Resource Paper

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Travel demand forecasting can and should be used in the planning and design of short-range and low-capital options. The degree and manner of use may vary, but either direct or indirect application of appropriately structured demand analysis is essential to responsible project design and implementation.

To back up this premise and to provide a framework for identifying appropriate research and development, this paper starts with a discussion and classification of applicable travel demand forecasting needs. Requirements imposed by the nature of short-range planning and the actors involved are then outlined. This provides a basis for delineation of desirable demand forecasting and analysis characteristics. Following a brief evaluation of the present state of the art is a statement of research and development needs.

JUSTIFICATION AND USES

Need for Forecasting

Discussion of demand forecasting requirements and applications in the context of planning short-range and low-capital options should start with recognition that there is disagreement as to the usefulness of such demand analyses. The argument supporting omission of demand analysis is that "short range" and "low capital" by their definitions denote projects inexpensive enough to approach on a cut-and-try basis. It is argued that skipping demand forecasting saves money and precious time in project initiation—money and time that could better be spent in responding to the real-life project results as determined in the field.

It seems reasonable to acknowledge that there will be project options of a scale not justifying any more forecasting than the qualitative evaluations implied by good project design. However, good project design itself can benefit from demand analyses structured to produce travel market response information of general applicability.

The state of knowledge regarding effects on transit ridership of service, price, and advertising was recently described by the general manager of a progressive transit operations as, "We don't know" (1). This statement is symptomatic of not just a communication gap but a very real need for demand-analysis information applicable to optimization of transportation service priorities and design criteria.

Many short-range, low-capital projects deserve direct application of project-specific demand forecasting. Such forecasting may be done to aid preliminary project design, to use in selecting the best of several alternatives, or to provide a basis for feasibility determinations.

The project design application of demand forecasting in particular involves processes that are not extensively developed. As a result, the planner is often better able to evaluate a proposed transportation option than he is to design one in the first place. Yet it is surely a basic requirement that we be able to conceive and structure effective transportation options.

Use of demand forecasting in comparison of alternatives is not at all diminished in importance by the current short-range and low-capital orientation of the transportation planning climate. The increase in citizen participation in the planning process places greater demand on the planner and the administrator to produce an array of information, including forecasts, for use in citizen evaluation. The forecasts must be easily explained and readily defendable.

Although capital investment is not so much an issue with short-range and low-capital options, there are other types of investment, risks, and need for justification that equally require demand forecasting. One of these is the investment in institutional change required for many of the policy options currently receiving attention. Another is the substantial risk of project failure that may jeopardize a transportation improvement program. There is also the real or imagined cost of change in the way of doing things, as exemplified by disruption of public travel habits and operating agency procedures.

Classification of Forecasting Uses

Given the forecasting needs discussed above, a categorization of travel demand uses can be outlined as follows:

1. Demand forecasting for design purposes
   a. For project-specific design
   b. For general design guidelines
2. Demand forecasting for project evaluation
   a. For comparison of alternatives
   b. For feasibility analysis

As outlined, use of demand forecasting in design can either be project specific or have more general applicability. Project-specific applications involve using travel forecasting models and techniques in preliminary design to identify the potential and the preferred characteristics of a short-range or low-capital option. Results are specific to study area characteristics. The demand models may be used to produce preliminary usage estimates, to identify areas of feasibility, and to evaluate alternative operating parameters in the search for optimum transportation service combinations.

Use of demand forecasting as a more general design tool implies making available a service planning handbook containing design guidelines and criteria recommendations derived from demand analysis. This would necessitate answering the basic questions about traveler response to alternative transportation system attributes, relating findings to a comprehensive array of typical planning options, and thereby deriving a series of suggested design approaches and evaluation criteria.

Demand forecasting for the purpose of evaluating concrete transportation proposals divides neatly into the subcategories of forecasting for alternatives comparison and forecasting for fiscal evaluation. The 2 processes are essentially similar, but with some difference in emphasis.

