4 Structure of Disaggregate Models

Antti P. Talvitie, University of Oklahoma

The workshop had 2 tasks: to broadly identify areas where more research is needed and to give specific directions to research in these areas.

STRUCTURE OF TRAVEL DEMAND MODELS

Fundamental theoretical work is needed to extend established theories of consumer behavior to travel demand and travel choice. Many existing demand or choice models consistently violate the established principles of consumer behavior as expressed in current theories. This is particularly true with the urban transportation planning (UTP) model system; alternatively, overly restrictive assumptions are introduced into the models to overcome the limitations of data availability or coefficient estimation.

The second topic that urgently needs attention concerns the identification of the behavioral structure on which the statistical choice models—logit, probit, and truncated linear—are based. The workshop discovered that starting with 2 sets of axioms regarding choice behavior it is possible to arrive at the same explicit mathematical expression. This raises the issue of whether the statistical models measure behavior based on stochastic transitivity (as defined by Luce) or absolute transitivity (as defined in micro-economic theory). The reader is referred to the excellent workshop resource papers in this Special Report for further study of these 2 approaches.

The third topic involves the choice of simultaneous or sequential models. A number of problems, both theoretical and practical, are associated with the use of sequential models. Members of the workshop found it difficult to justify sequential choice behavior by using a priori reasoning. Furthermore, empirical evidence suggests that the ordering of choices significantly affects the model coefficients. The workshop concluded, however, that further research is required to reveal how consumers make their choices from among the alternatives and whether and how these choices are ordered.

The fourth topic needing more research concerns the problem of the supply side of transportation. Almost all models used for the analysis of travel demand to this day neglect the fact that there are 2 types of decision-makers in the travel market. The failure to account for this may, therefore, have led to the calibration of models reflecting not the behavior of the consumers but the behavior of both consumers and suppliers. Thus, research is needed to ascertain whether the supply side should be brought into the model building process and, if so, how.

The fifth topic, which is difficult to separate from the previous ones, is the problem of equilibration (assignment) of demand and supply. Route choice cannot be separated
from choice of mode and other trip decisions. Thus, research is needed to ascertain that procedures exist that produce a unique equilibrium of demand and supply; at present no such method exists.

The sixth topic is the need for a more thorough understanding of the relations between travel-related decisions such as automobile ownership and household location on the one hand and trip-making decisions on the other. The location behavior of other activities should also be studied concurrently.

The seventh topic, which is not unrelated to the research tasks enumerated above, concerns the modeling of travel and related behavior over time. The workshop members felt that dynamic models are theoretically sounder than static models; consequently, the enormous challenge of a dynamic approach should be accepted.

SPECIFICATION OF VARIABLES IN THE MODEL

The first topic concerns the need to uncover how relevant alternatives are structured and conceived by the trip-maker. These alternatives include frequency of trip, time of day of trips, possible destinations, mixed trip purposes and tours, nontransport substitutes, or any combination of them. Although this research appears formidable, it may not be impossible. Members of the workshop produced evidence that suggests that the travel patterns of individuals are stable and focus on far fewer alternatives than is generally believed and that more than a third of the trips have multiple destinations and purposes (tours). These observations are also of importance in projecting travel behavior over time.

Another topic concerns the way in which the alternatives themselves are characterized. The variables in a travel demand model are normally divided into 3 groups: socioeconomic, activity (attraction), and level-of-service variables. The workshop devoted only a token of time to the socioeconomic variables. The consensus was that for social and other reasons division of the travel market into segments is mandatory, and research is in order to support the composition of these segments.

One of the important aspects in characterizing the alternatives is the way in which the alternative destinations are defined. The current practice of using the number of jobs (by type if necessary) to characterize destinations may or may not be the best way. The workshop felt that it is not the best way and strongly suggested more research in this area.

