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A STUDY FOR MODEL OF ONE DAY TOUR TO SOME RECREATIONAL FACILITIES BASED ON THE OCCACIONAL DIFFERENCE

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Abstract: One day tour to some facilities is divided into two cases. One is a tour which people plan beforehand. Another is a tour which people don't plan before and decide a next trip in the facility they stay now on (no plan trip). These trips are often on recreation travel and shopping travel. This research proposes a model for One day tour to some facilities with no pre-plan like the latter and applied it for recreation travel. Human behavior has a kind of dispersion. One of them is caused by occasional difference which shows that even same person has different behavior under same condition. The difference is introduced into the model. This study used this model into the results of an investigation which has been carried out about four recreational facilities in Miyazaki city on 1996 August." As a result, reproducibility of the investigations showed relatively a good agreement.

Key Words: One day tour, Dime decision, Disutility, Recreation trip

1. INTRODUCTION

In recent years, many tourist/attractive/shopping facilities concentrate into an area in tourist resort or downtown. In the area like this, people often do a sequence of trips to these facilities in a day. (We call the trips "tour" in this paper.) Understanding characteristics for tourist behaviors and the spaces is one of the important parts in order to promote the area and create attractiveness of the area. In this research, we propose a model which forecasts human behavior on "tour" in a day. This model is based on occasional difference for human behavior and treats the behavior which is not restricted temporally.

As to "tour" or excursion trip, there are some scholars who have done some related researches. Some of them are concerned with Disaggregate behavioral model. For example, Mizogami et al. (1991) assumed a nested choice structure of trip behavior. Also, Ono et al.

(1998) and Nishi et al. (1993) proposed Markov Chain model. MORICHI et al. (1992) proposed a serial choice model that destination choice is assumed to be independent of the distribution of staying time. These studies can treat various factors. This research is the one from a view of 24-hour life cycle. This model is of use when people plan facility arrangement or traffic management, especially using time of facility, fee and so on.

This “tour” behavior includes a choice of “make a trip” or “not”. There are two kinds of “tour”. One is “planed tour”. Another is “no planed tour” The latter is uncertain activity as compared with the former and is more sensitive to service of traffic policy and facility than the latter. Therefore, we attempt to make a model for the latter “no planed tour”. This type of tour has uncertain choice behavior. On each decision, they have dispersion of the behavior. So, we introduce occasional difference into the model as an uncertain factor and treat it probabilistically. In this paper, we applied a case of recreation “tour” because it is a simple one and it has clear trip purpose.

2. MODEL

2.1 Time Decision Model on leaving a place

It can be assumed that motivation for person’s behavior is to gain much more benefit and to minimize losses like cost, time and some efforts which are spent for moving to a destination and a stay when people achieve their transportation purpose under condition of no temporal restrict.

In this section, we explain a model that people decides a time for leaving a place on condition that he has arrival time. This model treats the loss of his satisfaction as disutility, where the loss of satisfaction means that he doesn’t stay enough at the place. Also, a satisfaction, which people get when he stays enough there, is a standard in this model.

2.1.1 Assumption for Disutilities

Taking the law of Diminishing marginal utility into consideration, we assumed some disutility functions as following

(a) Disutility for shortness of staying time at the place: $D_1(t_s) = m\exp(-\alpha t_s)$ (1.1)

(b) Disutility for lateness of arrival time at home : $D_2(t_h) = B(t_h - t_b)$ (1.2)

(c) Disutility for long staying time at the place (fatigue or tiresomeness):

$$D_3(t_s) = \delta t_s \tag{1.3}$$

(d) Friction factor of transportation (based on travel time between origin and destination): $D_4(t_t) = \gamma t_t$ (1.4)

(e)Fee for facilities: $D_f = c \times f$ (1.5)

Where

t_s: staying time, t_h: arrival time at home, t_b: threshold time where person can’t perceive disutility D_2, f : entrance fee, t_t: travel time to next a place, $B,m,\alpha,\delta,c,\gamma$: positive parameter.

2.1.2 A model of time decision on leaving a place

This model has a structure which measures other disutility from *m* which is a standard utility. We assume that each disutility can be added and people decide their leaving time to minimize their total disutility.