In a comparison of alternatives, demand forecasting provides relative measures of the degree to which each alternative meets facility-usage goals. For valid comparisons, the forecasting procedures and assumptions must be fully consistent among the tests of alternative concepts. Ability to differentiate among substantively different alternatives is of paramount importance, and thus demand-model sensitivity is a virtue.

In fiscal analysis, given a chosen plan, the basic concern is reliability. A degree of conservatism is generally desirable. The ideal best estimate for purposes of fiscal planning, seldom obtained, would in fact be a set of estimates, each prepared according to different procedures and assumptions and, thus, bracketing the full likely range of actual results.

PROCESS AND USER REQUIREMENTS

Planning Process Characteristics

In comparison with long-range forecasting, travel demand analysis for short-range and low-capital options generally involves fewer unknown elements. Most of the land use, population, and travel characteristics not directly subject to project impact can be described by means of trending or minor adjustment of data on present conditions. This on the one hand limits the scope of the demand-forecasting problem and on the other hand places greater demands on the planner for findings fully consistent with currently observable conditions.

Land use and development can generally be considered fixed. The potential change in trip generation can often be judged minor and either omitted from consideration or accounted for as a percentage. One exception is where a secondary mode is to receive order of magnitude improvement or a primary mode is to be curtailed, for example, the introduction of viable bus service into a currently unserved area or the institution of a major parking tax or vehicle use toll. For this type of option, quantification of effects on the absolute amount of trip-making activity would definitely be desirable.

Trip distribution falls in the same category as trip generation: Changes should be of minor significance except in the special cases just mentioned. Travel-mode choice, however, is a demand element of major interest and concern in planning most short-range, low-capital options. Almost any undertaking involving more than traffic-operations improvements will require mode-choice analysis if there is to be any formal demand forecast.

Route-choice forecasting is the other travel demand element consistently of interest. Route selection, reflected in the planning process by sub-mode-choice analyses and travel assignments, is significantly more sensitive to service changes than choice of prime mode itself. As will be further discussed, accurate demand forecasting at the transit route level of detail is particularly important in meeting informational needs of the transit operator.

Demand forecasting for short-range and low-capital options thus emerges as having primary concern with either mode choice or route selection or both. Consideration of change in land use, trip generation, and trip distribution can in many cases be omitted or simplified, with certain important exceptions where induced demand is of special interest. Availability of comprehensive and up-to-date base-year travel data is a corollary requirement of particular importance.

Geographic Areas of Application

It is probable that most short-range, low-capital demand forecasting will involve projects best evaluated by concentrating on some appropriate subarea of the metropolitan region. The subarea may be an entire transportation corridor, a major political jurisdiction, an operating division, or the area tributary to a specific transportation terminal or station.

Projects justifying demand forecasting may only involve a single street or transit route, but normally a larger area will require study to identify pertinent side effects.

Need for full metropolitan region forecasts will in certain instances be encountered, particularly in reference to evaluating policy alternatives. Travel analysis for short-range and low-capital options clearly must have a flexible structure applicable to a broad range of geographic area sizes and levels of analysis detail.

Requirements of Specific Users

Each potential user has specific needs and requirements of demand forecasting for short-range and low-capital options. These are not necessarily conflicting requirements, but they must all be accounted for in seeking techniques with broad applicability.

The metropolitan transportation planner represents users including the transportation planning arms of federal, state, and local governments; regional land use and transportation planning agencies; and consultants to those groups. His demand-forecasting requirements are fairly all-encompassing. A major concern, reinforced by environmental legislation, is to have a reliable capability for estimating and comparing mode shifts that may take place when alternative programs and policies are implemented.

