A1C02: Committee on Passenger Travel Demand Forecasting
Chairman: T. Keith Lawton

Passenger Travel Demand Forecasting

CHANDRA R. BHAT, *University of Texas, Austin*
T. KEITH LAWTON, *METRO Transportation Department, Portland, Oregon*

This paper addresses the importance of travel forecasting, the general direction of emerging forecasting methods, the importance of integrating land use and transportation forecasting, and this committee's relationship to other committees at the Transportation Research Board (TRB).

In particular, the movement from trip-based to activity-pattern or activity-scheduling methods of modeling is emphasized. This includes the explicit treatment of tours and scheduling of tours, leading to the emergence of trips as linked elements within a tour. A tour is defined as the linked trips that take a traveler from home to a series of activities and back to home. The importance of substitution of in-home for out-of-home activities is also addressed. There are many different approaches that can be developed, including process models. The committee also addresses the move from an aggregate approach to a microsimulation of individual and household behavior. This is probably a necessity for activity-based models.

This report discusses the committee's role as a bridge between research and practice. It shows directions for immediate future research and discusses proposals for relationships between this committee and other TRB committees.

INTRODUCTION

Since the beginning of civilization, the viability and economic success of communities have been greatly determined by the efficiency of their transportation infrastructures. The need for efficient transportation and land-use systems has never been more critical than it is today. There are serious concerns in many areas about the high levels of traffic congestion, mobile-source emissions, the sustainability of our growth patterns and travel, and the related adverse impacts on regional and national productivity. Aware of the serious consequences of traffic congestion and mobile-source emissions, most metropolitan areas are moving to coordinate and streamline their transportation systems, with a growing awareness of the role of urban form and land-use arrangement. Constraints on the availability of financial resources to maintain and expand the existing infrastructure and concerns about the environmental impacts of transportation investments have added to the need for a systematic evaluation of alternative plans associated with transportation infrastructure provision. The environmental impacts that need consideration have expanded beyond direct air and water quality to the impact on urban form and density.

To make informed transportation infrastructure planning decisions, planners and engineers have to be able to forecast the response of transportation demands such as in the attributes of the transportation system, built environment, and the people using the system. Travel demand models, which are used for this purpose, should therefore incorporate realistic representations of individual and household activity and travel decision making. As we move into the next millennium, this need for realistic representation of decision-

making behavior is particularly acute for at least two reasons. First, rising traffic congestion and associated air quality problems, combined with the limited effectiveness and increasing lack of financial and environmental viability of investment-based capital improvement strategies, has led to a shift toward shorter-term demand management policies. That is including alternate work schedules, telecommuting, and congestion pricing. The complex nature of responses to such demand management strategies can only be anticipated through incorporating realistic behavioral decisions in demand modeling. Second, as there are substantial shifts in household structures and individual and household sociodemographics, (for example, more single-parent households, more single-individual households, aging of the population, etc.), the activity and travel needs of the future will be considerably different. Forecasting these activity-travel needs for transportation planning purposes can be achieved only through incorporating realistic representations of behavior. Behavioral representation also provides a clear picture of the functioning of urban areas (for example, the spatial characteristics of intra-urban labor markets) and has the potential to identify or resolve the differential quality of transportation services associated with different segments of the population.

The need for realistic behavioral representations in travel demand modeling has been well acknowledged in the literature for some time. However, practice in the field has not reflected this need until recently. In particular, travel-demand models, for the most part, continue to use individual trips as the unit of analysis. These models were developed primarily to evaluate alternative major capital improvements and, in part, have their form driven by the computing constraints of the 1960s. Because of their many simplifying assumptions and narrow "individual-trip" perspective, they are unable to examine the potentially complex behavioral responses to demand management actions. For example, in a multi-stop tour from home consisting of grocery shopping and a social visit, the traditional approach fails to recognize that the travel mode for all trips (home to shop, shop to visit, and visit to home) will be the same. The travel mode chosen will depend on various characteristics of all three trips (and not any one single trip) and, consequently, these trips cannot be studied independently. Similarly, the location of a stop in a multi-stop tour is likely to be affected by the location of other stops on the tour. Such multi-stop tours are becoming increasingly prevalent and ignoring them in travel analysis implies discarding a critical element in the individual's organization of time and space.

The limitation of traditional trip-based travel demand models has led to the emergence of an activity-based approach to studying travel behavior. The activity-based approach views travel as a derived demand; derived from the need to pursue activities distributed over space and time. The conceptual appeal of this approach originates from the realization that the need to participate in activities is the basic reason for travel. By placing primary emphasis on activity participation and focusing on sequences or patterns of activity behavior (activity schedule), with the whole day or longer periods of time as the unit of analysis, a more realistic model of people's adaptation to a changing travel environment can be achieved. Such an approach can address congestion-management issues through an examination of how people modify their activity participation, (for example, will individuals substitute more out-of-home activities for in-home activities in the evening if they arrived early from work because of a work schedule change?).

