exceeded, a shift to automobile travel should be expected. Similarly, if transit speeds are improved through the development of better transit systems, and work travel could be accomplished in less than 1 h, then the travel-time-budget concept indicates that the use of the transit mode for additional nonwork trips may increase. This concept, if researched more thoroughly, could improve our understanding of the modal-split model.

3. Mobility--Whenever transportation plans are evaluated, a key concern is the impact on the mobility of residents, particularly those who do not own a car. It has always been very difficult to define what is an adequate level of mobility. The travel-time budget may provide the basis for a suitable mobility criterion. This preliminary research suggests that mobility may be defined as the ability to make more than the basic two work trips within the travel-time budget of 1 h. Further research of this concept is required.

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Analyzing Traveler Attitudes to Resolve Intended and Actual Use of a New Transit Service

MICHAEL R. COUTURE AND THOMAS DOOLEY

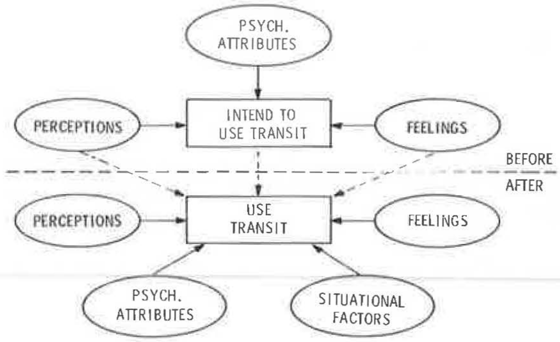
Traveler attitude data have been shown in the literature to be important in helping to predict the use of new transportation technologies or services. Reported prior intentions to use a new service often significantly overstate actual use once the service has been implemented. Differences obviously exist between the processes of intention formation and choice. An analysis is described that explores the differences between behavioral intentions and actual use of a new transit service by using extensive attitudinal data collected before and after implementation of a new transit system in Danville, Illinois. Several econometric models were developed, and the results are analyzed and compared. Choice constraints are treated explicitly in the analysis. Among the major findings are that level-of-service perceptions such as "convenience" and "enjoyment" and general feelings or biases regarding different transportation modes are important determinants in forming both intentions and choices. However, significant differences were found in terms of the relative importance of these attitudinal factors in the choice and intention processes, and these differences are highlighted.

During the past decade, a number of research efforts have been conducted on the use of attitudinal measures in travel demand models (1-4). Attitudinal measures that describe individuals' feelings, perceptions, and intentions with respect to the transportation system have been found to significantly improve the explanatory power of demand models, particularly disaggregate models of modal choice, because they take into account subjective or unobserved factors that are important in the travel decision process. Factors such as convenience, comfort, and safety have been shown in past research to be of considerable importance in modal-choice travel decisions (5,6) and should be included in choice models if possible.

In addition to these considerations, a major reason underlying the desire to use attitudinal information in the models, whether to supplement or replace the conventional use of observed information in the model specification, is to be able to better understand, and ultimately predict, the response to the introduction of new (i.e., untried) or greatly improved transportation services. It is felt that problems that involve demand for new modes or services are perhaps most amenable to solution through analysis of traveler attitudes rather than through extrapolation of observed measurements (1).

This study develops a set of behavioral models that incorporate attitudinal measures to aid in understanding the relation between the intended use of a new public transit system (reported prior to implementation) and actual use (reported after implementation). It is recognized in the literature

Figure 1. Modeling framework: hypothesized causal relations.



(7) that behavioral intentions (e.g., reported demand for a new mode) tend to significantly overstate actual behavior (e.g., actual use of the new mode). This stems partly from individuals' lack of experience using the new mode, from changing attitudes, and from omission of choice constraints (i.e., accessibility to the new mode). Thus, these factors were taken into consideration in the development of the models.

The data set used to estimate the models contained information on traveler attitudes and other relevant factors. The data were collected before and after implementation of a new transit system in Danville, Illinois, as part of an Urban Mass Transportation Administration Service and Methods Demonstration Program project.

