Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 41 (2019) 324–327

Transportation Research Procedia

www.elsevier.com/locate/procedia

International Scientific Conference on Mobility and Transport
Urban Mobility – Shaping the Future Together
mobil.TUM 2018, 13-14 June 2018, Munich, Germany

Investigate an Appropriate Spatial Resolution for Large-scaled Pedestrian Travel Demand Model

Qin Zhang [a], Kelly J. Clifton [a, b], Rolf Moeckel [a] *

[a]*Technical University of Munich, Arcisstraße 21, 80333 Munich, Germany*
[b]*Department of Civil & Environmental Engineering, Portland State University, Portland, OR, USA*

Keywords: Spatial resolution; Pedestrian; Travel demand model

1. Introduction

An appropriate spatial resolution plays a significant role in any travel demand models. It directly impacts the level of detail of model input data, outcomes, and sensitivities (Castiglione et al., 2014; Moeckel and Donnelly, 2015). Compared to motorized or bicycle travel, pedestrian trips occur over a shorter travel distance and they are sensitive to environmental conditions at a much finer grain. Thus, it is important for models to set an appropriate spatial resolution to capture variations in walking conditions, leading to better representation of pedestrian demand over space (Gehrke and Clifton, 2014).

The model of pedestrian demand (MoPeD) developed by Dr. Clifton's team integrates pedestrians into urban trip-based travel models for the Portland metropolitan area (Clifton et al., 2016a). It changes the spatial unit from Transportation Analysis Zone (TAZ) to a finer spatial scale called Pedestrian Analysis Zone (PAZ) defined by an 80m×80m grid cell and an aggregation of these PAZs into 400m x 400m zones called a superPAZ. Compared to the TAZs (Figure 1), PAZs can better represent pedestrian behavior and react to the changing pedestrian environment, but they also escalate computational burden, particularly in the destination choice step. Although the current computational power can manage such sizeable number of PAZs, the trade-off between efficiency of run times and

* Corresponding author. Tel.: +49 89 289 22699
E-mail address: rolf.moeckel@tum.de

10.1016/j.trpro.2019.09.053

complexity of models remain, particularly for applying MoPeD to a large-scaled study area or to a large number of scenarios.

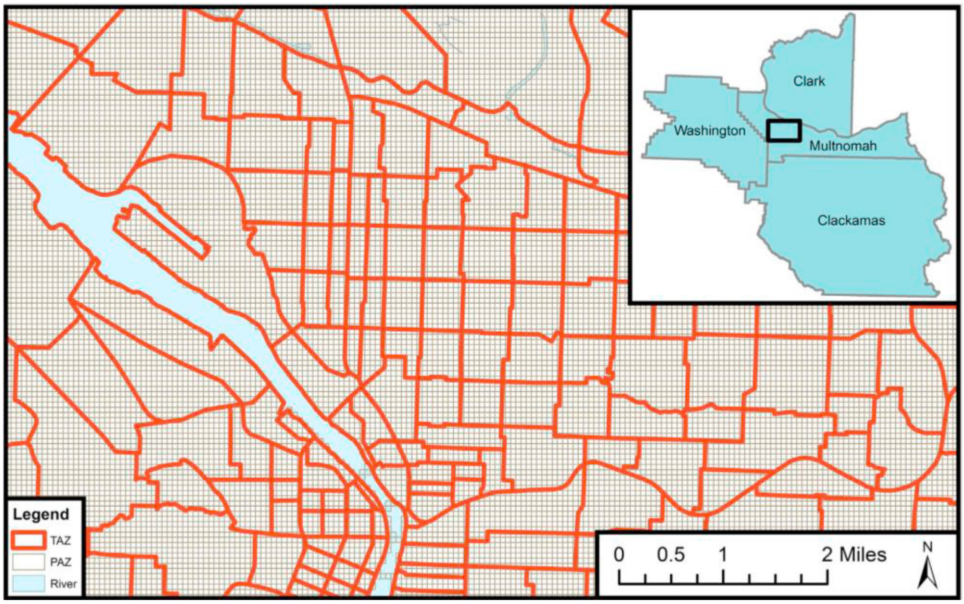

Figure 1 Comparison of two zonal structures—PAZs and TAZs—in part of the Portland, Oregon, region

It might be impossible to define an optimal spatial resolution. Although a finer spatial resolution is beneficial for model accuracy and sensitivity, there may not be a singular solution that fits various types of policy studies. As a result, the appropriate spatial resolution highly depends on the research questions that the model aims to address, the run times that the model shall not exceed, and the availability of spatial data needed to implement. Therefore, the aim of this paper is to try to balance these considerations and understand the various tradeoffs involved by testing various spatial scales for MoPeD for the Portland region.

