Travel-Choice Behavior: Models of Perceptions, Feelings, Preference, and Choice

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This paper reports on research designed to develop practical methods to assist transportation planners to understand and respond to consumer needs and desires for travel services. The integration of the knowledge from these disciplines leads to methods of consumer-oriented transportation service planning. This approach provides transportation planners and managers with important diagnostic information about travel behavior that can be used as a guide to formulate strategies that can influence consumers' travel behavior.

Effective planning and design of transportation services to meet consumer needs depends on the planner's understanding of consumer travel-choice behavior. This research draws on state-of-the-art knowledge in travel-demand forecasting, consumer behavior theory, and marketing research techniques to develop practical methods that assist transportation planners to understand and respond to consumer needs and desires for travel services. The city of Evanston, Illinois, provides a good context for this research because of its similarity to numerous other suburban communities in the United States.

This research has three main results. First, it...
supports previous demonstrations of the importance of perceptions in determining travel-choice behavior (1-5). Second, it extends the range of psychological measures to include feelings about alternatives in addition to perceptions about the performance of the alternatives. Third, it demonstrates the importance of including measures of preference, and choice. As a result, the models provide a limited understanding of the behavioral process underlying travel decision making. Further, because these models exclude measures of travelers’ attributes, including perceptions of service attributes and personal feelings toward different services, they do not reflect the wide range of strategies that can be designed to influence consumer travel behavior. In recent years, transportation researchers have demonstrated the importance of including measures of service perceptions in travel mode-choice models (1,2,8). It is necessary to draw on theories from psychology, consumer behavior, and marketing in order to fully understand the relationship between system characteristics, perceptions, feelings, preference, and choice. The focus of this study is to analyze and describe the consumer process for choice of mode for nonwork and nonschool trips to a suburban central business area. The major objective of the research is to examine the relationships between consumers’ mode perceptions, feelings, preference, and choice as a basis for understanding consumer mode-choice behavior and developing strategies to modify this behavior. These relationships can be described by the transportation decision-making paradigm (Figure 1) developed at Northwestern University (9) by extending Rasmussen’s lens model. In this paradigm, system characteristics (Xj) serve as cues in the formation of consumers’ perceptions of service characteristics (Yij). Each system characteristic is a partial indicator of one or more perceptions. This process of using system characteristics as cues to forming perceptions is called abstraction. Once perceptions are formed, they are aggregated to determine preference. Preference, modified by situational constraints such as mode availability, determines choice. Finally, experience gained by choice and behavior may feed back to modify perceptions. Situational and individual differences not explicitly depicted in this model influence the manner in which individuals form perceptions and aggregate perceptions to direct preference and choice. An important practical implication of this model is that the abstraction and aggregation process should not be studied singly and not confused by using system characteristics as direct determinants of preference or choice.

In this study we analyze the relationships among perceptions, feelings, preference, and choice as illustrated in Figure 2. This simplified representation is part of a more complex market process that describes consumer decision among input variables, information diffusion, changes in behavior based on experience, and differences between market segments (12-14).

THEORY AND MODELS OF MODE-CHOICE BEHAVIOR

Consumers are often presented with the need to choose one of a set of available alternatives. A decision situation arises in the selection of a residence; mode of travel to work; destination for a shopping, recreational, or other trip; etc. Disaggregate travel-demand models, developed in the early 1970s and widely used today, relate travel-choice behavior to objective measures of system performance and demographic characteristics (5,7). A particular set of causal links is assumed in this research. Although the relative strength of the causal linkages between attitudes and behavior is the subject of ongoing research (15-17), it appears that the impact of attitudes on behavior is significant. The components of the model structure studied in this research are described briefly in the following paragraphs and in more detail in the sections that follow.

Perceptions of transportation modes are measured by 24 attributes identified by review of the literature, qualitative research, and questionnaire pretesting (18). Factor analysis is used to reduce these transportation service attributes to a smaller set of underlying cognitive dimensions. This provides a simpler perceptual structure that more closely approximates the consumers' use of information in decision making, and it aids managerial interpretation. Feelings about modes are investigated to determine whether psychological or perceptual factors other than evaluations of mode performance influence transportation preference and choice. A variety of non-performance-related attitudes toward travel alternatives was measured (i.e., affect, personal normative beliefs, social normative beliefs, and extraneous events). These measures are factor-analyzed to develop an aggregate measure of feeling toward each mode.

Preference logit models are used to estimate the importance weights that relate perceptions and feelings to preferences. The estimated importance weights are used to compute a preference index for each individual. For example, modal choice models are used to estimate the influence of the preference index and a particular situational constraint (automobile availability) in determining choice behavior.