The planner is concerned about the effect of comfort, convenience, reliability, time, and cost. He needs measures for special services such as door-to-door bus passenger pickup, demand scheduling, and car-pool priorities; he needs to assess multimodal effects such as the impact on transit demand of fringe parking facilities. Special requirements are imposed by the need to assess transportation service impact on various socioeconomic groups and the need to take into account specific capacity restraints such as limited parking availability. Finally, because the transportation planner represents the party charged with producing travel analyses, he needs techniques that can be applied within reasonable time and expense limitations.

The first priority need of transit operators as demand analysis users is travel forecasts that they can believe in and feel comfortable with. This is not likely to happen until the planning profession can produce computer assignment output for present travel with transit line loadings close to observed loading. Even though corridor volumes may match, the operator has difficulty understanding how a process that cannot produce accurate line loadings without extensive hand adjustment can really have any validity as a short-range planning tool.

Not only are accurate line-by-line passenger-loading estimates necessary for credibility, they are needed by the transit operator for technical reasons as well. In particular, the schedule department needs such estimates to prepare schedules for major transit routing changes. Indeed, it would be desirable for transit assignment output to be adequate and sufficiently comprehensive for direct input into automated scheduling processes.

Other transit operator requirements include the need for basic marketing information on traveler response to service and fare changes. When specific proposals are being tested, operators would like to see detailed information on both favorable and unfavorable effects on riders. They would like to know the effectiveness of service changes in attracting new riders, but do not want this mode-shift information to mask impacts on the existing transit users. Lastly, operators of multimodal transit systems require the facility to examine effects of fares, parking charges, feeder service, and terminal facilities on mode of arrival at stations, station choice, and revenues.

Demand-forecasting requirements of the highway operator relate primarily to those instances where a proposed option impinges on the traffic operation of an existing freeway or street. If the option is transit oriented, the highway agency will desire demand forecasts to determine whether the highway capacity relinquished will result in a net transportation gain or loss. Reliable demand forecasting pertaining to highway vehicle route choice can be a useful tool in evaluating changes in traffic operations, but the analysis costs and accuracy obviously must compare favorably with manual techniques.

Political decision-makers and citizen participants in the planning process are the ultimate users of much of the demand forecasting done by planners and transportation operators. They depend on forecasting reliability and need clear statements defining the range of uncertainty inherent in each demand analysis finding. Citizen participants, in particular, are concerned with questions of basic demand forecasting validity. They are best served by models that have an obvious, easily explained correlation between model structure and some inherently logical travel-making decision process that the public can relate to. Finally, political decision-makers and citizen participants desire prompt response to the "what if" question, placing a requirement on the travel analysis process for quick response to testing of alternatives.

OBJECTIVES AND PRESENT STATUS

Desirable Features and Characteristics

The short-range, low-capital applications of demand forecasting, the specific needs of forecasting users, and the characteristics of the short-range planning process all serve to define desirable features and attributes for the applicable demand analysis methodology. In this section, a position is set forth as to what the key features of this methodology should be.

As previously discussed, it is the mode-choice and route-choice travel decisions that consistently bear most directly on short-range forecasting. This suggests an advantage to using sequential models for most short-range planning activities. Sequential modeling will allow bypassing of the generation and distribution stages of forecasting in those numerous projects where the theoretical advantage of considering all factors is clearly outweighed by the benefits of simplified analysis.

Use of mode- and route-choice models alone does imply availability of travel-interchange volumes from surveys or forecasts. Unfortunately these are not always available in suitable form. For such situations and for projects where latent demand is of critical importance, there is definite place for direct-demand transit-rider estimation techniques.

Two major considerations call for use of models with a clear, logical structure open to examination and study. First, use of the inscrutable "black box" type of formulation hinders the planner in explaining and justifying his processes to the ultimate users: the transportation system operator, the political decision-maker, and the citizen participant. A process with inherent logic that can be effectively illustrated provides more salable forecasts than one that nonstatisticians must take on faith. Second, models with a logical structure provide a basis for understanding mode-choice decision-making processes in a way that can be applied toward designing more attractive transportation alternatives. Sensitivity tests of any type of model can be used to determine that model's statement as to how travel will change as transportation service parameters are altered, but only a model structured on theory can significantly contribute to answering why. For these reasons, short-range demand forecasting appears best served by models based on the concept of describing actual human behavior with probability statistics.

