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“Technical Research and Development for Road Policy Quality Improvement” Study Summary

No.	Title	Principal Researcher
No.2020-1	New Behavioral Model Study for Multi-scale Site Spatial Planning.	Tokyo University. Prof. Eiji Hato

This study aimed to develop data-driven transportation demand forecasting methods at four scales: 1) within buildings, 2) within a 1-km square, 3) within urban areas, and 4) at the national level, for the placement and network development of regional transportation hubs, including bus terminals.

1. Backgrounds and Objects

Backgrounds and Objects

The development of transportation hubs, including bus terminals, and advancements in transportation survey technologies have been significant. As a result, the formulation of spatial planning and hub design in the vicinity of transportation hubs is required. The way people live in their communities has undergone significant transformations, necessitating a framework for multi-scale autonomous driving/bus transportation demand forecasting and planning evaluation methods from a regional to a local scale.

In this study, we focus on transportation demand forecasting at different scales and aim to construct a national mobility model by integrating the following methodologies: 1) construction of a flow prediction and control model within facilities, 2) development of transportation behavior analysis methods within a 1-kilometer radius, 3) development of transfer network analysis methods within urban areas, and 4) development of intercity hub flow prediction models.

2. Activities in Research Period

The following four scales were studied. By creating models for each scale, the ultimate goal of the research is achieved.

National level (macro-scale): Flow between cities

Urban area level (meso-scale): Flow within urban areas

1km square/building level (micro-scale): Around bus terminals and inside bus-terminal

Transportation-land use level (transportation-land use scale): Pedestrian roaming behavior after disembarking at bus terminals and land transactions.

3. Study Results

At the national level (macro-scale), we conducted traffic demand forecasting for intercity travel using text big data collected through Twitter, one of the social media platforms. Specifically, we considered the number of passengers on high-speed buses at the bus terminal in Shinjuku (Bus terminal) as the ground truth using AI camera data. We created a machine learning model based on tweets that included place names. The tweet data used for training the model underwent data cleaning through morphological analysis to identify frequently occurring words. In addition, for model improvement, data extraction through principal component analysis was performed until the R3 fiscal year, but in the R4 fiscal year, the model's accuracy was enhanced by using a topic model.

At the urban area level (meso-scale), we conducted traffic demand forecasting for intraurban travel using an activity model that reduces computational load by employing MFD-RL

(Macroscopic Fundamental Diagram). Specifically, we grasped the flow volume at the cell level based on probe person survey data in the region assuming bus terminal development.

At the 1km square/building-level (micro-scale), we predicted both the movement of vehicles around the bus terminal and the movement of pedestrians within the bus terminal after disembarking the bus. The prediction was conducted using a model that reduces computational load through surrogate modeling. The data applied to the model included the results of probe person surveys conducted around existing transportation nodes and pedestrian flow data obtained from Bluetooth data. With this model, it was possible to simultaneously simulate the vehicle queue and pedestrian movement around the bus terminal, enabling the construction of a model to verify the operational changes in route management and the effects of facility arrangement in future bus terminal developments.

At the "transportation-land use level (transportation-land use scale)," we predicted the pedestrian roaming behavior after disembarking the bus and the effects of development such as transportation node improvements and facility enhancements as stock effects of bus terminal development. In the process of model creation, we used land transaction data (land sales information) and probe person survey data as flow data to consider the effects of development. With the creation of this model, we were able to estimate not only the changes in macro-to-micro-scale pedestrian flow due to bus terminal development but also the fluctuations in surrounding land prices.

4. Papers for Presentation

- **Ogawa,D.**, & Hato,E. (2022). Quantized representation of traffic flow theory based on discrete cosine transform. 66th Annual Meeting of the Society of Civil Engineering, Japan.
- **Kobayashi,R.**, & Hato,E.(2022). Modeling and empirical analysis of micro-level land transaction mechanism using the Gale-Shapley algorithm. 66th Annual Meeting of the Society of Civil Engineering, Japan.
- **Hara,Y.**, & Hato,E.(2021). Understanding intercity transportation demand using social media and AI camera data. 64th Annual Meeting of the Society of Civil Engineering, Japan.
- **Kobayashi,R.**, & Hato,E. (2021). Responsive dual-sided market model of land considering changes in recreational choices due to urban development. Journal of Urban Planning, Vol. 56(3), 524-531.

5. Study Development and Future Issues

Based on the results of this study, multi-sensor, machine learning, and combinatorial optimization are important for future demand forecasting of transportation hubs. It has also been found that the optimal combination of MFD and microsimulation is effective in the development discussions of hubs. The stock effect through the management of roaming areas can be evaluated at the level of land transactions. The demand forecasting method is expected to evolve into a non-four-step estimation method, and the development of analysis techniques for non-stationary conditions becomes important.

6. Contribution to Road Policy Quality Improvement

The acquisition of pedestrian flow data using multi-sensors and the correction of data using deep learning models have demonstrated results as methods for understanding the actual state of micro-scale spaces. In addition, the combination optimization of policies through multi-scale analysis has achieved successful evaluation of diverse combinations that were not possible with conventional methods. A guideline has been created to evaluate development plans by summarizing the results.

7. References, Websites, etc.

https://www.ykandalab.net/research-themes/seminar/