PERCEPTION OF MODES

A central hypothesis of this study is that individuals choose among alternatives based on their perceptions of these alternatives rather than on objectively measured characteristics. That is, perceptions of modal attributes (system characteristics) serve as mediating variables between objective measures and preferences. Because formation of perceptions is influenced by both measured (age, income) and unmeasured (experience, psychological make-up) individual characteristics, as well as by modal attributes, perceptions of alternatives differ among individuals.

Consideration of consumer perceptions rather than direct (engineering) measures of alternatives also allows us to include attributes or characteristics for which engineering measures do not exist or that are difficult to obtain. The feasibility and usefulness of incorporating nonengineering measures in models of travel-choice behavior has been demonstrated in numerous studies (1,2,5,8,19). Differences between perceptions among individuals and/or differences between perceived and engineering measures have also been identified (20-24).

Factor analytic techniques were used to identify elemental or fundamental attributes that consumers use to describe local travel modes (18). Consumer ratings of these attributes provide an extensive description of their perceptions. These ratings provide a basis for assessing the relative strengths and weaknesses of each mode. For example, the automobile has the highest average ratings among local travel modes for 20 of 24 attributes rated.
More detailed analyses can be undertaken to examine the relative strength of different ratings and to identify variations in ratings among different groups of respondents (24). These analyses reveal that individuals using bus or walking rate their mode more positively than other individuals, whereas most individuals rate automobile similarly. This is consistent with the findings of Dobson and Tischer (23).

Information on fundamental attributes is cumbersome and difficult for the manager to interpret even when the number of stimuli (modes) is small. Also, research by Bruner and others (25) indicates that consumers identify a relatively small number of basic dimensions to reduce cognitive strain in evaluating products or services. These cognitive dimensions can be identified by factor analysis of the attribute ratings across modes and individuals (26).

Common factor analysis with varimax rotation of 24 fundamental attribute ratings for existing local transport modes was undertaken in two through six dimensions. The three-dimensional solution is selected for further analysis because it captures almost all of the information in perception with respect to its influence on preference and choice. That is, preference and choice models based on perceptions represented in three dimensions have almost identical statistics to those based on four or five perception dimensions (27). This perceptual structure can be used to describe average perceptions of the existing modes. The map of average perceptions in three dimensions (Figure 4) reveals large differences in perception of modes along the general service and convenience or accessibility dimensions and smaller differences between modes for the psychological comfort dimension. The low average rating of car with respect to psychological comfort suggests that car users are expressing a negative response to the strain associated with driving an automobile.

This reduced perceptual map is easier to work with and understand than the fundamental attribute map (Figure 3), which presents too many data to synthesize readily. It also identifies a smaller number of dimensions that trip makers use in evaluating alternative travel modes.

**FEELINGS ABOUT TRANSPORTATION MODES**

Generally, transportation researchers have employed only one psychological dimension, namely beliefs (or perceptions) about the attributes of the object (e.g., perceptions of the comfort or convenience of transportation modes), in explaining consumers' travel behavior. However, theory and research findings in social psychology indicate that other psychological dimensions might be important.
An individual's attitude toward an object is influenced not only by his or her beliefs about the characteristics of that object but also by his or her liking or disliking of the object (affect) (28). Fishbein (29) argued that an individual's attitude toward an object is not the only explanatory variable with respect to behavior. He found that social normative beliefs, i.e., an individual's perceptions of what others want him to do, are important in explaining behavior.

Similarly, Schwartz and Tessler (30) demonstrated that an individual's perceptions of what he or she ought to do (personal normative beliefs) also influence behavior. Wicker (31) found level of commitment, i.e., how easily an unanticipated event influences behavior, to be the most important explanatory variable in a study of church-related behavior.

In order to investigate whether any of the above-mentioned constructs influence transportation mode preference and choice, respondents were requested to express their feelings about transportation modes by responding to 27 statements incorporating the above constructs. The statements and their mean standardized scores are shown in the table below. High algebraic values indicate agreement with a particular statement.

