Resource Paper on Attitudinal Models

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What is an attitude? This is the first question that must be raised in the development of attitudinal models of travel behavior. It is an important question that has been ignored in the vast majority of the ever-increasing number of research projects that deal explicitly or implicitly with transportation attitudes. It is a question not merely of academic interest but at the very heart of the model-building process. Although this paper will make no attempt to crystallize an answer, it will attempt to place alternate attitude conceptualizations within the perspectives of urban passenger transportation planning and evaluation and to discuss the (2-way) linkages between these conceptualizations and the construct and testing of hypotheses of travel decision-making behavior.

Attitudes in the market research vein are thought of as mediating variables intervening between the consumers' psychological inputs and outputs (75). Yet, as discussed in detail by Fishbein (29), attitude conceptualizations have been the subjects of debates and controversies among psychologists and sociologists for more than half a century. The resultant absence of a clear conceptual consensus has forced even the most pragmatic of the marketing consumer analysts using "attitudinal" data to at least mention the existence of the alternate theories and in many cases to specify their particular measurements in the light of selected postulates. Moreover, the recent employment of a wide spectrum of multivariate statistical analysis methods to a multiplicity of both marketing and psychological data has brought about more concise specifications of hypotheses and conditional acceptances or rejections of them.

A brief excursion through the perceived mainstream of the psychological debate on the subject is thought to be relevant to the interpretation of the more analytically structured work exposed briefly in later sections of this paper. With brash disregard of the true genesis of the concepts, the initial definition to be presented is that of Thurstone (105): An attitude is "the amount of affect for or against a psychological object." Earlier Thurstone (104) had elaborated this unidimensional definition with the statement

that attitude is "the sum total of a man's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specified topic." (Opinion was in turn defined as the verbal expression of attitude.)

Although these definitions underlay Thurstone's landmark works on the establishment of probabilistic specifications for attitudes (and associated postulates concerning attitude frequency distributions that continue to serve as basic foundations for measurements), much of his terminology and many of his assumptions enjoyed no universal acceptance. Allport (3), after reviewing a large number of definitions of attitude, concluded that most investigators agreed that an attitude is a learned predisposition to respond to an object or class of objects in a consistently favorable or unfavorable manner. Allport's conceptualization was, like Thurstone's, a unidimensional one. However, the characterizing bipolarity corresponds strongly with some of the currently most widely used attitude scaling devices (e.g., semantic differential scales).

Doob (22) suggested that there is not necessarily a one-to-one correspondence between attitude and behavior; two persons may hold the same attitude, yet learn to react differently. More specifically, he linked attitude and behavior theories by specifying that attitude is a learned response; it may be evoked by any one of a variety of stimulus patterns; it is also a stimulus, which may evoke any of a number of learned responses; it cannot be directly observed (only its evoked responses); and it can only arbitrarily be distinguished from other types of responses. Chein (16), while applauding the usefulness of this relation between attitude theory and learning theory, attempted to clarify Doob's characterization of attitudes as being implicit by proposing that they be regarded as salient in the situation to which they become pertinent, otherwise unobservable except through effects.

Seminal work in the measurement of attitudes is that by Osgood and his associates (72, 73). They identified the projection onto the "evaluative" dimension of the total semantic space as "attitude" and developed an instrument to scale an individual's evaluation of an object. This instrument, known as the semantic differential, incorporates a subject's rating of an object on a 7-point, bipolar scale; the scale ends are identified by opposing pairs of descriptive words (e.g., good-bad, good looking-ugly, or safe-unsafe). This unidimensional technique allows measurement of attitudes in an operationally concise manner. Conceptually, this restriction to a single evaluative component underlies much of the more recent multidimensional work, if one were only allowed to ignore problems of terminology (i.e., whether the entire multidimensional space or just one or more dimensions are labeled as attitude).

