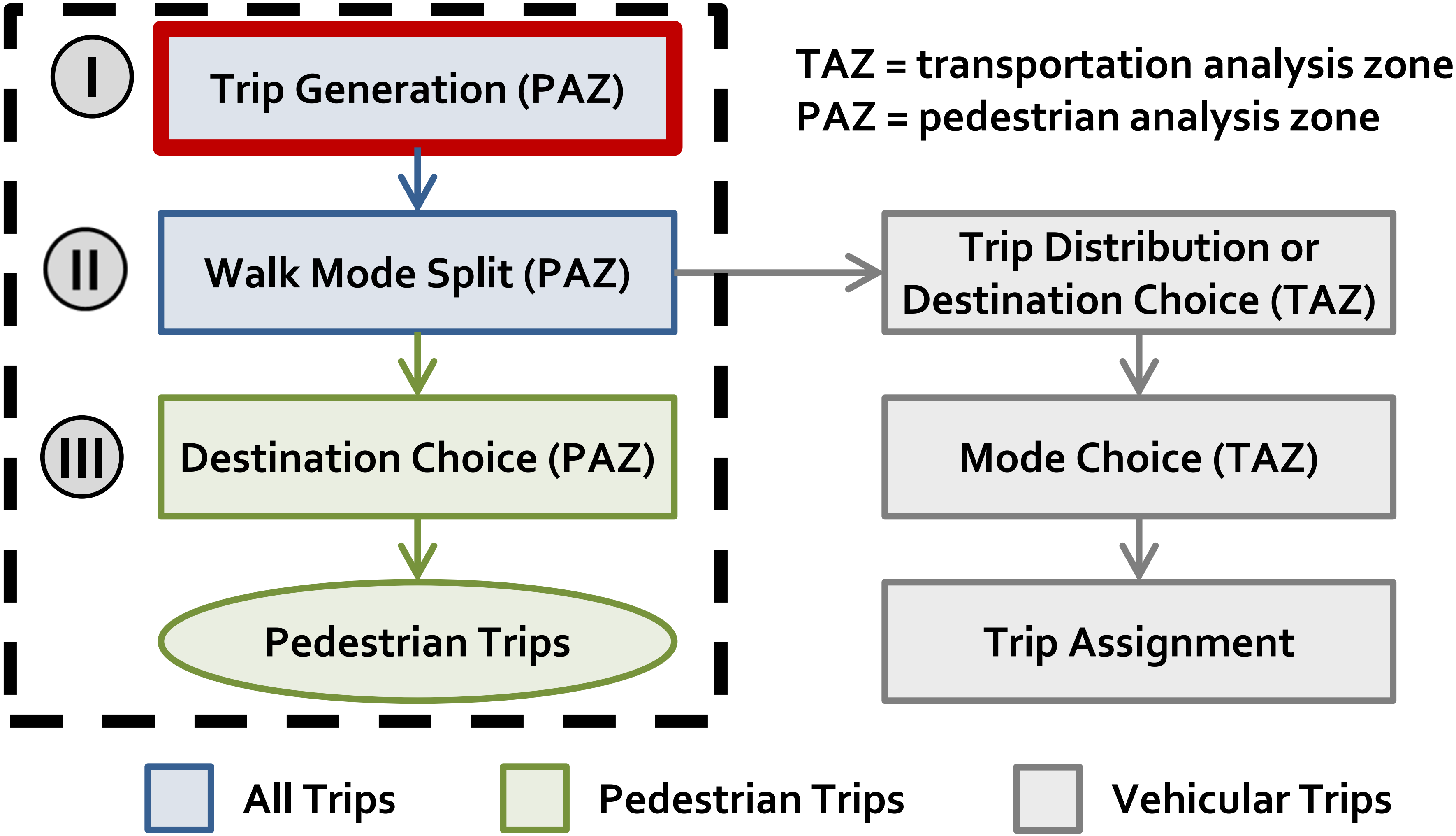

I Trip Generation

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Metro currently has 8 trip production models applied to ~2,000 TAZs:

- HBW – Home-based work;
- HBshop – Home-based shopping;
- HBrec – Home-based recreation;
- HBoth – Home-based other (excludes school and college);
- NHBW – Non-home-based work;
- NHBNW – Non-home-based non-work;
- HBcoll – Home-based college; and
- HBsch – Home-based school.

After testing for scalability, we applied <u>the same models</u> to our pedestrian scale ~1.5M PAZs