MODELING FRAMEWORK

The foundation of the analysis was the formulation of a causal framework that represents the relations between prior and current attitudes and intended and actual transit use. The hypothesized causal framework is shown in Figure 1. In developing this framework, attitudes were divided into three components: perceptions and feelings regarding the new transit service (versus other transportation modes) and intentions to use the new service. In this particular study, perceptions were measured as individual responses to survey questions regarding the relative comfort, convenience, speed, enjoyability, and cost of transit versus other modes including car, taxi, and walking. Feelings were measured as a respondent's agreement or disagreement with certain statements that clearly represented protransit or antitransit and procar or anticar biases. Intentions were measured (prior to service initiation) as a respondent's expected frequency of use of the new service (once implemented). This tripartite characterization of attitudes--i.e., perceptions, feelings, and intentions--is a concept widely accepted by social psychologists. However, the linkages among these components are still the subject of debate (4).

In reference to Figure 1, three primary relations should be enumerated.

1. Intention to use transit was hypothesized as determined by prior perceptions and feelings regarding the new service and underlying psychological attributes of individual travelers (upper portion of Figure 1). Underlying psychological attributes, which were represented in this study by sociodemographic factors such as sex and age, were expected to explain fundamental differences in attitudes and thus behavioral intentions.
2. Actual use of transit (after implementation) was hypothesized as determined by "current" (i.e., after) modal perceptions and feelings, psychological attributes, and situational factors. Situational factors represented such modal-choice constraints as automobile availability, transit accessibility (e.g., distance to the nearest stop), and individual mobility restrictions (e.g., physical disability).
3. Actual use of transit was hypothesized as determined, at least partly, by prior modal perceptions, feelings, and intentions (dashed lines in Figure 1).

The latter relation--i.e., actual use as a function of prior attitudes--was expected to be a tenuous one, depending in part on the stability of traveler attitudes from before to after initiation of the service (i.e., once the service became available and was experienced). However, even accounting for attitude changes from before to after, a relation was still possible if the choice process after implementation was consistent with attitudes before implementation. That is, a potential cause-and-effect relation could have been the following: Prior attitudes determined current behavior (i.e., actual choices), and this behavior in turn caused changes in current attitudes. This notion of interdependence between attitudes and behavior has received considerable attention from transportation researchers in recent years (4,8,9) and was an important consideration in analyzing the results of the models developed here.

THE MODELS

Based on the causal framework and primary linkages described, three models were relevant in addressing the problem: (a) a model describing intended transit use as a function of information collected prior to implementation, (b) a model explaining actual transit use using data collected prior to implementation, and (c) a model explaining actual transit use using information obtained after implementation. These models are represented explicitly below as models 1, 2, and 3:

1. Model 1--Intended use = f (prior perceptions, feelings, psychological attributes),
2. Model 2--Actual use = f (prior perceptions, feelings, intentions, psychological attributes, situational factors), and
3. Model 3--Actual use = f (current perceptions, feelings, psychological attributes, situational factors).

For application purposes, a model such as model 2, in which prior information is used to explain behavior after implementation, is most desirable. However, the model as formulated here is more a learning tool than a forecasting tool, as is discussed later.

To represent the processes of intention formation (model 1) and actual choice (models 2 and 3), a binary logit model structure was chosen. The statistical properties of the logit model are well documented (10) and are not restated here. The particular form of the model used was as follows:

$$\text{Prob}_i\,(\text{transit}) = e^{U_i}/(1 + e^{U_i}) \quad (1)$$

where e^{U_i} is the exponential of the relative utility to individual i of transit versus other modes (i.e., personal automobile, taxi, and walking in this case).

For the model of intended use, the dependent variable was the probability of individual i intending to use transit versus other modes (i.e., versus not intending to use transit) for any purpose. For the models of actual use, the dependent variable was the probability of individual i using transit versus not using transit for any purpose. Thus, the models addressed generally the question of whether a person intended to use or actually did use the new transit service, regardless of the frequency of use or the purpose for using it.

The independent variables that composed the utility functions (Ui) of the models included measures of the perceptions of transit level of service relative to the level of service of the other modes available and measures of explicit feelings or biases toward or away from transit or automobile (the two primary competing modes). Measures of underlying psychological attributes, modal availability, and degree of intended transit use were also factored into the utility expressions of all or some of the models. The precise variable definitions are described in the next section of this paper.

