Traveler Attitude-Behavior Implications for the Operation and Promotion of Transport Systems

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Alternative hypotheses on how traveler attitudes relate to system usage are examined to infer strategies for the operation and promotion of transport systems. Two different transport modes (carpools and buses) and two different data sets are analyzed. The analyses highlight the differential roles of perceptions of system attributes and modal affect in accounting for traveler behavior. In addition, the mutual dependence of attitudes and behavior on each other is confirmed. After these relationships are empirically demonstrated, some practical operational and promotional implications are developed. It is noted, for example, that system improvements by themselves can be insufficient to produce desired changes in system usage. Two specific promotional strategies that can complement system improvements and help increase system usage are described and linked back to the analysis of traveler attitude-behavior relationships.

Despite an abundance of research on attitudes toward transportation systems (1), there is no widely accepted theory of traveler behavior that incorporates traveler attitudes and allows specific predictions about the effects of changes in transportation systems. This has hindered attempts by designers of transportation systems to make cost-effective trade-offs between system attributes. It has also retarded the development of effective transportation marketing programs that encourage travelers to use existing transportation facilities in ways that minimize the need for new facilities.

Previous research has verified that attitudes are correlated with traveler behavior and sociodemographic characteristics (2, 3). The need for improved theory is reflected, in part, by the emerging interest in whether attitudes are determinants of traveler patterns or whether traveler behavior causes attitudes (4, 5). The latter issue is important because if attitudes cause behavior, then mode choice can be influenced by changing traveler viewpoints toward public transit, carpools, and single-occupant automobiles. By studying consumer preferences for transit attributes, for example, it is possible to specify one or more mixes of comfort, convenience, and safety that give optimum consumer satisfaction within given cost constraints. A modeling framework can be developed that links subjective reactions to objective features of the system.

Even if attitudes do not determine behavior, they can still be used in a number of transportation policy and planning contexts, such as the identification of perceived user benefits. In order to determine the proper role for attitudinal research in transport analysis, it is essential to determine the nature of the interrelationships between traveler attitudes and traveler behavior.

DEFINITION OF ATTITUDINAL COMPONENTS

It is important to clarify what is meant by attitudes, since transportation researchers have used the term rather loosely (6). Social psychologists accept the structuring of attitudes into the following three components: cognitions, feelings (affect), and behavioral intentions (7). However, there is much controversy about the relationships among these components.

The results presented in this paper refer exclusively to cognitions and affect. Behavioral intentions are important, but they form the focus of attention of other research summaries (8). The cognitive or perceptual components represent a person's information about a tangible or intangible object. Each piece of information can be broadly classified as either a belief in the existence of an object (awareness) or an evaluative belief about an object (perceptions or comparative judgments of specific attributes). The affective or feeling component deals with the person's overall feelings of like or dislike for an object, such as a bus. Affective (preference) judgments may be said to combine information about product evaluation and the individual's ideal product.

MODELING PERSPECTIVES

Several modeling perspectives from social psychology and marketing can be merged and extended to form the basis for a widely accepted theory of traveler behavior. These modeling perspectives can be adapted so that they yield benefits to transportation system designers and marketers. Multiattribute models help us to appreciate the combined effects of different kinds of perceptions; hierarchical models direct attention to linkages among different kinds of attitudinal components and behavior. Cognitive balance concepts identify the possibility that attitude-discrepant behavior can cause attitudes to change. That is, attitudes and behavior complement one another with respect to cognitive balance.

Multiattribute Models

Rosenberg and Fishbein have asserted that liking an object, such as a bus, is a function of perceptions about the attributes of the object and the importance of those attributes to individuals (9, 10). The functional relation between preference for an object and attribute perceptions and importance is frequently assumed to be linear and additive (11).

Beliefs pertain to object attributes. Some attributes may be very important and yet not influence consumer preference because the traveler does not believe that the bus possesses those attributes. Alternatively, a transport mode may be very high on an attribute (e.g., low cost), but not be liked to a commensurate degree.