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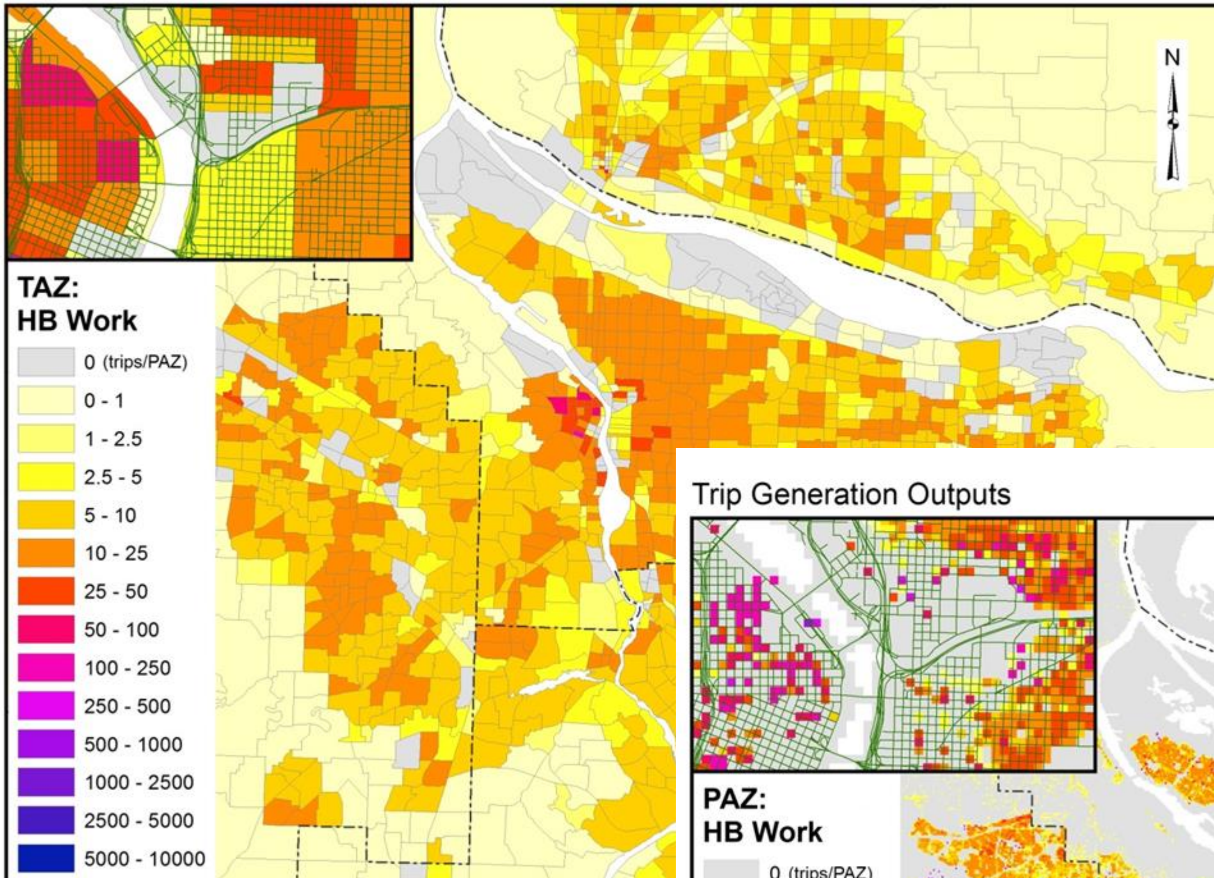
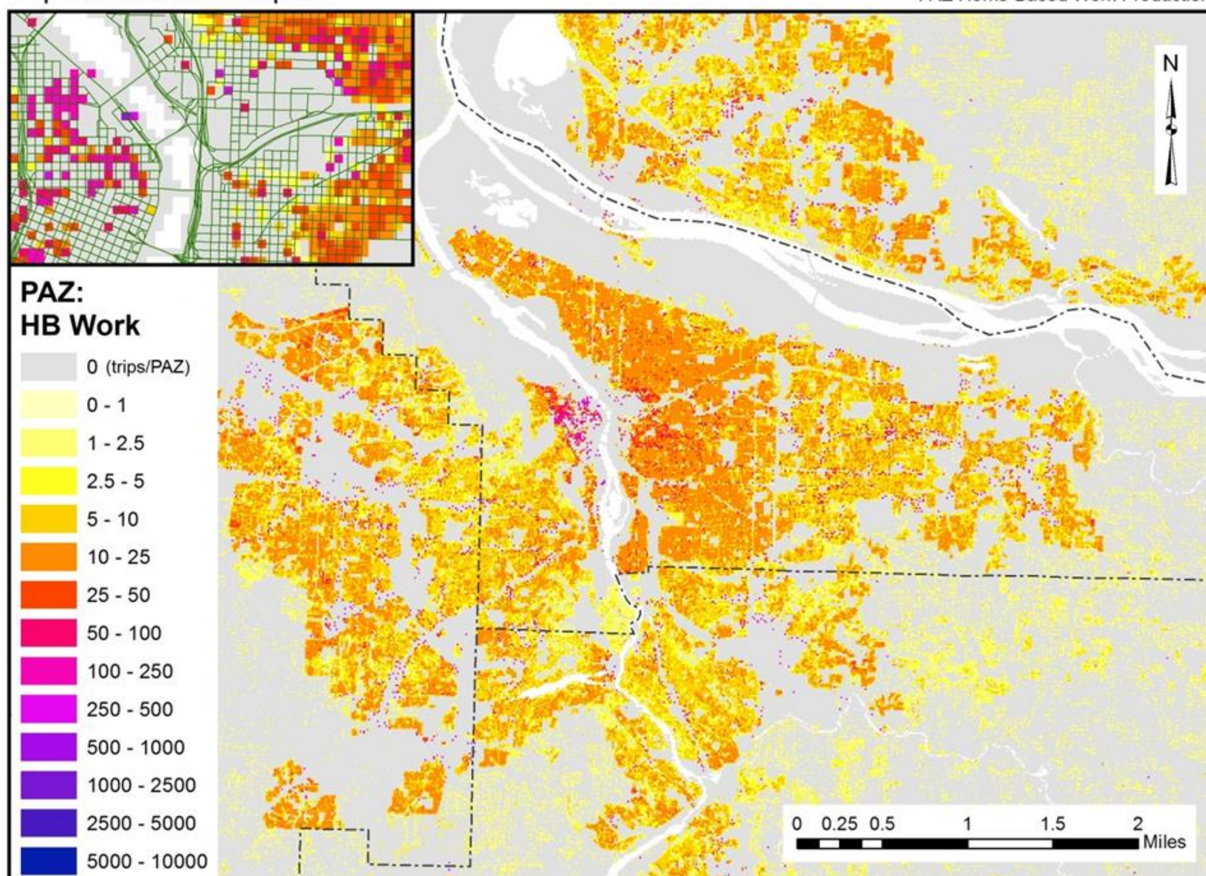
Trip Generation Outputs