Significant developments along the multidimensional lines were supplied by Rosenberg (85) and Rosenberg and Hovland (86). They perceived attitudes as "predispositions to respond in a particular way toward a specified class of objects" and isolated 3 dimensions of attitude: the affective component, the cognitive component, and the behavioral component. In a complementary fashion, Fishbein and Raven (30) developed a definition of "belief" analogous to Osgood's evaluative construct, and they employed a similar bipolar scaling technique to measure the degree to which a subject believed in the existence of a concept (i.e., rated from nonexistent to existent or improbable to probable). Katz (53) and Katz and Stotland (54) clarified the more functional approach to attitude by specifying that attitudes serve a series of human needs: ego defense, expression of value, utilitarian adjustment, and knowledge enhancement.

Fishbein (27, 28, 29) extended the multidimensional conceptualization to (what can be defined for purposes of this exposition) the fullest extent necessary to provide sound underpinnings for contemporary methodological and empirical work on attitudinal models of consumer decision-making behavior. Stating that increased precision and understanding can be gained by bringing definitions of attitude into closer harmony with the techniques by which attitudes are measured, Fishbein developed a theory in which both the evaluative component (attitude) and the cognitive component (belief) of an individual's perception toward an object are needed to explain behavior.

Variations of this theme are given by Palda (75), who formulates 3 components—attitudes, preferences, and images, and by Hansen (46), who proposes 2 sets of factors as intervening between the communications consumers receive and the choices they make. These factors are values, goals and motives by which alternatives are evaluated,

and attitudes about the alternatives that relate them to the values. Finally, Rokeach (83) developed a comprehensive definition of attitude that seemed to encompass much of the preceding work on conceptualization; he declared that an attitude is relatively enduring, is an organization of belief, is organized around an object or situation, is a set of interrelated predispositions to respond, and leads to a preferential response. Well, that seems straightforward enough.

ATTITUDES AND TRANSPORTATION PLANNING

It has been effectively argued in a number of papers on travel demand [e.g., by Lansing et al. (58), Ackoff (2), Wallace (111), Sommers (98), and Hartgen and Tanner (48)] that the employment of attitudes as explanatory variables in models of transportation decision-making behavior enables the qualitative or non-engineering-metric attributes of travel alternatives to be taken into account. The basic postulate here is that differences between travel alternatives in terms of these qualitative attributes (such as styling and cleanliness of vehicles and security from threatening behavior of other individuals) as well as differences in terms of quantitative attributes (such as travel time and cost) are determinative in travel choice.

Indeed, intuitive judgment and scattered empirical evidence [e.g., as reported by Mahoney (63), Brunner et al. (13), Paine et al. (74), McMillan and Assael (66, 67), Sommers (98), Golob et al. (34), and Sherret (90)] argue for the general acceptance of this postulate. It is not an objective of this paper to review the many disucssions on the topic to be found in the professional literature. It is an objective, however, to present in summary the major issues involving transportation-planning and -evaluation impacts that are perceived as being dependent in large measure on the development of attitudinal models along lines such as those outlined in later sections of the paper.

First, there is the new-mode demand-estimation problem. It is felt that attitudes toward a wide spectrum of system attributes as determinative variables are one effective way of projecting usage of new modes that differ substantially in terms of design and performance from present modes. As discussed in the professional literature, these substantial differences make extrapolation from observed present behavior on the basis of quantitative performance measures exceedingly difficult. Application of attitudinal models to new-product development in general is discussed briefly in the following section of this paper, and Wallace (111) specifically covers the new-mode problem in light of marketing "product clinic" approaches for gathering the respondents' perceptions of proposed new modes.

Second, there is the issue of the estimation of the more complete transportation-demand curve, or surface, as opposed to estimation of only the demand component known as modal split. Attitudinal behavior models hold the promise of forecasting the elastic or latent components of urban passenger-travel demand for (and complex shifts in the timing and destinational characteristics of trips) and diversions from existing modes to new or modified transportation systems of specified design and anticipated performance. This lofty anticipation is motivated by the implicit nature of attitudes brought out in the conceptualization discussion; it would seem possible to explore a decision-maker's desires to travel as well as his revealed behavior given present alternatives. The development of such elastic demand models, however, suggests that the currently popular scope of travel demand models be expanded to include the destination and timing of trips as well as certain other factors. These subjects are discussed in a later section.