(1) A model for one trip to a facility

When it is one trip to a facility, people decide the time to minimize the sum of disutility of using a facility. The total disutility is given by

$$D(t_o \mid t_{in}) = D_1 + D_2 + D_3 + D_f = m\exp(-\alpha t_s) + B(t_h - t_b) + \delta t_s + c \times f \tag{1.6}$$

If $D(t_o|t_{in})$ is minimum, representing the time when people want to leave $t_o=t_{om}$, then total disutility $D(t_{om}|t_{in})=D_{min}$, the utility which one gain, $U(t_{om}|t_{in})$ is given by

$$U\left(t_{om} \middle| t_{in}\right) = m - D_{\min} \tag{1.7}$$

(2) A model for excursion trip

When people make trips to some places, it needs to consider the disutility D_4 that indicates a friction factor for transportation on moving from a place to next place. $t^1{}_o$ stands for the leaving time for the first place and $t^2{}_o$ stands for the one for the second place. Also $D^1(t^1{}_o|t_{in})$ and $D^2(t^2{}_o|t_{in})$ stand for the disutilities for the first place and the second place respectively. The total disutility $D^{12}(t^1{}_o,t^2{}_o|t_{in})$ on deciding their leaving time appears as follows:

$$D^{12}(t_o^1, t_o^2 | t_{in}) = D^1(t_o^1 | t_{in}) + D^2(t_o^2 | t_{in}) \tag{1.8}$$

Therefore, the utility $U_{12}(t^1{}_o,t^2{}_o|t_{in})$ of trips to two places can be written as

$$U_{12}\left(t_o^1, t_o^2 \middle| t_{in}\right) = (m_1 + m_2) - D^{12}(t_o^1, t_o^2 | t_{in}) \tag{1.9}$$

Each optimum leaving time $t^1{}_o=t^1{}_{om}$, $t^2{}_o=t^2{}_{om}$ at these places are determined when the utility $U_{12}(t^1{}_o,t^2{}_o|t_{in})$ is max.

$$U_{12}\left(t_{om}^1, t_{om}^2 \middle| t_{in}\right) = \max[\,U_{12}(t_o^1, t_o^2 | t_{in})] \tag{1.10}$$

(3) Introduction of period around midday binding free activity

24 hours cycle a day can be classified into necessary time like eating and sleeping, time binding by other business and free time. Most recreation activity is on free time but some could be also on necessary time and bound time. If a traveler is in necessary or bound time, his activities are restricted by these times. In this study, we assume that travelers' activities are restricted on the period around noon and introduce this idea into our model. This period is composed of start time t_k and duration t_c. We also assume that the start time and the duration have probability distributions and $\varphi_{tc}(t_c)$, $\varphi_{tk}(t_k)$ represent these probability density functions as shown in figure 1. On any time t_{noon}, the probability of traveler's stopping his activity is given by equation (1.11).

$$P_{t_{noon}}(t_{noon}) = \int_{-\infty}^{\infty} \phi_{t_k}(t_k) \int_{t_{noon}-t_k}^{\infty} \phi_{t_c}(\tau)\, d\tau\, dt_k \tag{1.11}$$

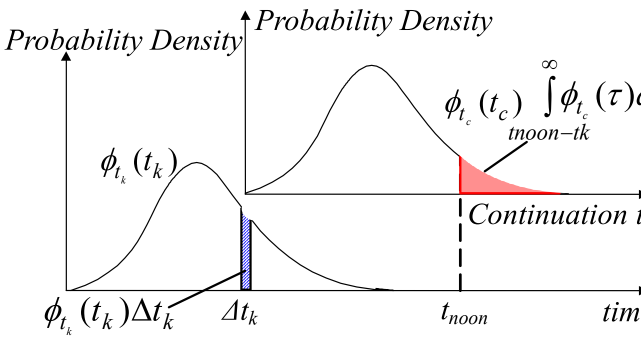

Figure 1 diagram of image for distribution of period binding free activity

(4) Introduction of individual difference

The person's wishful leaving time t_{om} can be different from others. In this research, the individual difference is made by the three distributions of $\alpha(D_1)$, $t_b(D_2)$ which are in the disutility functions and the times binding free activity on noon. The probability density functions are represented by $\varphi_\alpha(\alpha)$, $\varphi_{tb}(t_b)$, $\varphi_{tnoon}(t_{noon})$ respectively.

