A PROPOSAL FOR PRAGMATIC PURSUIT OF NEW-GENERATION MODELS
交通需要分析の新世代型モデルの実用的追及に向けた提案

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1. Introduction

One of the main objectives of travel behavior modeling is to accurately predict the behavioral response to changes in relevant policies. Travel behavior modeling has evolved over the last few decades from the relatively simpler conventional trip-based model to the complex and advanced activity-based models.

Most of the recent models are characterized by theoretically appealing bases, which is mainly to make them behaviorally more realistic. In this paper, we denote them as "new-generation models" setting them with the conventional trip-based models. However, the soundness of the background of the new-generation models did not initiate a swift shift from the conventional methods that are still widely used. Therefore, it is important to consider of how to address the gap between the theory and practice. In addition, if we expect practitioners to switch to the new-generation models from the conventional ones, they should be convinced of how and to what extent they can supersede the widely practiced conventional models, in practice[3].

Practitioners have often encountered the dilemma between behavioral realism and complexity of their models. The key to dissolve it is that the constraints the reality imposes need to be considered along with theoretical soundness. The perception that the new-generation models are entirely different from the conventional ones should also be tackled. In this paper paradigmatic approach to incorporate the concepts of the new-generation models is suggested. This is to enhance the conventional approaches in an incremental way, without urging for substantial shift from the conventional resources. The objective of the plan, available resources (the constraints) have a role to play in sorting out the modeling approach which might fit best for a specific case. In the following sections we try to review the main progress in travel demand modeling and main characteristics of the new-generation models. We also propose a flow chart for choosing an optimum modeling approach, with illustration of how to identify or develop a modeling structure taking into account the factors mentioned above.

2. Development of Travel Demand Modeling

In general the development of travel demand modeling may be categorized into three major parts based on the unit or theoretical background. The conventional four step trip-based modeling, which assumes trips to be mutually independent, is a typical example of the early trip-based models. Since then different attempts were made to improve the conventional four step method. The MTC model system which was developed for the San Francisco Bay Area (Ruiter and Ben-Akiva[5]) linked the trips based on conditionality and expected maximum utility. The model divides the decisions based on time framework into two groups such as long run and short run decisions, and it also divides the decision makers into two groups; workers and non-workers. These kinds of classifications are used in later models, however, the MTC model system models trips sequentially thus trip-based. It also excludes time of day in the disaggregate model. A similar attempt was made by Liang Su in 1992.

Tour-based models may be considered the most significant development in the field of modeling after the trip-base ones. A tour

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generally overarches trips made by a traveler and commonly represents a cycle of trips from a base. Tour-based models were developed in late 1970s and 1980s (Daly et al., 1983; Gunn et al., 1987; Hague Consulting Group, 1992; models. (Gunn, 1994). Since then, developments of tour-based models have been followed in Stockholm (Algers et al., 1995), Salerno, Italy (Cascetta et al.1993), the Italian Transportation System (Cascetta and Biggiero, 1997), Boise, Idaho, (Shiftan, 1995) and New-Hampshire (Rossi and Shiftan, 1997). The main strength of tour-based model is that temporal and spatial constraints of activities within a tour are explicitly represented. However, conventional tour-based models do not link multiple tours that might take place in a single day.

The drawbacks of tour-based model are overcome by activity-based models, which are based on the concept that the demand for travel is derived from the desire to take part in activities. Another fundamental idea in the activity-based models is concerned with the temporal and space constraints that decision makers face (Hagerstrand,1970).

Activity-based models aim to predict the activity and travel schedule of individuals, for a given time frame (usually 24hrs), in an integrated way (Damm and Lerman 1981, Kitamura 1984, and Hirsh et al. 1984). Different attempts have been made to understand and formulate the decision making process. Fig.1 shows the daily activity and pattern decision- making process which is part of a broader operational decision-making process framework developed by Ben-Akiva et al[1]. The framework classifies the decision based on the frequency interval that the decision may occur and it was applied in several models like Portland and San-Francisco activity-based models.

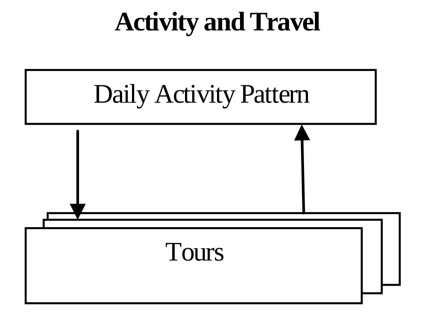

Fig. 1. The Daily Activity Schedule (Ben-Akiva et al 1996)

(1)Characteristics of New Generation Models

Compared to the conventional methods new generation models may be distinguished by all or one or of the following attributes.

a)The option of not to travel: Activity-based models assume that a person may avoid travel provided that carrying an activity without travel is more appealing. This is important in evaluating some policies, like the impact that communication technology has on travel behavior. Conventional trip-based models and early tour-based models cannot capture the possible trade-off between activity with travel and that of without travel.

b) The interactions of travel decisions: Unlike conventional trip-based models new-generation models assume that decisions for travel are fully or partly (if tour-based) interlinked and not carried out independently.