<table>
<thead>
<tr>
<th>Feeling Description</th>
<th>Mean Score</th>
</tr>
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<tbody>
<tr>
<td>Enjoy travel by car</td>
<td>0.73</td>
</tr>
<tr>
<td>Enjoy travel by bus</td>
<td>-0.03</td>
</tr>
<tr>
<td>Enjoy travel by foot</td>
<td>0.43</td>
</tr>
<tr>
<td>Depressing to travel by car</td>
<td>-0.85</td>
</tr>
<tr>
<td>Depressing to travel by bus</td>
<td>-0.42</td>
</tr>
<tr>
<td>Depressing to travel by foot</td>
<td>-0.69</td>
</tr>
<tr>
<td>Ought to travel by car</td>
<td>0.15</td>
</tr>
<tr>
<td>Ought to travel by bus</td>
<td>0.11</td>
</tr>
<tr>
<td>Ought to travel by foot</td>
<td>0.31</td>
</tr>
<tr>
<td>Peers surprised if drove car regularly</td>
<td>-0.67</td>
</tr>
<tr>
<td>Peers surprised if rode bus regularly</td>
<td>-0.04</td>
</tr>
<tr>
<td>Peers surprised if walked a lot</td>
<td>-0.21</td>
</tr>
<tr>
<td>If weather bad, fewer car trips</td>
<td>0.00</td>
</tr>
<tr>
<td>If weather bad, fewer bus trips</td>
<td>0.35</td>
</tr>
<tr>
<td>If weather bad, fewer walk trips</td>
<td>0.98</td>
</tr>
<tr>
<td>If gasoline price doubled, more car trips</td>
<td>-0.89</td>
</tr>
<tr>
<td>If gasoline price doubled, more walk trips</td>
<td>0.50</td>
</tr>
<tr>
<td>If gasoline price doubled, more carpool trips</td>
<td>0.04</td>
</tr>
<tr>
<td>If gasoline price doubled, fewer car-alone trips</td>
<td>0.65</td>
</tr>
<tr>
<td>If bus fares lower, more trips by bus</td>
<td>-0.08</td>
</tr>
<tr>
<td>If bus fares lower, fewer trips by car</td>
<td>-0.16</td>
</tr>
<tr>
<td>If bus ran more often, more bus trips</td>
<td>0.28</td>
</tr>
<tr>
<td>Would travel by car regardless of cost</td>
<td>-0.35</td>
</tr>
<tr>
<td>Would travel by bus even if long walk</td>
<td>-0.55</td>
</tr>
<tr>
<td>If parking cost doubled, would walk</td>
<td>-0.20</td>
</tr>
<tr>
<td>Willing to carpool some trips</td>
<td>0.41</td>
</tr>
<tr>
<td>Different from bus riders</td>
<td>0.21</td>
</tr>
</tbody>
</table>

A number of interesting observations may be made from these results. Respondents on average express very positive affect toward car (positive enjoyment, not depressed), less positive affect toward walking, and relatively neutral affect toward bus. They indicate a high degree of sensitivity to major
increases in gasoline prices (fewer car trips, more walk trips), but little sensitivity toward lower bus fares. On the other hand, they express a positive reaction toward improved bus service (more frequent service). Respondents indicate a willingness to carpool for some trips and to reconsider the predominant use of car in the event of cost increases. Thus, in general, respondents indicate a low level of commitment to existing travel choices.

As regards personal normative beliefs, respondents generally feel they ought to travel by foot rather than by car or bus. At the same time, most respondents do not feel their peers would be surprised if they drove a car regularly.

These 27 measures were factor-analyzed in three dimensions to develop a composite index of general feelings toward each of the three modes. The three-factor solution identifies a feeling (or disposition) toward each of the three existing local modes of bus, walking, and car. The factor loadings from this solution are presented in Table 1. A factor score for each mode and individual was computed from the factor-score coefficients for the three-dimensional solution to be used in estimation of preference and choice models.

The conceptual model illustrated in Figure 1 describes the consumer response process in terms of (a) the formation of perceptions about and feelings toward modes, (b) preference formation based on perceptions and feelings, and (c) choice of mode based on preference and situational constraints.

Preference analysis is used to estimate the relative importance of the various perception and feelings measures in the formation of preference for the modal alternatives. The objective is to find a function that maps consumer perceptions and feelings to a preference index that ranks the alternatives consistently with respect to consumer preference (independent of availability and situational constraints). The relative-importance weights are determined by estimating a linear compensatory model in the context of the first-preference logit model. The first-preference logit model estimated in this research has the following general form:

\[
P_{ij} = \exp \left( \frac{V(X_{ij}, h_i)}{\sum_k \exp [V(X_{ik}, h_k)]} \right)
\]

where

\[P_{ij} = \text{probability that individual } i \text{ ranks alternative } j \text{ as his or her first preference,}
\]

\[X_{ij} = \text{attributes of alternative } j \text{ as perceived by individual } i,
\]

\[V(\cdot) = \text{the observed (or measured) portion of the preference rating function.}
\]

The appeal of this model is that it explicitly accounts for stochastic behavior (32) and that it does not make metric assumptions about preference rankings. Its drawbacks are that it uses only first-preference information and that it estimates average (i.e., across a group of individuals) rather than individual importance weights. Therefore, additional analyses were undertaken by using a rank-preference logit model (33). These analyses produced results that are similar to those obtained by the first-preference analysis about importance weights, interpretability, and prediction (27).