In the latter case, multiattribute models presume that consumers simply do not believe that attribute is important. Multiattribute models are known to correlate with consumer preference; however, their chief value to consumer research is in the area of diagnosis, not prediction. Aggregate measures, such as satisfaction with the product and consumer purchase or usage intentions, perform better than measurements of beliefs as predictors of buyer behavior (12). However, these aggregate measures of consumer attitudes (i.e., satisfaction and usage intentions) fail to reveal the relative significance of product attributes as determinants of consumer preference. Furthermore, policy implications largely emerge from an understanding of those factors that can be adjusted to change consumer preference and behavior.

Hierarchical Models

Some behavioral theorists have suggested that several attitudinal constructs feed into one another before they ultimately influence behavior (13). Typically, three attitudinal concepts are differentiated: cognition, affect, and conation (see Figure 1). It is often argued in hierarchical models that affect toward a service is a function of cognitions about that service. This is compatible with the multiattribute models mentioned above. Hierarchical models are structured as they are because it is presumed that cognitions and affect do not influence behavior directly. Instead, these models presume that cognitions and affect influence behavior through their position in the hierarchy, which has the structure: cognition-affect-conation-behavior.

At the Second International Conference on Behavioral Travel Demand, the basic hierarchical model of cognition-affect-conation-behavior was suggested as an explanation of mode choice by travelers (14). Subsequent empirical research by Tischer and Dobson has shown that parts of the overall model are compatible with traveler judgments (8).

Cognitive Balance

Another basic approach to analysis of attitudes is cognitive balance or consistency theories (15, 16). This theoretical perspective uses drive-reduction principles to explain why people change their attitudes or behavior to avoid cognitive inconsistency, a noxious state. Festinger developed one of the most widely studied balance theories with his cognitive dissonance model (18-21). When relevant attitudes and behavior are the obverse of each other, then cognitive dissonance is generated. The degree of dissonance arousal depends on the importance of the cognitive elements (i.e., behavior and attitudes).

Cognitive balance is important in the present context because it implies that behavior can cause attitudes. Attitudes will be modified when they are at variance with behavior. This occurs because it is frequently easier to change attitudes than behavior. Horowitz and his associates (2, 5) have pioneered in the application of cognitive dissonance theory to travel behavior. Multiattribute models generally assume that attitudes influence behavior without acknowledging that behavior can concurrently affect attitudes. The formulations considered below are based on hierarchical multiattribute notions, and they permit attitudes and behavior to be mutually dependent on each other.

Research Objectives

This paper attempts to build on and extend prior efforts at theory construction and validation for attitudinally based models of travel behavior. Structural equations and flowgraphs are used to quantify and assess hypotheses about traveler attitude-behavior interrelationships. Our modeling orientation references multiattribute, hierarchical, and cognitive-balance notions. Two data sets are used to analyze assumptions about traveler behavior mechanisms with respect to two different transport modes—buses and carpools.

STUDY DESIGN

Data Sets

The analyses reported here were performed on attitudinal data collected by the Federal Highway Administration (FHWA) and General Motors Research Laboratories (GM). The FHWA data set was assembled from an attitudinal transportation survey conducted in the Los Angeles area in 1977. For the purposes of our analysis, the sample is composed of approximately 800 individuals who work in the downtown area and who live within 3.2 km (2 miles) of a freeway, which feeds radially into that area. Crisscross telephone directories were used to select households randomly that surrounded the freeways from census tracts with a high incidence of downtown workers. Only commuters who worked in this downtown area were eligible for the interview. When a household contained more than one downtown worker, the person taking the less frequently used mode was chosen to be interviewed.