The selection of a logit model structure was predicated on both practical and theoretical considerations. The successful application of logit models in analyzing discrete modal choice has been well documented in the literature, including applications using attitudinal data (2). In addition, a readily accessible estimation program that used a maximum likelihood technique was available. This program involved the use of the Time-Shared Reactive On-Line Laboratory (TROLL) econometric modeling system of the National Bureau of Economic Research, Inc.

DATA

The data used for estimating the models were obtained from a telephone survey administered one month before and eight months after the introduction of a bus transit system in Danville, Illinois, in 1977 (11). Danville is a city of approximately 42 000 people located 120 miles south of Chicago. The new transit service, which consisted of 11 routes, 6 operating at 60-min headways and 5 at 30-min headways, provided extensive coverage of the city. The base fare (using a prepaid ticket) was $0.40. After six months, the service was averaging 800 riders/day. The service characteristics (coverage, headways, and fare) of the actual service closely approximated the hypothetical service described in the preimplementation survey. The before-and-after survey questions covered those choices, perceptions, feelings, intentions, situational factors, and sociodemographics discussed above in relation to the modeling framework.

A sample of 567 individuals responded to both the preimplementation and postimplementation surveys. The sample size was reduced to 485 by eliminating those respondents who were physically unable to use transit and those who lived more than five blocks from a transit stop.

Key socioeconomic and situational characteristics of the sample included the following:

Characteristic	Percentage of Sample
Sex	
Female	80
Male	20
Age (years)	
<20	4
20-65	59
>65	37
Occupation	
Working or going to school	44
Retired or keeping house	56
Carless household	19
Living within one block of new transit service	71

Construction of Variables

The complete set of variables constructed for the model-estimation process is given in Table 1. The socioeconomic variables (age, sex, and employment status) were stratified into 0,1 variables by categorization (e.g., 0 if male, 1 if female). The situational factors constructed characterized the availability of the automobile mode and the relative accessibility of individuals to transit. The other modes--taxi and walk--were assumed to be available equally to all individuals.

Variables of level-of-service perception were defined in four ways by using ordinal-type specifications:

1. Assign a value of 1 if transit is ranked best (i.e., least expensive or most enjoyable, fast, comfortable, or convenient), else 0;
2. Assign a value of 1 if transit is ranked best (as above), a value of -1 if transit was ranked worst (i.e., most expensive, least comfortable, etc.), else 0;
3. Define as in method 1 but multiply by a weight depending on the reported relative importance placed on that perception (see the variable for relative importance of perceptions in Table 1), regardless of mode (e.g., convenience is most important, least important, etc.); and
4. Define as in method 2 above but weight as in method 3.

All of these methods were consistent with the model of transit choice relative to other modes (personal automobile, taxi, and walk). Method 2 included additional perceptual information, whereas methods 3 and 4 included additional information about individual values.

The feelings variables were defined as 1,0 variables: 1 if the respondent agreed and 0 if he or she disagreed or was neutral regarding a particular transportation modal issue. A variable for intended frequency of transit use (TRIPFREQ) was defined as the sum over all purposes (work, shop, and other) of the number of intended trips per week by transit given that transit was to be used for those purposes. This variable was used in model 2 to represent the degree of prior intent to use transit.

Preliminary Data Analysis

Extensive cross-tabulation and correlation analyses were conducted to determine initial variable sets for model estimation and to assess potential colinearity among the independent variables.

The cross-tabulation results showed that 81 percent of the women and 71 percent of the men in the sample intended to use transit and that only 35 percent of the women and 24 percent of the men actually used it. This translates into approximately three intenders for every actual user and confirms the earlier assertion regarding intentions overstating actual behavior. There were no significant differences among age or employment groups with respect to intended or actual use of transit. The results also showed that 37 percent of those who said they intended to use transit did use it whereas 84 percent of those who did not intend to use transit in fact did not. This is consistent

Table 1. Available model variables.