TAZ Home-Based Work Productions

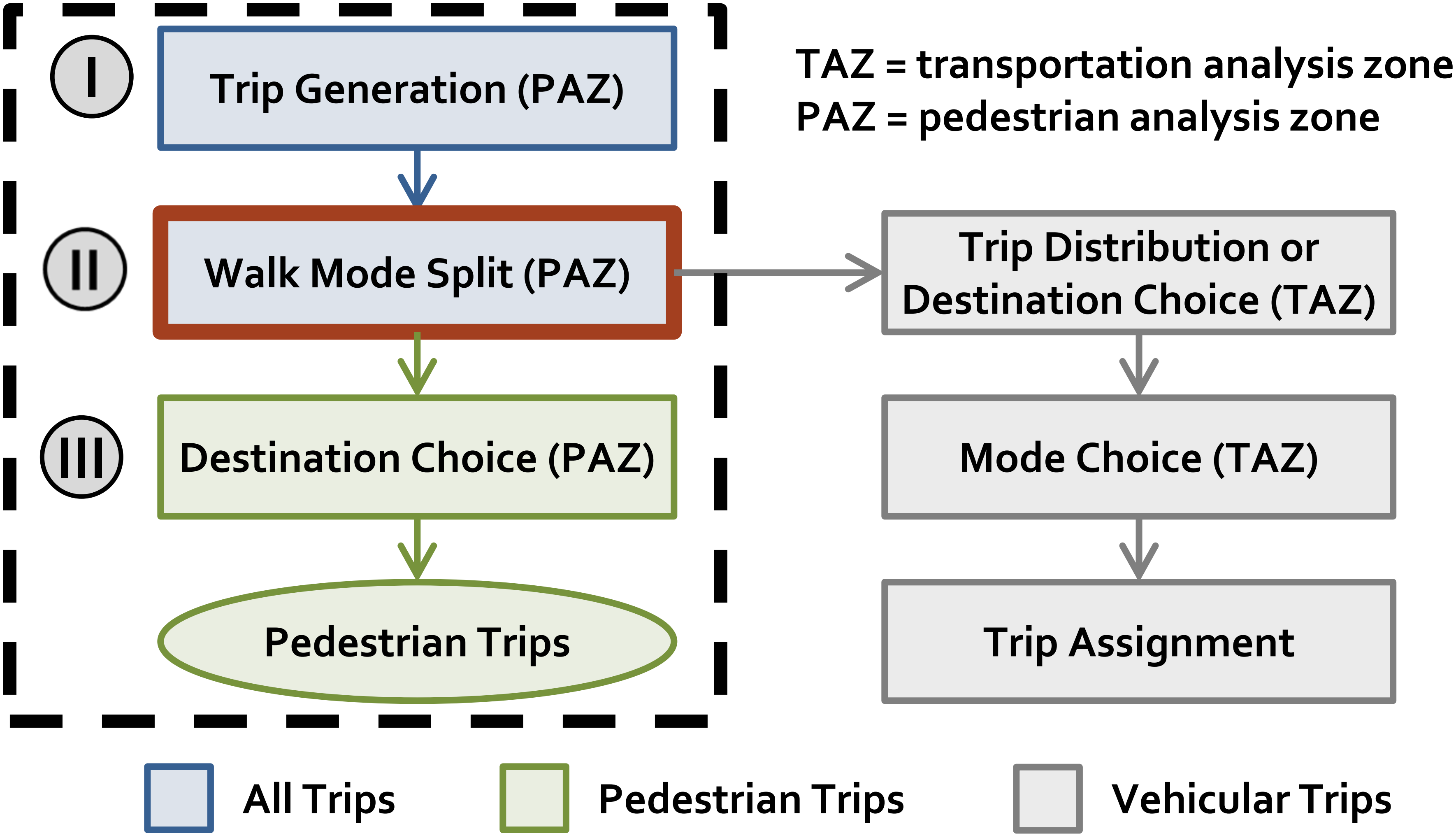


Trip Generation Outputs

PAZ Home-Based Work Productions



Walk mode split



II Walk mode split

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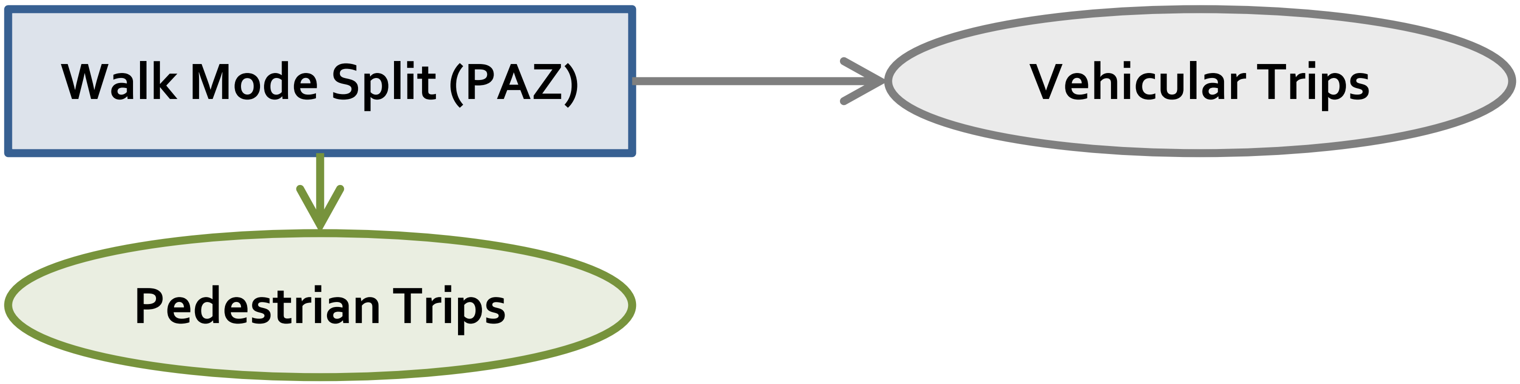

Prob*(walk) = *f(traveler characteristics, PIE)

***Data*:** 2011 OHAS, Production trip ends, 90% sample

***Method*:** binary logit model

***Spatial unit*:** pedestrian analysis zone (PAZ)

II Walk mode split models

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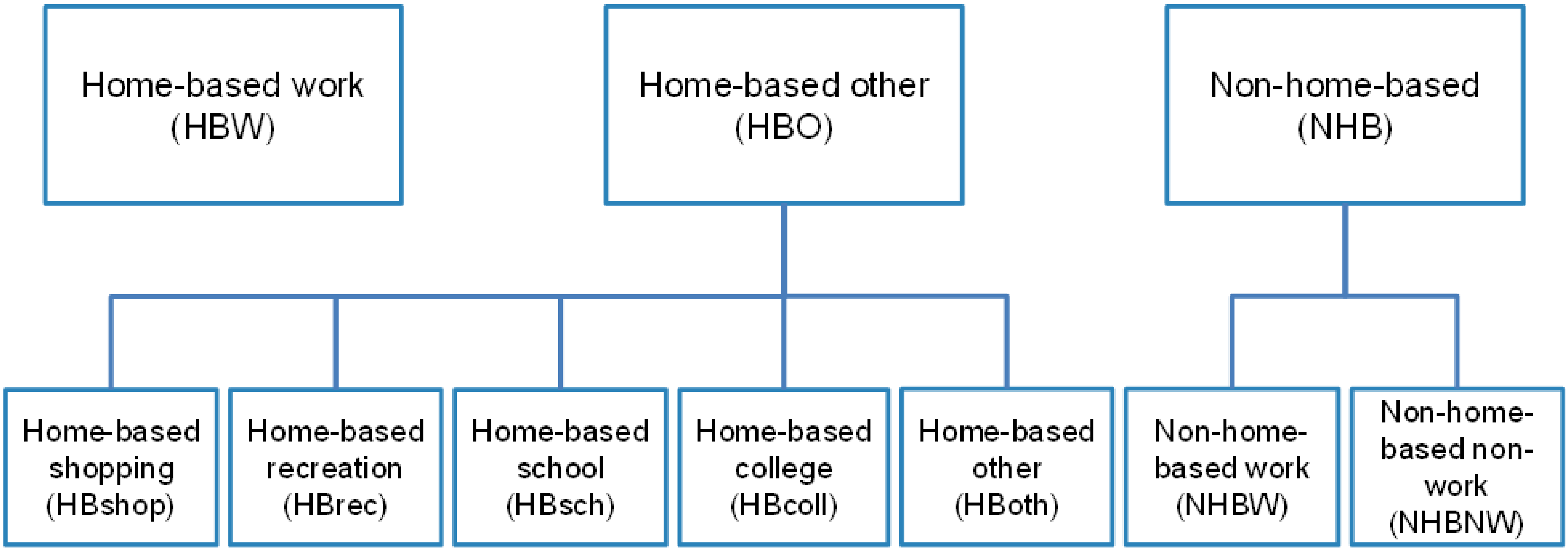
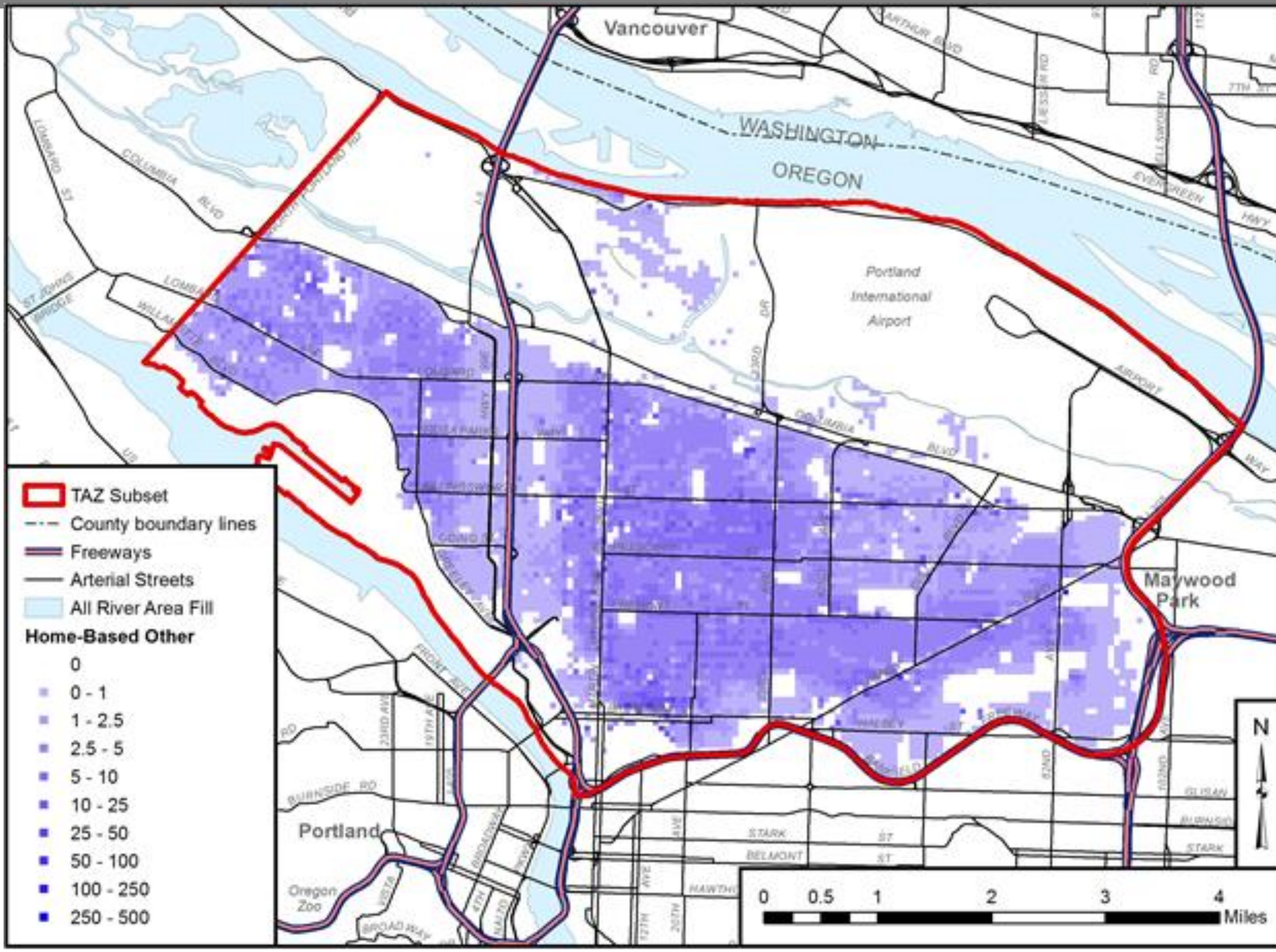


