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A day-to-day route choice model based on travellers' behavioural characteristics

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Abstract

This paper proposes a day-to-day route choice model based on travellers' behavioural characteristics. The model is able to reflect travellers' route choice in one day and describes the diversity of route choice behaviours. First, characteristics of the day-to-day route choice and travellers' bounded rationality are analysed. A loop architecture based on the evolution of travellers' daily choices is presented; deliberate route choice and habitual route choice in the architecture are discussed. A model is then proposed based on the theoretical analysis. In this model, travellers' behavioural characteristics in the day-to-day route choice are considered; i.e., forgetting previous travel times, risk attitude, habit effect, traveller's amount of attention on the route choice being made, perception of actual travel time, etc. Results of a numerical experiment show that the tendencies of the simulated travellers' choices are reasonable and similar with that in reality, and that the model is able to reproduce travellers' route choice with more behavioural characteristics.

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Keywords: Day-to-day; Route choice; Behavioural characteristics; Bounded rationality

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1. Introduction

A day-to-day route choice model plays an important role in the field of transportation planning and in the study of travellers' behaviour. In the long run, travellers' decisions gradually become regular, and deliberation and habit jointly determine his or her choice in a day (He et al., 2009). In decision-making, the stronger traveller's deliberation is, the weaker his or her habit becomes, and vice versa (Triandis, 1977; Staats et al., 2004). As for the day-to-day process, it is considered as a transformation of the deliberate 'preference-based' to 'script-based' choice (Gärling et al., 1998).

Travellers usually make the daily route choice with some degree of deliberation before habit forms; this is also known as deliberate route choice. In the deliberate route choice, travellers form a belief about expected route utility based on their previous travel experiences, and then choose a maximum-utility or satisfactory route to travel. Specifically, the process may include choosing a decision strategy, searching for relevant information, selecting or constructing alternatives, and evaluating these alternatives (Gärling and Axhausen, 2003).

How travel experience contributes to route choices is one of main topics of different studies concerning travellers' behaviours and their day-to-day route choices. Bayesian learning models (BL models) as a type of dynamic choice models that mainly study experience accumulation. The weighted average of measured travel times (Horowitz, 1984), average return (AR) model (March, 1996), and reinforcement learning (REL) model (Erev et al., 1999) are typical BL models. Expected utility theory (EUT) and random utility theory (RUT) are normally used to describe travellers' decision among route alternatives. In EUT, an expected utility is defined as the sum of the products of utility values and probabilities of its outcomes, and travellers usually maximize the utility when he or she chooses an alternative route from a give choice set. In RUT, a random term is considered, and many attributes that influence travellers' behaviour are treated as random. The multinomial logit (MNL) model (McFadden, 1974), multinomial probit (MNP) model (Currim, 1982), and generalized valued (GEV) model (McFadden, 1978) are common RUT models. However, the consideration of travellers' psychology is still lacking in these traditional mathematical models (Nakayama et al., 1999), and that their probabilities are still unable to clearly explain travellers' daily choices. Furthermore, although behavioural economics has obtained many achievements in solving the uncertainty problem through a combination of economics with psychology (Kahneman, 2002), it does not completely apply in the study of travellers' behaviour such as the day-to-day route choice behaviour. Hence, it is necessary to combine various research approaches and the results of the mathematical models and behavioural economics.

If outcomes of choosing a route are perceived to be rewarding in a stable traffic condition, habit to choose this route will develop (Gärling et al., 2001; Verplanken and Aarts, 1999). With the development of habit, deliberation gradually reduces, and travellers make a habitual route choice after the deliberation is replaced by the habit (Gärling and Garvill, 1993). The frequent choice of a particular alternative as a behavioural script stored in memory will result in a habitual choice of that alternative (Fujii and Gärling, 2003).

Travellers under habit to a context will choose a habitual alternative automatically. This, however, is not the final state of travellers' daily choices. Changes in the context associated with a habit and a deliberation intervention prior to behaviour are employed in the attempts to interrupting habits (Eriksson et al, 2008). Since a habit usually is connected to a specific context, habitual responses are attempted to be disrupted by changing the context (Wood et al., 2005). The habitual choice is usually a response with no deliberation. Thus, if travellers under habit are forced to deliberate, they may realize that another alternative could be better, and then the habit is broken (Garvill et al., 2003; Fujii and Kitamura, 2003).