Part of the analysis package should be a carefully derived and structured handbook setting forth demand forecast findings relevant to system design. Translation of these findings into service criteria and optimum service combinations under various conditions should be provided. The basis for such a handbook should clearly be the broadest possible array of well-substantiated behavioral modeling and sensitivity testing.

Requirements for analysis of alternatives obviously call for forecasting techniques that provide internally consistent comparisons, realistic sensitivity to the differences among options, and reliability in the absolute forecast. The ideal model should have the capability to analyze not only time and cost factors but also comfort, convenience, reliability, and various subcategories within each, such as walk time versus wait time. The ideal forecasting package must cope with special transit services involving boundary conditions, such as no-walk or no-fare; effects of incentives and special information services, such as in organized car pooling; and impacts of capacity constraints, such as capacity limits on station or downtown parking.

Part of the short-range demand forecasting package should be an assignment process capable of realistic passenger loadings on individual transit routes. This assignment capability should extend to systems containing mixes of express bus, local bus, rapid transit, and commuter railroad services.

It is desirable that the analysis package include capability for isolating the impact of service change on various socioeconomic and transit rider groups. In the instance of short-range transit alternative evaluation, it would also be desirable to provide for analyzing the known travel patterns of existing riders while at the same time to provide for calculating mode shifts associated with transit improvement. This capability would presumably be manifested in a technique for manipulating and analyzing detailed transit-rider survey data while retaining access to travel information and models required for mode-choice forecasting.

With all this, the ideal short-range and low-capital demand forecasting package would still have to be operable with considerably less expense and elapsed time than is characteristic of current efforts. The desirable goal would be to have no significant project forgo demand forecasting because it would require too much money and time needed for other aspects of project initiation.

State of the Art

Sequential demand models, identified in the previous section as appropriate for most short-range planning, are fortunately the most highly developed. Nevertheless, present examples do not provide all characteristics outlined as being desirable.

Disaggregate models structured to relate mode choice with human behavior give excellent promise for better understanding of user response to transportation system characteristics. The development status of this type of modeling has been covered recently in a comprehensive paper by Reichman and Stopher (2). At this point, there has been little production use of disaggregate stochastic models in transportation planning practice or in the translation of research findings into descriptions of preferred transportation system characteristics.

Concepts closely paralleling the probit analysis type of disaggregate model, but intended for use with aggregate data (3), have been recently applied in developing new mode-choice models for the Washington and Philadelphia regions. Direct-demand transit-rider estimation procedures developed by Kraft and others (4) are being employed in Boston, but have not at this point been adopted for production use in other urban areas.

Assessing the consistency and reliability of current models is made difficult by the fact that most "testing" is limited to replication of the same survey data as were used in model calibration. There have been all too few rigorous comparisons of modeled travel demand with actual before-and-after data.

The Traffic Research Corporation diversion curve mode-choice model for Toronto is one that has been examined by using comprehensive survey data from 2 points in time. The results indicated good stability where high levels of transit service were involved and some significant shifts in modeled response to lower levels of service (5). Tests of a mode- and sub-mode-choice model chain developed for the north suburbs of Chicago indicated an ability to forecast, within the range established by 2 separate surveys, the usage and mode shifts associated with opening a rapid transit branch (6). In both cases the models involved were of the sequential type. This author is not aware of any such comparisons made with urban applications of direct-demand modeling.

There does not exist any handbook of transportation service design based on knowledge of desirable system characteristics as derived from mode-choice model interpretation and sensitivity tests. There has, however, been some limited sensitivity testing along this vein in system-specific analysis. One such application was the use of direct-demand estimating models in an effort to describe desirable service characteristics for metropolitan Boston transit service (7). A second application was use of mode-choice models developed for the Chicago north suburbs (6) to examine local bus-rider sensitivity to fares and service frequency (8). This latter work also involved use of modeling in system design to establish basic ranges of feasible service coverage.