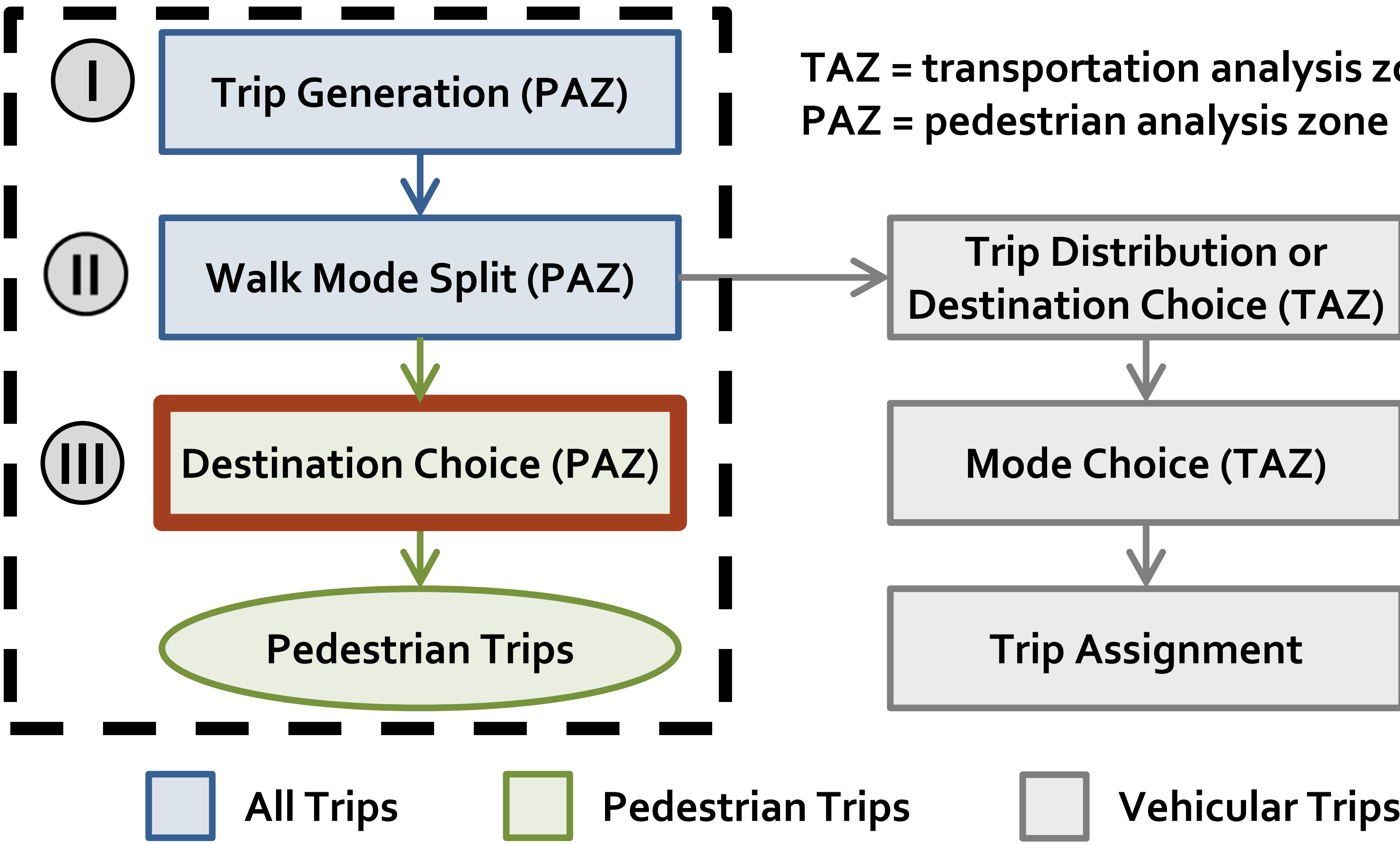
Traveler characteristics:	Household size, income, age, # of workers, # children, # vehicles
Built environment:	PIE