An associated issue involves the potential linking of travel demand models and the structure and growth of the urban environment. If it is indeed possible to identify and quantify latent demand dependent on changes in perceived accessibility or mobility, analogous efforts could be employed to project the demand for trips to and from conceived activity centers and residential areas. Of course, the reliability and validity of such projections are a function of the successful presentation of hypothetical new alternatives to individual travel decision-makers through the use of some sort of attitudinal survey instrument. It is also dependent on the ability of these decision-

makers to accurately estimate their future behavior in an artificial circumstance and in the absence of inputs from a large number of variables that affect the decision process but cannot be anticipated or are of a random nature. Nevertheless, the author is basically optimistic about the possibilities.

A fourth issue is the need for the establishment of a meaningful feedback loop from demand analysis to systems design in the urban transportation planning process. It is axiomatic that it is important to know the impact on system demand (i.e., the level and distribution of projected usage among groups of individuals) of changes in the design of the system and its components. These changes may be in terms of readily quantifiable attributes such as speed and headway of a fixed-route-and-schedule public transportation system, in which case feedback could be accomplished through application of traditional, although disaggregated, demand models; or the changes may be in terms of qualitative attributes such as vehicle styling or comfort. In this latter case, attitudinal models may hold the answer to the designer's problem. This use of attitudes is analogous to applications in the marketing field of new-product design, and some of the published applications are referenced in the section in this paper on alternative model formulations.

The fifth issue raised in this brief presentation of attitudinal model impacts on transportation planning concerns the linkage between demand estimation and systems evaluation. A primary advantage of the proposed disaggregate behavioral models (discussed in the section on attitudes and existing model approaches) is that individual-based demand estimates provide the appropriate information on distribution of usage for the user-oriented evaluation of a system of specified design and anticipated performance. This is particularly the case for the utility-maximizing models. Suffice it to say that all anticipated attitudinal models (at the very least the models currently formulated in the market research field and discussed below) are of this disaggregate class and conform to these and other listed advantages. [Stopher and Lisco (101) discuss one such accounting of disaggregate model advantages.] The use of attitudinal models in this context also opens the possibility of employing peoples' perceived values of cost or benefit (i.e., their attitudes toward changes) in addition to objectively specified values, although this opens up a number of evaluation problems outside the scope of this discussion.

The last issue to be cited is the future establishment of a general demand model framework that can be applied in a large number of metropolitan environments through recalibration only, without requiring basic changes in form. This need, verbalized effectively by Weiner (114), could probably be satisfied by any one of a series of disaggregate models [e.g., those reported by Stopher and Lisco (101), Hoel and Demetsky (50), and Rassam et al. (81)], but is considered particularly within the structure of attitudinal models. Aggregation in attitudinal models, by definition, can be performed with respect to data-derived relatively homogeneous perception toward transportation alternatives and can be related to demographic and socioeconomic measures on individuals and households through the use of multivariate statistical methods such as regression, discriminant analysis, and canonical correlation. Basing the aggregation process on relative differences in model variables is thought superior to a priori stratification, all else (i.e., predictive power) being equal. Also, comprehensive attitudinal models are expected to explicitly incorporate variables such as an individual's previous exposure to various generic types of passenger transportation systems. These variables differentiate the respective population of metropolitan areas just as distributions of socioeconomic and demographic measures do. Again, these pronouncements are made under assumptions of certain forms of the attitudinal model; those forms are summarized in the following sections of this paper.

GENERAL THEORIES OF ATTITUDE AND BEHAVIOR

Specification of Attitude Toward an Object

A number of interrelated theoretical, cognitive, affective, and conative structures

of attitude have been proposed by investigators in the fields of psychology and market research. Empirical tests of some hypotheses have been conducted, primarily with consumer data. No attempt is made to survey the breadth of this work nor to discriminate among it on the basis of subtle yet important differences in assumptions or functional forms. Rather, efforts in the area judged as being particularly relevant to the development of attitudinal travel-behavior models are explored to the degree deemed necessary for the purposes of this brief exposition.

