

Understanding the space-time structure of urban activity space based on the cell phone signaling data: a case study of Shanghai

Weijing Zhong¹, De Wang²

¹*Postgraduate. College of Architecture and Urban Planning, Tongji University.*

252443305@qq.com

²*Professor. College of Architecture and Urban Planning, Tongji University.*

dewang@tongji.edu.cn

Keywords: space-time structure; urban activity space; cell phone signaling data; Shanghai

Several attempts have already been made to analyze urban activity space, but the datasets employed have typically been neither dynamic nor fine grained. Against this backdrop the mobile phone signaling data is both highly mobile and yet still localizable in space, which makes it a uniquely useful tool for conducting large-scale, representative urban space-time structure research. The development of information communication technology provided an effective approach for the data collection of residents' temporal and spatial behavior and an opportunity for the transformation of research methods on the interrelationship of the urban spatial environment and individual behavior. This could bring about the opportunity to derive land-use information from mobile phone signaling data.

Since China's reform and opening, the cities have experienced a profound change in terms of society, economy, and space, along with the reform of land system, financial system and housing system. Nowadays, China's urban space is still in the phase of reconstruction, which will affect the urban spatial structure and thus the urban activity space. While with the development of globalization and informationization, especially the mobile information and communication technologies have accelerated the changes of people's daily life, which will affect the urban activity space and thus affect the urban spatial structure. The spatial distribution of urban elements is the major carrier of urban residents' activities and the important factor of affecting the temporal

and spatial behavior as well. Based on this understanding, this paper tries to taking Shanghai as a study case and collecting spatiotemporal cell phone signaling data from China Mobile (the largest telecommunications company in China) to study the urban space from the perspective of residents' real activities.

This paper (1) analyzes the overall characteristics and dynamics changes of urban activity space, and its formation mechanism from the three perspectives of time, space and activity; (2) selects several locations of different activity types and some works have sought to in selected locations. We then employ some approaches for this complex dataset to identify and extract patterns of mobile phone usage in selected locations, thus identifies the elements of urban activity space base on people's activity and analyzes the urban activity spatial structure; To verify the application of this new data source to urban land-use classification, we first construct a vector of aggregated mobile phone signaling data to characterize land-use types. (3) through the comparison of urban activity spatial structure and the current urban spatial structure (measured by urban residents' population, land use, infrastructure, etc.), analyzes urban spatial structure in the Information age from the perspective of urban hierarchy, relationship of activity and land use, space in flow, and function zoning.

The results demonstrate the strong ability that the cellular network data can give a continuous representation for the temporal and spatial behavior in aspects of sample size, coverage and time span of the mobile phone data. Through data mining and analysis, both a broadly comparable rhythm and significant different signatures in each of locations can be characterized. Different types of activity space have quite unique patterns, including a clear double/single peak and varying ratios of weekday-to weekend activity. An analysis of the land-use classification results shows that the detection rate decreases as the heterogeneity of land use increases, and increases as the density of cell phone towers increases. As a new classification different from the conventional method according to the physical space attribute, this method can reflect the actual density in the existing urban environment objectively. The paper is concluded with a discussion on the application value of cell phone signaling data on urban activity space assessment and some suggestions on adjusting and optimizing of the spatial development and residents' behavior in urban environment. The results

support the computational and comparative analysis of space through the lens of telecommunications usage, enhance our understanding of the urban activity space and provide an important new way of looking at the city as a holistic, dynamic system. The research achievements in this paper have a great scalable application in urban temporal and spatial behavior research. By combining with spatial elements data, the interrelationship of urban environment and residents' temporal and spatial behavior can be grasped to effectively manage and coordinate the relationship between traffic demand and supply and improve the capacity of planner and decision-maker to master the trend and direction of urban development in future macro-decisive urban spatial analysis.