3. Motivations to Apply the New-generation Models or Principles

Despite the noticeable advantages that the new-generation models have, as mentioned earlier, conventional models are still widely used. Practitioners or planners would only switch to the new-generation models, if their objective can no longer be met by the conventional models or if more accurate outcomes are required. Some of the transport policies related with HOV, congestion pricing or joint-activity may lead to a complex response which needs the characteristics of new-generation models.

Behavioral realism of the new-generation models is expected to yield more accurate results. However, this comes at the cost of getting more complex. Data required to implement the new generation models is the other main concern. Beside the technical and financial obstacles, legal and privacy issues are making the access for detail data difficult. Moreover, conventional models have been established through decades of application and experience (P. Vovsha et al[4]), that cannot be simply ignored. Therefore, the advantage of the new-generation models over the conventional models should be evaluated from all the above aspects.

In the following section we demonstrate how an optimum model may be selected or developed in a pragmatic way for a given case based on the purpose of the project and constraints the reality impose.

(1)Choosing an optimum modeling approach

Fig. 2 shows how an optimum modeling approach may be identified based on the specific purpose of a plan, the constraints that the reality imposes. The model may be based on all or part of the fundamental concepts of the new-generation models, based on the measure requirements and constraints.

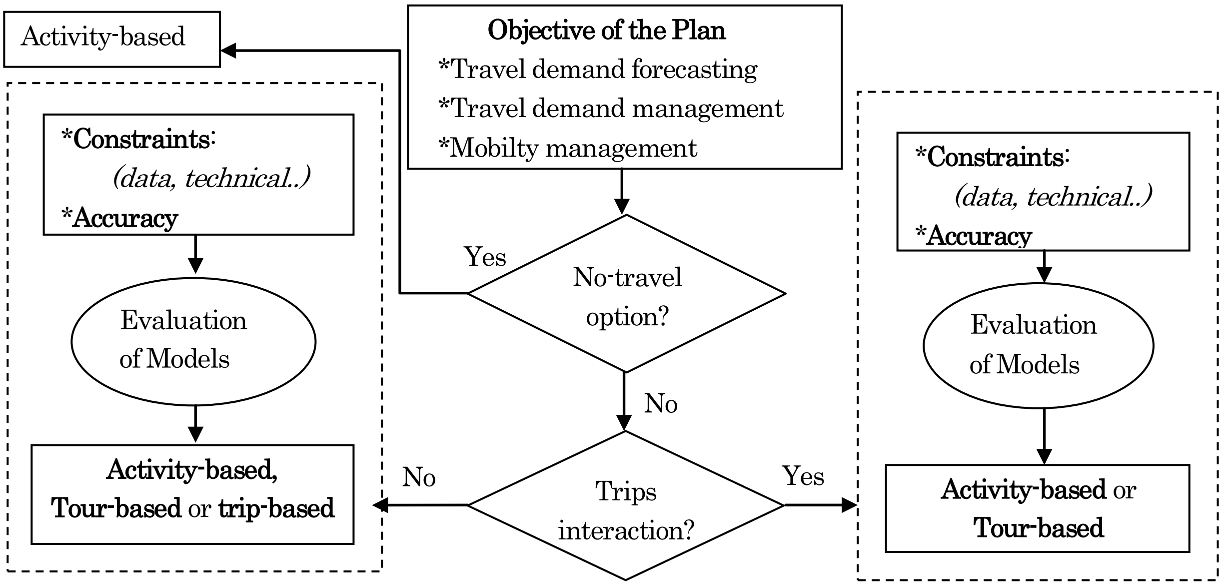

Fig. 2. Flow chart to choose optimum model

The objective of the plan might be for travel demand forecasting, travel demand management (TDM) or mobility management (MM) in general. The second and third objectives need relatively more advanced analysis methods. If the policies involve *no-travel option* as a measure planning issue, there is hardly other alternative than the activity-based modeling approach.

However, not all plans make the activity-base models as the only alternative. Other modeling types may yield an output, even though the accuracy and degree of sensitivity may vary. Deciding factors from the objectives of the plan and from the reality on the ground may be used to sort out the optimum type of among the possible modeling alternatives. If trips interlink is the main impact of the policies of the plan, or if activity without travel is expected to have insignificant role, then tour-based may accord with the objective. Other factors might be the constraints, data or technical, and the degree of accuracy required in optimizing approach. Through this pragmatic approach, a final optimum modeling approach may be identified, or a modeling structures based on the fundamental principles may be developed. The following sections illustrate how to apply these procedures on an empirical case.