The division of an overall attitude toward an object or situation into a number of similarly defined, separable components has characterized much of the specification work of recent vintage. This division fits nicely into the main body of the current and anticipated attitudinal travel-behavior modeling. As discussed in the following section of this paper, the division is particularly consistent with the fundamental basis on which many of the models are constructed, specifically the new approach to consumer theory postulated by Lancaster (57), who specifies the direct objects of utility as the properties of attributes of the consumer good, as opposed to the good itself.

A logical starting point is Rosenberg's cognitive summation theory of attitude. The hypothesis specified by Rosenberg (85) is

$$A_{ij} = \sum_{k=1}^{n} P_{ijk} V_{ik} \tag{1}$$

where

A_{ij} = affect aroused in individual i by object j;
P_{ijk} = perceived potency or perceived instrumentality of object j for achieving or blocking value k for individual i;
V_{ik} = rated value importance of the k th value to individual i; and
n = number of salient values.

Employing data on the ranking of value item statements and chi-square tests of association, Rosenberg reported the successful testing of the above hypotheses and also the successful testing of hypotheses relating overall affect to each of perceived instrumentality and value importance taken alone. However, as Howard and Sheth (51) point out, a number of procedural and methodological problems prevented Rosenberg from establishing convincing comparisons among the differences in explanatory power of his 3 hypotheses. Rosenberg chose to focus on the "affective" component of attitude, which was then described in terms of the postulated attitudinal cognitive structure. This approach [similar to that of Peak (76)] characterizes, with some modifications, much of the psychological and consumer theory work on attitude structures judged as being directly relevant to travel demand modeling.

Fishbein (26) and Anderson and Fishbein (6) presented a 2-component cognitive theory in which the variables were defined as follows:

$$A_{ij} = \sum_{k=1}^{n} B_{ijk} a_{ik} \tag{2}$$

where

A_{ij} = individual i's attitude toward object j;
B_{ijk} = strength of belief k held by individual i about object j;
a_{ik} = evaluative aspect of B_{ijk}; and
n = number of salient beliefs.

Fishbein and his associates noted that, although evaluative beliefs represent only

one type of belief, they make up that particular subset of beliefs related to an individual's attitude toward an object. [Other beliefs listed by Fishbein (29) include beliefs about the object's component parts, the characteristics or qualities of the object, the object's relation to other objects or concepts, what should be done with respect to the object, and what the object should or should not be allowed to do.] For evaluative beliefs, the object is considered to be perceived as an instrument that can satisfy the evaluator's goals and objectives (i.e., block or aid the attainment of various valued states), and the attributes of the object are considered to be perceived as goal-satisfying properties.

This cognitive-summation theory of attitude organization and change was proposed as an alternative to the cognitive-consistency theories in which attitude is viewed as a weighted average of belief scores. Consistency theories were advanced by Osgood and his associates (72, 73) under the label of the congruity principle, by Heider (49) under the label of balance theory, and by Anderson (5). The evidence from comparative tests of the 2 approaches, as provided by Fishbein and Hunter (31) and Anderson and Fishbein (6), argues in favor of summation, primarily because of the discovered significant contribution to attitude of the set size, n.

Market researchers soon applied the cognitive-summation model, with few modifications, to consumer buying behavior (9, 45, 46). This work was consistent with the definition by Kotler (55) of a product as "a bundle of physical, service, and symbolic particulars expected to yield satisfactions or benefits to the buyer." Attitude was approached as a unidimensional expression of the degree of favorableness toward a product, and Sheth (91) observed that the general consensus in the field was that attitude is "an affect-type construct in which buyer's likes and dislikes of a brand or product class are abstracted." However, Sheth and his associates scrutinized the major assumptions built into the cognitive-summation models of Rosenberg, Fishbein, and others. Sheth (95) listed 4 questions concerning the model: Are 2 factors necessary for the calculation of attitude scores? Why employ a multiplicative combination of these 2 factors? Why aggregate over all salient beliefs (i.e., object attributes) to a single value? Should such summation be performed before or after factor multiplication?