All of the currently operational demand forecasting techniques and related models are sensitive only to a limited range of transportation system characteristics, although obviously those parameters thought to be of critical importance are included. A current Washington, D.C., study of short-range, low-capital options available for reducing automobile travel (9) serves to illustrate present capabilities and needs. Forecast results are not available, but study design has identified the new Washington, D.C., choice models as being directly sensitive to effect of policies concerning parking fees, transit fare, road pricing, and increases in transit service as described by coverage and frequency. Policies under consideration that cannot be examined without supplementary modeling include car-pooling incentives and expansion of commuter fringe parking. Neither will direct examination be possible, should it be desired, of certain other service attributes including standee policy and service reliability. Hard data are lacking for rigorous development of supplementary models to address such questions.

The major available work concerning importance of mode-choice factors other than those directly related to time and cost is the Chicago area research done by the Illinois Institute of Technology (10). Factors investigated include considerations such as privacy, ability to read a newspaper while commuting, and likelihood of obtaining a seat. Certain of these considerations were identified as being of importance. However, for whatever reason, the findings of this study do not appear to have engendered consideration of more factors in operational demand forecasting models. The recent Purdue session on transit operations research needs concluded that "much more research on the determinants of demand for transit service is absolutely essential to rational planning" (1).

There exists one example of forecasting demand for special transportation services by using disaggregate mode-choice modeling. The travel modes considered were private automobile, rental car, taxi, and limousine as used for access to airports in the Baltimore-Washington area (11). The authors of a paper on the project, which used a multimodal logit model, indicate this initial work to be promising. It is pertinent to note that the architects of this analysis, as so often happens, also report being severely hampered by incomplete survey data on the characteristics of current transportation service use.

There are a number of other models or estimating procedures that have been developed for forecasting special transit service demand. However, these tend to be structured on unverified hypothetical user response pending availability of better information.

The first and major use to date of the HUD transit-planning package for short-range transit improvements provides an instance where impact of service changes on existing transit-rider groups was specifically looked at. This use was in the investigative UMTA demonstration project undertaken during 1968 in conjunction with the Washington Metropolitan Area Transit Commission and D.C. Transit, Inc. (12). Travel time and transfer reductions (or increases) were quantified in terms of origin and destination areas of transit-rider trips, with no socioeconomic stratification. The techniques on hand then and now required substantial additional data processing to obtain this information. The data for this particular project were a detailed survey of existing transit usage, but the work suffered from inability to make statements about mode shifts that might be occasioned by specific service-improvement proposals.

It was in this demonstration project, which used the HUD programs, that the need for more realistic transit route assignments was first identified. Although satisfactory manual adjustment techniques were developed, they were time-consuming and not easily transferable to significantly altered routing systems.

The success of recently implemented multipath highway assignment techniques (13) in providing realistic highway vehicle loadings gives indication that realistic transit assignments should be possible to achieve. Work in the areas of transit submode choice and highway route choice gives evidence that models applicable to multipath assignment can be readily structured (14, 15). Transit sub-mode-choice modeling to date, however, has been based on limited data. There has been no known investigation of transit-route choice within an all-bus system.

The present overall picture of demand forecasting for planning short-term and low-capital options is one of an activity that holds significant promise, but of practical applications and achievement to date that have been limited in number and scope. For any major growth of accomplishment in this activity, there needs to be more basic understanding of market forces and demand forecasting, more dissemination of knowledge, and introduction of analysis program mechanisms designed specifically to meet short-range forecasting requirements.

SUGGESTED RESEARCH AND DEVELOPMENT

The suggestions that follow comprise a position and preliminary statement on specific research and development activities thought to be of particular importance in the development of demand forecasting for short-range and low-capital options. Obviously many of the suggested projects have direct input into other areas of demand forecasting as well.

