

Towards a Measure of Joint Space-Time Accessibility: Conceptualization and Theoretical Framework

T. Neutens¹, T. Schwanen², F. Witlox¹ and Ph. De Maeyer¹

¹Ghent University
Geography Department
Krijgslaan 281, S8
B-9000 Ghent
Belgium

Telephone: +32 9 264 46 96
Fax: +32 9 264 49 85

Email: {Tijs.Neutens, Frank.Witlox, Philippe.Demaeyer}@ugent.be

²Utrecht University
Faculty of Geosciences
P.O. Box 80115
3508 TC Utrecht
The Netherlands

Telephone: +31-30-2534437
Fax: +31-30-2532037

Email: t.schwanen@geog.uu.nl

1. Introduction

Space-time accessibility modelling has become an important and well-established approach in accessibility research (Kwan 1998, Miller 2005). Measures of space-time accessibility are inextricably linked to the time-geographic framework of Hägerstrand (1970), and emphasize the constraints that confine individual movement in space and time. Doing so, these measures are able to capture differences in the extent to which people can access activities at a very disaggregate level.

Up to now, studies about space-time accessibility have only focused on individuals performing single activities. However, an important part of human activities is performed jointly with others, and the activity patterns of individuals often depend strongly upon the activity patterns of others with whom they interact. Rather than being taken in isolation, activity decisions are the outcome of a complex process, balancing individual activity schedules with those of others, as well as the characteristics of the urban context in which they are embedded (e.g., the attractiveness of facilities). Within the domain of activity-based travel demand analysis and transport geography, attempts have recently been made to model within-households interactions (e.g., Gliebe and Koppelman 2005, Srinivasan and Bhat 2005) and to incorporate group decision mechanisms in household allocation behaviour (Zhang et al. 2005, Zhang and Fujiwara 2006).

The current paper seeks to integrate the work on space-time accessibility with that on joint activity participation and proposes a conceptual and methodological framework for analyzing *joint space-time accessibility* or the ease with which people can meet each other in space and time.

2. The proposed approach

The measure of joint space-time accessibility proposed in this paper draws on time geography and random utility theory, and quantifies the accessibility of places to a particular group of people willing to engage in a joint activity given the time budgets available to all group members and the activity locations where they have to engage in fixed activities (anchor locations).

The approach adopted comprises three major components. First, we provide a theoretical framework for measuring the interaction possibilities. Point of departure is the framework originally proposed in Burns (1979) and subsequently developed in Miller (1999) which accounts for the attractiveness of activity locations, the activity participation time, and the cost of spatial separation. We extend this framework for situations with multiple facilities and activity participants, being available for multiple periods of time to multiple activity participants. Second, based on this theoretical framework, we describe a procedure for calculating the locational benefits by taking into account network-based travel times, individual activity schedules, relative influences of participants, and the attractiveness and temporal availability of facilities. More specifically, the concept of joint accessibility is implemented as a module of a spreadsheet using Visual Basic for Applications (VBA). Third, as an illustration of our conceptual model, we carry out a simulation analysis in a study area north of Brussels. A possible output of our model is a map of joint accessibility that indicates the utility of group's feasible activity locations. Several scenarios are elaborated to analyse the effects of spatiotemporal constraints on joint accessibility. With these scenarios we try to reveal to what extent joint accessibility is influenced by the spatial (de)centralization of anchor locations and the pressure of time in individual activity schedules. Furthermore, we show how accessibility patterns can change if different activity participants have different relative influences in the joint decision process.

The simulations indicate that the proposed model successfully detects differences in joint space-time accessibility across everyday situations. Nonetheless, the model should be considered preliminary to the extent that several future extensions can be envisaged. These include the incorporation of delay and wait times and more explicit consideration of power differentials between group members via group decisions mechanisms.

3. References

- Burns, L.D., 1979. *Transportation, temporal and spatial components of accessibility*, Lexington books, Lexington.
- Hägerstrand, T., 1970. What about people in regional science? *Papers of the Regional Science Association*, Vol. 24, pp. 7-21.
- Gliebe, J., and Koppelman, F., 2005. Modeling household activity-travel interactions as parallel constrained choices. *Transportation*, 32, 449-471.
- Kwan, M.-P., 1998. Space-Time and Integral Measures of Individual Accessibility: A Comparative Analysis Using a Point-Based Framework. *Geographical Analysis*, 30, 191-216.
- Miller, H.J., 1999. Measuring space-time accessibility benefits within transportation networks: Basic theory and computational procedures. *Geographical Analysis*, 31, 187-212.
- Miller, H.J., 2005. Place-based versus people-based accessibility. In: D. Levinson and K.J. Krizek (eds.) *Access to Destinations*, London: Elsevier, 63-89.
- Srinivasan, S., and Bhat, C.R., 2005. Modeling household interactions in daily in-home and out-of-home maintenance activity participation. *Transportation*, 32, 523-544.
- Zhang, J., Timmermans, H.J.P., and Borgers, A., 2005. A model of household task allocation and time use. *Transportation Research Part B*, 39, 81-85.
- Zhang, J., and Fujiwara, A., 2006. Representing household allocation behavior by endogenously incorporating diverse intra-household interactions: A case study in the context of elderly couples. *Transportation Research Part B*, 40, 54-74.