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ABSTRACT

Based on a typology of the user expectations about alternatives modes of travel, a psychological model is developed in this paper which hopefully provides an explanation for systematic choices people make about a specific mode for travel purposes including for commuting to work in an urban area. The user expectations are presumed to be five dimensional: functional, aesthetic-emotional, social-organizational, situational, and curiosity. The specific expectations about a mode on these five dimensions are determined partly by supply factors such as mode availability, mode design, mode operations and mode marketing; and partly by demand factors such as demographics, life styles, trip purpose, and prior awareness and satisfaction in the mind of the user.

Introduction

The objective of this paper is to provide a comprehensive psychological model of travel mode choice behavior. Despite considerable research on people's mode preferences and choice behavior especially for urban travel, there is a conspicuous absence of any comprehensive systematic theory of mode choice behavior anchored to the psychology of the user. This is largely due to the strong engineering and economic orientation to transportation research in which the search for the determinants of mode choice has been limited to either engineering designs and systems, operations and scheduling and economic costs associated with the mode usage; or to very broad socio-economic-demographic characteristics of the individual users (See Vance, 1974 for an extensive and excellent bibliography on mode choice models).

Only recently there has been some empirical research on mode choice behavior which is based on the psychological processes of the users (Golob, Canty, Gustafson and Vitt, 1972). While this research has generated greater respectability for understanding the psychology of mode selection, there exists no comprehensive psychological model of travel mode choice behavior.

A psychological model of mode choice behavior is likely to be extremely useful in transportation research due to many diverse reasons. First, psychological factors are often the basis for deep-rooted habits and preferences of people which favor private transportation such as the automobile and which reject many good public transportation systems especially within an urban area. Second, we

know relatively little about the psychological basis of public transportation alternatives because most research has been concentrated on the engineering-economic aspects related to the supply of these alternatives. For example, while we know quite a lot about the prestige and status symbols associated with the automobile, there is no comparable body of knowledge about the bus or the train. Third, psychological factors are often easier to bring about a change in the desired direction by managerial actions. Relative to engineering design changes, they are quicker, short-term strategies which are easier to implement with significantly less costs associated with them. Furthermore, often the costly engineering redesigns produce no desirable results because a particular mode is preferred or disliked strictly due to psychological perceptual factors associated with that mode. In other words, a psychosomatic illness needs a psychosomatic and not a physical remedy. Finally, the enormous individual differences among user preferences across the cross-section of the population can only be understood properly by a detailed micro-level psychological analysis of the phenomenon. The traditional system-based variables such as schedules, fares and safety or even broad demographic variables such as income, education and age often do not account for a very large percentage of the variations in user preferences. Furthermore, from a public policy point of view, it seems only appropriate that the user psychology be fully understood to provide adequate consumer welfare and protection, and also to minimize the "catch-22" phenomenon so common in public regulation.

Overview

The fundamental concept underlying the model of mode choice behavior is that each user has a five-dimensional subjective space of mode utility. Each mode is evaluated with respect to these five dimensions and all feasible modes are placed in the five dimensional hyperplane as points in the utility space. The five dimensional psychological utility space reflects the user's expectations with respect to the functional, aesthetic-emotional, social-organizational, situational and curiosity-based needs wants hopes problems or barriers associated with travel behavior. The regular usage of a mode is determined by the user's evaluation of how well it performs on each of these five dimensions as compared to what he would like in a mode given his economic and time resource limitations.