Walk model application

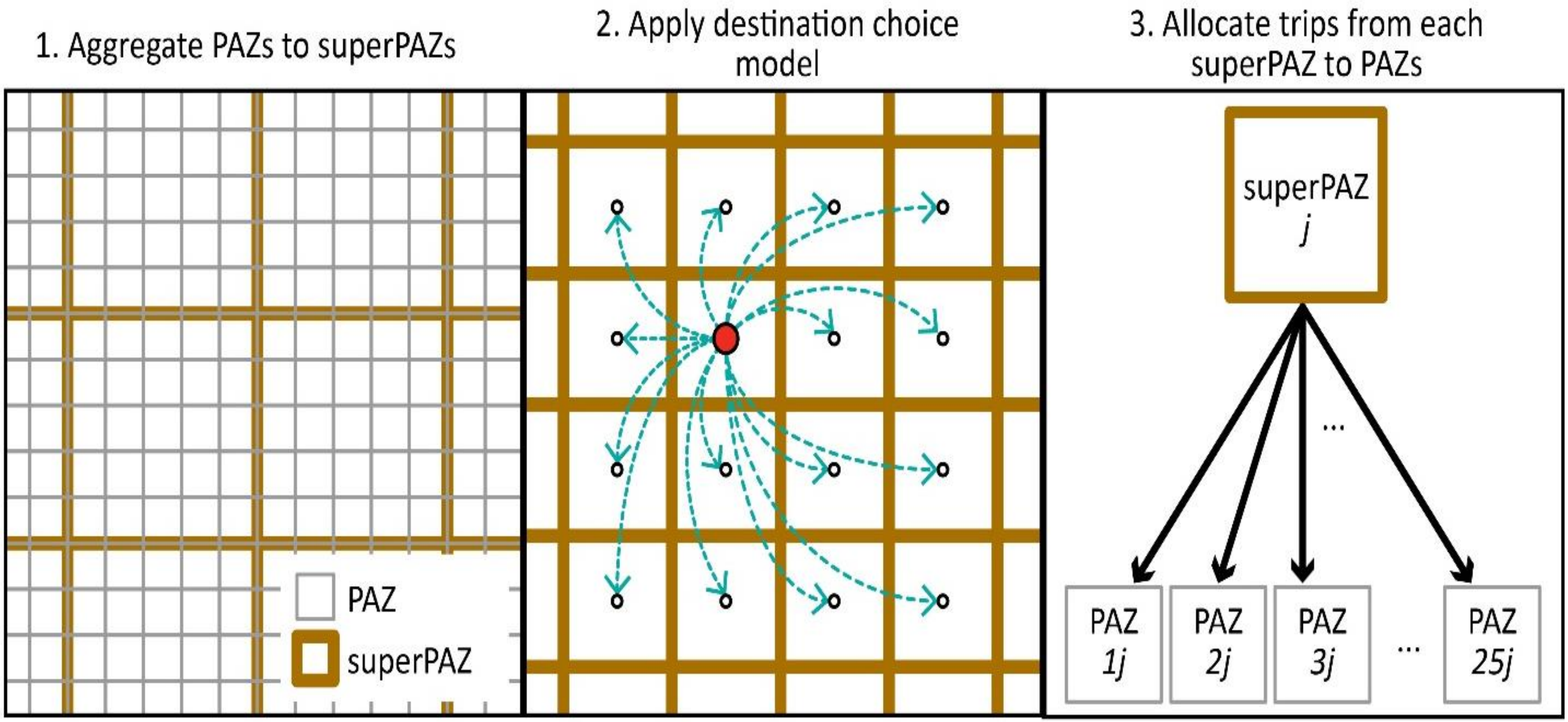


Ⓘⅰⅰⅰ Destination choice

TAZ = transportation analysis zone
PAZ = pedestrian analysis zone



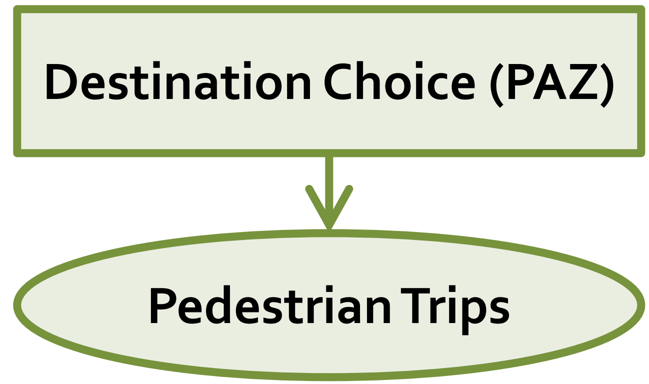
Ⅲ Destination choice



Ⅲ Destination choice

Prob(dest.) = *function of*…

- network distance
- size / # of destinations
- pedestrian environment
- traveler characteristics



Data: 2011 OHAS

Method: multinomial logit model

Spatial unit: super-pedestrian analysis zone

Six trip types:

home-based: work (HBW), shopping (HBS), recreation (HBR), & other (HBO);

non-home-based: work (NHBW) and non-work (NHBNW)