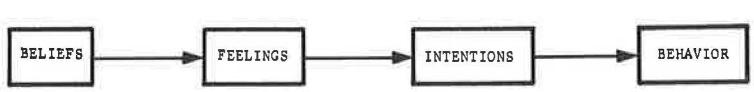
The GM data set, the carpooling questionnaire, includes 1010 respondents from the Chicago area, not all of whom were instructed to complete the entire questionnaire (2). Respondent selection was dependent on modal status and place of employment. Enterprises that employed at least 100 people were randomly chosen from a list of Chicago firms and those firms agreeable to participation distributed the questionnaire to their employees. Because of the unique requirements of this analysis, the eventual sample for the results reported here is based on approximately 400 respondents.

Variables

Three types of variables are used in our analyses. These are attitudes, behavior, and sociodemographic characteristics. The attitudes and behavior are examined for their mutual dependence on each other as conditioned by sociodemographic characteristics.

Two types of attitudinal measure are included in the analysis. The first of these attitudinal variables is the perception of system attributes, a cognitive attitudinal component. A previous analysis of these data derived factors that corresponded to convenience and comfort perceptions for buses (22). Bus convenience was defined with respect to specific consumer evaluations of ease of use, reliability, on-time arrival, ease of getting from the bus to the final destination, wait time for the bus, and convenience. The specific attributes that

Figure 1. Simple, hierarchical attitude-behavior model.



define bus comfort were crowding, relaxing experience, space for packages, and comfort. The second type of attitudinal variable was overall affect toward buses. It was defined by responses to a seven-point scale, from completely satisfied to completely dissatisfied.

Respondents were asked to state the way they traveled to work. The frequency of bus and carpool usage (the behavioral variables) were designated on a category scale that ranged from never through five or more times per week. This response was converted to a monthly frequency prior to analysis.

Sociodemographic characteristics were used as background variables for studying the interrelationships of attitudes and behavior. Characteristics used to identify interrelationships were income, number of automobiles available, number in household, number of driver's licenses in a household, number of blocks from bus to final destination, and a quantity called impedance, based on the travel times of buses and automobiles.

Analysis Method

The primary analytical tool is structual equations estimated by two-stage least squares. The general topic is discussed from a broad social-science perspective by Heise (23) and Hanushek and Jackson (24). Flowgraphs, which are discussed extensively by Heise, are used to represent structural equations and to display estimated t-values for structural equation coefficients.

Figure 2 depicts, in flowgraph form, a simple example in which attitudes (A) and behavior (B) are mutually dependent. This sort of feedback is referred to as a nonrecursive relationship. The variables EX_1 and EX_2 are exogenous variables because their values are determined by factors outside of the system of equations depicted by the relationships shown in Figure 2.

In this research, exogenous variables are demographic, objective, or transport system variables (e.g., EX_1 = income and EX_2 = automobile availability). The variables A and B are called endogenous variables because their values are determined by the system of equations. The structural equations for Figure 2 have the following representation:

$$B = f_a (A, EX_2) \quad (1)$$

and

$$A = f_b (B, EX_1) \quad (2)$$

Since attitudes and behavior are on both sides of the system of equations, ordinary least squares is not an appropriate estimation procedure. Ordinary least squares requires that right-hand variables be independent of residuals, which will be violated when any variable appears on both sides of a system of equations. However, unbiased estimates can be obtained by using two-stage least squares. The first step is to estimate the endogenous variables as a linear function of the exogenous variables. The least-squares representation of this step is

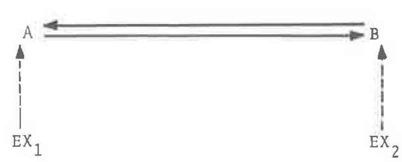


Figure 2. Mutual dependence of attitudes and behavior on each other.

$$B \simeq f_1 (EX_1, EX_2) = \hat{B} \quad (3)$$

and

$$A \simeq f_2 (EX_1, EX_2) = \hat{A} \quad (4)$$

The estimates of the endogenous variables ($\hat{B}$ and $\hat{A}$) are substituted into the structural equations to estimate the coefficients of the structural equations. The second stage can be denoted by

$$B \simeq f_3 (\hat{A}, EX_2) \quad (5)$$

and

$$A \simeq f_4 (\hat{B}, EX_1) \quad (6)$$

The results of the second stage can be used to test hypotheses about the relation between attitudes and behavior. For example, the interpretation of mutual dependence can be based on the statistical significance of the coefficients for A and B in Equations 5 and 6. If the coefficients for both estimated endogenous variables are statistically significant, then mutual dependence is supported.