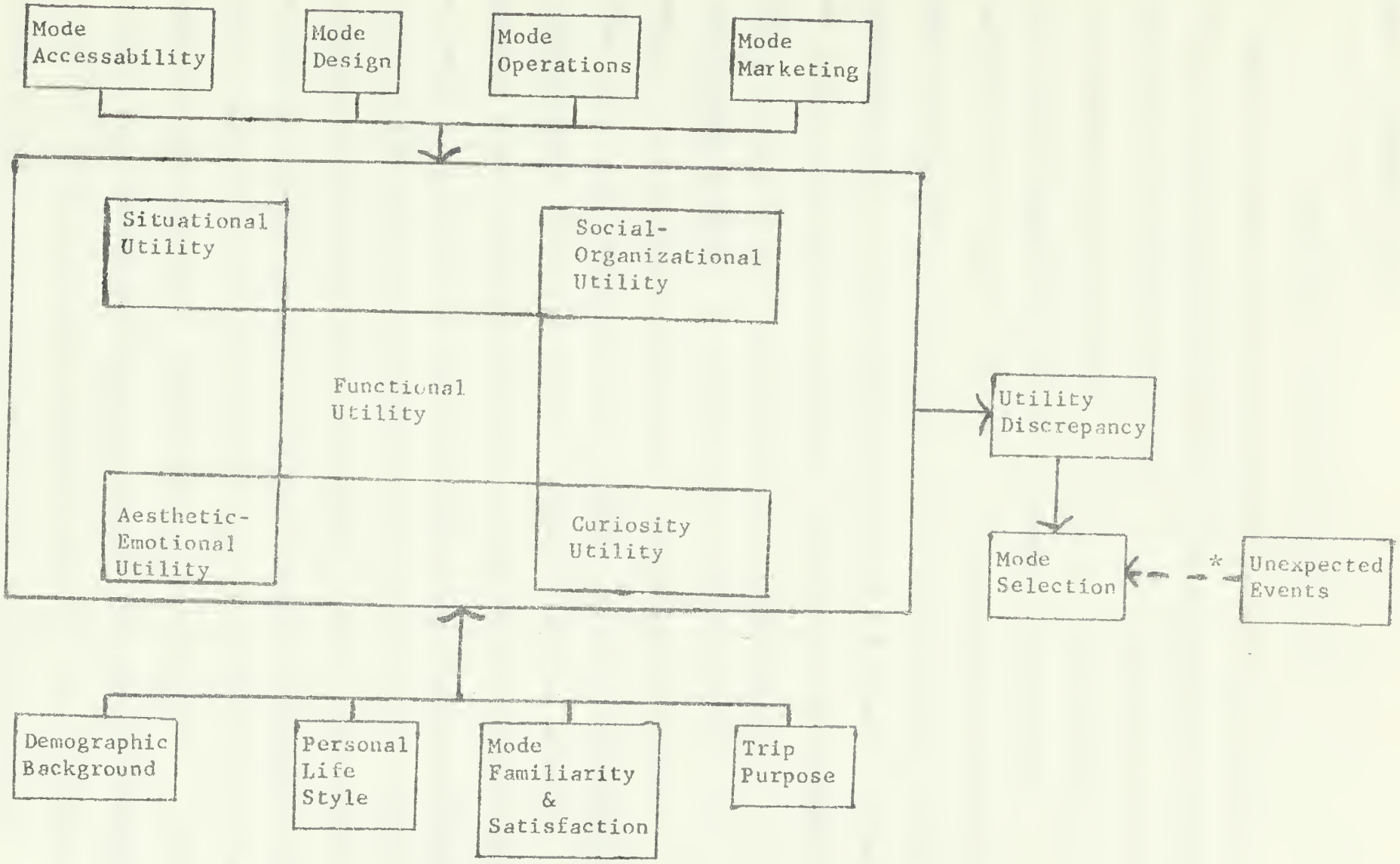
There are several aspects of this model of mode choice behavior which need to be reviewed before fully describing it. First, it is a psychological model anchored in the subjective worly of the user and not in the objective reality of mode characteristics. Therefore, the operationalization and testing of the model is, by definition, anchored at the individual user level. Aggregation at the total system level can be achieved only by assessing similarities and differences among individual users with respective to their subjective expectations. Often, this is likely to result in creating segments of system users who have similar perceptual mapping of the modes within each segment but contrasting mapping between segments.

Second, the model presumes that the impact of objective factors anchored to either mode engineering and operations or to user characteristics such as age, income and education on mode selection

is not direct but mediated bia the psychological expectations of the user. Thus, for example, the safety and scheduling of a public transportation mode such as the subway in a large metropolitan area will impact on a user's mode selection process only if they are mediated by his psychological expectations. Similarly, user's education and age may produce an impact on his mode selection if they determine or influence his psychological expectations.