A distribution of the times when people enter a place also is represented by$\varphi_{tin}(t_{in})$. We assume that these PDF are independent of each other's. Using change of variable technique, t_{in} is transformed into t_{om} on condition thatα, t_b, and t_{noon} are initial values. The PDF of whole travelers' wishful leaving time t_{om} is shown by equation (1.12).

$$\begin{aligned}\varphi_{tom}(t_{om}) &= \iiint \varphi_{tom}(t_{om}|\alpha, t_b, t_{noon})\varphi_\alpha(\alpha)\varphi_{tb}(t_b)\varphi_{tnoon}(t_{noon})d\alpha dt_b dt_{noon} \\ &= \iiint \varphi_{tin}(t_{in})\left|\frac{dt_{in}}{dt_{om}}\right|_{\alpha,tb,tnoon} \varphi_\alpha(\alpha)\varphi_{tb}(t_b)\varphi_{tnoon}(t_{noon})d\alpha dt_b dt_{noon}\end{aligned} \tag{1.12}$$

2.2 A Model for choosing "tour"

2.2.1 Basic concept

Making new trip or not is not always sure to subject to rational choice behavior strictly. So, we propose a model for the choice behaviors for "tour" based on an occasional difference. This model has a structure of comparison of the utility for "no more tour" with the utility for "tour", and introduces dispersion of human behavior as an error term.

2.2.2 A law of comparative judgment(Thurstone,L.L(1927))

In this section, we suppose a case of a choice between "trip to a facility" and "trips to two facilities". Let U in equation(1.7)and U_{12} in equation (1.10)express the occasional difference which is independent of α. We introduce error terms ε_1, ε_2 which depend on average 0, standard deviation σ_1 and σ_2. The utility function $U_{non\text{-}Exc}$ in case of "trip to a facility" and the utility function U_{Exc} in case of "trips to two facilities" are expressed as following equations.

$$U_{non-Exc} = U(\alpha, t_{in}) + \varepsilon_1 \tag{2.1}$$

$$U_{Exc} = U_{12}(\alpha, t_{in}) + \varepsilon_2 \tag{2.2}$$

In consideration of the theory of utility maximization and the probabilistic dispersions of $U_{non\text{-}Exc}$, U_{Exc}, the probability P_{Exc} is expressed as

$$P_{Exc} = \Pr[U_{Exc} > U_{non-Exc}] \tag{2.3}$$

Where Pr[*] means a probability when a phenomenon "*" happen.

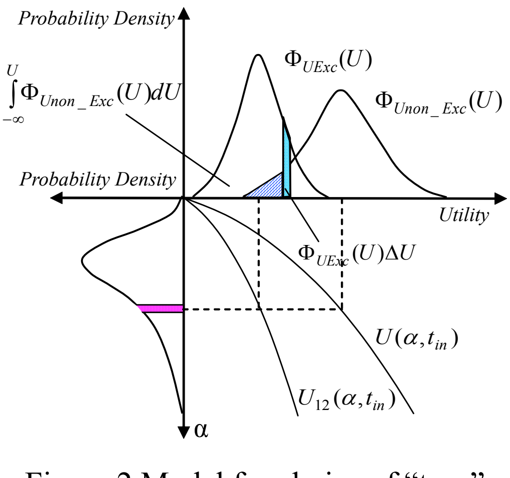

Figure 2 Model for choice of "tour"

Figure 2 shows a relationship between two distributions of $\Phi_{UExc}(U|\alpha,t_{in})$ and $\Phi_{Unon\_Exc}(U|\alpha,t_{in})$ which are PDF of the utility functions $U_{non\text{-}Exc}$ and U_{Exc}. It also shows an individual difference α. The probability $\Delta q_1(U|\alpha,t_{in})$ when $U_{Exc}=U$ is

$$\Delta q_1(U) = \Phi_{U_{Exc}}(U)\Delta U \tag{2.4}$$

When $U_{non\text{-}Exc}<U$, people chose “trips to two facilities”. Therefore, the probability $P_{Exc}(\alpha,t_{in})$ of it about a whole group is following.

$$P_{Exc}(\alpha,t_{in}) = \int_{-\infty}^{\infty} \Delta P_{Exc}(U \mid \alpha,t_{in})dU = \int_{-\infty}^{\infty} \Phi_{U_{Exc}}(U \mid \alpha,t_{in}) \int_{-\infty}^{U} \Phi_{U_{non-Exc}}(s \mid \alpha,t_{in})dsdU \tag{2.5}$$

When there are many places and facility where people can travel, the probability $P^k_{Exc}(\alpha,t_{in})$ that certain group select the k-th place is given by following equation as same as equation (2.5).

$$P^k_{Exc}(\alpha,t_{in}) = \int_{-\infty}^{\infty} \Phi^k_{U_{Exc}}(U|\alpha,t_{in})[\int_{-\infty}^{U} \Phi_{U_{non-Exc}}(n|\alpha,t_{in})dn \prod_{m\neq k} \int_{-\infty}^{U} \Phi^m_{U_{Exc}}(s|\alpha,t_{in})ds]dU \tag{2.6}$$