Category	Variable	
Sociodemographics	SEX	= 0 if male, 1 if female
	OLDAGE	= 1 if age >65, else 0
	WORKAGE	= 1 if age >20 and <65, else 0
	FULLT	= 1 if full-time worker, else 0
	MUSTMOVE	= 1 if either full-time worker or student or looking for work, else 0
	NOMOVE	= 1 if keeping house or retired, else 0
Situational factors	HHFULL	= number of full-time workers in household
	NLIC	= number of licensed drivers in household
	AA	= 1 if automobile available, else 0
	TBLOCKS	= 1 if ≤1 block away from nearest transit stop, else 0
Level-of-service perceptions[a]	COSTA,B	= 1 if transit least expensive, else 0
	COMFA,B	= 1 if transit most comfortable, else 0
	CONVA,B	= 1 if transit most convenient, else 0
	ENJA,B	= 1 if transit most enjoyable, else 0
	FASTA,B	= 1 if transit fastest, else 0
Relative importance of level-of-service perceptions[b]	COSTWTA,B	= 3 if cost is a very important attribute
		= 2 if cost is a somewhat important attribute
		= 1 if cost is not a very important attribute
		= 0 if cost is not at all important
	COMWTA,B	= (3,2,1,0) if comfort is a very important attribute, etc.
	CONVWTA,B	= (3,2,1,0) if convenience is a very important attribute, etc.
	ENJWTA,B	= (3,2,1,0) if enjoyability is a very important attribute, etc.
	FASTWTA,B	= (3,2,1,0) if speed is a very important attribute, etc.
Feelings		
Protransit	REDCARA,B	= 1 if agree that use of cars should be reduced by supplying effective public transit, else 0
	IMPTRANA,B	= 1 if agree that drastic action must be taken to improve transit service, else 0
	FIGHTA,B	= 1 if agree that lack of adequate public transportation causes squabbles in family, else 0
	CHILDA,B	= 1 if agree that children need good public transportation, else 0
Antitransit	PUBTRANA,B	= 1 if agree that riding transit makes people feel uncomfortable, else 0
	EMBARA,B	= 1 if agree that it would be embarrassing taking someone to social function on public transit, else 0
	DIRECTA,B	= 1 if agree that getting directions from a bus driver is awkward, else 0
	AFFORDA,B	= 1 if agree that only people who cannot afford other means use the bus, else 0
Procar	GIVEA,B	= 1 if cannot imagine giving up car regardless of transit service provided, else 0
	NICECARA,B	= 1 if agree that having a nice car is appealing beyond just transportation, else 0
	LIKECARA,B	= 1 if agree that driving is or would be enjoyable, else 0
	TRAPA,B	= 1 if agree that not having a car available is like being trapped, else 0
	SOCSUFA,B	= 1 if agree that social life suffers if there is no car available, else 0
Anticar	NUISA,B	= 1 if agree that cars are a nuisance, else 0
	CARUSEA,B	= 1 if agree that cars have outlived their usefulness, else 0
	FRUSTA,B	= 1 if agree that driving in city is frustrating, else 0
	DISCRGA,B	= 1 if agree that cities should make it difficult to drive or park car in city, else 0
	CONGSTA,B	= 1 if agree that traffic congestion in this city is major problem, else 0.
Intentions	TCHOICEB[c]	= two-column matrix: column 1 = 1 if intend to use transit, else 0; column 2 = 1 if do not intend to use transit, else 0
	TRIPFREQ	= sum of number of intended work, school, shopping, and other trips per week on transit
Behavior	TCHOICEA[c]	= two-column matrix: column 1 = 1 if use transit, else 0; column 2 = 1 if do not use transit, else 0

Note: Suffix A in variables refers to postimplementation data and B refers to preimplementation data.

[a] An alternative formulation of level-of-service perceptions assigned 1 if transit was least expensive or most comfortable, convenient, etc.; -1 if transit was most expensive, least comfortable, etc.; and 0 otherwise.

[b] Weighted level-of-service perception variables were created by multiplying the level-of-service variable (e.g., COSTA) by the weight (e.g., COSTWTA).

[c] Dependent variable; format consistent with the requirements of the logit estimation program.

with the consumer research literature, in which negative intentions have been found to be better indicators of nonuse than positive intentions are of use (11).