Destination Choice

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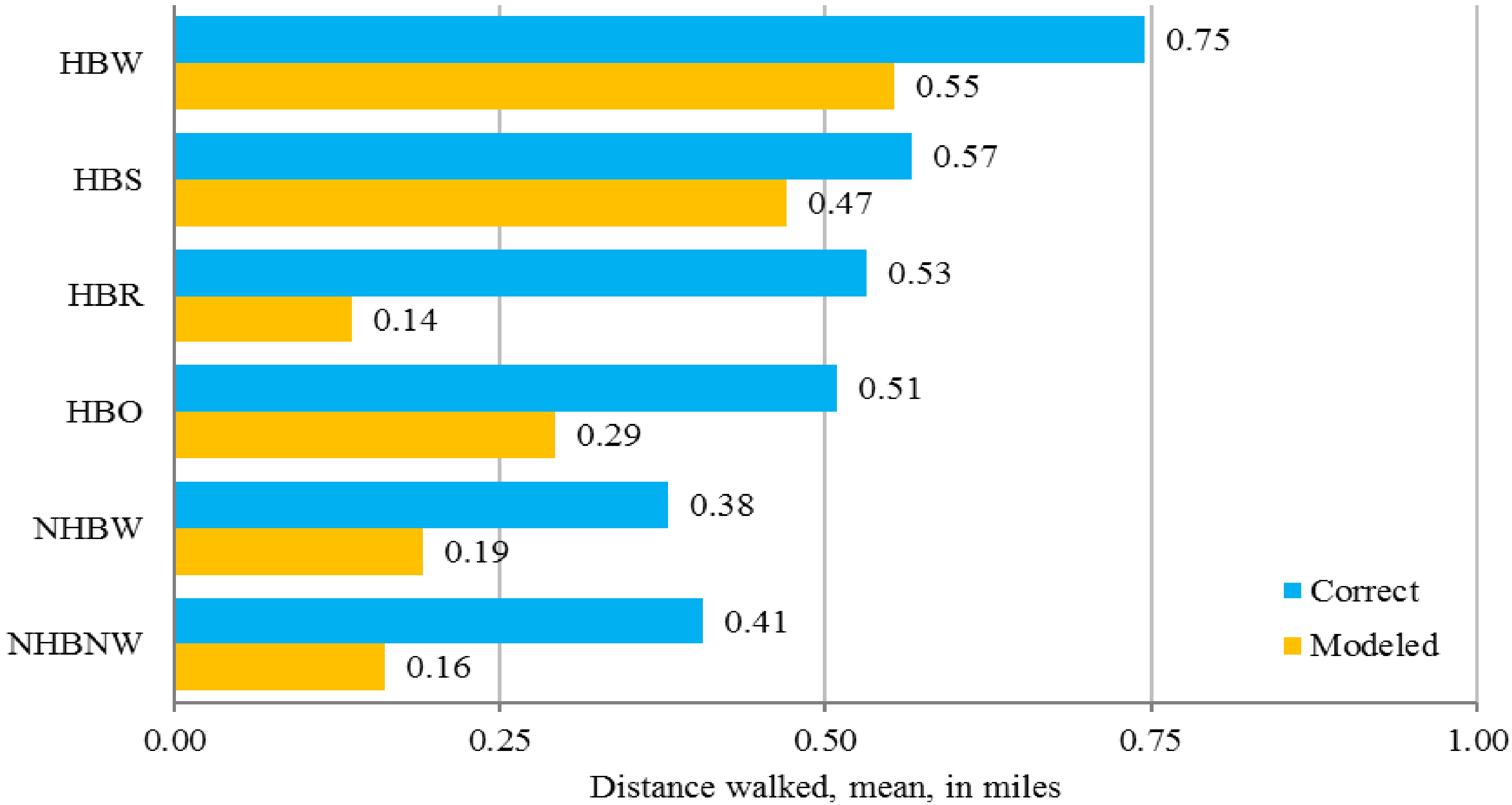
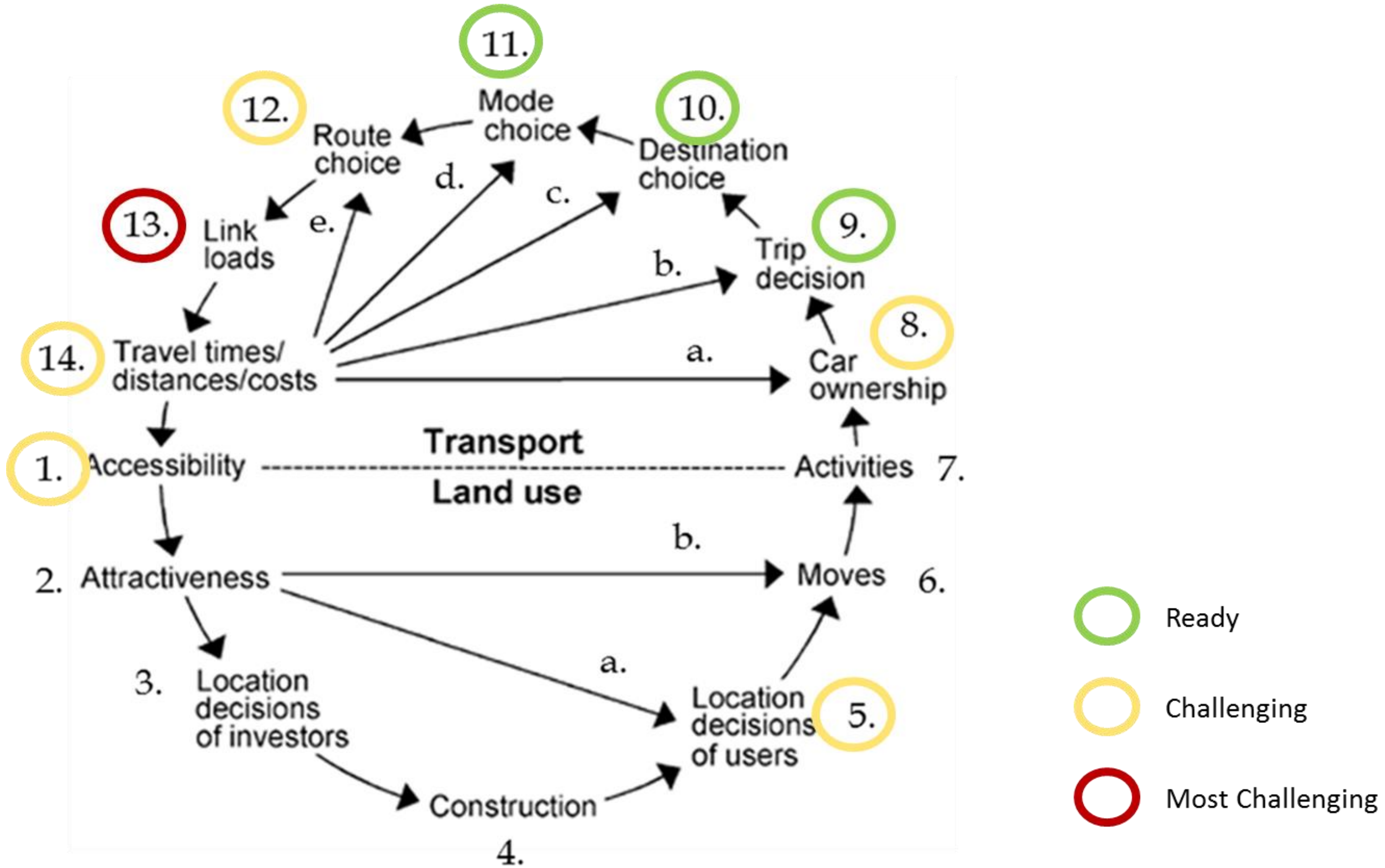
Model Validation – Avg. Distance Walked



Future work

- **Pedestrian Environment**
  - Policy Sensitivity & Forecasting
- **Microsimulation –integration with ABM**
- **Trip Generation**
  - Multinomial Logit model
- **Pedestrian mode choice**
  - Feedbacks to trip generation & destination choice
  - Better representation of attributes of other modes
- **Destination Choice**
  - Explore non-linear effects & other interactions
- **Route choices or potential pathways**
  - Need fundamental research to improve understanding



OPPORTUNITIES & CHALLENGES

Adapted from: Wegener and Fürst, 1999

BEHAVIORAL RESEARCH

Behavioral research

Decision sequencing:

activity, mode, destination;
activity, destination, mode;
mode, activity, destination

Destination choice considerations

– choice set generation

Willingness to walk

Path/route choice considerations

Behavioral Research

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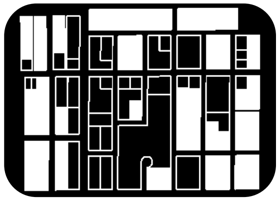


Built environment

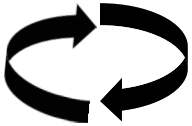
- Thresholds & nonlinearities
- Mixing
- Scale

Lifestyle questions:

- Vehicle ownership & residential location
- Attitudes, motivations & values

Positive Utility of Travel

- What aspects?
- Diminishing returns?