Third, the psychological model of mode selection presented in this paper is capable of explaining and predicting only that mode choice which the user patronizes on an ongoing, regular and repetitive manner over a period of time. The model is not capable of predicting small, ad hoc deviations from regular mode usage which people occasionally make due to extraneous circumstances. For example, a person may regularly commute by private car but one day takes the bus to go to work because the car has broken down or is being serviced that day. Similarly, a person may usually take the train to go to work but one day goes in his personal car because he is going out of town straight from the place of work. In order, therefore, to predict each ad hoc use of a mode, we must go beyond the general psychological model and assess highly specific and unique situational factors. If the situational factors dominate in mode choice behavior, we would expect considerable degree of unstable behavior over time. In that case, the model developed in this paper is likely to be less useful. However, it is hoped that people manifest some regular patterns in their mode selection over time for each specific travel purpose. The model is represented in Figure 1. The rest of the paper describes various elements of the

FIGURE 1. A PSYCHOLOGICAL MODEL OF MODE SELECTION



* Needed to account for occasional deviations from regular mode usage.

model in greater detail.

Dimensions of Psychological Utility

Based on a recent theory of individual choice behavior (Sheth, 1975), the psychological dimensions of mode utilitieis and underlying expectations are presumed to be as many as five dimensions. Not all the dimensions may be relevant to all types of travel behavior. In fact, the most important empirical research is likely to be identification of dominant dimensions of psychological utility which vary from individual to individual, from one trip purpose to another teip purpose for the same individual, and from one mode to another mode across a cross-section of users. Each dimension of psychological utility associated with a mode will be described in detail.

1. Functional Utility. It represents the perceived utility of a mode which is strictly limited to it's performance as a mode of travel for a specific purpose. For example, the most common aspects of psychological functional utility related to various modes for commuting purposes tend to be arrival on time, direct route, safety, no transfers, having a seat, low maintenance costs, parking problems, etc. In other words, the psychological world of functional utility is limited to those mode expectations which directly relate to the function the mode is presumed to perform. As such, functional utility tends to more directly relate with the engineering design and system operations characterestics. Considerable research exists in transportation area on both the objective and the psychological assessments of a mode's functional characteristics (Vance, 1974; Golob, Dobson and Sheth, 1973). Most of this work has focused on the relative importance of functional attributes in determining people's mode

selection and usage. Although perceived functional utility is clearly a function of a large number of mode attributes, this paper will not concentrate on how specific mode attributes combined together produce a certain level of functional utility or disutility in the mind of the individual user. It should, however, be pointed out that the functional utility is the net outcome of both positive and negative evaluations the user makes of a particular mode on a set of functional characteristics.

2. Aesthetic-Emotional Utility. The aesthetic-emotional utility is defined as that non-functional utility of a mode, which is anchored to fundamental values of the individual user in the emotive areas of fear, social concern, respect for quality of life, appreciation of fine arts, and other emotional feelings. The emotional-aesthetic utility toward a mode is often manifested in terms of style, interior and exterior decoration, comfort and luxury, as well as safety of the mode. However, often the user associates strong emotional feelings with a mode anchored to early experiences or some unexpected ad hoc experience. For example, a person may be involved in a train accident which may produce such a traumatic shock that the person is incapable of riding the train as it associates with very fundamental emotional feelings of death and survival. The aesthetic-emotive utility toward a mode is also developed by early childhood socialization processes. Thus, a person may reject the use of public transit based on a fear that he may catch diseases from other people's use of the same mode of travel.

The aesthetic-emotional expectations of a user toward modes of

travel are often looked down by researchers as "irrational" motivations. However, often they determine his mode selection behavior and, therefore, must be fully researched.

3. Social-Organizational Utility. Travel modes especially in urban transportation tend to acquire certain stereotypes or imageries because they are selectively associated with certain socioeconomic, demographic and occupational groups of people. These socially anchored stereotypes produce certain mode utilities or disutilities which become an important dimension of user expectations. For example, carpooling or vanpooling may be looked down by some people if it is associated with lower income blue collar or clerical white collar workers. The suburban train may have social prestige since it is more used by upper socioeconomic professional people. Finally, certain bus routes within a city may acquire social disutility if it is primarily patronized by a select group of people such as Blacks.