A Hierarchical Model

Figure 3 shows a flowgraph and a set of structural equations similar to the ones that will be discussed here. The flowgraph depicts a model in which cognitions (CONV and COMF for convenience and comfort perceptions, respectively) act as determinants of feelings (MA for modal affect). It is hierarchical because CONV and COMF indirectly influence behavior (BEH) through MA. Since there is an isomorphism between flowgraphs and structural equations, the flowgraphs provide an overall view of an interconnected set of structural relationships. Figure 3 draws the analogy for a system of Equations 7-10. The exogenous variables EX_1-EX_5 designate demographic and transport system variables.

Each structural equation defines a part of the flowgraph. For example, Equation 7 denotes BEH and the two arrows that go into it from MA and EX_5. The coefficients of the structural equations correspond to the arrows that link the variables in the flowgraph. It is possible to indicate the statistical significance of the equation coefficients and the corresponding linkages by placing t-statistic values on the arrows. As with the simpler model above, the computation of the coefficients and the relevant t-statistics can be achieved through two-stage least squares.

RESULTS

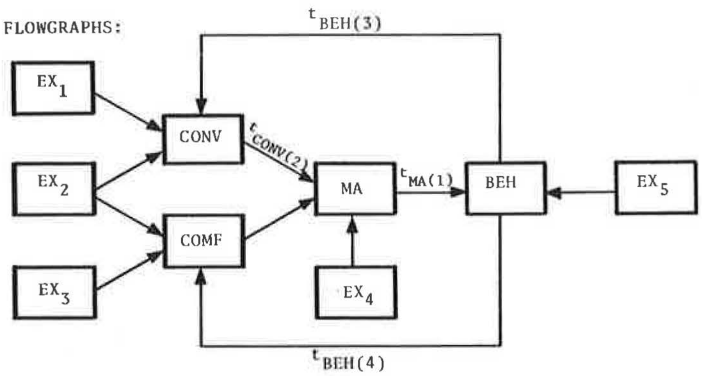
The top flowgraph of Figure 4 shows a hierarchical model derived from the FHWA bus data. The exogenous variables in the model are defined at the bottom of the figure; they will not be explicitly discussed since our focus is on the interrelations among endogenous variables. The flowgraph shows convenience and comfort perceptions that feed into modal affect. Modal affect corresponds to overall satisfaction with the bus. Behavior, namely frequency of commuting by bus, is pictured as being directly influenced by modal affect; convenience and comfort perceptions are shown to contribute indirectly to behavior through modal affect. The t-statistics for this model show that the link from convenience to modal affect is significant but the link from comfort to modal affect is not. However, this does not mean that perceptions of comfort are unrelated to modal affect; rather, when comfort is combined with convenience to predict modal affect, comfort does not add any predictive power over that obtained from convenience. The link from modal affect to behavior is highly significant.

The bottom flowgraph of Figure 4 shows a model that is identical to that in the top flowgraph except for the addition of behavioral feedback. The links from behavior back to perceptions of convenience and comfort are both significant. This confirms the findings of a previous report (4) that cognitions are influenced by behavior.

These two flowgraphs represent two alternative hypotheses about the influence of feedback on cognitions.

Figure 3. Equivalence between structural equations and flowgraphs.