This paper analyses travellers' day-to-day route choice behaviour and presents a model, which is able to reflect travellers' choice in one day and describes the diversity of their route choice behaviours. In the model, travellers' forgetting and risk attitudes are considered into the calculation of expected travel time. In the determination of choices, the influences from habit to a route and little attention on the route choice itself are added into the comparison in order to reflect the bounded rationality of the daily route choice. In addition, travellers' perception of the actual travel time is taken into account along with experience accumulation.

This paper is organized as follows: Section 2 characterizes the day-to-day route choice and presents travellers' bounded rationality; Section 3 presents a loop architecture describing the evolution of travellers' daily choices; in Section 4, a day-to-day route choice model with travellers behavioural characteristics is developed; and Section 5 provides two numerical experiments that illustrate the performance and validation of the model. Finally, the conclusions are given in Section 6.

2. Evolution of travellers' day-to-day route choice

2.1. Loop Architecture

The day-to-day route choice is a dynamic process of travellers' learning as the days passed. Loop architecture can thus be constructed as follows:

(1) The deliberate route choice can be considered as the starting point of the loop architecture. When facing a strange O-D, travellers are usually willing to collect more information, and then make the route choice based on the information with some deliberation.

(2) When individuals travel between the O-D repeatedly, they gain experience about the traffic conditions. With the accumulation of travel experiences, travellers' habit (i.e., preference for a specific route) grows, and the choice gradually tends to become stable.

(3) When traffic conditions are relatively stable within a time period, the repeated choice to a route will lead to habit formation. The route choice under habit, which is called habitual route choice, is a conditioned reflex to a specific condition.

(4) Habit is usually associated with specific conditions, which means that the habit will disappear once the conditions change. When the variability is out of travellers' acceptable range, the habit will be broken and the deliberation will return. Afterwards, travellers' decision-making returns to phase (2).

2.2. Deliberate Route Choice

Based on the aforementioned travellers' behavioural characteristics pertaining to their day-to-day route choices, a framework (Figure 1) is developed to present relevant factors and their relations. The framework integrates travellers' experiences, risk attitudes, expected travel time, amount of attention on the route choice, habit effect (will be discussed in next subsection), perception of actual travel time, and individuals' characteristics.

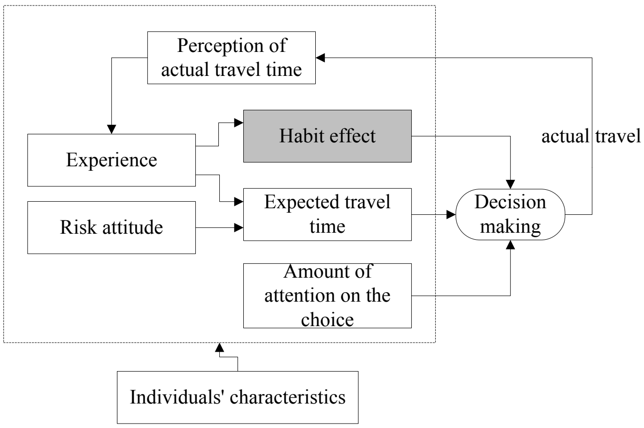

Fig.1. Relevant factors and their relations in the day-to-day route choice.

(1) *Experience.* Experience gained from travel condition is an important basis for decision making;

(2) *Risk attitude.* Travellers' risk attitude depends on both their inherent risk level and the trip purpose;

(3) *Expected travel time.* Expected travel time is evaluated based on travellers' previous experiences and should meet their respective risk attitudes. Note that we assume that travellers choose the departure time strictly based on their expected travel time;

(4) *Amount of attention on the route choice being made.* This factor refers to the one that is considered by

travellers instead of the one caused by habit increase. We assume that the choice without any attention is usually made randomly;

(5) *Perception of actual travel time.* Travellers' perception of actual travel time refers to a feeling or opinion they have developed about a previous trip, which is influenced by travel outcomes. There may be a reference point that influences travellers' evaluation (Avineri and Prashker, 2005). The reference is different for each traveller's respective characteristics and trip purposes.