There have been several studies recently emphasizing and demonstrating the virtues of the activity-based travel approach. Some metropolitan planning organizations (MPOs) are already embracing this new approach and the efforts to develop comprehensive activity-based model systems to replace the traditional four-step trip-based methods. Many other MPOs realize the need to switch to an activity-based modeling system in the near future.

Although it is beyond the scope of this paper to review these developments and efforts, there is no question that activity-based methods are gaining momentum in the travel-demand modeling profession. There are already several applications of these methods to develop synthetic activity-travel patterns for forecasting and to assess the impact of transportation control measures (TCMs) on traffic congestion and air quality. Thus, it is probably fair to state that activity-based studies have gone past the usual cliché of promoting a better understanding of human activity-travel behavior to application for purposes of forecasting and policy analysis. Much of this transition toward activity methods has occurred within the past five years or so, and the stage is set for further development and implementation of such methods by planning agencies as we move into the next millennium. It is in this pivotal and critical setting that we next discuss the past and intended future role of the TRB Committee on Passenger Travel Demand Forecasting.

COMMITTEE'S ROLE

The committee has always been at the forefront of efforts to foster the development and implementation of new, better methods for passenger travel demand forecasting. The committee is the leading forum in North America for discussions and interactions among academics and practitioners working toward this common cause. It is a unique committee, since its focus is on the interface between new research developments and the state of the practice. Although the committee supports basic scientific research on passenger travel-demand forecasting, its emphasis is on research developments that have the potential to be implemented in the near future. Purely academic research, while important, is not the prime focus of this committee. Similarly, although the committee is receptive to the application of traditional, well-established methods in travel-demand modeling practice, its primary focus is the development of potential new techniques in travel forecasting. The committee's stand on new innovations may have been less than clear in the past, but it now intends in future activities to focus on new technologies in travel forecasting. This change in perspective is consistent with the committee's long-standing reputation of "keeping up with the times." The committee believes that important new refinements in travel-demand modeling are critical, if not mandatory, for transportation planning and air quality planning in the new millennium. Therefore, the committee will play a proactive role in facilitating the adoption of such new techniques in the face of inertial forces to stay with traditional methods.

The committee has always been active in bridging the gap between research and practice by sponsoring sessions at the TRB Annual Meeting, peer review for publication of research for dissemination purposes, holding workshops for academics and practitioners to introduce new methods into practice, and having committee meetings and other activities. Committee membership comprises leading individuals in the field from both academia and the practitioner community. Recently, the committee decided to form a subcommittee on "Emerging Methodological Developments in Urban Activity and Travel Analysis" to disseminate information on emerging estimation and implementation methods, as well as to potentially further the development and application of such methods in the urban travel demand analysis field.

The committee recognizes that there are several important directions for future research in the activity-travel area as we move into the new millennium. Committee members look forward to these challenges and to continuing to maintain the committee as a flagship for academia-practitioner interactions and dissemination of important developments in the field. In the next section, we provide a sampling of important research areas of interest to the committee in the coming years.

DIRECTIONS FOR FUTURE RESEARCH

Analysis of Inter-Individual Interactions in Activity-Travel Behavior

Interactions among individuals in a household, and the effect of such interactions on individual activity patterns, is an area that has received limited attention thus far in the activity analysis literature. Interactions among individuals might take the form of joint participation in certain activities, such as shopping together or engaging in recreational and social activities together. An example of this would be "serve-passenger" and "escort" activities, in which one individual oversees the participation of another in activities (for example, the "soccer mom" activity pattern), and allocation of activities among individuals. Such interactions can lead to constraints or inter-individual reallocation of tasks that may be very important in individual activity and travel responses to changes in the transportation or land-use environment.

Modeling Time-Space Interactions in Individual Activity-Travel Patterns

Most earlier activity-based demand studies have focused on either the spatial dimension or the temporal dimension characterizing activity and travel involvement; however, few have explicitly incorporated the time-space interactions due to time constraints, activity accessibility considerations, and joint activity duration and travel time duration choices. Important research issues include differences in the type of interactions in space and time for different activity types, effect of rigid temporal constraints on activity participation attributes, and the impact of space-time interactions on activity sequencing choices.

In-Home and Out-Of-Home Activity Substitution

In-home and out-of-home activities have quite different implications for travel; an in-home episode does not involve travel, while an out-of-home episode requires travel. Thus, the in-home and out-of-home participation decision has an impact on the generation of trips. Understanding this substitution is important, particularly at a time when opportunities for working, shopping, and entertainment at home are increasing because of the widening accessibility of households to computers, theater quality audio and video systems, and an almost unlimited choice of movies to view from home. Despite the importance of understanding in-home and out-of-home substitution effects, there have been very few studies that examine this issue.

