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

No.	Title	Principal Researcher
No. 26-2	Effective traffic management measures on Tokyo metropolitan urban expressway rings	Univ. of Tokyo Prof. Takashi Oguchi

Study on the assessment of traffic management measures using a large-scale network traffic simulator, which is developed in this study including logistics facility location choice model and route choice model of heavy trucks so that the integrated model system has high potential to be used for effective usage of the road network.

1. Backgrounds and Objects

In near future, Tokyo metropolitan urban expressway three rings will be almost completed. The effects of the rings on user behavior, network traffic flow including surface streets, and location choice behavior or land use will be investigated and the models to describing the effects will be established in this study. The study also try to propose effective management schemes based on monitoring of dynamic traffic phenomena. Objectives are as below; 1) truck route choice behavior analysis based on commercial truck probe, 2) road network traffic simulation analysis at Tokyo metropolitan area, and 3) large logistics facility and/or commercial facility location choice analysis affected by the completion of three rings. In addition, new schemes of effective management measures, such as advanced network control, appropriate truck guidance, and policies to guide logistics and commercial facility location choices, will be proposed to maximize the performance of three rings at Tokyo metropolitan area.

2. Activities in Research Period

Large-scaled Tokyo metropolitan road network is constructed by using Digital Road Map (DRM). Hourly small and large vehicles' OD volume is estimated for meeting with hourly section traffic volume for each type of vehicle observed at permanent observation stations based on daily OD volume for B zones provided by Census 2010. Truck route choice model is established applying recursive logit model for truck route choice behavior collected by commercial truck probe data, and its implementation to large-scale network traffic simulator SOUND is planned. Large number of hourly volume observed and link travel speed observe by probe are used tor proper calibration of parameters of the developed network traffic flow simulation. Hourly truck traffic OD matrix change is estimated based on a location choice model for logistics facility and its application for future expressway rings completion. Modified truck OD matrix and reconstructed estimated missing links are combined with established model and evaluate traffic condition after completion (BAU). At last, effects of three measures (monetary incentive introduction, dynamic route guidance, inflow control at inner ring area) to use rings is conducted, and evaluated in comparison with the result in BAU.

3. Study Results

Commercial heavy truck route choice behavior (31,421 trips and 2,509,957 route choices) is applied for calibrating proposed model based on "recursive logit" model which is applicable to the network traffic simulation model. Effective measures to establish parameter identification without problems of instability are introduced, and parameters are obtained with acceptable reliability.

Location choice model of logistics facility affected by levels of service is established based on recent "Tokyo metropolis logistics survey", and changing potential of land use is estimated, so that the change of heavy truck OD matrix is quantitatively estimated.

Network traffic simulation model for 2010 is established; composed with road network approx. 186

thousands nodes and approx. 410 thousand links, hourly OD volume for each vehicle type are used as input to the traffic simulator, and validated with hourly volume at permanent observation stations and link travel speed provided by probe data (Base case).

Traffic condition with three rings completion is estimated (BAU case) adding missing link of rings and modified truck OD demand. Traffic congestion is alleviated compared with Base case because of the network effect, however still congestion remains, especially on Bay line of Metro. Expressway.

Table Summary of case studies

cases	comparison	total congestion loss	feature of congestion reduction	feature of congestion increase
BAU	to Base case	approx. 12% reduction	reduction on Metro. Expressway and surface streets inside Ken-o-do	increase on Gai-kan-do & Ken-o-do and the effect of commercial facilities
Monetary incentive introduction	to BAU	approx. 3% reduction	reduction on Metro. Expressway and surface streets inside Gai-kan-do	increase on Gai-kan-do & Ken-o-do caused by excess detour resulting in volume increase
Dynamic route guidance	to BAU	approx. 24% reduction @ 30% penetration rate	reduction on all-over the network at 30% penetration rate	minimized Motorway congestion at 100% penetration rate, but increase of congestion because of surface street volume increase
Inflow control at inner ring area	to BAU	approx. 1% increase	slight reduction around inner ring area	increase inside Gai-kan-do, inefficient scheme

The three measures promoting to use rings more is evaluated by simulation study. The reduction rate of traffic congestion loss comparing to BAU case is approx. 3% with the measure of monetary incentive introduction to induce demand to rings, and is approx. 24% with the measure of dynamic route guidance under the penetration rate of the guiding system of 30%. On the other hand, slight increase of congestion loss is obtained with the measure to control the inflow at inner ring area. The effectiveness of dynamic measure to reduce traffic congestion is proved as a conclusion.

4. Papers for Presentation

T. Oguchi, M. Chikaraishi, et. al. (2017) Traffic management measures on Tokyo metropolitan urban expressway rings. Proc. of Inf. Plan. (JSCE), No.55, in Japanese.

J. Tanabe, M. Chikaraishi and T. Oguchi: A Consideration on Freight Traffic Flow on the Tokyo Metropolitan Urban Expressway Networks Using Probe Data. Proc. of Inf. Plan. (JSCE), No.55, in Japanese.

T. Oguchi, M. Chikaraishi, M. Iijima, H. Oka, R. Horiguchi, J. Tanabe and Y. Mohri (2016): Advanced simulation model in the region of Tokyo metropolitan urban expressway rings. Proc. of 23rd World Congress on ITS 2016, Melbourne, Australia.

M. Chikaraishi, S. Nakayama (2015) How well drivers can estimate travel time? Estimating travel-time-dependent variance based on a q-generalized logit model. Paper presented at the 13th International Conference on Travel Behaviour Research, London, UK.

5. Study Development and Future Issues and Contribution to Road Policy Quality Improvement

In the study, less study is conducted for the dynamic management schemes such as dynamic ramp metering and dynamic road pricing. As future studies, such dynamic measures would be studied with improvement of the network traffic simulator, in addition, some impact studies would be done, such as Olympic games 2020 held in Tokyo, and large-scale road replacement.

Quality of road policy will be improved as achieving effective road network management to decrease traffic congestion much, when expressway companies are integrated, and cooperatively conduct traffic control dynamically and comprehensively; using the same dynamic simulation system as developed in this study.

Empirical study and model development for small car route choice behavior are remaining challenges after conducting huge scale real data of route choice behavior of commercial trucks.

6. References, Websites, etc.

A demo movie of large-scale road network traffic simulator is available at below;

https://www.youtube.com/watch?v=TjsuwXcLsfk&vl=ja