

The Effect of Snow Accumulation on the Time Value of Traffic

降積雪が交通時間価値に及ぼす影響

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1. Background

What is the value of time?

You can consider the time you spend, for example one minute of your time; how much it is worth? How much it costs you? How much are you willing to pay for your time? We can say for example that your time is valued as 30 yen per minute, but that value can go up or down depending on the conditions. Talking in leisure time the value of time does not matter, but if we talk about time that we lose in a store queue, the most ideal is to pass a less time as possible because it is time you are losing and it is costing you. That resembles when you use transportation, the most ideal would be to be as fast as possible, but there are also trips for fun and there you do not care about the time or the value of the time you are spending¹⁾.

The value of time is considered by people who want to choose the best available alternative to travel. In modern times, an application such as Google Maps makes this easy to understand for anyone. Google Maps gives its users a choice of routes and time of expected travel as relevant information provided for the user to choose the final route. People want to get to their destination in the least time possible because time has value and that value influences travel choices. This has been modeled for years by transport experts. It is interesting to note that even such variables as waiting times and walking time are considered when simulating user decisions, for example when deciding on the use of public transportation system versus using a car, or when choosing between the train or a plane.

When considering the best transportation route, you want the transport time to be short, but the price is high,

and vice versa if the price is low, the transportation time is long. But first we must consider the characteristics of each person as to what value they give time or maybe they ignore it completely.

2. Research purpose

The purpose of this research is to show the contents of "Research on the time value of road traffic, technical research and development results report that contributes to improvement of quality of road policy".

In many snowy areas including Niigata prefecture, it is generally known that traffic congestion worsens when snow falls. Based on the report in the above report, it is possible that the time value of traffic may have changed in the winter period when traffic congestion deteriorates. In this research, we aim to clarify the influence of snow accumulation on time value of traffic.

Ultimately, we aim to reflect it in the calculation of benefits taking account of the influence of the winter period in road project evaluation.

In this study we will focus on routes with snow accumulation between a Nagaoka city and a Niigata city or the intermediary cities either Mitsuke city, Sanjo city.

In this research, in order to obtain the time value in traffic, the revealed preference data based on the of actual behavior data of the road traffic information obtained from the ETC 2.0.

Between the two cities, it is assumed that there are two routes of general road and expressway, and it is assumed that either route is selected. For this route selection behavior, we build a binomial logit model. We add personal attributes to this binomial logit model and

clarify the selected behavior when the travel time, travel distance which it is used to calculate the travel cost. Estimate the time value of traffic by using the time required for traveling and the traveling cost parameters used to create this model and estimate the time value by the season with snow and the season without snow. In addition, the transportation cost is calculated using the estimated time value, and it is determined which route is an efficient route that can reduce the transportation cost and time, by using either the general road or the highway.

In this research, we will target all types of car except fare car between Nagaoka City and the Niigata city by using the Hokuriku Expressway or the National Road No.8, No.116, No 402

3. Methodology

The methodology developed for this thesis was to first identify the days that snowed in the area.

After grasping the operation ID of the analysis target, confirm each driving behavior for the operation ID of the analysis subject and check which route (general road, expressway) is traveling.

The following is creates analysis data of the specified vehicle, travel distance, required time and travel cost in the trip.

The distance travelled is the sum from the starting point coordinates to the ending point coordinates, calculating the distance between two points.

The required time was taken as the difference between the end point time of the trip and the starting time point of the trip.

For travel cost, calculate the car fuel consumption dividing by distance travelled in highway or general road, and multiplying by fuel price. And in the case of highway plus that toll fees.

For the creation of hypothetical choice, the coordinates of the real choice were used and, using Google maps, we were able to calculate its hypothetical time and

distance.

Within the data of ETC2.0 there may be some IDs with stops at gas stations for using the toilet, purchase of food or simply to charge gasoline; that time and distance spent on those things can affect our calculation. That's why it was also decided to create data using the choice of highway and general road of ETC 2.0 and the one of Google Maps distance and time and thus have a comparison of the two methods.

After created the analysis data of the specified vehicle using the non-aggregated logit model, which those each individual assumes a rational behavior of "choosing the option that gives the utmost utility from among the available options" and sets the individual selection probability by the transportation service variable and personal attribute of each transportation agency predict. The general formula of the non-aggregated logit model is as shown in the following equations (1) and (2).

$$P_{jn} = \frac{\exp(V_{jn})}{\sum_{j \in J_n} \exp(V_{jn})} \quad (1)$$

$$V_{jn} = \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_3 + \dots \quad (2)$$

The time value is calculated from the ratio of the time required for the utility function of the logit model and the parameter of the travel cost. Therefore, parameter estimation of non-aggregate logit model can be calculated by using R software.

4. Results

Table 1 Resume of results

ETC 2.0	With Snow			Without Snow		
	Time Value	7.170			201.57	
Google Maps	Weekdays	Weekend	All	Weekdays	Weekend	All
Time Value	160.899	29.712	27.463	27.775	59.001	48.782

Unit: Yen/minute

$$\text{Highway utility} = \theta_1 x_1 + \theta_2 x_2 + \theta_3 x_3$$

$$\text{General Road utility} = \theta_1 x_1 + \theta_2 x_2$$

Table 2 Results with snow

Variable	Parameter	Standard Error	t-value
Time(h)	2.085	0.702	2.971
Cost(Thousand Yen)	0.216	0.318	0.680
Period of Time Dummy	-0.944	0.792	-1.192
Number of samples	152		
Likelihood ratio	0.287		
Hit-Ratio1 (%)	78.289		
Time Value (Yen/Minute)	160.899		

5. Conclusions

The estimated time in the transport was calculated using the information ETC 2.0, the logical method, using as support tools Google Maps and Mobmap. In this estimation several problems arose, such as that in the ETC 2.0 data in some cases the IDs contained time where the drivers stopped at the service stations. And doing that calculation with those times the results were a bit strange or out of the ordinary. Therefore, we opted to use Google Maps times and distance.

Because it started calculating with the times and distances of the data ETC 2.0 a lot of time was lost creating the samples and corroborating that they were giving a little weird results at the moment of the estimation, could not create as many samples as would have been desired. The few samples may be influencing the result.

In the estimation was also calculated with several dummy to compensate for the lack of samples but not good data and therefore cannot be concluded as to whether snow accumulation has any effect on the estimation of time.

6. Future Task

Due to the number of samples used is small, it is considered to have great effect or rather is causing an error. For future research it is necessary to analyze more samples to create a more correct result.

In addition because it seems that there is a limit to RP-based analysis by only ETC 2.0, we should also analyze SP-based (Questionnaire) using the questionnaire survey.

References

- 1) 加藤浩徳, 上田孝行, 加藤一誠, 谷下雅義, 毛利雄一: 道路交通の時間価値に関する研究, 道路政策の質の向上に資する技術研究開発成果報告レポート No.21-1, 2012
- 2) 杉野朝子: ETC カードまるわかりガイド <http://www.etc-navi.net/archives/0002etc/>
- 3) 一般財団法人 ITS サービス高度化機構 ITS-TEA: ETC2.0 の概要, ETC 総合情報ポータルサイト GO! ETC <https://www.go-etc.jp/etc2/etc2/>
- 4) 内田佳希: 都心部における道路プローブの適用に関する課題と解決法に関する一考察, 平成 27 年度近畿地方整備局研究発表会, 新技術・新工法部門 No.11, 2015
- 5) Mobmap Shibasaki Laboratory, the University of Tokyo, <http://shiba.iis.utokyo.ac.jp/member/ueyama/mm/tour.html> 2018.