# A SURVEY OF TRANSIT SYSTEM MODELING IN THE STATE OF FLORIDA

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**Abstract**

Minimizing vehicle emissions and their adverse impact on air quality, preserving the delicate ecosystem, maintaining the economic viability of the transportation system, ensuring social equity, and serving mobility needs of the transportation disadvantaged are but a few of the major issues confronting transportation planners, transit agencies, state departments of transportation, and metropolitan planning agencies today. In addressing these complex issues, recent federal and state legislation, notably the 1990 Clean Air Act Amendments (CAAA) and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA), have placed great demands on metropolitan and state planning agencies to make transit a viable alternative mode to the single-occupant private automobile. Despite the importance and potential of transit systems in meeting the mobility needs of an increasingly diverse population, the "state-of-the-practice" in transit systems planning and modeling has traditionally not been able to address the wide range of policy issues facing transit agencies. Transit demand modeling processes tend to constitute only a small part of the traditional four-step urban transportation planning/modeling process. Indeed, more often than not, the four-step modeling process is used to identify deficiencies in the highway network with respect to the automobile mode. As a result, transit models are generally found to be poor in their predictive ability, unresponsive to policy needs and issues, and inadequate in their representation of complex relationships underlying travel behavior, mode choice, transit system performance, and land use development. This paper reports on a survey of transit planning and modeling tools currently used in Florida and presents recommendations for enhancing them.

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**Introduction**

Transportation agencies around the country are constantly faced with the challenge of providing mobility to people in their jurisdiction. Over the last several decades, the transit industry has had to face the greatest amount of adversity in the wake of the growing popularity and ubiquitous nature of the automobile. The modal share of transit as a percent of all trips has declined to such an extent that most transit agencies depend heavily on subsidies to stay in operation. In many urban areas, the fraction of trips by transit is so small that they are considered "inconsequential" to the transportation system. This results in a neglect of the transit system, which, in turn, leads to further losses in ridership and a vicious cycle of "transit doom" is formed.

Escape from this vicious cycle requires careful policy planning and decision-making. In turn, this requires relevant information that is accurate and reliable. Until recently, transit planners and decision-makers have not been able to obtain such information. In the past, transportation data collection efforts, surveys, and models have concentrated on providing information on the demand and supply of the highway system. Very little was done in the way of collecting and producing information specifically for transit planning purposes. However, recent federal and state legislative acts have provided the impetus for undertaking detailed transit data collection efforts and transit modeling efforts. Unfortunately, many urban areas around the country have initiated such efforts simply because they are required to do so by law and are not seizing the opportunity as one where they could vastly improve the performance of their transit systems.

One possible reason for this is that transit modeling processes have generally been perceived to provide information that has been characterized as irrelevant, inaccurate, unreliable, and not understandable. This general perception is not far-fetched. Most transit modeling processes are either based on the traditional four-step urban transportation planning process that is more suited for highway modeling or made up of a set of ad-hoc and simplistic procedures that have been patched together in response to legislative requirements. As such, transit modeling processes are rarely comprehensive and detailed enough to aid in successful transit policy making.

With the recognition of the ill-effects of an automobile dominated transportation system and the realization that one can no longer build out of congestion, increasing numbers of urban areas are looking to making transit an alternative and viable transportation mode. However, decades of sprawled development and transit deterioration are trends that are extremely difficult to reverse. In order to develop and implement effective policies that would make transit competitive with the automobile, the transit industry needs planning tools that provide accurate, reliable, and understandable information in response to policy questions. The tools need to account for complex relationships underlying human travel behavior and choices, land development and transit use, and intermodal network performance, among others.

In response to the growing planning needs of transit agencies around the state, the Office of Public Transportation of the Florida Department of Transportation contracted with the University of South Florida to conduct an extensive survey of transit modeling in Florida. More specifically, the project was aimed at synthesizing the state-of-the-practice of transit modeling, identifying data needs and data availability for transit modeling, and developing recommendations for improving transit modeling processes in the state.

The remainder of this paper is organized as follows. The next section provides an overview of the state-of-the-practice of transit planning and modeling in Florida based on a review of Transit Development Plans (TDP's) and Mass Transit Elements (MTE's) in the state. The third section discusses and presents results from the statewide survey of transit planners and modelers that was conducted in conjunction with the research project. The fourth section briefly analyzes the Florida Standard Urban Transportation Model Structure (FSUTMS) as a transit planning and modeling tool. The fifth section discusses issues related to the need for and the availability of data required for transit planning and modeling. Finally, the last section provides concluding remarks and recommendations for enhancing transit modeling processes in the state.