Mode feedbacks to trip generation

DATA & MODELS

Spatial/Temporal Scale

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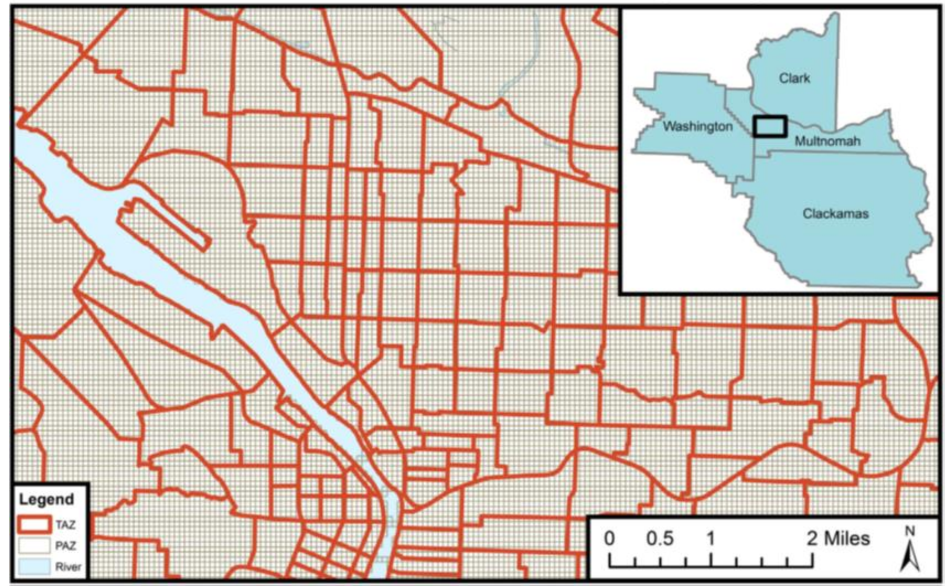
- Depends on output needed for policy/research
- Capture variations in the pedestrian built & natural environment
- Spatial accuracy
- Theory/Behavior

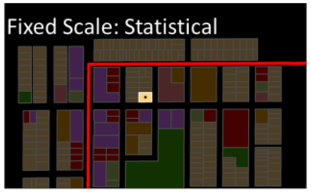
PAZs and TAZs in Part of the Portland, Oregon, Region

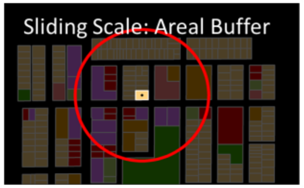


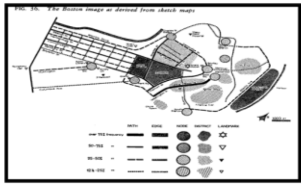
Fixed Scales
- Administrative
- Statistical
- Artificial

Sliding Scales
- Areal Buffer
- Network Buffer
- Activity Space

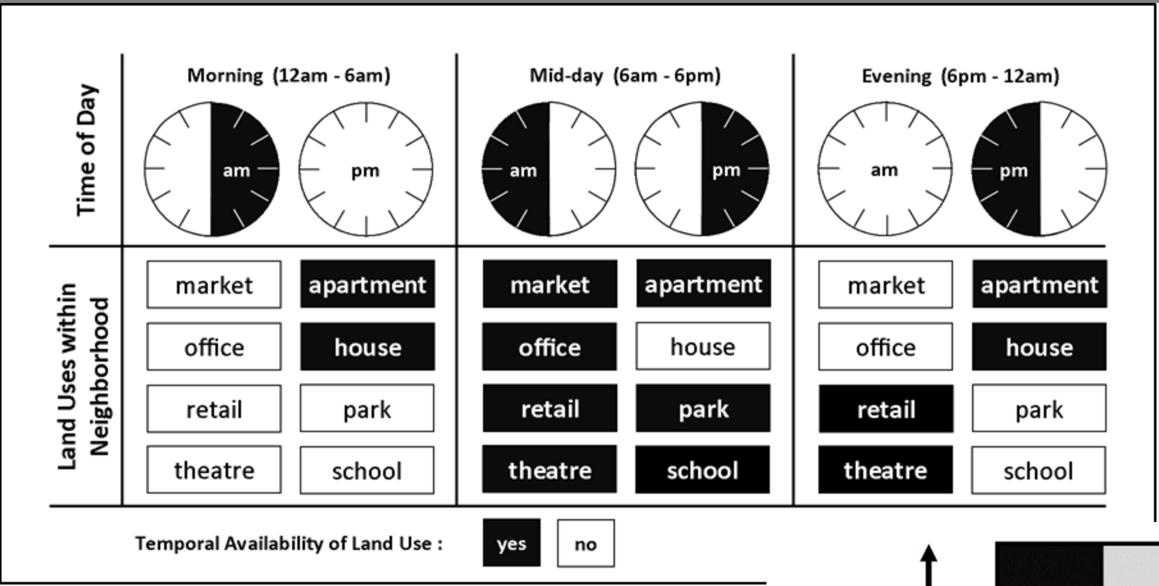
Perceptive Scales
- Mental Maps





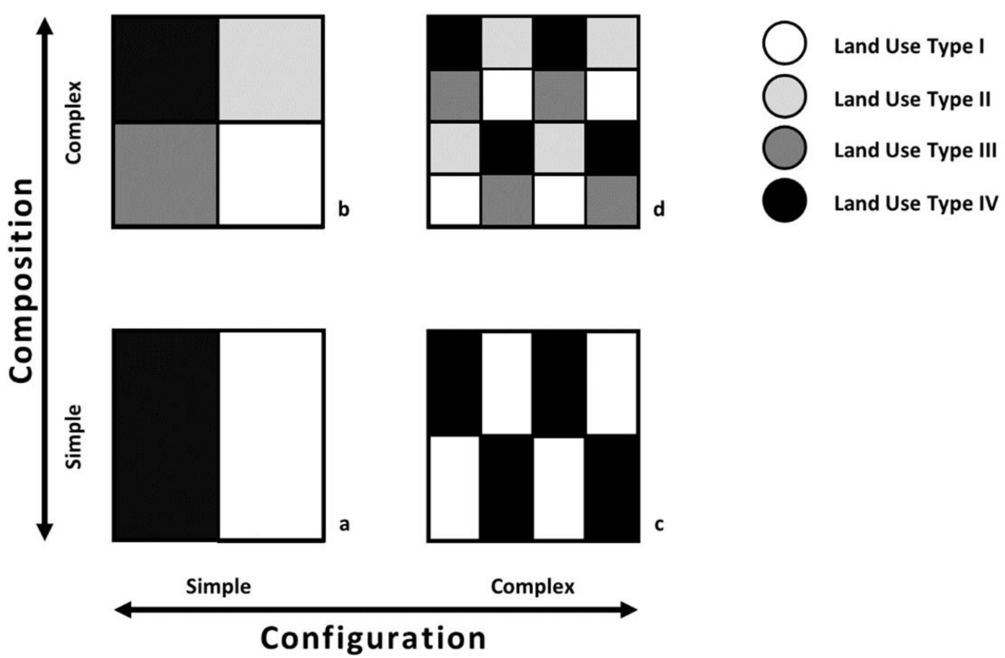


Built environment



- How & what to represent?
- Indices, proxies
- Forecasting

S.R. Gehrke, & K.J. Clifton. (2016). Toward a spatial-temporal measure of land-use mix. *Journal of Transport and Land Use, 9(1):171–186*
S.R. Gehrke, & K.J. Clifton. (2014). Operationalizing land use diversity at varying geographic scales and its connection to mode choice: Evidence from Portland, Oregon. *Transportation Research Record: Journal of the Transportation Research Board* 2453: 128-136.