(6) *Individuals' characteristics.* Individuals have imperfect characteristics, which lead to travellers' bounded rationality.

We considers four individual characteristics that directly influence travellers' choice as follows: (1) *level of care about the travel outcomes* explains the extent of travellers' concern about arriving early, arriving on time, or arriving late; (2) *level of attention on doing things* indicates the consistent level of attention given when individuals perform certain acts, while (3) *level of forgetting the experience* is about the accuracy of traveller's memory; (4) *level of habit formation* will be discussed in the next subsection.

2.3. Habitual Route Choice

Habit is considered as an unconscious pattern of behaviour responding to a given stimulus, which is acquired through frequent repetitions (Triandis, 1977, 1980; Gärling 1993). As a conditioned reflex, the habitual route choice is relatively simple. Our concerns lie on identifying habit formation and the expression of the habit effect in the formation process. In the paper, we added "habit effect" into the factors of deliberate route choice in order to complete the framework of the day-to-day route choice (Figure 2). The habit effect plays a role in irrationalizing travellers. It means that with the increase of the number of times that a route is repeatedly chosen, the possibility that the route is chosen in the next period increases. Furthermore, the number of times that the route is chosen repeatedly can be used as an argument for the habit effect.

For the identification of habit formation, we defined one of travellers' characteristics as level of habit formation, which is a fixed number of times and varies from one person to another. When the number of times a route is repeatedly chosen exceeds the level of habit formation, we consider that travellers are in the habit of choosing that specific route.

3. The model

In this section, the notations used are presented first. Then, the functions of the three parts are developed, namely, the habit effect, expected travel time, and perception of actual travel time. Since travellers' behavioural characteristics are difficult to describe exactly, we only present the relationship of the characteristics in the model. The hypothetical expressions for the numerical experiments are specified in the next section.

3.1 Notations

Assume that travel time is the only decision basis of travellers' decision-making. The following notations will be used throughout the paper:

Indices

k a day,
j a day before day k, $j = 1,\cdots k$,
i_k an alternative route on day k,
i_k^* a route that is actually chosen on day k,

Risk related

$\gamma_k^{(0)}$ risk attitude to the choice of day k, and $\gamma_k^{(0)}$ is negatively correlated with risk seeking in the mode, $\gamma^{(1)}$ travellers' inherent risk level,

Time related

$t_{i_k}^{(0)}$ travellers' expected travel time to route i_k,
$t_{i_k^*}^{(1)}$ travellers' actual travel time on route i_k^*,
$t_{i_k^*}^{(2)}$ travellers' perceived time of $t_{i_k^*}^{(1)}$,
$\tau^{(0)}$ an upper threshold of travellers' acceptable delay time,
$\tau^{(1)}$ a lower threshold of travellers' unacceptable delay time,
$\tau_{i_k^*}^{(2)}$ travellers' actual delay time on route i_k^*,
$\tau_{i_k^*}^{(3)}$ travellers' perceived delay time of $\tau_{i_k^*}^{(2)}$,

E_{i_k} mean travel time before day k on route i,
R_{i_k} the part of expected travel time exceeded E_{i_k}, which is related to $\gamma_k^{(0)}$,

Traveller's characteristics related

θ_1 level of habit formation,
θ_2 level of forgetting the experience,
θ_3 level of attention on doing things,
θ_4 level of care about the travel outcomes,

Other factors

ξ_{i_k} habit effect to route i on day k,
l_{i_k} number of times that route i has been repeatedly chosen on day k,
λ_k travellers' amount of attention on the daily route choice on day k,
η_k trip purpose on day k,
U_{i_k} travellers' expected utility of route i on day k,
$\varepsilon_k^{(1)}$ memory error on day k,
$\varepsilon_k^{(2)}$ error of travellers' attention on day k,
$\alpha_1, \alpha_2, \alpha_3, \alpha_4$ coefficients.

3.2 Risk Attitude

Travellers' risk attitude towards time is determined by both trip purpose and travellers' inherent risk level. Let $\gamma_k^{(0)} \in (0,1)$, and the function of $\gamma_k^{(0)}$ is written as: $\gamma_k^{(0)} = \gamma_k^{(0)}(\gamma^{(1)}, \eta_k)$.