FLOWGRAPHS:



STRUCTURAL EQUATIONS:

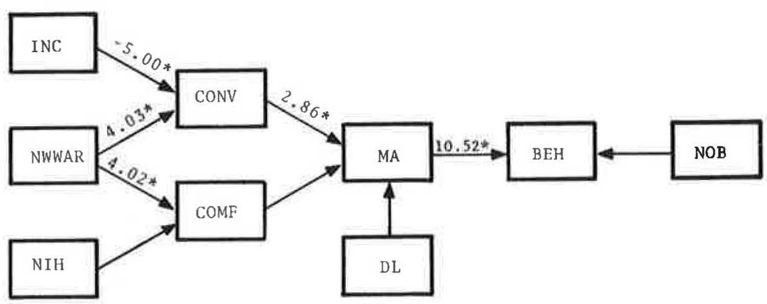
(1) BEH = $f(MA, EX_5)$

(2) MA = $f(CONV, COMF, EX_4)$

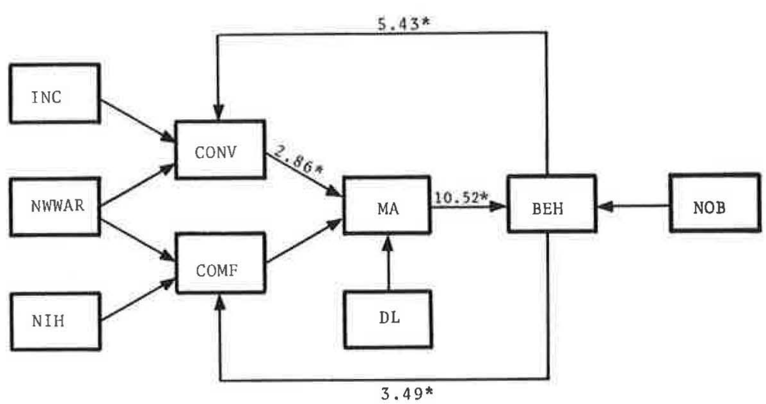
(3) CONV = $f(BEH, EX_1, EX_2)$

(4) COMF = $f(BEH, EX_2, EX_3)$

Figure 4. Behavioral feedback in a simple attitude-behavior model.



*p<.05



EXOGENOUS VARIABLES:

INC = Income

NWWAR = Number of autos in household divided by number workers in household

NIH = Number of residents in household

DL = Number of drivers licenses in household

NOB = Number of blocks

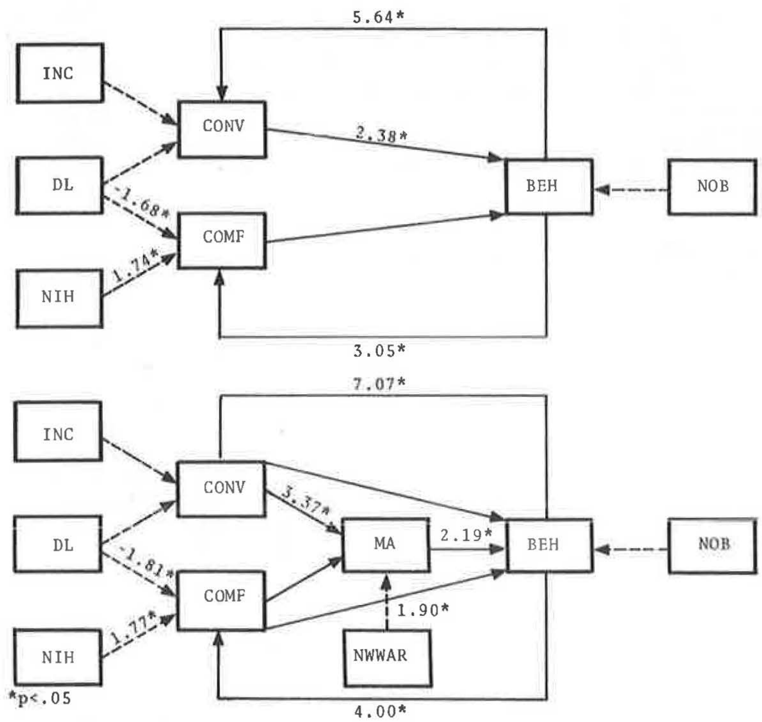


Figure 5. Role of affect for bus attitude-behavior relationships.