Further analyses indicated that 63 percent of those who had no car available used transit whereas only 25 percent of those who had a car used transit. Among those to whom a car was available, 29 percent of those who intended to use transit did and only 11 percent of those who did not intend to use transit did use it. A similar pattern (20 percent difference) existed among those who did not have an automobile available, which suggests that intention is in fact important in determining use.

ESTIMATION RESULTS

Several variable specifications were tested for each of the three hypothesized models. Care was exercised not to incorporate into the model sets of variables that were highly correlated in order to avoid multicolinearity.

In the first phase of the modeling effort, specifications including sociodemographic characteristics, situational factors, and level-of-service perceptions were tested. Feelings variables were incorporated in a second phase to test for their additional contribution to the models' explanatory powers.

Phase 1 Models

Table 2 gives the estimation results of the final specifications developed for the three models in the first phase. All coefficient estimates have the correct signs, and nearly all are highly significant (i.e., they have large t-statistics). A positive coefficient in the model indicates a tendency (i.e., greater utility) for using transit versus the other modes of travel. The goodness-of-fit statistic ρ^2 (commonly called the McFadden coefficient) is moderately high, considering that the scale from worst to best ranges from $\rho^2 = 0$ to approximately $\rho^2 = 0.6$.

As Table 2 indicates, some variables were excluded from the model specification because of colinearity with other variables. Several of the perceptions and feelings variables were correlated,

Table 2. Phase 1 estimation results.

	Model 1		Model 2		Model 3	
Independent Variable	Coefficient Estimate	t-Statistic	Coefficient Estimate	t-Statistic	Coefficient Estimate	t-Statistic
Constant	0.51	1.31	-1.46	-3.37	-1.63	-3.92
Sociodemographics						
Sex	0.64	2.42	0.64	2.10	-[a]	
Situational factors						
Within one block of transit	NA		0.69	2.57	0.45	1.67
Automobile available	0.11	0.33	-1.56	-5.63	-0.81	-2.63
Level-of-service perceptions						
Transit least expensive	-[a]		-[a]		0.68	2.37
Transit most comfortable	-[a]		1.05	2.93	-[a]	
Transit most convenient	1.02	2.24	1.17	3.66	2.07	6.32
Transit most enjoyable	1.52	2.82	-[a]		1.09	3.73
Intention						
Number of intended transit trips per week	NA		0.13	5.22	NA	
Model goodness of fit						
ln likelihood	235.08		238.59		226.90	
ρ^2		0.30		0.29		0.33

[a]Indicates that variable not included in model specification because of multicolinearity or insignificance of coefficient estimate.

as one would expect, because of the large number and qualitative nature of these variables. In cases where colinearity was detected among variables, those variables that provided the greater explanatory power were left in the specification and the others were excluded.

The only sociodemographic variable found to be of significance in any of the models was sex in models 1 and 2. Apparently, women felt more positive about using transit service prior to and after the implementation of service than did men. These results correspond to those of the cross tabulations, in which a higher percentage of females indicated intended and actual use of transit than did men. The sex variable was excluded from model 3 because of colinearity with the variables for postimplementation perceptions of level of service. This was primarily caused by the characteristics of the sample, in which, after service implementation, women as a group had positive perceptions of transit versus other modes whereas males' perceptions of transit were generally negative with respect to other modes.

As hypothesized, situational factors (e.g., automobile availability and transit accessibility) were significant in explaining actual choice to use transit (models 2 and 3). By comparing the respective coefficients, it can be observed that having a car available was considerably more important (in a negative sense) in the choice to use transit than having superior access to transit (i.e., living within one block of a transit stop). In addition, as hypothesized, situational factors were not significant determinants of peoples' intentions to use transit. This hypothesis was tested by including the variable of automobile availability in model 1 and observing that the estimated coefficient was not significantly different from zero (note the small t-statistic in Table 2).

The variable that represented the number of intended weekly transit trips (or degree of prior transit intent) was found to be a significant positive explainer in model 2. This indicates that the more trips an individual planned on taking prior to the new service, the greater was the likelihood that he or she would actually use transit after initiation of service.