With respect first to the aggregation issue, Sheth (91) introduced a multiple-regression approach for the explanation of attitude in terms of the n separate belief scores. Using semantic differential scale data obtained from a longitudinal consumer panel, he obtained (multiple) correlations between separate scores and overall attitudes toward a brand (as measured by a single rating score). Those correlations were significantly higher than (simple) correlations between single aggregated belief scores and the overall attitudes. There is at present little disagreement in the market research area concerning the superiority of the disaggregate model over the aggregate one, and additional evidence on improvements in explanatory power has been supplied by Sheth (92, 95) and Alpert (4).

A major advantage of the disaggregate model is that it enables the identification of the relative contributions of the beliefs or attributes of the object toward formation of the consumer's attitude, which is, of course, important information in promotional planning and new-product development. A wide variety of statistical estimation processes can be used to obtain this information from various survey data sources. Among such efforts are the regression approaches of Sheth (91, 92), Cohen and Houston (18) and Alpert (4); the discriminant analysis approach of Banks (8), Perry (77), and Cohen and Ahtola (17); and the canonical correlation work of Lutz and Howard (62) and Sheth (94).

A disaggregate approach of a slightly different nature is the ideal point model advanced by Lehmann (59):

$$A_{ij} = \sum_{k=1}^{n} V_{ik} | P_{ijk} - I_{ik} |^{r} \qquad (3)$$

where A_{ij}, V_{ik}, P_{ijk}, and n are defined as in Eq. 1, I_{ik} represents individual i's "ideal" point for attribute k, and r is an integer defining the distance metric. This model is strongly related to the psychometrician's ideal point multidimensional scaling research. Although success in predictive ability has been reported (59), some operational problems have been experienced, such as the respondent's revealed inability to conceptualize ideal point values (12). As one interesting variation to the above, Einhorn and Gonedes (25) tested a model in which the discrepancy between an object's value and the ideal point is an exponentially increasing function.

With respect to the issue of whether 2 factors are necessary for the determination of scores, i.e., whether both evaluative belief and importance are needed, there is contradictory evidence. Arguing for a single measurement per attribute, Howard and Sheth (51) reanalyzed the tables of Rosenberg (85) and tentatively concluded that his "value importance" terms actually suppressed the correlation between attitude and "perceived instrumentality" in the aggregate model. Moreover, Sheth and Talarzyk (96), Lutz and Howard (62), and Sheth (92) each uncovered additional information (determined through multiple regression, canonical correlation analysis, and multiple-set canonical analysis respectively) that the attribute (or value) importance measure, as reported by respondents through direct questioning using semantic differential scales, adds nothing to the explanation of overall attitude accomplished by the data from the semantic differential scales of beliefs (or perceived instrumentalities). On the other side of the coin, Hansen (46), in tests of a model describing the difference in attitudes between 2 alternatives, found that the value-importance terms contributed significantly to the variance explanation.

$$A_{i1} - A_{i2} = \sum_{k=1}^{n} V_{ik}(P_{i1k} - P_{i2k}) \qquad (4)$$

where the variables are defined as in Eq. 1.

The 1- or 2-factor issue remains open to debate today. Nevertheless, it is reasonably clear that the direct questioning approach to determining attribute importances has at most proved marginally valuable. It is hypothesized that these importances are best determined through covariance methods similar to those outlined above or through indirect survey techniques. The former approach would employ perceived instrumentality or evaluative belief measures as exogenous variables and measures of attitude or, more properly, behavior toward the object as endogenous variables; the link to behavior is the subject of the next section of this paper. The latter approach is a partial subject of the section on measurement and data collection.

Prediction of Behavior

The linkages among beliefs and value importances, overall attitude, behavioral intention, and behavior impinge on the areas of psychological inquiry concerned with cognitions, affects, and conations. A modest amount of theoretical work has been performed on these linkages and is of relevance to the development of travel demand models. Fishbein (28) did not substantially differentiate between affect and behavioral intention (i.e., an individual's intention to react in a certain way, given his attitude toward an object), although he introduced a concept of social normative beliefs to help account for institutional and social constraints. Dulany (23, 24), in his theory of propositional control, explicitly incorporated these constraints by specifying behavioral intention as a function of attitude, beliefs (weighted by their reinforcing values), and social and institutional pressures (weighted by their strengths). This approach is similar to the distinction drawn by Rokeach (83) between attitudes toward an object and attitudes toward a situation and, together with the related work of McGuire (65), forms a basis for much of the consumer theory work in the field.