Social-organizational utility is also nonfunctional in nature. Again, while considerable research on this type of perceived mode utility is available about the automobile, we know relatively little about public modes of transportation. The factors that tend to create social utility or disutility in a mode are the demographic factors of sex, race and age, the economic factors of income and price, and the social factors of education and occupation.

4. Situational Utility. This refers to perceived utility of a mode which is strictly due to the circumstances surrounding its availability and accessibility. It also refers to the degree of utility or disutility a particular mode acquires as it relates to the total set of activities associated with a trip purpose. For example, while the automobile may be

functionally a very good mode of travel for commuting purposes, the difficulty of parking, and the distance from place of work may produce disutility in it. Similarly, a person may go for shopping by bus because the spouse takes the single family car to work. People often prefer to drive on long-distance trips rather than fly due to the inconvenience of airline schedules of arrivals and departures as well as the time it takes to reach the airports.

Situational utility is similar to functional utility except that its presence or absence is often associated with the compatibility or difficulty with which related antecedent or subsequent activities involved in travel. The mode's own functional utility is, therefore, either enhanced or inhibited by the performance of related activities. It should be kept in mind that a mode's situational utility is likely to vary from individual to individual. In fact, it is often determined by individual's own characteristics such as the area in which he lives, his household composition, and his personal life style.

5. Curiosity Utility. A mode may acquire additional utility beyond its functional utility simply because it is new or different. Many of the radical engineering innovations in transportation often generate curiosity utility which may temporarily increase the usage of the mode. This happens, for example, when new buses or train cars replace obsolete ones. Probably the new Bart system in the San Francisco Bay area may be, at present enjoying greater ridership because it is something new or different.

The curiosity utility is by definition, short-lived. Once a new

innovation becomes old hat, it is more likely to be evaluated on the basis of other four types of customer expectations. However, when two modes of travel are equal in regard to other dimensions of psychological utility, the mode which offers innovative ideas, is likely to gain marginal utility due to curiosity, novelty expectations of consumers.

Each mode of travel is therefore, evaluated by a trip maker on each of the five dimensions of psychological utility. Based on the mode's utility vector, the trip maker decides on a particular mode as his regular mode of travel for that specific purpose such as commuting, shopping, vacations, visiting friends and relatives or sightseeing.

The model presumes that the individual, given his time and income constraints, has a desired profile of expectations with respect to what he seeks in travel behavior in terms of his own functional, aesthetic-emotional, social-organizational, situational and curiosity needs, wants, desires, problems and barriers. The discrepancy between the desired and perceived vectors of psychological utility will determine whether a particular mode will be acceptable to the individual. However, the utility discrepancy is presumed to be only one-tailed in nature. In other words, if a mode offers more than the desired utility on a specific dimension, the additional utility has no value to the individual. On the other hand, if it offers less than the desired utility on some other dimension, it will be regarded as less than satisfactory. Depending upon the extent of one-tailed or positive discrepancy, a particular mode will become either acceptable or unacceptable to the

individual. What is that critical level of positive discrepancy is an unknown parameter which can only be estimated by empirical research. However, it can be safely stated that the greater the positive discrepancy between desired and perceived utility of a mode, the less is the probability of it remaining acceptable to the user.

Mathematically, the Utility Discrepancy of a mode (UD_j) is measured as follows:

$$UD_j = \sum_{k=1}^{5} (U_{dk} - U_{jk}), \qquad (1)$$

under the constraint that $UD_{jk} = 0$ if U_{jk} U_{jk}; and
where,

UD_j = Utility Discrepancy of jth mode of travel for a specific purpose.
U_{dk} = Desired utility on kth dimension
U_{jk} = Perceived utility of jth mode on kth dimension.

