

DYNAMIC ACCESSIBILITY MODELLING: ACCESS AS A FUNCTION OF TIME



Olle Järvi^{1*}, Henrikki Tenkanen¹, Maria Salonen¹ & Tuuli Toivonen¹

* olle.jarvi@helsinki.fi

¹Department of Geosciences and Geography, University of Helsinki, Helsinki, Finland

INTRODUCTION

We take the "mobilities turn" at heart [1], and argue that spatial accessibility research need to move beyond static residential locations of a "sleeping" people and integrate multi-dimensional temporality to accessibility modelling [2]. In the age of Big Data, human interactions through mobile devices create continuously spatially and temporally referenced digital footprints of people, and hence, mobile devices such as mobile phones can be considered as proxies for people [3]. While mobile phone data enhance our understanding about human mobility and social processes, then it can be implemented to accessibility research.

We consider the spatial accessibility as a function of time while the locations of people (origin), the access through transport network (medium), and opening hours of services (destination) depend on time. Temporal dimension is recently acknowledged as an essential aspect to accessibility research [4], however, varying locations of people in time has not yet been taken into account.

DATA & METHODS

Four data sets are applied to assess: 1) anonymous call detail records of mobile phones for representing population distribution; 2) open-access GTFS data for public transport (PT) routes and schedules; and 3) road network dataset to model travel times in transport network; 4) opening hours of service network.

We apply a place-based approach and perform routing calculations for PT using advanced door-to-door approach [5], and use our developed codes and tools [6]. We calculate travel times and network distances at predefined 500 m grid cell resolution for each hour of an average working day. We apply a multi-dasymeric approach to interpolate mobile phone data to represent the distribution of population [6].

OBJECTIVE

- (1) to propose an advanced framework for dynamic multimodal accessibility modelling;
- (2) to understand how spatial accessibility patterns vary in time and by transport mode;
- (3) to what extent spatial accessibility patterns are influenced by the actual distribution of people in time.

We contribute to the theoretical and methodological framework of spatio-temporal accessibility research – we propose a novel framework where Big Data (mobile phone data) is applied for detecting actual locations of people, and combine it with a multimodal travel time calculations using temporal information on both transport and service network.

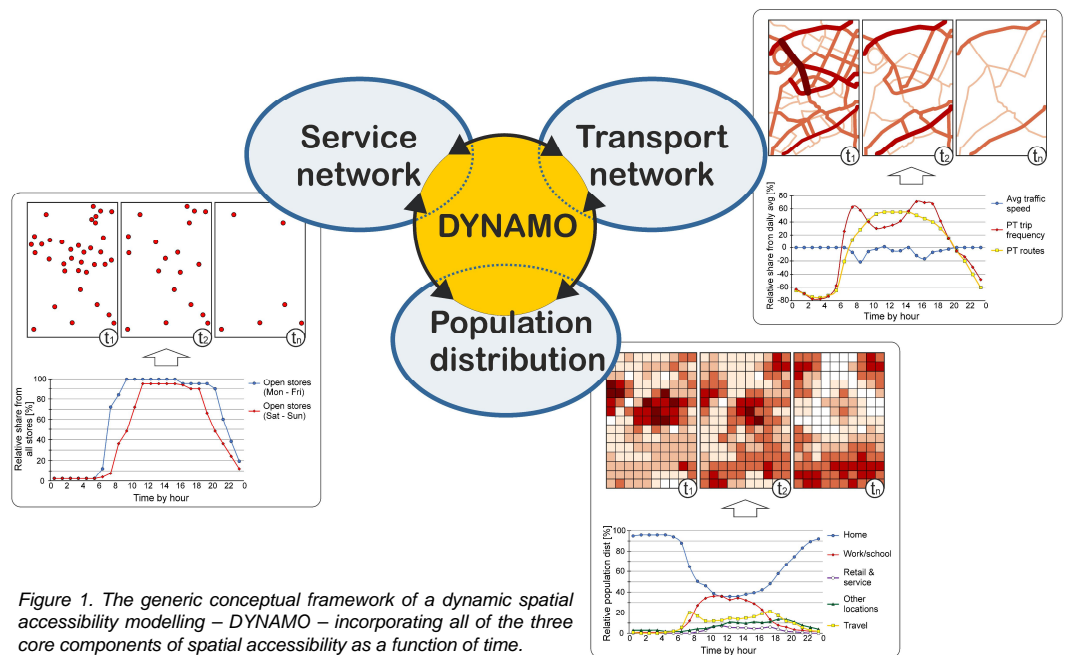


Figure 1. The generic conceptual framework of a dynamic spatial accessibility modelling – DYNAMO – incorporating all of the three core components of spatial accessibility as a function of time.

RESULTS & DISCUSSION

The main outcome of the research is the conceptual framework and open-access codes and tools for the proposed DYNAMO (Figure 1).

Results reveal spatio-temporal variations in accessibility by PT in case of each hour of day (Figure 2), and indicate significant differences on accessibility patterns compared to the modelled accessibility based on population registry data (Figure 3). Preliminary results already emphasize how time influences accessibility, and hence influence urban and transport planning.

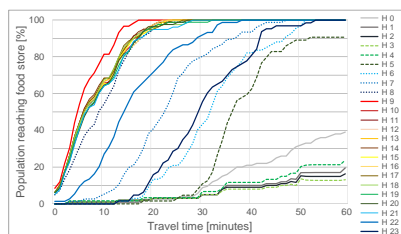


Figure 2. Temporal variability of spatial accessibility to reach the closest food store by PT regarding each hour of the day.

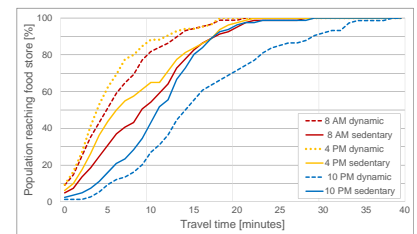


Figure 3. The comparison of the spatial accessibility to reach closest food stores between the proposed dynamic and sedentary (register based) accessibility modelling in case of three time frames: 8 AM, 4 PM, 10 PM.

LITERATURE

- [1] Sheller, M., Urry, J., 2006. The new mobilities paradigm. *Env Plan A*, 38(2): 207-227.
- [2] Kwan, M.-P., 2013. Beyond Space (As We Knew It): Toward Temporally Integrated Geographies of Segregation, Health, and Accessibility. *Ann Assoc Am Geogr*, 103(5): 1078-1086.
- [3] Järvi, O., Ahas, R., Witlox, F., 2014. Understanding monthly variability in human activity spaces: A twelve-month study using mobile phone call detail records. *Transp Res Part C*, 17(1): 3-27.
- [4] Widener, M.J., Shannon, J., 2014. When are food deserts? Integrating time into research on food accessibility. *Health Place*, 30: 1-3.
- [5] Salonen, M., Toivonen, T., 2013. Modelling travel time in urban networks: comparable measures for private car and public transport. *J Transp Geogr*, 31: 143-153.
- [6] <https://github.com/AccessibilityRG/SocialMedia>
- [7] Järvi, O., Tenkanen, H., Toivonen, T., (manuscript) Enhancing spatial granularity in mobile phone-based research: a temporally sensitive multi-dasymeric interpolation approach.