## Review of Transit Planning in Florida

In order to assess the current use of transit models in Florida, Transit Development Plans (TDP's) and Mass Transit Elements (MTE's) of comprehensive plans were reviewed. Transit Development Plans are short-term plans corresponding to a 5 year planning horizon. On the other hand, Mass Transit Elements cover a longer 20 year planning horizon. These documents were examined with respect to the modeling methods and databases used. This section summarizes the relevant findings of the review in two sub-sections. The first sub-section provides an overview of methods used in TDP development while the second examines methods used for MTE development.

### *Review of Transit Development Plans*

Seven TDP's of various transit agencies within Florida were obtained from the Public Transit Office of the Florida Department of Transportation and three additional TDP's were obtained from individual transit agencies. Thus, ten TDP's were reviewed for this study; they are:

- Broward County Division of Mass Transit
- Hillsborough Area Regional Transit
- Lynx Services
- Lee County Transit
- Jacksonville Transit Authority
- Metro-Dade Transit Administration
- Volusia County Transit
- Tallahassee Transit
- Palm Beach County Transit
- Pinellas Suncoast Transit Authority

Among the TDP's reviewed, those of Broward County, Metro-Dade Transit Administration, and Volusia County Transit make explicit mention of using information from the Florida Standard Urban Transportation Model Structure (FSUTMS) modeling process for predicting ridership and analyzing alternatives. FSUTMS is a standardized transportation modeling package that implements the traditional four-step modeling process of trip generation, trip distribution, modal split, and traffic assignment in a structure that has been adopted across the state. In the case of

Metro-Dade Transit Administration, this modeling effort appears to be done in-house, while the others seem to obtain the model information from the Metropolitan Planning Organization (MPO) that undertakes FSUTMS modeling activities as part of the development of the long range transportation plan (LRTP). As the LRTP invariably involves long-range forecasting (20 year horizon), the TDP's have had to make adjustments to the information to reflect their shorter 5 year horizon. One possible adjustment involved interpolating for five years between base year and 20 year forecast figures. Another method involved only the partial use of model generated information; only the modal split information was taken from the FSUTMS output. Trend line projections applied to base year census and travel data provided five-year forecasts of total trips; modal splits derived from FSUTMS were then applied to these projections to obtain short-term transit ridership forecasts. As with any traditional four-step forecasting process, this method implicitly assumes that modal split will remain constant over a five-year time frame.

Lee County Transit contracted its TDP formulation to the Center for Urban Transportation Research at the University of South Florida in Tampa. In this particular TDP, a statistical linear regression model was developed to predict future transit ridership. The regression equation was calibrated using ridership data from 1984 to 1993. While the regression equation was found to provide a good fit (explanation of variation in ridership levels) from a statistical viewpoint, the model appeared limited with regard to its sensitivity to major policy or transit system changes. As a result, elasticity methods were also used to predict ridership. Fare and level-of-service elasticities of ridership derived from reports of the American Public Transit Association (APTA) were used in conducting the ridership analysis. However, it is unclear whether these approaches can accurately depict ridership impacts of fare and level-and-service changes across competing routes.

Palm Beach County Transit used demographic data, population data, employment trends, and socio-economic characteristics in the county to perform ridership analysis. In addition, a transit ridership survey and an origin-destination travel study which consisted of a telephone survey and a travel diary instrument were conducted within the last five years. The survey data was used to determine growth trends in selected areas and to plot travel patterns of captive and choice riders (by trip purpose). These plots were made as overlays and were used in conjunction with attitudinal data from the telephone portion of the survey to determine route alignments. These overlays were also used in conjunction with census overlays to identify areas which are conducive to transit and are not currently being served. It is noteworthy that this methodology is being increasingly adopted in urban areas outside Florida with a good measure of success.

A few TDP's did not provide a detailed description of their modeling method. For example, the analysis methods used in the formulation of the TalTran TDP are unclear. However, it appears that TalTran also uses a combination of socio-economic, demographic, and ridership trend projections to develop its short-term plans.

All of the agencies evaluated the performance of their transit systems based on a set of performance indicators including efficiency measures, productivity measures, and service dependability measures. Service dependability was examined by calculating percentage of bus trips met, percentage of pull-outs met, percentage of on-time performance, and other such measures of service reliability. Productivity measures were obtained by calibrating routes against passengers per hour.  Efficiency measures considered included fare recovery, cost efficiency, and vehicle utilization.

With regard to data used for TDP formulation, census information appeared to be the most popular source of base year data.  This included population, households, employment, and journey-to-work data.  In addition, historical time series data providing aggregate ridership levels over the past decade were used extensively in performing graphical trend projections.  While these data may prove extremely useful in performing simple trend projections, they offer very little in the way of demand elasticities, rider profiles, and rider perceptions/attitudes.