Finally, the choice of a mode as a regular mode of travel for a specific purpose is likely to be based on the principle of minimization of utility discrepancy. In other words, choose jth mode if UD_j is less than UD_1, any other mode of travel.

While the model may look highly rational from the decision-making process point of view, two things must be kept in mind. First, the basis for the mode choice contains at least four dimensions of psychological utility which are not based on the functional aspects of the mode performance. In other words, we presume that the consumer has a rational decision-making process even if what he desires in travel behavior may not be good for him. Secondly, as stated before, the model attempts to explain only those mode selections for a specific purpose which are stable over time except for occasional, ad hoc changes. The model is not capable of predicting a person's mode choice

for a specific day and for a single trip. Such specific predictions are more difficult and probably not amenable to model building effort because too many unpredictable factors tend to be involved in those choices.

Determinants of Psychological Utility

The vector of psychological utility is likely to vary from mode to mode, from individual to individual and from trip purpose to trip purpose. Given this three-way variability in the psychological utility, it becomes necessary to isolate factors which seem to determine it. It would appear that some of the determinant factors are likely to be supply-oriented and others are likely to be demand-oriented. We will discuss each type of determinant factors below.

1. Supply-Oriented Determinants. How a person will perceive the psychological utility of a mode of travel is at least partly determined by what the supplier of the mode has to offer to the customers and the manner in which he offers mode selection relative to other suppliers of other modes of travel. The psychological utility of a mode is presumed to be partly determined by at least four supplier-oriented factors. They are mode availability, mode design, mode operations and mode marketing.

Mode availability includes ease of accessibility of a mode to the trip makers. It also includes the total network of the mode system. For example, in a bus system, it is important to consider the total routing system, distance from places of work, residence, shopping and recreation as well as the frequency with which it is accessible to the trip makers. Similarly, the availability of a car implies a relatively

large amount of capital expenditure and its accessibility for a trip purpose depends on the highway system. In general, it is safe to state that the private modes of travel such as the automobile have a far better availability factor in their favor relative to most public modes. This has resulted in greater functional and situational utility in the automobile as a mode of travel in general.

Mode design is a second supply-oriented factor. It includes the variety of product or service as it is offered to the customers. Thus, in the case of the automobile, it includes variety of models, styles and conveniences as well as distinct features relevant to its performance as a mode of travel. Similarly, the subway cars, their interior design, seating arrangements, and station conveniences constitute mode design of a subway system. Mode design is not limited to the physical carrier but also includes all related facilities. For example, parking lots and parking spaces, the highway design and scenery will be relevant elements of automobile product design. Similarly, the stations, platforms, newsstands and restrooms will be part of the subway mode design. The mode design variable provides both the functional and aesthetic-emotional utilities to a mode. Furthermore, it often is capable of injecting curiosity utility by planned changes in secondary or nonfunctional characteristics. Examples include styling changes in automobiles, buses and subway cars.

Mode operations refers to the actual usage related man-machine interface involved in the daily operations of a travel mode. For example, in a bus system, it includes the driver, the procedure for paying the fare, and the procedures for getting in and out of the bus at

predetermined stops. Similarly, the mode operations in carpool include the rotation of carpoolers as drivers, the specific route taken to pick up and drop off carpoolers as well as fuel and maintenance aspects of the car. It is often the mode operations which either enhances or inhibits the functional and situational utility of a mode. It is not at all uncommon to find the same system put under a new management which actually has saved the mode of travel from going bankrupt. The managerial talents are extremely useful or important in this regard. Amtrak is a good example of this supply-oriented factor.

Finally, mode marketing is an important determinant of the psychological utility of a particular mode. Although marketing is somewhat narrowly defined in this paper, it includes both price and promotion strategies. The role of mode marketing is primarily to enhance the functional, situational and social utilities involved in a mode. It can also perform the role of providing adequate information to the trip maker.

The supply-oriented factors combined together generate differential psychological utilities for different modes of travel. It is these factors which often create mass acceptance or rejection of a mode in the market place.