3.3 Habit Effect

Take l_{i_k} as an argument of ξ_{i_k}, and let θ_1 be a fixed number of times that a route is repeatedly chosen to identify travellers' habit formation. First, the bigger θ_1 is, the more difficult it is for a habit to form and vice versa; second, when $l_{i_k} < \theta_1$, the travellers will still make a deliberate route choice; when $l_{i_k} \geq \theta_1$, the travellers will choose the habitual route i and not change the choice any more, indicating that a traveller is in the habitual route choice. Considering the combination with other sub-models, we thus give the function ξ_{i_k} as:

$$\xi_{i_k} = \begin{cases} 1 + \alpha_1 \tan(\frac{\pi}{2} \cdot \frac{l_{i_k}}{\theta_1}), & l_{i_k} < \theta_1 \\ M \quad , & l_{i_k} \geq \theta_1 \end{cases}, \tag{1}$$

Where $l_{i_k} = \begin{cases} l_{i_{k-1}} + 1, & i_k = i_{k-1}^* \\ 0, & i_k \neq i_{k-1}^* \end{cases}$, M is sufficiently large, and $\alpha_1 \in (0, \infty)$.

3.4 Expected travel time

An exponential form of θ_2 is used to depict travellers' forgetting the experience (Cheung and Daniel, 1997). It means that the nearer to the present the day is, the bigger the weight of the travel time in that day become. Meanwhile the equation, $\varepsilon_j^{(1)} \in [-1,1], \; j = 1, \cdots, k$, refers to travellers' memory error. The weighted mean travel time, E_{i_k}, is calculated (Equation 3) as a description of the everyday speech "this road usually takes xx minutes."

$$E_{i_k} = \frac{\sum_{j=1}^{k} \delta_{i_j} (\theta_2)^{k-j} (1 + \varepsilon_j^{(1)}) t_{i_j^*}^{(2)}}{\sum_{j=1}^{k} \delta_{i_j} (\theta_2)^{k-j}}. \tag{2}$$

In the above equation, δ_{i_j} equals 1 if route i is chosen on day j, and 0 if otherwise. It also indicates the aforementioned "difficulty of knowing the traffic conditions of other routes."

The other part of travellers' expected travel time is R_{i_k}, which transfers traveller's risk attitude into the expectation of travel time. First, $(t_{i_j^*}^{(2)} - E_{i_k})$ is collected when $t_{i_j^*}^{(2)} > E_{i_k}$, and their mean is calculated as the travel time exceeded E_{i_k} in general. Then, travellers' risk attitude of this time $\gamma_k^{(0)}$ is used to modify the mean, in order to turn the general time to time with travellers' risk attitude. So we have the formulation R_{i_k} bellow:

$$R_{i_k} = \gamma_k^{(0)} \cdot \frac{\sum_{t_{i_j^*}^{(2)} > E_{i_k}} \delta_{i_k} (\theta_2)^{k-j} (t_{i_j^*}^{(2)} - E_{i_k})}{\sum_{t_{i_j^*}^{(2)} > E_{i_k}} \delta_{i_k} (\theta_2)^{k-j}} \quad . \tag{3}$$

Then, we obtain the expected travel time by: $t_{i_k}^{(0)} = E_{i_k} + R_{i_k}$.

3.5 Amount of attention on the route choice being made

The fewer travellers attention on the route choice is, the more random travellers' choice becomes. Here, λ_k is used to randomize travellers' choice, and is a function of travellers' level of attention on doing things as well as the trip purpose of the day. Thus, we write the function λ_k as follows: $\lambda_k = \lambda_k(\theta_3, \eta_k, \varepsilon_k^{(2)})$.

3.6 Decision making

We presume that travellers who have not yet affected by habit and do pay full attention on the route choice would choose the route with the shortest expected travel time. However, habit and little attention on the daily route choice do exist; thus, we use an expected utility in which the habit and the amount of attention are considered, as criteria for comparing the alternative routes. Through such an approach, normal bounded rational decision makers are changed to bounded rational travellers. Note that the expected utility has no actual meaning in the model and is only used for the comparison and selection of the alternative routes. The expected utility is given: $U_{i_k} = U_{i_k}(\lambda_k, \xi_{i_k}, t_{i_k}^{(0)})$ .Let travellers make the route choice using the maximum utility principle: $i_k^* = \arg\max_i \{U_{i_k}\}$.