Travel Data Surveys

The need for survey data is an aspect of research that too often leads to projects that gather data and do little else or that structure elaborate data-dependent models on the thinnest of observations. Moreover, there is often only one chance to obtain survey data pertinent to important before-and-after situations.

It is suggested that a program be initiated with the explicit purpose of obtaining and processing empirical travel data structured specifically to meet mode- and route-choice modeling requirements. A key initial step in such a survey program is establishment of a board of control or a similar structure for use by the researchers to specify data needs and oversee survey design. This board of control should comprise practitioners and researchers with demonstrated experience in using survey data for mode-choice model research, development, calibration, and application. The board should have representation from each of the principal schools of thought concerning model structure.

Under direction of this board of control, special surveys would be commissioned. In addition, survey designs would be specified for pertinent UMTA grant projects.

In the area of special surveys, it would seem particularly useful to initiate sets of closely controlled surveys directed at obtaining travel behavior information for circumstances where only one variable changes or is different. For example, it is doubtful that the effects of walking distance on transit usage or submode choice can be adequately described without observations obtained when other factors are held under close control. Appropriate data should be obtained from areas with relatively isolated bus routes and transit stations. Separate large-sample, microlevel surveys or survey sets could be directed to assessment of response to various potential determinants of mode choice, route choice, and mode-of-access choice.

The obvious purpose of a rigorous survey program in connection with UMTA-grant projects is to obtain before-and-after data. The effects surveyed need not be dramatic to be important. It is said that the transit-riding population on Chicago's parallel Lake Street and Eisenhower Expressway rapid transit lines has for years been shifting from one route to the other in response to schedule and equipment changes. Time-sequence surveys in this narrow corridor, had they been taken, would be invaluable to those concerned with comfort and time factors. As with the special surveys suggested above, before-and-after surveys should be carefully selected and controlled to produce a maximum of pertinent traveler-response information.

Model-Testing Procedures

Procedures and means for independent testing of demand models need to be made an integral part of the research and development process. Models or model chains thought or intended to be of general interest and utility should be examined for transferability from one data set to another and for capability to predict before-and-after travel characteristics. This is not to say that a choice model developed in Pittsburgh should necessarily be rejected because it cannot reproduce St. Louis transit riding; a correct reproduction of relatives might be judged sufficient for given purposes. My opinion is, however, that if a choice model is not transferable it is because some specific and ultimately quantifiable determinants have not yet been properly accounted for.

Initiation of a demand forecasting test program need not await development of new models and techniques, but could move forth in 2 stages. The first stage could be to provide a better understanding of the strengths and limitations of those current demand models that have received or deserve more than local attention. The traditional transit operator rules of thumb for estimating ridership potential might well be similarly examined. The evaluation program could then move on to a second phase of testing new model developments as they become available.

This testing program should provide funds specifically allocated for such calibration and adjustment as the authors of each model might specify as being appropriate. Funds should also be available for actual assistance and review by the developers of a model under examination. It should be stressed that this testing program is not suggested as a punitive control measure. Certainly one key purpose would be self-education of the planning profession. Further, it should be understood that an open and publicized validation program would be invaluable in gaining the confidence of transportation operators and public decision-makers where that confidence is deserved.

Market-Response Analysis

Analysis of demand-model structure and conduct of sensitivity tests to establish market-response relations are fully deserving of research and development status. As with model testing, analysis of market-response relations could move forward in 2 phases. In phase one, some half dozen existing models found to have merit in the validation process could be applied in parallel to service- and policy-parameter sensitivity tests by using a series of data sets. The results, and such findings as could be inferred directly from the model structure, could then be assembled into a preliminary market-response statement. In phase two, the work would be expanded by using new and advanced modeling techniques as they become available.