Application of Microsimulation Techniques in Activity-Travel Pattern Analysis

Microsimulation techniques are already widely applied in the context of short-run policy analysis and forecasting under the label of sample enumeration. In the short-run policy analysis situation, the analyst typically already has a representative sample of decision-makers. However, there are forecasting situations in which one may not have a representative sample, or may have a very sparse representative sample for a subpopulation of interest, or may not have any sample at all. Microsimulation techniques offer an approach in such situations to update an available sample or synthesize a representative sample based on aggregate data.

Application of New Methodological Techniques for Demand Analysis

The desire to model travel as part of a larger (and holistic) activity-travel pattern has led to the analysis of activity attributes (such as activity participation, activity duration, home-stay duration, etc.) either in isolation or jointly with one another. This has led to the adoption of relatively nontraditional (in the travel analysis field) estimation methodologies such as duration analysis, limited-dependent variable models, and computational process

models. Application of these new techniques in demand modeling is an important avenue for further work.

Integrating Travel and Land-Use Forecast Models

The field of land-use forecasting has lagged behind travel forecasting, mainly because of a lack of research funding. The urban system, which is an inseparable whole comprising both the built environment, or land-use structure, and the travel infrastructure, has been modeled as two largely independent entities, or with embryonic transportation depiction within land-use models.

The reality is that in an urban region, the behavior that leads to development patterns and the behavior that leads to travel in the satisfaction of daily activities are inextricably intertwined. It is one system.

It is clear that the environmental community correctly understands this linkage and requires the consideration of land-use effects (leading to further transportation effects) of transportation scenarios and the consideration of land use actions to mitigate travel demand. Such consideration is also included in the Clean Air Amendment Act.

Land-use development decisions resulting from location behavior of individuals and firms are a continuation of long-run decisions based on the same adaptive and responsive behavior of households and individuals pursuing their activities as the intermediate-run decisions on auto ownership, the shorter-run decisions on mode choice and activity scheduling and location, and the very short timeframe route choices.

Research in two areas is important. The first is in the iterative linkage of existing and emerging travel models with existing and emerging land-use models, usually run on very different spatial and time scales. The second is the development of consistent integrated transportation and land-use models. Close cooperation with TRB's Transportation and Land Development Committee will be necessary.

Use of Geographic Information Systems

A modeling tool that has developed quite considerably in the past few years is geographic information systems (GIS). A GIS facilitates the representation of and the storage and manipulation of spatial information in an intuitive manner. Thus, it is useful in modeling the spatial contexts of activity episode patterns and the interaction of temporal characteristics with spatial attributes. Research into the application of GIS for urban travel demand modeling is another important area for future work.

RELATIONSHIPS WITH OTHER COMMITTEES

This committee has historically maintained an independent stance, with some involvement with A1C04, Traveler Behavior and Values, A1C07, Transportation Planning Applications, and A1C08, Telecommunications and Travel Behavior. The strongest link has been with A1C04, the "petri dish" in the development of new theory and research.

This committee has a very strong model-development focus and needs to be far more proactive in developing joint calls for papers, joint sessions that have a strong model-focus component, and proposing research areas with the following committees:

- Traveler Behavior and Values (A1C04). This committee is the wellspring for new ideas and is part of our primary focus as a bridge between research and practice.
- Transportation Network Modeling (A1C05). Network modeling is integral to our work, the true depiction of supply strongly affects emergent demand. This might also be a

channel to integrate information from the wealth of intelligent transportation systems research under way.

- Transportation Planning Applications (A1C07). The border between the Committee on Passenger Travel Demand Forecasting and this committee is blurred, with some overlap. Refinement of applications needs to be steered there. The development of a session on emergent applications in their biennial conference might be fruitful.
- Telecommunications and Travel Behavior (A1C08). This committee's focus on the substitution of communications for travel is of interest in our attempts to develop more holistic models that combine telecommunication opportunities with TCM and transportation demand management scenarios.
- Statewide Multimodal Transportation Planning (A1D01). This area is one that is developing more sophisticated approaches to long-distance passenger travel. There is potential overlap of methods as well as a more practical approach to "external" travel. The issue of reconciling the output of two model systems at the boundary will become an issue.
- Transportation and Land Development (A1D02). There is a strong need to work with this group in developing more holistic model systems. There is an analog with Travel Behavior and Values in our relationship with this committee.
- The two data committees, Urban Transportation Data and Information Systems (A1D08) and Travel Survey Methods (A1D10) are integral to the development of models. The input of A1C02 into these committees is essential. The content and form of household surveys and other data gathering efforts is critical to us.

The committee proposes appointing volunteer liaisons from this committee to follow and communicate with these related committees. Their charge will be to contribute our input (when needed) and to develop joint research agendas, calls for papers, and sessions where this is necessary.