Dulany made no distinction, however, between behavioral intention and behavior.

This was accomplished by Howard and Sheth (51) and Sheth (92). They specified actual behavior as a function of behavioral intention and nonpredictable (often random) situational factors, such as the availability of a brand or the sudden introduction of a new product. Multiple-regression tests performed by those researchers have confirmed the hypothesis that evaluative beliefs (and possibly value importances) are most strongly related to affect, then to behavioral intention, and least to behavior in the brand purchase context. Sheth (94) reinforced this stepwise explanatory chain concept by testing the strengths of critical combinatorial correlation links through canonical analysis of consumer panel data: Beliefs and some situational factors made up the predictor set; and affect (overall attitude rating), behavioral intention (intention to purchase), and behavior (reported actual purchase) made up the criterion set. Finally, Lutz and Howard (62), using multiple-set canonical analysis, established with similar data that both evaluative beliefs alone and beliefs weighted by importances were significantly more correlated to product preference measures than to actual buyer behavior.

Although these multivariate statistical studies serve to validate particular postulates concerning relations among cognition, affect, and conation, they all reveal a rather poor connectivity between attribute-level attitude and actual behavior in the consumer context. Those few travel-behavior models employing attribute data (and discussed in the section of this paper on existing transportation demand models) have secured behavioral explanations as good as those encountered in reviewing the market research literature, although these behavioral explanations were generated with the same data on which the models were calibrated and not on independent measurements.

The first general area that might be explored for the purpose of increasing the predictive validity of the cognitive-structure models is concerned with alternate measurement devices and data subjects. The first issue is the subject of the following section; examples of some possible new data subjects are information as to the degree of a subject's involvement with and preceived confidence in judging an object, proposed by Day (19) in his discussions of the stability dimension of attitude judgments, and attempted quantification of specific situational factors, along the lines initiated by Sheth (94). Another productive data source might be the "subjective" attribute data suggested by Dichter (21), Martineau (64), and Mindak (69). These attributes, which may well prove determinant in behavioral prediction, would vary across both objects and respondent socioeconomics and demographics; examples are prestigious-nonprestigious and for whites-for blacks.

Another general area to be considered for the purpose of increasing predictive power, particularly in a real forecasting situation with independent data, is the reduction in multicollinearity in the attribute data. One method for accomplishing this reduction is the application of factor analytic techniques to the raw attitude data, although this method introduces several major problems, not the least of which are factor interpretation and addition of a transformation in the design feedback loop of the demand system. A second method, employed by Sherret (90) in the travel demand application, is the econometric application of simultaneous equations to structure multicollinearity hypothesized as resulting from supply-side phenomena. This method is explored in detail in another paper by Wallace and Sherret (112).

Additional sources for predictive error are those listed by Wallace (111): the naiveté of the cognitive model (e.g., linearity assumptions); the omission of certain salient attributes or values; and the assumptions underlying aggregation across individuals possessing unique value systems and perceptions toward alternatives. This last source of error may be somewhat alleviated by the implementation of multivariate statistical optimal aggregation techniques such as various cluster analyses, Q-type of factor analysis, and discriminant analysis for the aggregation of individuals on the basis of their revealed preferences of perceptions. Such alleviation has as yet been accomplished in principle only, however, and aggregation remains a limiting factor in the entire utility theory class of individual-based travel demand and general-buyer behavior models.

Measurement

For reasons associated with brevity and intended emphasis on model structure, major issues related to the measurement of attitudes and other perceptual variables will be only briefly enumerated. The reader is referred to the many works in the professional literature identified in this section for more detailed treatments of the subjects.