Networks

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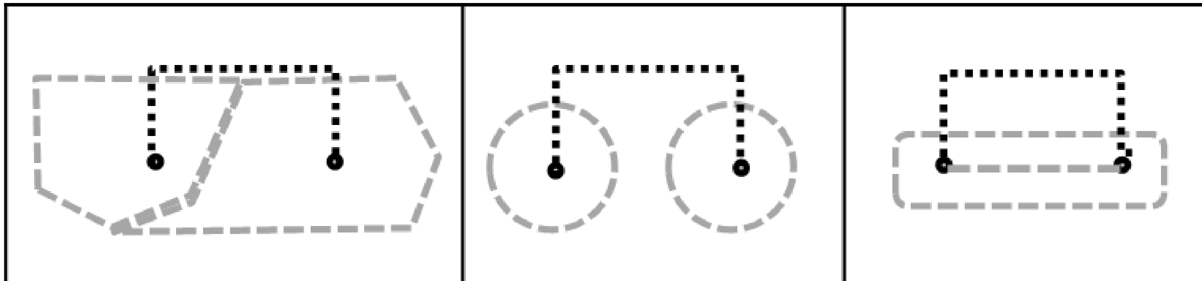
- Network representation
- How do we attribute networks?
- Feedbacks of travel costs
- Do we need to assign trips to a network?



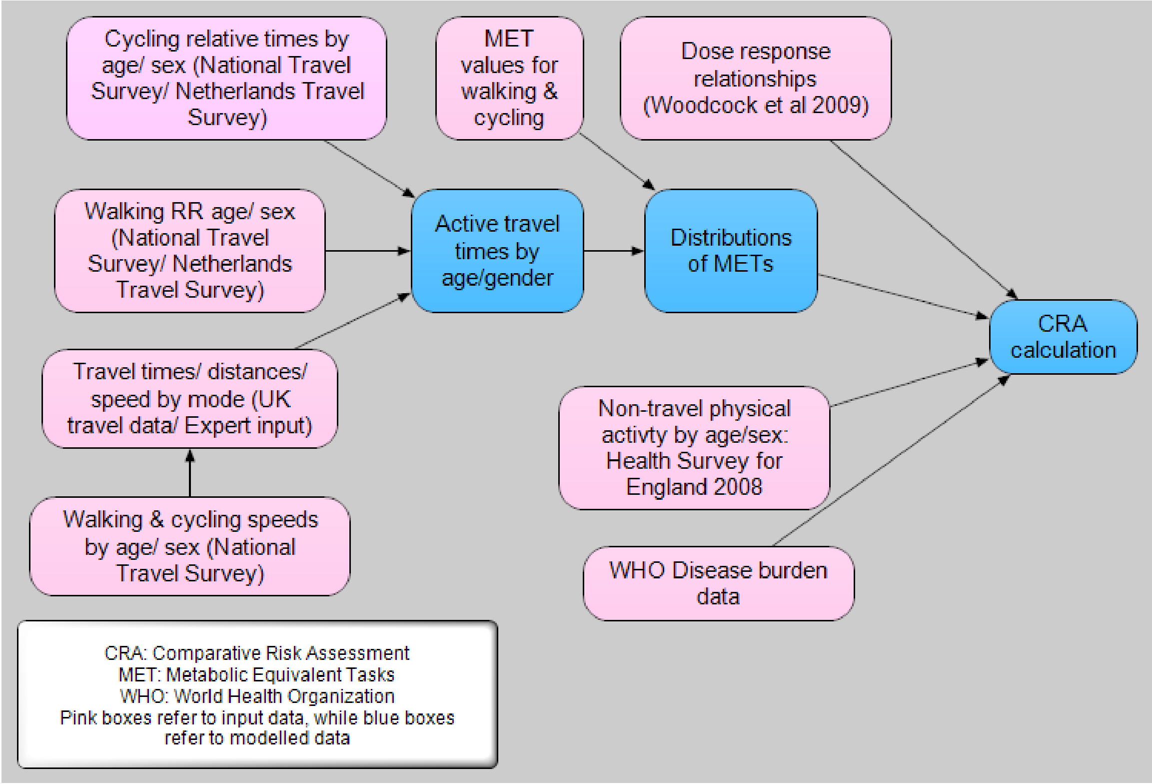
Zone-based: Aggregate built environment into irregular zones around trip origin and destination (may not cover entire trip).	**Buffer:** Aggregate built environment into circular or network-based polygon buffers around trip origin and destination (may not cover entire trip).	**Route:** Measure built environment around or along shortest path or actual (reported) path (shortest path may not correspond to actual path; reported path may not correspond to actual path for all modes).

Actual route ········· **Measurement area** – – – – – **Origin/destination** •

Broach, J. P. (2016). *Travel mode choice framework incorporating realistic bike and walk routes* (Order No. 10061477). Available from Dissertations & Theses @ Portland State University; ProQuest Dissertations & Theses Global.

Link to Health Outcomes

- Health impact analysis
- Total time spent walking + speeds
- Physical activity budgets
- Crash risk exposure
- Pollutant exposure
- Feedback into life expectancy



Woodcock J, Givoni M, Morgan AS. Health Impact Modelling of Active Travel Visions for England and Wales Using an Integrated Transport and Health Impact Modelling Tool (ITHIM). Barengo NC, ed. PLoS ONE. 2013;8(1):e51462

Questions?

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Project info & reports:
http://trec.pdx.edu/research/project/510
http://trec.pdx.edu/research/project/677

Singleton, P. A., Schneider, R. J., Muhs, C. D., & Clifton, K. J. (2014). "The Pedestrian Index of the Environment (PIE): Representing the Walking Environment in Planning Applications," *Proceedings of the 93rd Annual Meeting of the Transportation Research Board*, 2014.

Clifton, K. J., Singleton, P. A., Muhs, C. D., & Schneider, R. J. 2016. "Representing pedestrian activity in travel demand models: Framework and applications", *Journal of Transport Geography*, Vol. 52:111-122. http://dx.doi.org/10.1016/j.jtrangeo.2016.03.009.

Clifton, K. J., Singleton, P. A., Muhs, C. D., & Schneider, R. J. 2016. "Development of destination choice models for pedestrian travel", *Transportation Research Part A*, 94: 255-265

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