With respect to level-of-service perceptions, the simple 0,1 variables provided better model fits for all three models than did either the weighted variables or the 0,1,-1 variables. This suggests that the constructed perception variable weights were not consistent with the true choice or intention processes (i.e., the true variable weights). Furthermore, it suggests that there was an unevenness in the scale between the perception of transit as best or worst or neither best nor worst along the given level-of-service dimensions. The symmetric 1,0,-1 scale used did not capture this unevenness, and hence the 1,0 measures (i.e., transit best or not best) were better explainers.

The perception of relative convenience was an important factor in all three models, and relative modal enjoyment was important in forming both intentions (model 1) and actual choices (model 3). Relative comfort and cost were also important factors in forming choices in models 2 and 3, respectively. In reference to the earlier discussion of the interdependency between behavior and attitudes, several inferences can be drawn from these results. That relative modal cost and enjoyment were significant in model 3 but not in model 2 suggests that perceptions had changed from before to after to become consistent with the choice to use or not use transit. Another important result is that relative comfort was significant in model 2 but not in model 3, which tends to support the hypothesis that attitudes regarding relative comfort had changed but that behavior (i.e., the choice process) was consistent with the preimplementation perceptions of comfort. These results suggest that along some level-of-service dimensions (i.e., comfort) prior perceptions were better explainers of actual use, along other dimensions (i.e., cost and enjoyment) current perceptions were better explainers, and along still other dimensions (i.e., convenience) prior and current perceptions were both significant explainers of actual use.

Since all of the variables in the models, except the number of intended weekly transit trips in model 2, were 0,1 measures, comparison of variable weights within each model is straightforward. In model 1, it can be observed that perceptions of whether transit was most enjoyable or convenient were the most important determinants of intentions to use the system. In model 2, prior perceptions of relative convenience and comfort and automobile availability were the key factors in explaining actual use, along with the number of intended weekly transit trips (if

Table 3. Phase 2 estimation results.

Independent Variable	Model 1 Coefficient Estimate	Model 1 t-Statistic	Model 2 Coefficient Estimate	Model 2 t-Statistic	Model 3 Coefficient Estimate	Model 3 t-Statistic
Constant	-1.32	-2.47	-1.55	-3.36	-2.08	-4.13
Sociodemographics						
Sex	0.69	2.32	0.60	1.92	-[a]	
Situational factors						
Within one block of transit	NA		0.66	2.46	0.38	1.35
Automobile available	0.25	0.65	-1.42	-5.06	-0.74	-2.29
Level-of-service perceptions						
Transit least expensive	-[a]		-[a]		0.47	1.57
Transit most comfortable	-[a]		0.92	2.50	-[a]	
Transit most convenient	0.80	1.64	1.14	3.55	2.02	5.77
Transit most enjoyable	1.27	2.17	-[a]		0.98	3.22
Intention						
Number of intended transit trips per week	NA		0.12	4.79	NA	
Feelings						
Protransit						
Need to improve transit to reduce cars	0.74	2.79	-[a]		1.22	3.87
Children need good transit	0.80	2.82	-[a]		-[a]	
Antitransit						
Embarrassed to use transit	-0.56	-1.84	-0.59	-1.79	-[a]	
Some can only afford transit	-0.84	-2.95	-[a]		-[a]	
Procar						
Feel trapped without car	-[a]		-[a]		-0.72	-2.88
Anticar						
Cars are a nuisance	0.96	3.14	0.45	1.93	-[a]	
Cars are no longer useful in city	-[a]		-[a]		0.56	2.08
Driving in city is frustrating	0.67	2.18	-[a]		-[a]	
Traffic congestion is a problem	0.57	1.98				
Model goodness of fit						
ln likelihood	195.57		235.05		209.94	
p^2		0.42		0.30		0.38

[a]Variable not included in model specification because of multicolinearity or insignificance of coefficient estimate.

that number was significantly large, i.e., eight or more trips). Finally, in model 3, current perception of relative transit convenience dominated all other variables by about two to one in explaining actual transit use.

Phase 2 Models

The estimation results of the final specifications for the three models, in which "feelings" variables are incorporated, are given in Table 3. Nine of the 18 feelings variables available proved to be a significant factor in at least one of the models. All coefficients had the correct signs. Anticar sentiments dominated the list of important feelings variables. In the case of all three models, the feelings variables contributed significantly to the explanatory powers of the phase 1 models [at the 95 percent level or better according to the likelihood ratio test (12)]. Model 1 showed the most dramatic improvement in fit as p^2 increased from 0.30 to 0.42 with the addition of feelings variables.