2. Demand-Oriented Factors. It is not sufficient to presume that the psychological utility is fully determined by the supply-oriented factors. If that were the case, the task of management and public policy would be relatively simple. The psychological utility of a mode is also determined by a set of demand-oriented factors. These factors tend to produce differential psychological utilities for the same mode of travel among a cross-section of users resulting in the same mode accepted by

one group of customers and rejected by others.

There are four distinct demand-oriented factors. They consist of (1) personal demographics of the trip maker, (2) his personal life style, (3) his familiarity and satisfaction with the mode and (4) purpose of his trip.

Demographics of the trip maker consists of sex, race, age, income, education and occupation of the trip maker. In general, it includes the individual's life cycle and socioeconomic status. There is no question that personal demographics especially sex, age and race heavily influence what the individual desires by way of psychological utility in a mode. In addition, income is likely to influence these desires. Considerable research exists today to support the influence of demographics on people's mode preferences (Hille and Martin, 1967; Wynn and Levinson, 1967; Bostick and Todd, 1966; Golob, Canty, Gustafson and Vitt, 1972).

Life style refers to an individual's allocation of time and money in the daily activities of one's life including specific choices he makes in terms of food, shelter, clothing, recreation, religion, work, community involvement and the like. Life styles tend to reflect individual's fundamental value system. Often they influence a person's psychological utility in a manner which is independent of demographic factors. Recently, considerable research has been generated in consumer research to indicate that life styles tend to provide insights into consumption differences among otherwise homogeneous demographic segments (Wells, 1974 and 1975). Very little research in transportation area has been undertaken so far to measure the impact of life styles on mode

choice behavior either directly or mediated via psychological expectations and preferences.

Mode familiarity and satisfaction is an obvious but very useful determinant of mode expectations. As has been pointed out by Bostick and Todd (1966), people tend to choose a given mode and stay with it if they are satisfied even though other modes may be more appropriate for them. Often, an individual does not choose a mode of travel simply because he is not even aware that it exists, or knows so very little about it as to ignore it. Similarly, people who tend to use a mode regularly form habits which are often difficult to change.

The final demand-oriented factor is trip purpose. This is included primarily to account for differential preferences of a mode on the part of the same individual for different trip purposes. For example, many people take the train or the bus to go to work but prefer to go in a personal automobile for shopping even if the place of work and shopping are in the same location. Each trip purpose is presumed to have somewhat different set of needs, wants, desires and problems associated with it so that the same mode may be best for one purpose but quite inferior for another. This is dramatically true when the businessman drives to work but flies for out-of-town business activities.

The influence of the supply-and-demand-oriented factors on the vector of psychological utility is presumed to be monotonic and additive. Mathematically, we can state the formal relationship as follows:

$$U_{ijk} = \sum_{l=1}^{r} a_{jkl} S_{ijkl} + \sum_{m=1}^{p} b_{jkm} D_{ijkm} \qquad (2)$$

where U_{ijk} = Utility vector of ith individual for jth mode for kth trip purpose

S_{ijkl} = Evaluation of the jth mode for kth trip purpose by ith individual on lth supply-related factor.

D_{ijkl} = measurement of individual i's lth demand-related factor with respect to jth mode for kth trip purpose.

a_{ikl} and b_{jkl} are constants to be estimated.

It should be noted that some of the variables will have less than four subscripts if they are generalized measures affecting all modes or all trip purposes. These include the demographic and the life style variables as well as some of the supply-oriented variables.

Conclusion

A psychological model of mode choice behavior has been presented in this paper which has the fundamental basis of evaluation of a mode on a five dimensional utility analysis. It is suggested that the mode selected by the individual for regular usage, for a specific purpose is likely to be based on the minimization of discrepancy between what is desired and what is perceived of a mode in regard to the five dimensions of psychological utility.

A number of supply and demand-oriented factors are suggested as determinants of the psychological utility of a special mode j, for a specific trip purpose k in the mind of individual i. These include mode availability, mode design, mode operations and mode marketing on the supply side, and demographics, life styles, prior familiarity and satisfaction with the mode as well as trip purpose on the demand side.

It is hoped that the model is comprehensive enough to understand the phenomenon of travel mode behavior. Whether the model will be validated or not remains to be tested.

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