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

No.	Title	Principal Researcher
No.30-1	Short-term travel demand prediction and comprehensive transport demand management	Hiroshima Univ. Assoc. Prof. Makoto Chikaraishi

Keeping in mind of achieving transport market where different service providers cooperate with each other, this study develops AI-based short-term traffic prediction methods and a number of new observation and intervention tools for a comprehensive transport supply and demand management, and examines the next generation ICT architecture for the successful utilization of the methods and tools developed in practice.

1. Backgrounds and Objects

Utilizing Information and Communication Technology (ICT) and Artificial Intelligence (AI) for a better transport service would become an important national policy strategy. For the practical use of these advanced technologies for transport management, the development of systems that can comprehensively evaluate the impacts of transport measures such as dynamic pricing, car sharing, and so forth would be required. In this study, we aim to develop AI-based short-term traffic prediction methods and new observation and interventional tools, which would be essential for comprehensive transport management.

2. Activities in Research Period

To achieve the above-mentioned objectives, we set the following three research themes: (1) develop AI-based short-term traffic prediction methods, (2) develop new observation and intervention tools, and (3) examine the next generation ICT architecture for comprehensive transport supply and demand management that considers both normal and disaster conditions.

3. Study Results

(1) Development of AI-based short-term traffic prediction methods

(1-1) A comprehensive review on the utilization of machine learning methods for short-term traffic predictions with a meta-analysis on the factors that influence prediction accuracy

We conducted a comprehensive review on the use of machine learning methods for short-term traffic predictions, and conduct a meta-analysis to quantitatively confirm the impacts of model type, sample size, prediction time horizon, etc. on the prediction accuracy.

(1-2) Short-term traffic state predictions using machine learning methods

We developed a number of short-term traffic state prediction models using machine learning methods in both normal and disaster conditions, and confirmed (1) traffic states in disaster conditions can be predicted with a certain level of accuracy, (2) decision tree models show the higher prediction accuracy, but less consistent with traffic flow theory.

(1-3) Short-term OD demand predictions using machine learning methods

We developed two different types of short-term OD demand prediction models using machine learning methods. In particular, we developed a novel Entropy Tucker model that integrates the tucker decomposition model (used in the machine learning field) and the entropy model (used in the transportation field).

(1-4) Short-term prediction of traffic states in disaster situations using transfer learning

We empirically confirmed the drastic improvement of prediction accuracy by using transfer learning techniques.

(2) Development of observation and intervention tools and their application to transport demand management

(2-1) Real-time context-aware stated preference (SP) survey and its application to congestion pricing

We developed a real-time context-aware SP survey method and confirm the effectiveness of asking SP questions in real time. We also applied the developed survey method to evaluate different congestion pricing policies and confirmed that modal shift would occur only when people travel from the CBD of the city.

(2-2) Development of a personalized incentive algorithm and the implementation of intervention experiment

We developed a personalized incentive generation algorithm based on the strategy of private vehicle use minimization

and confirm its impacts on travel behavior through an intervention experiment.

(2-3) Exploring the impacts of Multi-Service Transport Platforms (MSTPs) on activity-travel behavior

We empirically confirmed the impacts of MSTPs on activity-travel behavior using the data collected in Jakarta where Gojek and Grab (online MSTP platforms) are becoming widely popular. We observed that people may not really use online food delivery services when the online merchants are located far from their place of residence.

(3) The next generation ICT architecture for a comprehensive transport supply and demand management

We theoretically explored whether the relationship between MSTPs and existing public transport systems are supplemental or competitive in nature. This highlighted the importance of focusing on both supply and demand sides for efficient transport management. We also proposed a new SP scheme for the disaster context. We then conducted a comprehensive review on the impacts of ICT on transport systems (**Fig. 1**) and examined the next generation ICT architecture for a comprehensive transport supply and demand management.

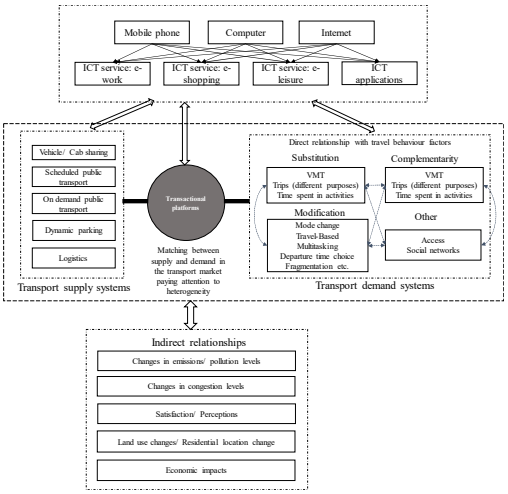

Fig 1. Comprehensive understanding of ICT-travel relationship

4. Papers for Presentation

1. Chikaraishi, M., Garg, P., Varghese, V., Yoshizoe, K., Urata, J., Shiomi, Y., Watanabe, R. (2020) On the possibility of short-term traffic prediction during disaster with machine learning approaches: An exploratory analysis, Transport Policy, 98, 91-104.
2. Varghese, V., Chikaraishi, M., Urata, J. (2020) Deep Learning in Transport Studies: A Meta-Analysis on the Prediction Accuracy, Journal of Big Data Analytics in Transportation, Vol. 2, 199-220.
3. Chikaraishi, M, Urata, J., Yshino, D., Fujiwara, A. (2019) Variation properties of trip generation, trip attraction, intra-zonal trips, and travel time under transport network disruption, Journal of JSCE B1, 75(1), 214-230.
4. Safira, M., Varghese, V., Chikaraishi, M., Gershenfeld, S., Zhao, F. (2021) Toward a Comprehensive Understanding of ICT Impacts on Activity-Travel Behavior: Preliminary Results from a Two-week Smartphone-based Survey in Jakarta, Indonesia, Accepted for 2021 EASTS conference.
5. Varghese, V., Chikaraishi, M. (2021) Personalized Incentive Design for Travel Behavior Modification: Preliminary Results from a Novel Experiment in Hiroshima, Accepted for 2021 EASTS conference.

5. Study Development and Future Issues

Based on all the findings of this study, we believe that rather than developing a tool for transport management for a specific purpose under a specific technology, it would be better to develop ICT- and AI-based applications that could be improved through a try-and-error process, i.e., that are designed under the concept of adaptive diversification strategy. To achieve it, the ICT architecture should be flexible enough. For example, it should be easily linked with other components through the application programming interface (or API). With such a flexible management tool, many trials could be conducted in a number of regions, and the information obtained from this could be utilized in other areas to foster collective learning. In the future, it would be necessary to develop schemes that will enable the efficient learning from trials made in other areas, and provide a framework on how to measure the impacts.

6. Contribution to Road Policy Quality Improvement

We believe that it is worth developing and using a transport demand-supply management application handled by a public organization. In particular, the use of such an application during disaster situations could ensure efficient transport management. In addition, the data collected through such applications could be used as the main data source to develop disaster prevention plans. Also, opening up these applications to other transport supply firms (e.g., can be connected using API) would contribute in establishing a transport market where different service providers cooperate with each other.

7. References, Websites, etc.: None