Another important concern in characterizing the alternatives is the inclusion of the right level-of-service variables in the model. The workshop members felt that past models placed too much emphasis on curve fitting and not enough on incorporating into the models those variables that are under the control of planning authorities or private operators and may, thus, be used in formulating transport policies. In addition, the members of the workshop felt that new situations and policy variables should be anticipated and ad hoc techniques should be used in specific cases without undue fear as a part of the normal model-building process. Some of the variables that have been ignored in the past are traffic management measures, pricing, location and provision of parking, licensing, shared-ride and freight taxi, bus lanes, car pooling, reliability of service, and schedule delay.

The variables that are functions, e.g., travel time as a function of volume, number of lanes, signalization, and access control, should be quantified.

Not only is the inclusion of the right variables in the model important but also the way in which they are mathematically represented in the equations. The observed stability of individual travel patterns and supporting evidence of the existence of response thresholds (i.e., a change of certain magnitude is needed before it is recorded) suggest that behavioral models may not assume continual travel response. This observation is especially important for strategic and short-range planning purposes. Further diagnostic research pertaining to this problem is clearly called for.

The research projects described briefly above in this and the previous section cannot be successfully conducted by using existing data. Therefore, a government-funded data collection effort should be undertaken in 2 parts. The first part should include a
diagnosis of what needs to be measured and small diagnostic surveys to measure re-
sponses of travelers and nontravelers to identified relevant variables. Some of the
surveys might well be attitudinal surveys to identify the relevant variables.

A specific research institution should be selected to manage the sampling design and
the necessary diagnostic research. That institution should be required to appoint an
advisory group to direct the sampling design and to act as a steering committee for all
of the diagnostic work required to probe which factors enter into decisions relating to
trip-making behavior.

The end product of this first part would consist of a detailed sample design, includ-
ing appropriate questions directed toward the measurement of all those parameters
that are known or that are thought to be relevant to trip-making behavior. This would
form the basis for the second part, which is detailed and continuing surveys. The sec-
ond part should probably be done under separate contract and not necessarily involve
the same research institution.

All the data should be made generally available to further develop and test disaggre-
gate behavioral models to ultimately replace the present UTP model system.

PRACTICAL APPLICATION OF NEW KNOWLEDGE

Employment of new travel demand models in practice is of paramount importance
because the current UTP model system is theoretically, empirically, and computa-
tionally unjustifiable. The separate models in that system as well as the system itself (and
we mean the latest versions of it) can only be marginally improved. The structure of
the model system is rigid. It accepts only one type of modular sequence and cannot be
applied with confidence. Clearly, research in this field should concentrate on develop-
ing models with sound theoretical bases.

Several things, however, can be done now before new models are developed to help
bring the new models into common use. The first is the incorporation of measures of
accuracy for each model separately as well as for any sequential grouping of models in
the UTP system (and also for the new models, of course) to provide an adequate insight
into the actual performance of the model or model system. The accuracy should per-
tain to measures such as product of interest, zonal interchanges, and path volumes and
not to popular but useless measures such as trip length frequency, expressway link
volumes, and vehicle-miles of travel.

In addition, greater use can be made of existing behavioral models—aggregate and
disaggregate—in dealing with a limited range of planning problems. Models are already
in existence that can be used to deal with problems such as provision and pricing of
parking, changes in frequency of public transit, closing of lightly used stations or stops,
fare changes, air pollution controls, and energy consumption.

The third thing that can be done now is to allow and encourage those ongoing studies
that want to develop new models to update their plans to do so. Because the current 2-
front effort, using what exists and developing new and better methods besides, has failed
to produce meaningful changes in models within a reasonable time period, merging the
2 fronts in some transportation studies to help the change take place is the sensible thing
to do.

The initiative should come from the study itself, and the first of these attempts are
likely not to meet our highest expectations. Therefore, the enterprising agency should
be granted a bargaining position with the federal government with respect to time dead-
lines and study costs. Although this suggestion does not detail in step-by-step fashion
how a practicing agency can develop and employ new models, it does describe the at-
mosphere in which useful and healthy progress can occur.