A few TDP's mention the use of additional data beyond that available through the census.  For example, Palm Beach County obtained certain additional data and economic forecasts from the University of Florida Bureau of Economic and Business research.  TalTran and Palm Beach used data available in the Federal Transit Administration (FTA) Section15 Reports that provide detailed information regarding transit performance, ridership, and attributes. It is also encouraging to note that a few transit agencies and urban areas have conducted on-board transit surveys within the last few years.  For example, TDP's of Lee County, Jacksonville Transit Authority, Palm Beach County, Lynx Services, and Metro-Dade Transit explicitly mention the use of data obtained from transit rider/user survey(s).  Such data offer valuable insights on the demographic and travel characteristics of transit users.

In general, the use of FSUTMS-type modeling processes for TDP development appeared very limited.  In most cases, trend line projections of base year census data (usually 1990 census data) or ridership survey data provided estimates of future ridership.  Various assumptions tend to be made regarding the potential percentage of traffic that a certain transit route may be able to capture or the average passengers per route mile (e.g., Volusia County TDP uses 1.5 riders per route mile) to estimate potential ridership along individual routes or corridors.

### *Review of Mass Transit Elements*

The review undertaken for this study was also aimed at obtaining an understanding of the transit modeling methods and data used by urban areas for long-range transit planning purposes.  To this end, mass transit elements (MTE's) from comprehensive plans of ten counties in Florida were reviewed, namely those of Brevard county, Broward county, Dade county, Hillsborough county, Leon county, Manatee/Sarasota county, Ocala/Marion county, Pasco county, Pinellas county, and Volusia county.

All of the above mentioned counties used ridership data together with other socio-demographic and economic data to estimate the future demand.  Ridership data was mostly obtained from transit surveys conducted in the county, while other demographic and socio-economic data were mostly obtained from the U.S. Bureau of Census (1990), the Bureau of Economic and Business Research (BEBR), and the U.S. Department of Commerce.  In addition, certain location specific data was also obtained from other state and local agencies.

Marion county used 1985 zonal data sets developed for FSUTMS for ridership analysis.  Five out of ten counties used demographic variables such as population and vehicle ownership in addition to economic variables describing employment. For obtaining ridership information, Ocala/ Marion county conducted a mail back survey in 1989 for 5,000 residences (of which only 864 responded) to estimate potential transit users. Hillsborough county used household characteristics, age distribution, household income, and employment to estimate demand. Most other counties just examined trends in the population to estimate the future demand for transit. Only two counties were found to use FSUTMS to develop their Mass Transit Elements while a third was found to use information obtained from FSUTMS for its Mass Transit Element development.

Performance evaluation of transit systems was another aspect covered by most MTE's. Variables used to assess transit system performance included service frequency, levels of service, total passengers, passengers per mile, percentage of system ridership, vehicle revenue miles, and operating expenses per mile. Pasco county examined the transit coverage area and the size of the population living within a one-quarter mile radius of transit routes (besides the above mentioned variables) to determine the productivity and efficiency of the transit system. Dade county also examined transit corridors and potential service extension as a part of performance evaluation. In order to conduct these performance evaluations, most counties obtained their data from the Offices of Planning and the Divisions of Mass Transit. The counties that used FSUTMS for their Mass Transit Element development were also found to use certain evaluation measures provided by FSUTMS for their performance assessment.

In general, some of the key findings of the review may be summarized as follows:

- Transit development plans in Florida currently involve limited use of models and model generated information except in areas where transit systems are very large and warrant the added expense and effort associated with implementing a transit demand modeling process.
- In several urban areas, adequate transit and travel behavior related data may not be available for implementing elaborate transit demand modeling processes.
- For short-range planning purposes and for small urban areas with small transit systems, elaborate modeling processes may not be necessary; simple demand estimation techniques such as elasticity methods and trend analysis may suffice.

The results of the literature review documented here were combined with results from the transit modeling survey (reported in the next section) to develop recommendations for improving transit modeling processes in Florida.

## Survey of Transit Modeling in Florida

In order to assess the state-of-the-practice of transit modeling and obtain insights about the key issues facing transit modelers and transit model users in Florida, a survey of public agencies was conducted. Public agencies to which the survey was administered included transit agencies, MPO’s, FDOT District Offices, and the FDOT Central Office.

The survey was limited to obtaining information on current transit modeling practices, transit model applications, and potential deficiencies or needs with respect to the transit modeling process that are felt by the agency. This section first describes the survey and the sampling plan adopted to select participating agencies. This description is followed by a presentation of the results of the survey with analysis and interpretation.

### *Sampling Plan*

As the survey effort in this study was intended to serve as a follow-up to a 1993 Statewide Transit Modeling Survey (also sponsored by the Public Transit Office of the Florida Department of Transportation) and as project resources were rather limited, a sample of MPO's and transit agencies was selected for participation in this project survey.