Model Estimation and Interpretation

Estimated model parameters, standard errors of estimate, and goodness-of-fit statistics for first-preference logit models based on perceptions only (model 1) and on perceptions plus feelings (model 2) are reported in Table 2. All three mode-performance dimensions are significant in the perceptions-only model. General service is most important, followed by convenience or accessibility and psychological comfort. Perceptions of general service and convenience or accessibility and all three mode-specific feelings measures are significant in the perceptions-plus-feelings model.
The introduction of the feelings measures produces a highly significant \( p < 0.001 \) improvement in the model. Their inclusion does not affect the relative importance among the mode performance variables. The likelihood ratio statistic \( \chi^2 \) is 527.6 for model 1 and 565.7 for model 2; the pseudo-\( \text{R}^2 \) (information) is 54.2 percent for model 1 and 56.1 percent for model 2. These results support the hypothesis that attitude variables other than perceptions of mode performance influence preference for transportation modes. The model that includes mode feelings is selected as the base preference model for further analyses.

The intermediate-preference index is computed for each individual (and mode), and this index is used along with situational constraints in predicting choice. Thus, the relative importance of perceptions and feelings is based on reported preference, rather than preference as revealed by choice.

The advantage of estimating importance weights by use of the conventional revealed-preference choice model is that it relies on observed or reported choice behavior rather than on reported preference data. The drawback of the revealed-preference approach is that the estimates of the importance weights for the perceptions and feelings measures may be biased if the nonpreference choice elements are not carefully specified. Such bias would occur if an omitted constraint variable were correlated with a preference variable. For example, distance to the nearest bus stop is a possible constraint not incorporated in the choice models developed in this research. However, this constraint is likely to be highly correlated with the perceptual dimension for convenience or accessibility. Thus, the parameter estimates for perceptions and feelings could be biased in the revealed-preference formulation.

**Model Estimation and Interpretation**

The situational constraint used in this study is the number of automobiles per licensed driver in the household \((\text{A/D})\). This variable is a measure of the availability of the car mode. We compare our hypothesized preference-index choice model (model 3) with the more-conventional revealed-preference choice model (model 4) in Table 3.

In the preference-index choice model, the relative values of the parameters for mode perceptions and feelings are constrained to equal the importance weights obtained in model 2 (Table 2). Thus, the preference-index model (model 3) has seven fewer degrees of freedom than the revealed-preference model (model 4). Because of this, we expect that the revealed-preference model will have better, but not significantly better, goodness of fit to the data.

The revealed-preference model fits the data significantly better than the preference-index model at the 2.5 percent level. However, the revealed-preference model obtains nonsignificant parameters for three variables (psychological comfort, car feelings, and bus feelings) that theory suggests are important in the mode-selection process. \( \text{A/D} \) is statistically significant in both models. This supports our hypothesis about the influence of situational constraints on mode-choice behavior. The likelihood ratio statistic \( \chi^2 \) is 464.2 for model 3 and 481.6 for model 2; the pseudo-\( \text{R}^2 \) (information) is 50.4 percent for model 3 and 52.3 percent for model 4.
Given these results, we select the preference-index model to describe the travel mode-choice decision process. This model correctly predicts 80 percent of all trip choices and explains 52 percent of the information in the data set (35). This compares favorably with random or equally likely models (33 percent correctly predicted, 0 percent information) and a market shares model (50 percent correctly predicted, 29 percent information).

**SUMMARY**

This paper describes the application of a consumer-oriented paradigm of transportation decision making to the development of travel mode-choice models in the context of nonwork and nonschool trips to downtown Evanston. This paradigm provides an improved understanding of consumer travel behavior by inclusion of important attitudinal variables. The consumer-oriented approach described here also provides important diagnostic information about travel behavior, thus assisting in the development of appropriate strategies.

Underlying the proposed methodology is a conceptual model of the interrelationships between system characteristics, perceptions, preference, constraints, and choice. The conceptual model is operationalized in the form of interrelated component models of perceptions, feelings, preference, and choice (Figure 2). The analysis produces powerful mode-preference and mode-choice models based on measures of perception and feelings as explanatory variables. The research indicates that psychological measures of mode feelings, as well as perceptions of mode performance, are important in consumers’ preferences for and, hence, choice of travel modes. This has important implications for strategy development, since it implies that preference (and thereby choice) can be altered without necessarily changing the service. Alternatively, it may suggest that changes in mode use in response to service improvements may be limited if deep-seated feelings about modes are not changed.

The conceptual model developed in this research considers choice to be determined by preference and situational constraints, such as car availability. In other words, certain constraints are considered to mediate between preference and choice. This concept is operationalized by using a preference index and a measure of car availability (A/D) in a preference-index choice model. In this analysis, the preference-index model yields statistics similar to those of the more conventional revealed-preference model but provides better understanding and interpretation of the travel choice process.

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