Vehicular Mobility Networks in a Regional City: A Preliminary Case Study

Keywords: POI network; vehicular mobility network; mobility diversity; well-being; complex networks

Extended Abstract

Human mobility reflects not only daily routines but also the diverse needs underlying them. Recent studies have shown that greater diversity in mobility and longer travel distances are positively associated with life satisfaction [1]. From a network perspective, mobility can be understood as generating dynamic connections among places, and incorporating mobility-based point-of-interest (POI) networks has been shown to improve predictions of economic outcomes [2]. However, much of the existing literature on mobility has focused primarily on large metropolitan areas, while analyses of smaller regional or rural cities remain limited. Moreover, although many studies examine mobility patterns, relatively few have considered how transportation modes such as walking, taking the train, or driving shape these patterns.

Here, we focus on vehicular mobility in a small regional city in Japan. We constructed daily POI networks based on vehicle location history. The vehicle movement data were collected in 2024 from a small regional city in Japan. They were officially provided by Honda Motor Co., Ltd. under a formal collaborative research agreement, and the results reported here were not influenced by the company. No personal information was included in this research. POI data from OpenStreetMap were obtained via the Overpass API, and any location where the vehicle stayed for at least five minutes within 100 meters was defined as a 'visited place.' The nearest POI was then assigned to each visit, and networks were constructed for each day. Each day was categorized as either a weekday or holiday, and mobility behavior was compared in terms of visit time distribution, number of visits, and spatial distribution of visited locations.

The results showed that visits on weekdays were concentrated in the early morning and evening, reflecting commutes to and from the workplace, while holiday visits were more frequent during daytime hours. The number of visits per day was significantly higher on holidays than on weekdays (Mann–Whitney U test, $p < .01$). Spatially, weekday mobility was limited to movement between two locations—presumably home and work—whereas holiday visits were more widely distributed, with different destinations appearing on different days (Figure 1). These differences suggest a bi-modal structure: constrained and functional mobility on weekdays, and more diverse and flexible movement patterns on holidays, potentially reflecting the shifting roles and needs of individuals depending on the day.

The results revealed a clear difference: weekday mobility was dominated by commuting-related "lower-order needs" for daily living, whereas weekend mobility was characterized by "higher-order needs" such as leisure and social interaction [3]. These findings suggest that focusing on POI networks shaped by higher-order needs will be particularly important, because autonomous driving

and route optimization may limit mobility to necessary trips (lower-order need trips) and reduce its diversity. Therefore, it is crucial to carefully capture human vehicular mobility behavior and to highlight the context-dependent and flexible decision-making processes embedded within it. These insights will be valuable for the design of future autonomous mobility systems.

In the future, we plan to extend our analysis to multiple cities and to quantitatively examine the structural properties of POI networks more deeply. Furthermore, by classifying POIs into lower-order and higher-order needs [3] and taking physical distances into account, we will be able to reconsider the social and psychological meanings of daily mobility and to provide implications for designing mobility systems in the era of autonomous driving that balance efficiency and diversity.

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References

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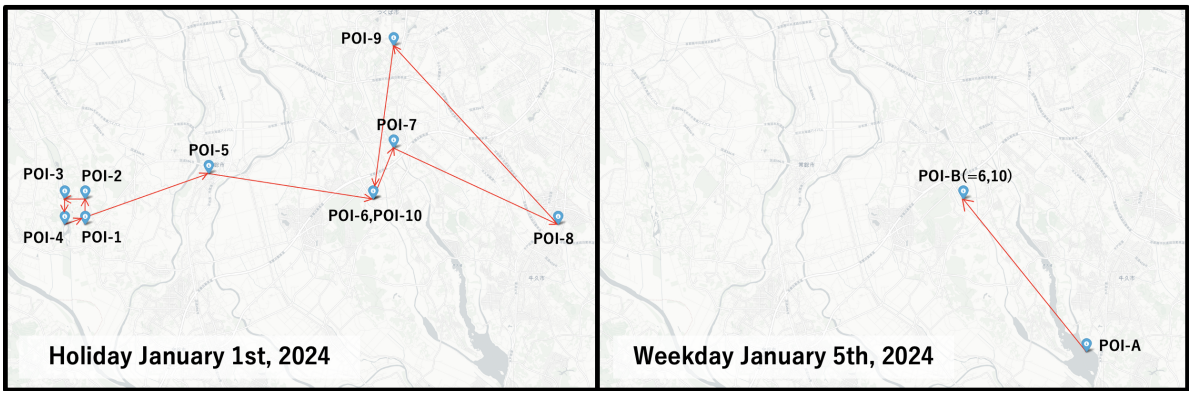

Figure 1: Spatial distribution of visited POIs on a holiday (left) and a weekday (right), showing more diverse destinations on holidays compared to weekdays.