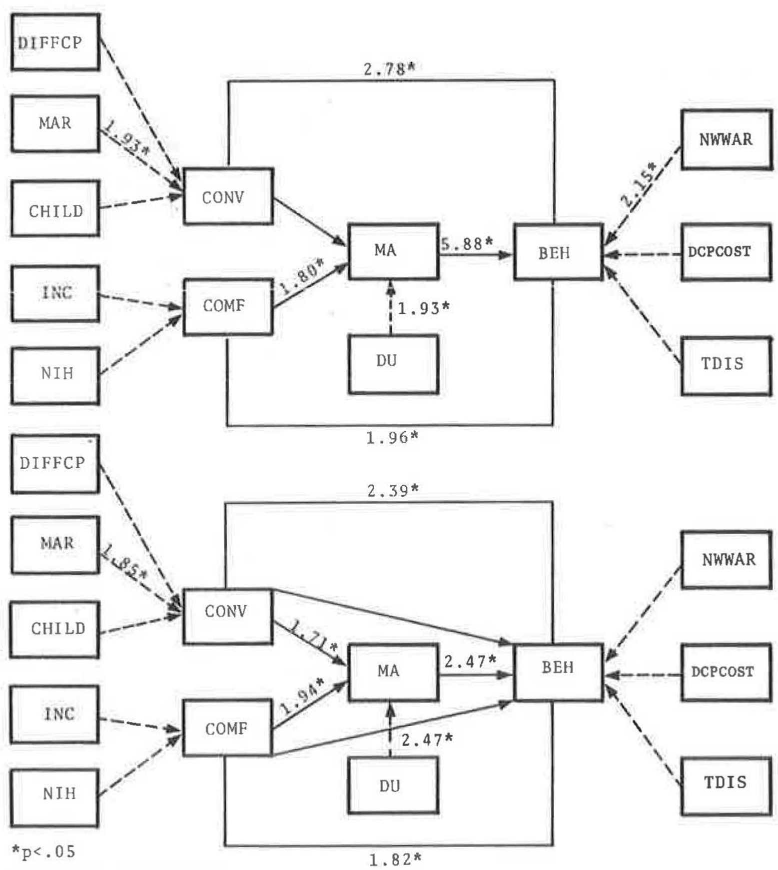
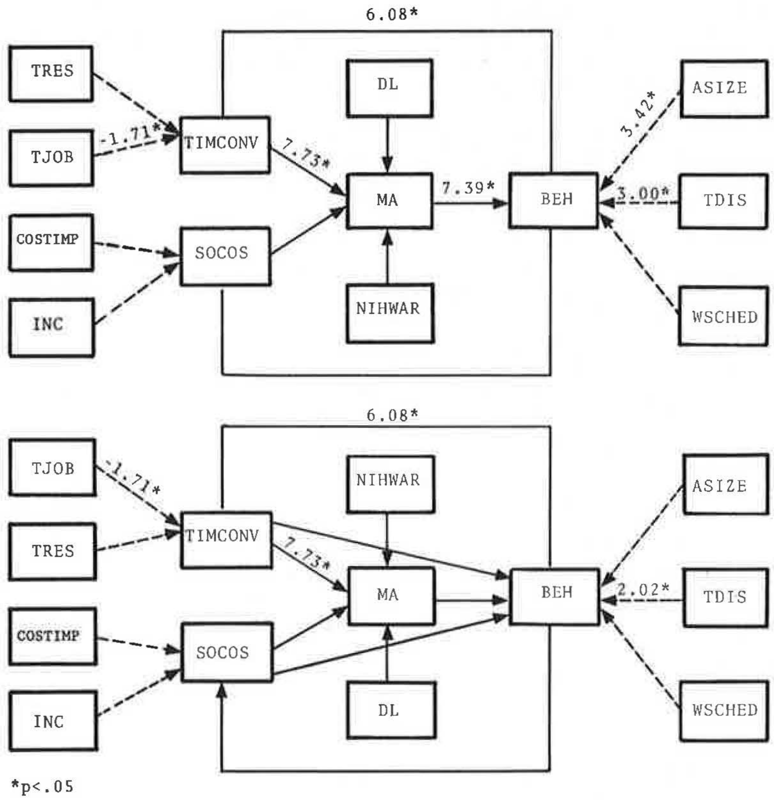