Where

$\Phi^m_{U_{Exc}}(U|\alpha,t_{in})$: the PDF of trip to m-th place

$\prod_{m\neq k}$: when $m=k$, do not multiplication

Therefore, integrating equation (2.6) in a whole range of α, the total probability is given as equation (2.7).

$$P^k_{Exc}(t_{in}) = \int_{-\infty}^{\infty} P^k_{Exc}(\alpha,t_{in})d\alpha = \int_{-\infty}^{\infty} \phi(\alpha)\left[\int_{-\infty}^{\infty} \Phi^k_{U_{Exc}}(U|\alpha,t_{in})[\int_{-\infty}^{U} \Phi_{U_{non-Exc}}(n|\alpha,t_{in})dn \prod_{m\neq k} \int_{-\infty}^{U} \Phi^m_{U_{Exc}}(s|\alpha,t_{in})ds]dU\right]d\alpha \tag{2.7}$$

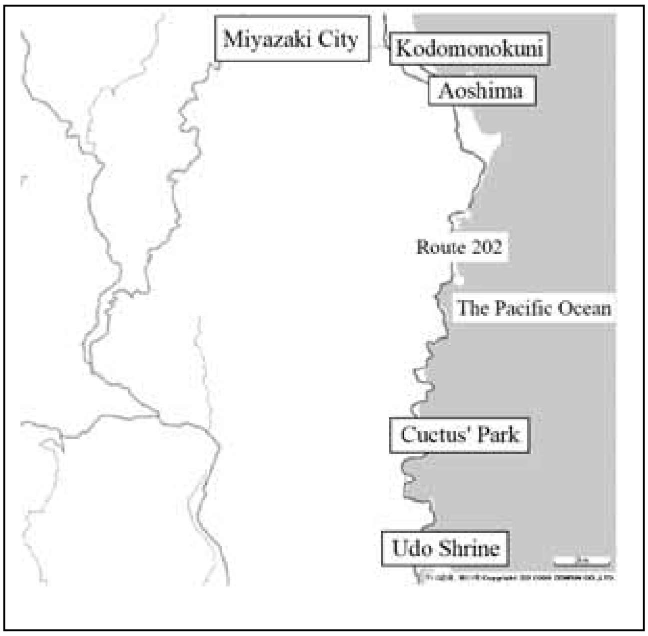

Figure 3 Application area

2.3 Application to a tourist resort

2.3.1 Using data and application area

We used a research data to apply the model. The data is from a questionnaire which held to car tourists who went around to four tourist facilities in August of 1996 in Miyazaki prefecture. Figure 3 shows the application area and each travel time between tourist facilities. A way to survey is to record car numbers on a plate and each set of entering time and leaving time in each facility. Using the data to the model is the one where people visited Udo shrine first. "Kodomonokuni" and "Cactus' park" have admission fees. The one of "Kodomonokuni" is 600(yen) and the one of "Cactus' park" is 500(yen).

2.3.2 Estimation of parameters

(1) The method

We estimated these parameters in the model from the data in case of Miyazaki. Before estimating, we assume that whole tourists in the data stay in night in Miyazaki city. And also assume that PDF of period around midday binding free activity is Weibul distribution, PDF of α is Log-normal distribution, PDF of t_b and error distribution which expresses occasional difference are Normal distribution.

First, we give initial values into parameters in the model. Then theoretical distributions of leaving time on each tourist facility are calculated from a process of the model.
Comparing the calculated distributions with the observed ones and modifying there parameters to minimize R value of chi square χ^2 as shown by equation (4.1), we estimated the optimum distributions of leaving time.

$$R \to Min$$
$$R = [\sum_k \sum_j \frac{(M_{mj}^k - M_{cj}^k)^2}{M_{cj}^k}] + [\sum_k \sum_j \frac{(M_{mj}^k - M_{cj}^k)^2}{M_{mj}^k}] \tag{4.1}$$

Where $M^k{}_{mj}$ is an observed number of people leaving on time category j on facility k, $M^k{}_{cj}$ is a theoretical number of that.

(2) The estimation results

As to the standard deviations of the parameters ε of each facility, the one of Udo shrine was 0.29, Aosima, 0.28, Kodomonokuni, 0.32, Cactus' park, 0.28. The average of α was 1.12 and standard deviation was 1.23. The average and the standard deviation of t_b are 3:45pm and 0.65minutes. As to degrees of attractiveness of each facility, Udo shrine was 1.0, Aoshima was 0.62, Children' park was 1.87 and Cactuses' park was 1.09. The other parameters were B=0.59, δ=0.12, c=0.18(1/100(yen)), γ=1.63(1/h).