4. Incorporating New-generation Model's Principles to Enhance Conventional Approaches

(1) Objectives and constraints

Conventional-models explain trip making based on demographic changes, which makes them as a policy instrument for long run changes only. Nowadays, however, there is an understanding that changes in travel behavior are not only the result of demographics characteristics. Thus, a modeling approach which may capture the complex short-run and long-run responses to changes in specific transportation system is inevitable. TDM & MM policies are getting much attention recently, and for effective evaluation of such policies daily travel decision interactions would be important. In this case we examine the extent that modeling concepts crucial to such policies can be incorporated provided that we have conventional person trip–data (PT-data).

We used Kofu PT-data that was surveyed in 2005 for regional transportation planning. The data, which is commonly for conventional trip-based modeling, consists of two main parts: household (HH) attributes and trip attributes. Household number, age, auto-ownership, license are the main are the main components in the HH data. Trip attributes include the departure and destination zones, the mode and timing.

Trade off between at-home and out-of-home activities may become the core issue in TDM, policies. However, there will be data constraints as PT- data doesn't systematically record at-home activities to enable activity-based models. Nevertheless, we enhanced conventional tour-based model so that the interaction between all the travel (out of home) decisions of the day can be grasped.

(2) Enhancing tour-based model and estimation

As mentioned in section.2 conventional tour-based fails to grasp the link between the multiple tours of the day. Based on

Ben-Akiva[1] scheduling framework, the conventional tour-based model was upgraded to interlink all the tours of the day, as a daily travel-pattern (as shown in Fig.3). For each travel-pattern one primary tour is designated based on a decision tree developed by prioritizing the main destination type, purpose and duration[2].The remaining secondary tours are conditioned by the primary tour. Each tour is characterized by trip-chaining type, time-of-day and mode.

We estimated the model as nested-logit model. The logsum parameters are found to be within the limit and statistically significant. Contrary to the assumptions of conventional models, this confirms the interdependency of daily travel decisions.

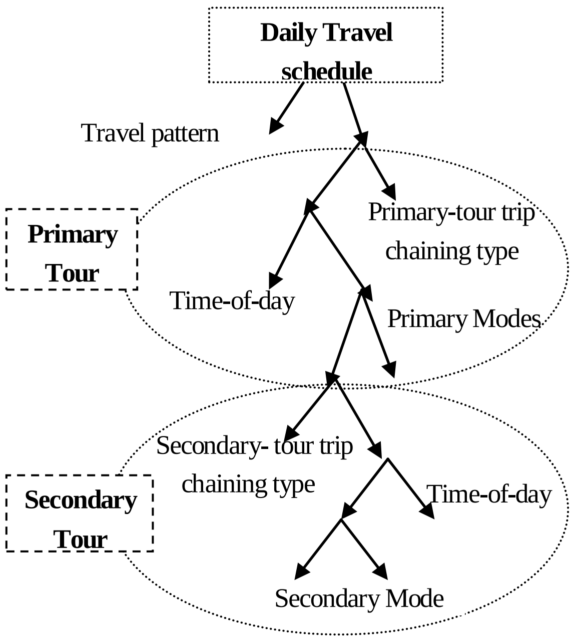

Fig.3. Enhanced tour-based model structure

(3) Applying the model to assess the effectiveness of HOV policy

The decrease in cost or travel time of HOV at peak time might increase HOV share relative to drive alone. However, this might motivate some of HOV to shift to the peak period which offset some of the desired benefits. The other possible response for the same policy might be by adjusting daily travel pattern. A traveler might shift to HOV to take advantage of the incentive, however for only one of two previously combined activities and add one more separate tour for the remaining activity which results in increase of gross traffic volume. If explicitly represented conventional tour-based models might capture the effect on time choice and chaining of activities within a tour. However, the response by adjusting the daily travel pattern cannot be grasped by the conventional tour- based models.

We applied this model to examine how effective HOV prioritizing system would be, if LOS of HOV at peak period is improved. We found that travelers are more sensitive for travel time changes then cost, and the impact of decreasing of the travel time by 10% would decreases the drive alone mode share of secondary tours by 5.2% and that of primary tours by 1.6%. The shift from peak to off-peak period is 1.44% for secondary tours. The impact on other primary tour choice dimensions and on the daily travel pattern is found to be not significant. Unlike the secondary, primary tours are less sensitive and this can be attributed to the fact that primary tours are mainly for work activity that it is less flexible to adjust.

5. Conclusion

With the readily available resource to the conventional models, concepts of new generation models may be incorporated to enhance their ability as policy instrument which otherwise they could not. Based on the objective of a plan, the constraints and optimum modeling approach may be identified. The enhanced tour-based model proposed applied for HOV illustrates how this could be done. In general, a pragmatic approach of enhancing the conventional models would play in narrowing the gap between the theory and practice.

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