3.7 Perception of actual travel time

Travellers' perception of actual travel time is impacted by the travel outcomes, especially when delay occurs (Small, 1982). Travellers' perception is thus associated with their attitude regarding delay. If the delay is in travellers' acceptable range, it may not draw their attention; but if the delay is out of the acceptable range, additional consideration would be given. Hence, we first defined an upper threshold of travellers' acceptable delay time as the reference point, after which we proposed a hypothetical function of travellers' perception with regard to actual travel time (shown in Figure 2). The final formula is shown in Equation (2).

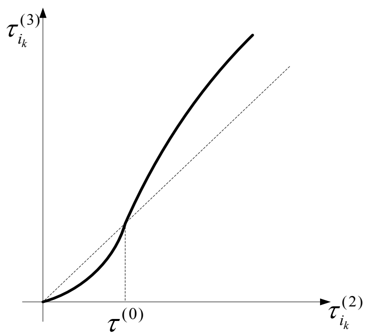

Fig.2.A hypothetical function of travellers' perception of actual travel time.

$$\tau_{i_k^*}^{(3)} = \begin{cases} \alpha_2 (\tau_{i_k^*}^{(2)} - \tau^{(0)})^{\alpha_3} + \tau^{(0)}, & \tau_{i_k^*}^{(2)} \ge \tau^{(0)} \\ \dfrac{1}{(\tau^{(0)})^{\alpha_4 - 1}} (\tau_{i_k^*}^{(2)})^{\alpha_4}, & 0 \le \tau_{i_k^*}^{(2)} < \tau^{(0)} \end{cases}, \tag{4}$$

where $\alpha_2 \in (0,\infty)$, $\alpha_3 \in (0,1)$, and $\alpha_4 \in (1,\infty)$ are the coefficients related with the curve shape, in which α_2 indicates travellers' deviation to actual travel time when the delay time is considered out of the acceptable range.

Assuming that travellers depart according to their expected travel time, we have:

$$\tau_{i_k^*}^{(2)} = \max\{ t_{i_k^*}^{(1)} - t_{i_k^*}^{(0)} \ , \ 0 \} . \tag{5}$$

The upper threshold of travellers' acceptable delay time (i.e., the reference point) is dependent on their level of care about the outcomes, trip purpose, and the lower threshold of travellers' unacceptable delay time expressed as: $\tau^{(0)} = \tau^{(0)}(\theta_4, \eta_k, \tau^{(1)})$ .Finally, we have: $t_{i_k^*}^{(2)} = t_{i_k^*}^{(0)} + \tau_{i_k^*}^{(3)}$.

4. Numerical experiments

In this section, two numerical experiments are conducted based on the day-to-day route choice model. In the first experiment, 50 travellers with work purposes are tested, and their route choices are observed in the given experimental environment. In such an experiment, we are able to identify the tendency of the group of travellers' choices. In the second experiment, three travellers with different characteristics are built by taking the different parameter values. The daily choices of the different travellers are presented and compared. Both experiments are used to demonstrate the performance and the ability of the model in reproducing travellers' route choices with various behavioural characteristics.

4.1 Parameters Values and Formulations

According to the experimental requirements, we set $\alpha_1 = 0.1$, $\alpha_2 = 2.25$, $\alpha_3 = 0.88$, $\alpha_4 = 3$ for the hypothetical curve, and gave the aforementioned functions to depict the relationship among the parameters as follows:

$$\tau^{(0)} = (\theta_1 + \eta_k) \cdot \tau^{(1)} \ , \tag{6}$$

$$\gamma_k^{(0)} = \gamma^{(1)}(1 - \eta_k) , \tag{7}$$

$$\lambda_k = 1 + \theta_3 \cdot \eta_k \cdot \varepsilon_k^{(2)} , \tag{8}$$

$$U_{i_k} = \lambda_k \cdot \frac{\xi_{i_k}}{t_{i_k}^{(0)}} . \tag{9}$$

4.2 Experimental Set-up

(1) Two routes, A and B, are set between an O-D; and, the simulated travellers are only allowed to make day-to-day route choices between the O-D;

(2) The simulated days are set to 52. We randomly assigned 50% of the travellers to Route A, while the others are assigned to Route B on the first day. Moreover, they are forced to choose the alternative route on the second day. In the next 50 days, the travellers made the day-to-day route choices based on the aforementioned model. Only the travel results in the next 50 days are collected and counted;

(3) In the simulation, we do not allow the travellers' choices to influence the traffic condition. The travel times of Routes A and B are drawn from the normal distributions (41.29, 3.48) and (38.90, 6.88),

respectively. The difference between the two routes is that, one route has a higher mean travel time and a smaller variance, while the other route has a lower mean travel time and a larger variance. Figure 3 presents the means and variances of the travel times in blocks of 10 days each.