Considering the potential for colinearity among the specified perceptions and feelings variables, it was surprising that in model 1 seven feelings variables could be incorporated that were statistically significant (at the 90 percent level or better). It is also apparent in model 1 in Table 3 that part of the explanatory power of the level-of-service perceptions (convenience and enjoyment) was subsumed by the feelings variables, particularly those biased toward transit or away from cars (note the smaller t-statistics for the coefficients for convenience and enjoyment compared with model 1 in Table 2).

In comparing models 2 and 3, changes in feelings from before to after implementation can be inferred (as was the case for level-of-service perceptions). Of the three feelings variables that were significant in model 3, none were significant in model 2, which indicates that those feelings changed from before to after and became consistent with the choice process. On the other hand, neither of the two significant feelings variables in model 2 was significant in model 3, which suggests that these preimplementation feelings were better explainers of the choice to use or not use transit than were the current feelings regarding those issues.

CONCLUSIONS

The results of this study reconfirm several well-established tenets of travel-behavior theory:

1. Intentions overstate actual behavior,
2. Negative intentions are better indicators of nonuse than positive intentions are of use,
3. Situational factors (e.g., automobile availability and transit accessibility) are important determinants of mode choice,
4. Attitudes are important in forming intentions and choices, and
5. Attitudes and behavior are interdependent.

In addition to confirming these established findings, this study has produced several important new insights:

1. Individual feelings regarding specific transportation issues, especially anticar sentiments, were shown to be powerful explanatory variables, particularly in forming behavioral intentions.
2. Although a measure of intended use versus nonuse of transit is not a useful explainer of ac-

tual use, intended frequency of use (indicating degree of intention to use) was found to be a significant determinant.

3. The perception of relative modal convenience was found to be a dominant factor in forming both intentions and actual choices to use transit, and its perception was more stable over time than were the perceptions of other level-of-service measures.

From a practical standpoint, perhaps the single most important development of the study was the simplicity with which the attitudinal variables were defined to produce effective explanatory models. All of the feelings and perceptions variables were constructed as 0,1 variables. Moreover, the 0,1 perceptions variables were found to have superior explanatory power over the more sophisticated variable definitions that were attempted by using relative weights or additional perceptual information. The implication is that the analysis method used here can produce useful results while being relatively easy to apply.

Although the models developed in this study are limited in their application as forecasting tools--primarily because of the categorical nature of the variables and the lack of variables based on objective data that can be transferred from one site to another--they can be used effectively as policy tools in planning and marketing new transportation services. For example, a planner who wished to market a new transit service could ascertain from a behavioral-intentions model that perhaps convenience, enjoyment, anticar sentiments, and being female were important factors in his or her marketing effort to build initial support for the service. Once the service was implemented, the marketing effort could focus more heavily on the convenience of the service, which was found to be the major determinant of actual use.

Clearly, these models need to be developed and tested further to substantiate their validity and usefulness. Similar data sets and models need to be collected and estimated for other sites and the results compared with those reported here. Similar models should also be developed by using objective data and be compared with the attitudinal-based models and evaluated with respect to model cost-effectiveness. Finally, work is needed in the area of attitude formation to gain a greater understanding of the factors that influence variations in attitudes (e.g., across time and individual travelers). Such knowledge would enable attitude changes to be controlled for in the models and make the models more useful for prediction purposes.

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Understanding the Effect of Transit Service Reliability on Work-Travel Behavior

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Research directed at understanding the impact of transit service reliability on work-travel behavior is described. The research focuses on the impact of service reliability on commuter decisions of modal choice and trip departure time. By working with the hypothesis that service reliability is an important attribute in explaining departure time and modal choice, measures of service reliability (tied in many cases to work-arrival-time considerations) are proposed that capture the impact of service reliability on work-travel decisions. The theory is subsequently tested empirically through the estimation of departure-time and modal-choice models by using data collected in the San Francisco Bay Area. Several interesting results emerged from the research effort. First, arrival-time