Focusing first on the unidimensional scaling of direct attitudinal responses, we can readily see that the most widely used technique in market research is the semantic differential scale developed by Osgood and described in the attitude concept section of this paper. Other widely used techniques include the Thurstone scale (106), the Likert scale (60), the paired-comparisons scale (103), the successive-intervals scale (87), and the Guttman scale (43). The unidimensional nature of these techniques is emphasized by the fact that procedures used to determine scale consistency [e.g., those of Green (37)] employ unidimensionality as a criterion. Each of these devices is based on slightly different assumptions regarding the subject's ability to respond and the nature of the variable that is being measured, and each should be evaluated in the light of its applicability to various measurement phases of specific attitudinal demand models. Too often semantic differential scales have been applied in ignorance of these alternate techniques and without regard to their own genesis and intended scope of application.

The question as to how many response categories to use in a technique such as the semantic differential scale has been partially answered by Green and Rao (40) through a simulation model test employing geometric interpoint distance recovery criteria. Their work reaffirmed the 7-point scale previously defended by Miller (68) on the basic arguments involving the human capacity for processing information.

In another development related to this class of techniques, Day (20) has argued for adoption of a "constant sum" scale, which requires a respondent to distribute some portion of a fixed set of evaluation "points" to each attribute, as a solution to skewed distribution and lack of variance problems encountered in semantic differential data (52). The question of monadic (i.e., separate) versus paired ratings of alternatives has been investigated empirically by Greenberg (41), and his conclusions favor monadic ratings for most applications.

As an alternative to the unidimensional measurement of direct data, Abelson (1), Green and Carmone (39), Green (38), Day (20), and Greenberg (42), among others, have applied methods of multidimensional scaling from the psychophysical domain to attitude-similarity data in attempts to map the psychological space underlying attitude perception. These methods were originally developed by Richardson (82), Attneave (7), Torgerson (108), and Shepard (88, 89) and are based on a mathematical theorem of Young and Householder (115). Examples of recent methodological advances are given by Tucker and Messick (110) and Carroll and Chang (15). Computer programs to construct spaces in which the rank order of distances corresponds maximally with the nonmetric rankings of the respondents' pairwise similarity judgments are described by Young and Torgerson (116) and Kruskal (56).

These multidimensional scaling methods are not without some very profound difficulties, however, and two of these are the number and interpretation of dimensions (88, 89, 102) and the computer capacity and time required to run the programs with medium or large data sets. Other shortcomings with respect to the applications considered here have been the relative restriction of multidimensional scaling experience to similarities as opposed to preference data and the (associated) inability to develop a joint space in which measures of affect or conation or both are directly related to the cognitive components. Moreover, Green and Rao (40) have simulated an important application where traditional factor-analytic methods provide equally good results as multidimensional scaling. All comparative evidence is inconclusive, however, and it is felt that the future will bring a number of applications in which advanced multidimensional scaling will provide unique and penetrating analyses.

There are many direct-measurement techniques beyond those few popular ones discussed above, and the methods can be broadly classified in a number of ways. Fishburn (32) provided one such taxonomic scheme in his thorough methodological study of alternate additive utility theories and their measurement requirements, and Stevens (99) and

then Torgerson (109) presented the famous ratio, interval, ordinal, and nominal scale classification. All of the direct-measurement devices are subject to semantic generalization, however, and that is the tendency for respondents to view 2 objects similarly without regard to obvious dissimilarities. This is particularly relevant in the transportation context, where 2 "public transit" systems, perhaps one radically new, might be viewed the same by certain individuals. As pointed out by Roman (84), this tendency must be identified and attacked through the structuring of questions about both the objects and the selected generic classes of objects [i.e., employment of both the "attitude-toward-situations" and the "attitude-toward-object" of Rokeach (83)].

Indirect survey measurement techniques will not be discussed in any detail; they are summarized by Myers and Alpert (70) and Alpert (4). In many cases, these devices have been developed in response to very real questions (21), such as, "Do respondents know the answer to direct perceptual questions?" The techniques range from third-person hypothetical questioning in which "most people" is substituted for "you" in attitudinal scales (44) to highly controversial motivational research methods. Campbell (14) discussed the assessment of social prejudices through the use of nonstructured or disguised (or both) techniques that may be relevant to the use of attitudinal models in perceived evaluations of transportation system costs and benefits.