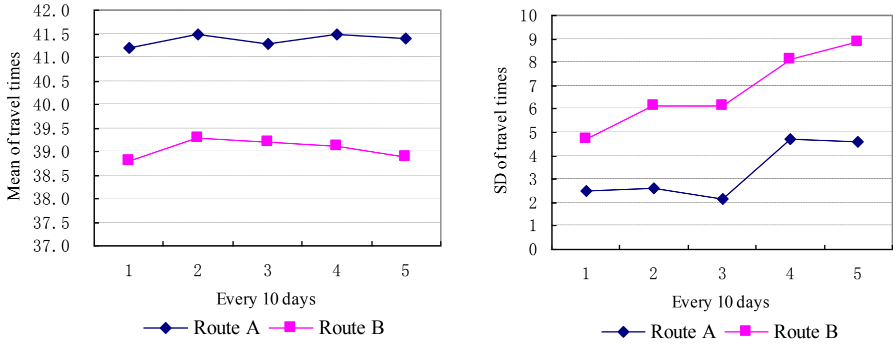

Fig.3. The means and variances of the travel times presented in blocks of 10 days each

4.3 Numerical Experiment

In this experiment, 50 travellers are tested by randomly assigning the parameter values from the ranges presented in Table 1. The value range of η_k showed that these travellers had the trip purposes with a strict constraint for no delay ($\eta_k \in [0.1, 0.4]$), and we supposed that they are daily work travellers. The results of the simulation of the travellers' daily route choices are presented in Figure 4.

Table 1. The value ranges of parameters used in Numerical Experiment.

	θ_1	θ_2	θ_3	θ_4	
Value range	[10 , 20]	[0.6 , 0.9]	(0 , 1)	[−0.1 , 0.1]	
	η_k	$\gamma^{(1)}$	$\tau^{(1)}$	$\varepsilon_k^{(1)}$	$\varepsilon_k^{(2)}$
Value range	[0.1 , 0.4]	(0 , 1)	60	(−0.2 , 0.2)	(−1 , 1)

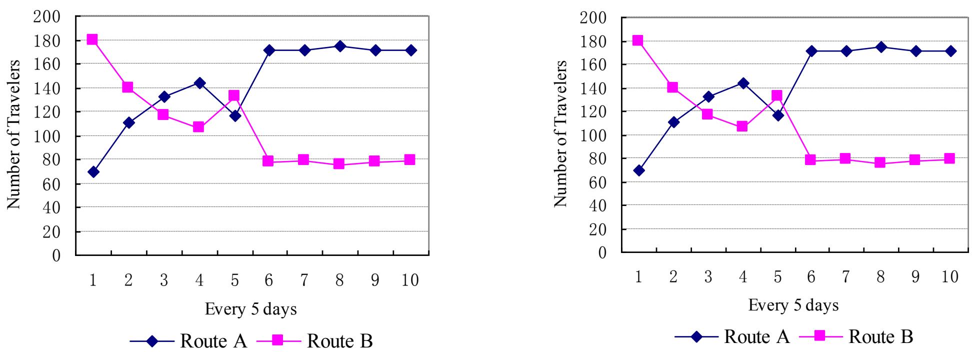

Fig.4.(a) The numbers of travellers on Route A and B in blocks of 5 days each;(b) The relative variations of SD and Mean of the numbers of travellers on Route A and B in blocks of 10 days each.

In Figure 4(a), it can be seen that the numbers of the travellers on each route is fluctuating at the beginning, but gradually became stable as the days passed. The lines show that the travellers learn and become familiar with the travel conditions until the habits gradually forms.