In addition to more general informational reporting, one specific product of market-response analyses should be the previously suggested design handbook for short-range, low-capital options. As with the precursor analyses, this handbook could be developed in stages as information becomes available. The purpose of the handbook would be to distill findings of travel demand analysis into concrete service design and marketing guidelines and recommendations.

Such a handbook might well contain nomographs and other manual design aids to better allow translation of recommendations to fit local conditions. Design information should be accompanied wherever possible with concrete examples of actual applications and their successes and failures. The handbook should be structured for use by all those involved in transportation service design, planning, and marketing, but with specific attention to needs of those projects where it would likely be the only demand-forecasting information input.

Mode and Route Choice

Implicit in the above recommendations is an assumed major program of mode- and route-choice modeling research. Such a program should be closely structured and directed to obtain pertinent results. A substantial portion of the research should be done under performance specifications having near-term application in mind.

A demand-modeling research program should obviously not put all of its eggs in one basket. On the other hand, it would appear that primary funding should go to mode-and route-choice modeling in the behavioral school with preference for efforts with clearly structured theoretical bases. Within this scope there is room for aggregate and disaggregate modeling, as well as for network modeling and modeling independent of specific network processes.

A key element of mode-choice research should be further investigation into the determinants of mode choice including the many comfort and convenience factors not yet well accounted for. For full utility, such research must be conducted within the framework established by model development. The results need to be readily transferable into the demand modeling context, not just independent statements of relative parameter importance.

A share of the research effort should go into direct-demand modeling to meet those needs for such models as have been outlined in previous discussion. It is hoped that such direct-demand modeling can draw on the findings of sequential, behavioral modeling such as to allow a comparably logical structure. In connection with developmental work on direct-demand techniques, it would be useful to obtain better information and forecasting ability concerning the secondary effects of induced transit ridership. Specifically needed are a better understanding and quantification of the social benefits that accrue from improved service to the transit-dependent individual.

Impact-Analysis Techniques

In the development of both model and analysis packages, attention needs to be given to isolation and examination of transportation service impacts on special user and socioeconomic groups. Work pertinent to this need may only be practical to undertake as part of specification and development of a broader analysis package. This circumstance does not in any way diminish the importance or urgency of such impact isolation capabilities. Perhaps there should be a task force established to define reasonable requirements for user-group impact analysis and to pursue its inclusion in the development of an overall analysis package.

It should be possible to accommodate the important special interest in accurate handling of existing transit-rider groups by development of relatively straightforward techniques. The need is for a program package allowing analysis of short-range transit improvements with primary emphasis on existing transit users but, nevertheless, providing appropriate estimates of mode-shift potential and risk. Such a package would use existing transit-rider trip data as the primary basis for route-specific volume and rider-impact analysis. Adjustments for mode shifts would be calculated on the basis of differential shift modeling that could be either direct demand or sequential as applied in conjunction with a separate total person-trip table.

Multipath Transit Assignment

The existing unmet requirement for accurate line-specific forecasts of transit riders has already been highlighted. This is a clear-cut and major program development need.

The problem could be approached in stages if appropriate for technical reasons. The problem element requiring the most immediate attention is the need for accurate assignment within the transit mode. This capability clearly requires multipath assignment responsive to sub-mode- and route-choice characteristics. The other principal problem element is that of obtaining realistic multimode loadings with full consideration of the automobile-driver and automobile-passenger means of access to transit service. The ultimate objective would be to have a program package allowing, for example, accurate estimation of line and station volumes for changes induced by collection and distribution changes in transit service, fee manipulation of fringe parking, and adjustments of line-haul service.

Time and Cost

Again it must be emphasized that time and cost of analysis are critical factors in the usefulness of demand forecasting in planning short-range, low-capital options. Improvements and elaborations to analytical capability will not be of value if they cause undue added expense, time, or necessity for special expertise. Indeed, requirements for these items must be reduced if advanced demand-forecasting techniques are to find broader acceptance and applicability in short-range planning. Program development activities must thus be vitally concerned with time, cost, and ease of program use.

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