Figure 4 and Figure 5 show the theoretical distribution and the observed one for leaving time which were given from the parameters. Figure 6 shows the distribution of period around midday binding free activity. And figure 7 shows the probabilities of choice on each entering time in case of "a trip" which are calculated from equation (2.7). K-S tests between the observed distribution and the theoretical one on figure 4 and figure 5 were accepted at 20% significance level. Therefore, the model we proposed has good reappearance.

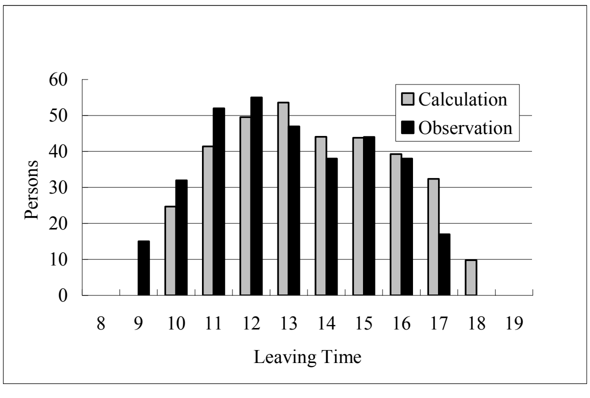

Figure 4 Distribution of leaving time on Udo shrine ("no tour")

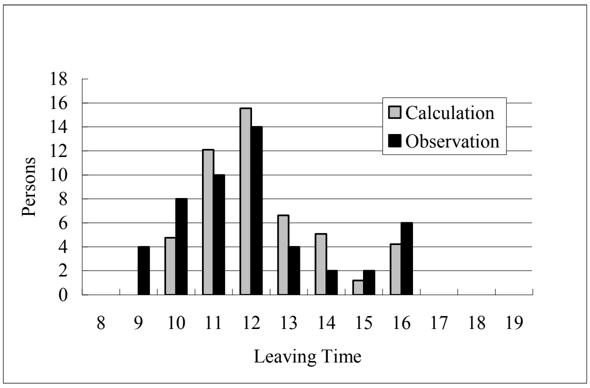

Figure 5 Distribution of leaving time on Udo shrine (“tour”)

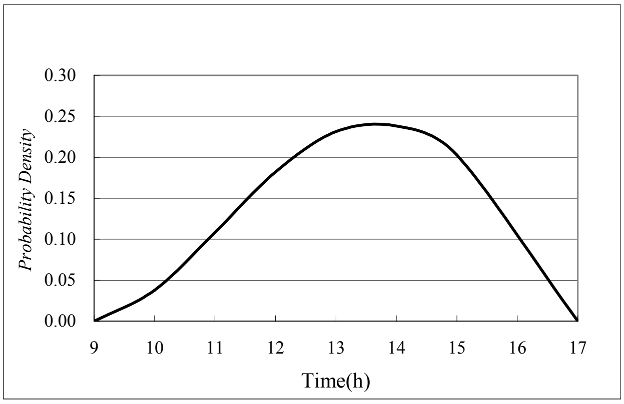

Figure 6 Distribution of period around midday binding free activity

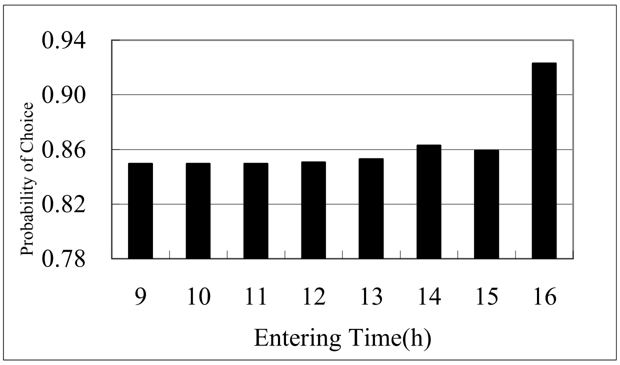

Figure 7 probabilities of choice on each entering time (“no tour”)

3. CONCLUSIONS

We proposed the model which predicts the human behavior on “tour”. This model can express the dispersion of the human behavior which is not clear by introducing error term into given utility.

We applied this model to the case of the facilities in tourist resort. Then, the appropriateness of this model was confirmed by comparing the observed value with the calculated the one. We also estimated the distribution of period around midday binding free activity and the

probability of choosing tours where entering time was given as initial condition.
We concluded that this model can give useful information to traffic management policy and effective facility management in tourist resort.

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