Relationship between Characteristics of Freight and Freight Truck Expressway Use Ratio

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1. Introduction

The Traffic Engineering Division is conducting research to develop a "route selection model" to be used to predict how freight flow on road networks will be changed by freight truck traffic measures introduced to strengthen international competitiveness and improve living environments in residential districts. This report introduces an outline of an analysis of the relationship between "characteristics of freight" and "expressway use ratio", which is the most fundamental freight truck route selection behavior in order to obtain basic information for the model.

2. Outline of the analysis

We set hypotheses, "the ratio of expressway use, which ensures rapid delivery, is high in the case of the transport of perishables such as raw fish, for which express transport is preferred," and "delivery time-specified freight is highly likely to be transported via expressways, which are known to be more travel time reliable, as any delay in the delivery of such freight is not allowed," and verified the hypotheses using data from the Commodity Flow Census (2005). A Z-test performed as shown in Figure 1 confirmed that the ratio of expressway use is higher in the case of refrigerated and frozen freight and delivery time specified freight than it is for other kinds of freight at a significance level of 0.1%.

$$Z = \frac{P_a - P_b}{\sqrt{P_{average} \times (1 - P_{average}) \times \left(\frac{1}{N_a} + \frac{1}{N_b}\right)}}$$

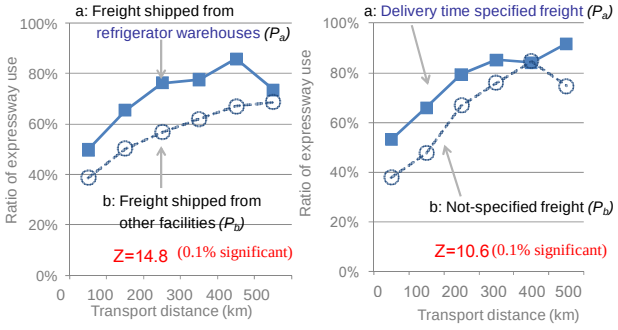

Figure 1. Significant Difference Test

Regressing the Logit converted expressway use ratio f to four parameters (transport distance (x1), refrigerated, frozen freight dummy (x2), and delivery time specification dummy(x3) and lot (x4)) obtained an equation which estimates the expressway use ratio according to characteristics of freight (Table 1). Coding conditions conform, and a significance level of 0.1% was satisfied. This suggests that all of the above four parameters are factors which explain freight truck route selection behavior.

Table 1. Parameter Estimation Result

$$Logit(f) = log\left(\frac{f}{1-f}\right) = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4$$

Estimated coefficients

Coefficients	Estimate	Std. Error	Z value	Signif.
(Intercept)	-0.5182	0.0522	-9.92	***
X1: **Transport distance**	0.0050	0.0002	31.47	***
X2: Freight refrigeration status	0.7231	0.0536	13.50	***
X3: Delivery time specification	0.2072	0.0513	4.04	***
X4: Freight lot	-0.1531	0.0200	-7.66	***

0.1% confidence level

Change in expressway use ratio accompanying improvement of commercial practices was simulated using the above equation. As shown in Table 2, it is confirmed that the rise of the just-in-time transport ratio increases the expressway use ratio by 2.6 points.

Table 2. Description and Results of the Simulation

	Change of commercial practice	Description of Simulation	f	Change
Case 1	Increasing transport distance	50% increase in transport distance	74.3%	+7.4
Case 2	Increasing just-in-time transport	Delivery time specification ratio of 100%	69.6%	+2.6
Case 3	Reducing lot size	Average lot size decrease of 50%	67.7%	+0.8

3. Conclusion

This report has shown that it is possible to estimate "change of expressway use ratio caused by future improvement of commercial practices" by applying the resulting relational equation.

It is anticipated that the "relationship between road structure specifications and route selection characteristics" will be studied to further improve the route selection model, and that this knowledge and model will be applied to evaluate freight truck traffic measures.