2. Methodological approach

MoPeD employs the modeling framework shown in Figure 2. Trip generation and walk mode split use a zonal structure defined by a PAZ. The destination choice step utilizes a spatial scale that is an aggregation of PAZs into larger geographic zones called superPAZs (grids of 5×5 PAZs). Firstly, it estimates the trip destination at the superPAZ level, then it allocates the trips of each superPAZ to PAZs. This paper will retain the MoPeD modelling framework but vary the scale of the PAZ and the superPAZ and analyze the results spatially against the following set of performance criteria:

1) Run times in minutes
2) Number of intrazonal trips
3) Walk mode share (or number of walk trips) after calibration with observed data
4) Trip length distribution after calibration with observed data

The approach is composed of four main parts:

1) identify a set of test PAZs
2) prepare input data in correlation with the test scales
3) implement the test scales in MoPeD
4) evaluate these scales according to the indicators listed above.

Five different resolutions will be examined (Figure 3). The current size of PAZ (80m×80m) is considered as the reference scale and is the minimum grid cell size. The coarsest scale considered is 400m×400m. The superPAZ will be changed based on the size of PAZ proportionally. The varying test scales will decrease the number of grid cells from about 1.5 million (reference PAZ) to 60,000 superPAZs, which covers the four counties in the Portland region.

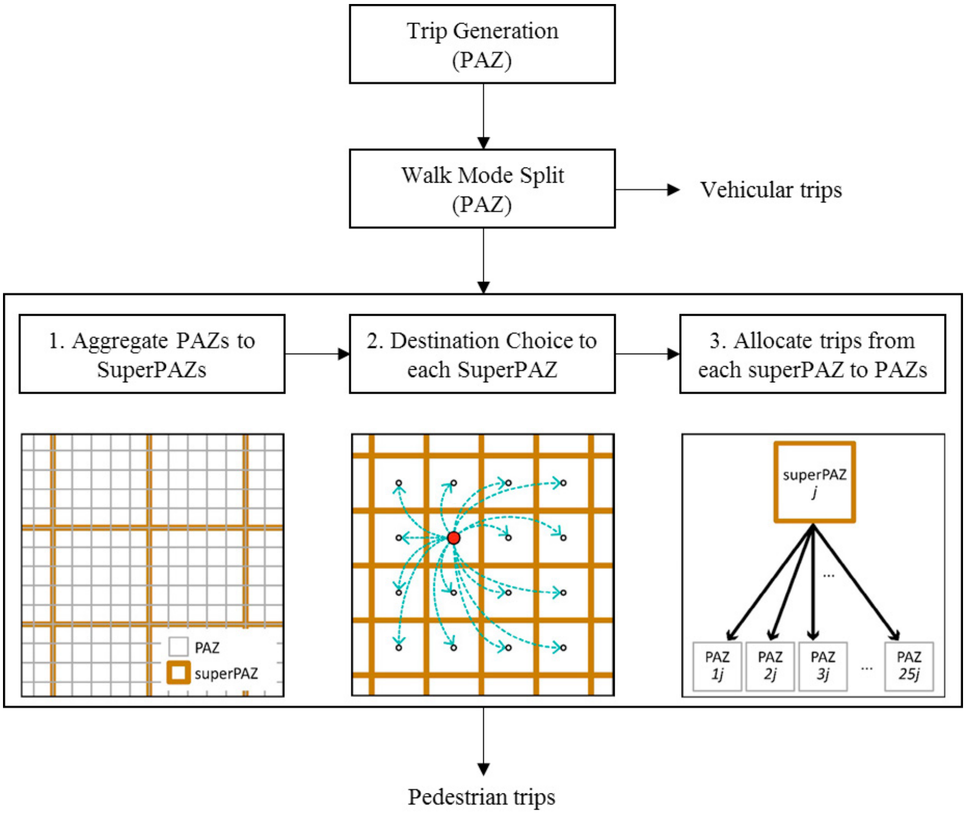

Figure 2 The framework of MoPeD (adopted from (Clifton et al., 2016b))