Figure 6. Hierarchical model for FHWA carpool data.

EXOGENOUS VARIABLES:

DIFFCP = Difficulty obtaining carpools
MAR = Marital status
CHILD = Children under 18
INC = Income
NIH = Number of household members
NWWAR = Workers-autos divided by workers
DCPCOST = Auto-carpool costs
TDIS = Trip distance
DU = Type of dweling

Figure 7. Hierarchical model for GM carpool data.



EXOGENOUS VARIABLES:

TJOB = Years at job

TRES = Years at residence

COSTIMP = Cost of carpooling

INC = Income

NIHWAR = Number in household-autos divided by number in household

DL = Regular drivers

ASIZE = Auto size

TOIS = Trip distance

WSCHED = Work schedule

A comparison of the two hypotheses permits an evaluation of the role of behavioral feedback in traveler attitude-behavior interrelationships.

Both flowgraphs verify that the attitude-to-behavior links are statistically significant. These flowgraphs support a hierarchical relationship in which perceptions influence affect and affect, in turn, contributes to behavior. When behavioral feedback is introduced into the set of relationships, the t-values of the exogenous variable antecedent of perceptions become statistically nonsignificant, but the attitude-to-behavior links remain unchanged. Behavioral feedback is highly significant with respect to cognitions, but the feedback of behavior on attitudes does not require changes in attitude-to-behavior relationships.

Figure 5 shows two flowgraphs that clarify the role of modal affect in the hierarchical model. The exogenous variables in these flowgraphs are the same as those in Figure 4 and their influence is similar. The top flowgraph in the figure shows that when modal affect is taken out of the equations, the link from convenience to behavior is significant. The link does not have as large a t-statistic as that from modal affect to behavior in Figure 4. But behavior can be predicted from beliefs on a statistically significant basis. This is the kind of link that researchers depend on when they look at the relationship between perceptions of system attributes and behavior.

However, the bottom flowgraph shows how important modal affect is in predicting behavior. The direct links from convenience and comfort to behavior are not significant when modal affect is included with them as a predictor of behavior. On the other hand, the link from modal affect to behavior is still significant. It is, perhaps, an overstatement of the case to say that all of the predictive power of convenience comes from its relationship with modal affect. However, these flowgraphs clearly show that modal affect predicts frequency of use over and above the effect of beliefs on behavior.

Figure 6 shows two flowgraphs derived from the FHWA carpool data. The endogenous variables in this model are the same ones as in the previous models. The exogenous variables are demographic and system variables that would be expected to be related to carpool usage. The link from comfort to modal affect is significant in both flowgraphs. This indicates that, relative to convenience, perceived comfort is a more important factor for carpools than it is for buses. However, our analyses of a large number of models for carpools show that comfort is not always significant. It is not a consistent predictor of modal affect. Notice also that convenience is significant in the bottom flowgraph but not in the top one. In general, perceptions of system attributes are not strong predictors of modal affect for these carpool data.

The feedback links from behavior to perceived convenience and comfort are both significant. This shows that behavior influences attitudes toward carpools as well as toward buses.

