

Relationship between Functional Urban Polycentricity and Spatiotemporal Pattern in Terms of Human Mobility in the Tokyo Metropolitan Area

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Abstract

A metropolitan area means a region consisting of a densely populated urban core and its less-populated surrounding territories, sharing the resource of residence, industry and infrastructure. Urban polycentricity is the pattern of networked socioeconomic activities and human mobility within a metropolitan territory instructed by multiple centers (central city and its satellite cities) instead of a single center (traditional CBD).

On the other hand, human mobility is a kind of micro phenomenon of urban's agglomeration and diffusion, whose characteristics can be applied for classifying an area's urban functions in one metropolis. Understanding the spatial pattern of functional urban polycentricity and its factor in the metropolitan area can help us to rethink the urban planning and to reveal the regional characteristics and differences of human mobility.

Tokyo Person-trip Survey describes the person's movement by one-minute break during one weekday (October 1st, 2008), that is to say, questions of "who he/she is", "for what purpose he/she travels a trip", and "where is start-point and where is end-point" can be known. The author intends to use it to investigate the functional urban polycentricity in the Tokyo metropolitan area (TMA).

The objectives of this research are to clarify the spatial pattern of functional urban polycentricity, to elucidate the triple-side thinking on combining the pattern of functional urban polycentricity with the regional characteristics and differences of human mobility and the policy effect of the Tokyo Master Plan (TMP), and lastly to reveal the relationship between functional urban polycentricity and spatiotemporal pattern in terms of human mobility under the consideration of dynamic urban structure in the TMA.

Based on an original mesh-based GIS microscope, this research constructs a reasonable analytical framework for the functional urban area (FUA) detection within the TMA. It becomes possible for considering each FUA's indexes (e.g. scale, boundary, inflow/outflow amount, etc.) at the mesh scale. The author also designs a new definition of functional human mobility dominance (HMD) and makes an original recognition method for identifying it, by examining five different kinds of human mobility, i.e. home-returning, school-commuting, commuting, consuming and business activities.

Using the Multi-step Decision-making Newman (MDN) Algorithm designed by the author, the FUA detection has been successfully performed. On the other hand, the triple-side thinking of combining the pattern of functional urban polycentricity with the regional characteristics and differences of human mobility and the policy effect of the TMP has practical significance. Through a series of analyzes, firstly, this research identifies 20 functional urban areas within the TMA. Secondly, the author uncovers the spatiotemporal pattern of functional urban polycentricity in each FUA by eight time-breaks (i.e. 00:00-02:59, 03:00-05:59, 06:00-08:59, 09:00-11:59, 12:00-14:59, 15:00-17:59, 18:00-20:59 and 21:00-23:59). Lastly, this research uncovers the relationship between functional urban polycentricity and spatiotemporal pattern in terms of human mobility. The static-dynamic pattern of urban structure and the daily rhythm of functional connection pattern in the TMA are investigated together.

Based on the results, it is clear that the functional urban polycentricity (urban structure) of the TMA appear a four-level-annular concentric pattern. Furthermore, the relationship between functional urban polycentricity and human mobility pattern within each FUA reflects different spatiotemporal characteristics, depended on its different urban functional allocation and different development level. The dynamic pattern of urban structure and daily rhythm of functional connection pattern in the TMA show a loop of “simple; strongly linked; mixed & complex; complex & weakly linked; linked; simple”. Furthermore, functional complementarity, regional and temporal similarity and temporal symmetry can be read from the regional difference. Besides, the TMP, as a successful exemplification, still has room for the improvement towards the sustainable urban planning in the TMA.

This research provides some accomplishments on urban studies, focusing on the topic of functional urban polycentricity. Achievement of this research can bring urban planners academic references for rethinking Japan's master plan. Through a new research thinking, this research possesses a value for transport geography and urban policy.

Keywords: *functional urban polycentricity; functional urban area detection; geo-tagged big data; human mobility dominance; Tokyo Master Plan*