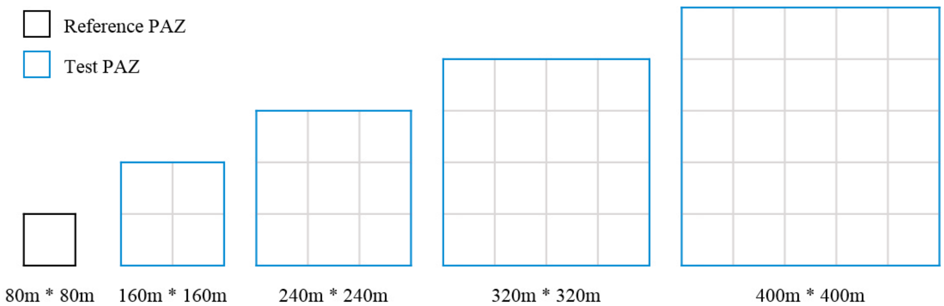

Figure 3 The size of reference PAZ and a set of test PAZ

Obviously, the number of grids cell have an impact on the model efficiency. When the test scales become coarser, the run times will decrease and will be documented in this research.

For a zonal-based travel demand model, intrazonal trips cannot be ignored and are always difficult to measure. The great number of intrazonal trips will to some extent reduce the accuracy of the model estimation. Walking is a relative short distance trips so that the intrazonal walking trips are much more sensitive to the spatial resolution. Thus, the number of intrazonal trips will be investigated for each test scenarios.

Pedestrian demand models can inform several types of applications including but not limited to: transportation investments, safety analysis, and health impact assessments. However, each of these uses have different requirements with implications for the spatial resolution. For example, regional land use scenarios may require a scale that can detect modal responses to the changes in local and regional accessibility. Safety studies may necessitate finer-grained scales that can provide pedestrian demand at specific intersections or corridors to better identify risk exposure. There is increasing interest in conducting health impact assessments for planned transportation investments with an emphasis on safety, air quality exposure and physical activity. The latter requires some estimation of total minutes spent in physical activity from active transport modes, which could be approximated from the trip distance. The error introduced by increasing the spatial resolution of the model could have an impact in its ability to inform these various studies.

3. Conclusions

Archived spatial information on travel behaviors and built environment conditions are becoming available at very fine scales and computing power is ever increasing. Yet, these are still constraints to model development and implementation in locations around the world, as some places have more limited resources devoted to such efforts. Understanding the compromises made with the choice of particular resolution remains an important consideration in pedestrian model development. Although there have been some studies examining the pedestrian behavioral response to built environment measures taken at various scales (e.g. Gehrke and Clifton, 2014), these studies operate a much courser resolution (400m buffers and larger). To date, there has been no exploration of the responsiveness and efficiency of a pedestrian demand model to finer scales (<400m×400m). This paper fills this gap and provide recommendations for the appropriate resolution, which is ever more important as the development in pedestrian models is on the rise (Singleton et al. forthcoming).

Acknowledgements

The research was conducted with the support of the Technische Universität München – Institute for Advanced Study, funded by the German Excellence Initiative and the European Union Seventh Framework Programme under grant agreement n° 291763 and the Hans Fischer Senior Fellowship.

References

Castiglione, J., Bradley, M., Gliebe, J., 2014. Activity-Based Travel Demand Models: A Primer. https://doi.org/10.17226/22357

Clifton, K.J., Singleton, P.A., Muhs, C.D., Schneider, R.J., 2016a. Representing pedestrian activity in travel demand models: Framework and application. J. Transp. Geogr. 52, 111–122. https://doi.org/10.1016/j.jtrangeo.2016.03.009

Clifton, K.J., Singleton, P.A., Muhs, C.D., Schneider, R.J., 2016b. Development of destination choice models for pedestrian travel. Transp. Res. Part A Policy Pract. 94, 255–265. https://doi.org/10.1016/j.tra.2016.09.017

Gehrke, S., Clifton, K., 2014. Operationalizing Land Use Diversity at Varying Geographic Scales and Its Connection to Mode Choice. Transp. Res. Rec. J. Transp. Res. Board 2453, 128–136. https://doi.org/10.3141/2453-16

Moeckel, R., Donnelly, R., 2015. Gradual rasterization: redefining spatial resolution in transport modelling. Environ. Plan. B Plan. Des. 42, 888–903. https://doi.org/10.1068/b130199p