The top flowgraph shows that the largest t-statistic is from modal affect to behavior. The bottom flowgraph shows that modal affect influences behavior over and above the influence of convenience and comfort on behavior. However, the links from convenience to comfort are not significant when the influence of modal affect is included with them. These findings show that modal affect is an important predictor of behavior for carpools as well as for buses.

Figure 7 shows two flowgraphs from the GM carpool data. As noted above, the attributes rated here are different from those included in the FHWA survey. TIMCONV is a combination of the perceived convenience and perceived time savings of carpools. SOCOS is a combination of judgments of the social costs of automobiles. The measures of modal affect and behavior are similar to those used in the FHWA survey.

The top flowgraph shows that, in general, the relations are similar to those in the FHWA data. The bottom flowgraph shows that the links from convenience and social cost to behavior are not significant when the influence of modal affect is included with them. However, unlike the FHWA data, modal affect is not a significant predictor of behavior when the influence of perceived convenience and social costs is included. For this data set then, modal affect is a strong predictor of behavior but does not add any additional predictive power over perceived convenience.

DISCUSSION OF RESULTS

This paper presents structural-equation modeling analyses of traveler attitude-behavior interrelationships. The results provide information on three topics that relate to bus and carpool usage:

1. Behavioral feedback influences perceptions of system features,
2. Convenience perceptions are more important than comfort perceptions for buses and more important than perceived social costs for carpools, and
3. Affect has incremental explanatory power over cognitions in describing bus usage.

The impact of behavioral feedback on traveler attitude-behavior interrelationships is important for several reasons. Our findings suggest that travel attitudes and behavior mutually influence each other, and it is for this reason that the exclusive study of either one by transport analysts will lead to an incomplete understanding of traveler behavior and potentially faulty policy implications for the design and operation of transportation systems. Self-reports of feature ratings do predict behavior, but behavior also changes the rating of features. From a theoretical perspective these results show that a behavioral feedback mechanism that is consistent with cognitive dissonance theory can concurrently exist with attitudinal influence on behavior. From a marketing viewpoint these findings suggest a promotional strategy that transit operators might use to increase patronage. Our results suggest that experience with a system improves users' perceptions of its features, which are in turn related to usage. Therefore, offering potential patrons free or reduced-fare rides to give them experience with a system should enhance their evaluation of it, and this in turn should increase the frequency of use.

A second promotional strategy is suggested by the links from perceptions of attributes to behavior. It would emphasize those features of a system that are most strongly related to usage. For the data sets we have analyzed, convenience perceptions stand out as an extremely important factor, which underlies traveler behavior. Perceptions about social costs of automobile driving and comfort have a weaker association with travel behavior. A promotional campaign that emphasizes convenience is likely to be more successful than one that emphasizes comfort or social costs. There may also be other features that we have not analyzed that are important to transit usage. In addition, analyses of these data reported elsewhere (22) have shown that the strength of the links between attitudes and behavior vary for different subgroups or market segments. An effective promotional strategy should, then, emphasize not only the important features but should also be targeted to specific market segments for which that factor is especially important.

Our analyses also showed that, at least for buses, the relation between perceptions of system features and behavior is mediated by their relations to modal affect. Modal affect was found to be not only the strongest predictor of behavior but also to add predictive power over and above the influence of perceived convenience and comfort. This suggests that favorable evaluations of transit attributes are necessary but not sufficient to attain transit ridership. Perceptions of attributes do influence affect, but there appears to be a component of it that is independent of the perceived attributes of a system. It may be necessary, therefore, to change a potential user's image or overall evaluation of a mode before favorable perceptions of features can lead to increased usage.

We need to achieve a better understanding of modal affect, its determinants, and what can be done to manipulate it. It may be determined by such factors as peer group norms and social class variables. We also need to know more about how market segmentation influences the interrelationships among cognitions, affect, and behavior.

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