ATTITUDE THEORY AND DEMAND FOR TRANSPORTATION: NATURE AND SCOPE OF RECOMMENDED ANALYSIS

The cognitive structures of affect and behavior discussed in the preceding section are consistent with the treatment of urban passenger transportation as an attribute-defined consumer good. This conceptualization is based on the new (general) consumer theory of Lancaster (57) and was initially adopted to the case of transportation by Quandt and Baumol (79) and their associates. As detailed in a number of sources in the professional literature, this conceptualization can be refined to treat transportation as an intermediate economic good. This is the approach taken by the economic utility theorists, who seemingly roam at will throughout the transportation research field. They have been known to attempt to describe the travel decision-making process as a trade-off between the perceived benefits of making a trip to a particular destination at a particular time for the satisfaction of a purpose and the perceived generalized costs of making the trip by a particular mode along a particular route.

It is felt that this framework provides for the logical inclusion of attitude theory and, moreover, holds the potential of accomplishing the state-of-the-art advances outlined in the section of this paper on attitudes and transportation planning. The decision-makers' perceptions of the available travel alternatives, in terms of the destinations and scheduling of trips as well as the modes and routes, can be explicitly handled in these models. They must not be viewed as a panacea, however, because all the vexing problems described above, and more, must be tackled.

Theoretical specifications of the utility models are available [e.g., Niedercorn and Bechdolt (71) and Golob and Beckmann (34)], as are limited empirical test applications with nonattitudinal data [e.g., Pratt (78), Shunk and Bouchard (97), Hoel and Denetsky (50), and Golob et al. (36)]. Beckmann et al. (10) have extended the utility approach to the description of automobile-ownership decisions. Also, the probabilistic approaches to modal choice [e.g., Warner (113), Lisco (61), Quarmby (80), and Stopher (100)] are considered compatible with the attitude-utility framework because of the widely accepted statistical distribution properties of utility perception [e.g., Thurstone (105)].

The few pioneering demand studies that have employed attitudinal data in cognitive structures [e.g., Sommers (98), Hartgen and Tanner (47, 48), and Sherret (90)] have, taken together, established a base line from which to expand the efforts. Needed are studies that incorporate the attributes of the trip destination-purpose-schedule complex, that investigate the combinatorial properties of attribute cognitions across multiple modes and modal interfaces, and that test quantifications of the social and institutional

factors impacting on travel behavior. In this latter area, Hartgen and Tanner (47) have attempted with some success to incorporate factors related to decision-making with the environment of the household [Sheth (93) has also addressed this topic].

It is hoped that the research briefly alluded to above and a wide range of small-scale attitudinal hypothesis formation and testing using a variety of data sets will be cumulative toward a comprehensive model. These data sets, which need not be of extensive sample sizes, might be generated through mail questionnaires, panel surveys, on-board ridership surveys, telephone interviews, in-depth group interviews, and the usual home interviews. [An example of the use of the former data collection method for the first-stage testing of one cognitive structure is given by Golob (33).] Moreover, it is hoped that these studies will take advantage of the potential before-and-after data associated with demonstrations of new transportation systems.

Recommendations by Beckmann et al. (11) for travel demand research are both complementary and reinforcing to those outlined above.

CONCLUSIONS

The theoretical formulation, empirical testing, and practical application in planning and evaluation of attitudinal models of urban passenger travel demand (with but a few exceptions) are in a primitive state, vis-à-vis the formulation, testing, and application in new-product development of analogous attitudinal models in the field of market research. Moreover, the use of the term attitude is not well understood by most transportation researchers, who nevertheless embark immediately on its measurement. Discussion of the possible reasons for this relative discrepancy is beyond the scope of this paper, but it is felt that this fact signals the presence of potentially productive research topics. Such research might be along the general directions indicated in the preceding recommendations, along the directions of the few existing attitudinal travel-demand models, or, more probably, along imaginative new directions outside the present limited insight into the subject.

The urban transportation context dictates that attitudinal travel demand models be of a more complex structure than the analogous models in consumer buyer theory. Such complexity, however, is strongly associated with a high level of expected returns from research efforts: The explicit handling of social and environmental attributes of transportation systems in attitudinal models may prove invaluable to systems evaluation that is interrelated with the complex of human activities and social and institutional concerns within the urban framework.

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