The sum of the travellers who chose Route A is 1436, while in Route B, it is 1064 (Table 2). This means that more travellers chose the route with the smaller variance and the larger mean travel time. It is noted that the trip purpose with strict constraint resulted in a group of travellers giving up the route with the lower mean travel time to avoid its instability. The results demonstrate a tendency of travellers' choice in their daily commute to work. Both of the results are seen to be consistent with what actually happens in real situations.

Table 2.The number of travellers on Route A and B every day in Numerical Experiment.

Day	Number of travellers		Day	Number of travellers		Day	Number of travellers	
	Route A	Route B		Route A	Route B		Route A	Route B
1	25	25	19	31	19	37	35	15
2	25	25	20	32	18	38	34	16
3	25	25	21	32	18	39	34	16
4	26	24	22	32	18	40	34	16
5	25	25	23	35	15	41	34	16
6	26	24	24	35	15	42	34	16
7	25	25	25	35	15	43	34	16
8	30	20	26	35	15	44	37	13
9	30	20	27	36	14	45	37	13
10	30	20	28	37	13	46	37	13
11	30	20	29	37	13	47	37	13
12	26	24	30	37	13	48	37	13
13	27	23	31	37	13	49	37	13
14	26	24	32	37	13	50	37	13
15	26	24	33	37	13	51	37	13
16	27	23	34	37	13	52	37	13
17	32	18	35	37	13			
18	31	19	36	37	13	**Sum**	1436	1064

Note: The sums of travellers who chose Route A and B in the 3rd-52nd day are 1436 and 1064.

The ratios between the mean of the number of the travellers who chose Route B every 10 days and the mean in the first 10 days are calculated and presented in Figure 4(b). As can be seen, the lines pertaining to the standard deviation (SD) had been drawn in the same way. The relative changes between the SDs and the means are studied in order to show the effect of habit in the model. It can be seen that the means dereased with the increase of SDs. However, the decreasing speed slows down as the days passes. The process is explained as follows: the travellers become familiar with the travel condition through repetitious attempts, then the ones who can accept the fluctuation of the route (or the reliability of the route can meet the the travellers' requirement) choose Route B for a smaller travel time. The travellers' repeated choice of a route increase their habit to continue choosing the same route, and the habit causes irrationality as previously mentioned. This irrationality leads the travellers to choose the habit route even when some bigger fluctations occasionally occur. Therefore, the number of travellers do not obviously decrease with the increase of SDs in the final days of observation.

The results in Numerical Experiment show that the travellers' choices gradually move to stability because of the effect of habit. On the other hand, the travellers for work have a tendency of giving up the shorter route for a more stable route in their daily route choices. Moreover, the sensitivity to the differences of travel times shows a marked decrease as the days passes. We believe that these tendencies are similar to those that can be observed in actual situations.

5. Conclusions

This paper first analyses the characteristics of a day-to-day route choice including small impact of the outcome, little attention on the choice, difficulty of knowing the traffic conditions of other routes, and difficulty of measuring the outcome. Then we discuss travellers' bounded rationality which is exhibited in the day-to-day route choice, and list them further in four items. A loop architecture describing how travellers learn about traffic conditions and form habits is presented. In the architecture, travellers' choice transforms from deliberation to habit, and then goes back to deliberation with the changing of traffic conditions. The travellers gradually became experienced ones in the manual transformation.

Based on these characteristics, a day-to-day route choice model is proposed. In the model, we considered travellers' behavioural characteristics such as forgetting previous travel experiences, risk attitude, habit effect, the amount of attention, perception of actual travel time, and so forth. Through the model, we are able to identify travellers' route choice in one day and describe the diversity of route choice behaviours.

A numerical experiment is also conducted to illustrate the performance of the model in the description of travellers' day-to-day route choices. A simulation environment with two alternative routes between an O-D and the given travel times in 52 days is established. In the first experiment, we randomly choose 50 travellers with work purposes, and simulate their route choices in the given environment. The experiment results showed that travellers' choices gradually become stable because of habit formation. Moreover, travellers have a tendency of giving up the shorter route for a more stable route, while sensitivity to travel-time differences decrease as the days pass. Although the numerical experiments seem to be reasonable, there remains a concern that the model is not tested through empirical study. We intend to conduct a further study on the empirical test of the model.

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