First, it was felt that all FDOT district offices should be included in the survey. Several district offices have in-house modeling activities, while others tend to support or use modeling processes that are undertaken at other agencies. At each district office, both the public transportation and planning divisions were included for survey participation.

The selection of transit agencies and MPO's for participation in the survey was more complicated. Urban areas that have substantial transit service were considered important to be included in the survey due to the greater probability of their being involved in modeling activities. These included urban areas such as Miami, Tampa, Orlando, Jacksonville, and Broward County. Both, transit agencies and MPO's belonging to these areas were selected for inclusion in the survey. Following this preliminary assignment, a sampling scheme was devised so as to ensure that the final sample met the following criteria:

- The final sample included smaller urban areas with relatively smaller transit systems
- The final sample included urban areas that were geographically spread across the state of Florida
- The final sample included urban areas that had special characteristics, e.g., high percentage of elderly population, high tourist traffic, etc.

Information regarding various transit systems in Florida was obtained from the Florida Transportation Almanac (CUTR, 1995). Based on the above criteria, the final list of survey participants was prepared. MPO's corresponding to those transit agencies selected were automatically included in the survey. In addition to these public agencies, several members of the consulting community drawn from the Statewide FSUTMS Task Force were also included for participation in the survey. Finally, staff at the Systems Planning Office of the FDOT Central Office were included in the final sample.

### *Survey Design and Administration*

Survey design and administration play a key role in determining response rates, quality and accuracy of responses, and the ability to obtain detailed insights into the phenomena under investigation. A review of the literature related to surveys indicates that administration of the survey over the telephone maximizes response rates and provides an opportunity for the interviewer and interviewee to seek clarifications during the interview itself.

On the other hand, telephone survey administration may sometimes lead to possible biases as the interviewer or interviewee may attempt to promote certain ideals during the interview process, thus affecting the objective nature of the responses. However, for a small sample survey of the kind undertaken in this study, it was felt that maximization of response rates should be the over-riding factor in determining the method of administration for the survey. Moreover, the exploratory nature of the research project called for the use of a survey administration method that would provide opportunities for in-depth clarifications.

In order to minimize the potential interviewer/interviewee bias, several steps were taken. First, a draft survey questionnaire was sent to the Public Transit Office and the Systems Planning Office of the FDOT for comments. The final survey instrument was mailed to all participating agencies in advance of the actual survey administration. This was done to allow participating agencies to involve several staff members in preparing their responses, prepare their responses in advance, be familiar with the survey in advance, and follow along with the interviewer as the interview was conducted. In general, it was found that this method of survey administration met with success.

A complete copy of the survey questionnaire can be found in Pendyala (1996). It consisted of three main sections. The first section consisted of questions that obtain information about the agency, the general level of modeling and other activities undertaken by the agency, and the sources of data for the agency. The second section dealt specifically with transit modeling activities currently undertaken by the agency. The modeling methods used, their applications, their input and output variables, and other transit model characteristics are obtained in this section. If an agency does not undertake any transit modeling activities, a separate set of questions inquiring about their transit planning process was presented to the respondent. Finally, the third section dealt with the potential deficiencies and needs in transit modeling in Florida. A series of questions regarding the adequacy of FSUTMS in meeting transit modeling needs and transit planning applications were presented to the respondent. Also, possible refinements to the transit modeling process were presented and the respondent was asked to rate the importance of such refinements. Finally, the section concluded with an examination of the benefits and problems associated with FSUTMS type modeling efforts for short range and long range planning efforts. Respondents who were very familiar with FSUTMS were also asked to provide their assessment of the individual modeling modules within FSUTMS.

Administration of the survey occurred during the latter half of August and the first half of September 1995. Attempts were made to administer the survey in a two or three stage process. An initial phone contact was made with the agency to determine the contact person for obtaining survey responses. If possible, an appointment was made to speak with that person and obtain the responses. The person was then contacted at the scheduled appointment time and the survey administered. In general, however, conflicting schedules and the difficulty associated with reaching people promptly by phone lead to a more ad-hoc survey administration approach, i.e., collect responses whenever contact is made.

### *Survey Results*

The final survey sample consisted of a total of 40 entities; of these, 38 entities provided usable responses to the survey, representing a 95% response rate. These include 11 transit agencies, 12 MPO's, seven FDOT District Planning sections, seven FDOT District Public Transportation sections, and one Systems Planning section staff member in the FDOT central office. This response rate may be considered excellent given the length of the survey instrument and duration of the survey administration process. Information obtained from these 38 responding entities provide valuable insights to draw conclusions regarding transit system modeling in the state of Florida.

A note must be made regarding the presentation of survey results and the conclusions that may be drawn from them. Despite the small sample nature of the survey, survey results are provided in this paper in terms of percentages of respondents choosing various options. Attribution of any type of statistical significance to the percentages presented should be done with extreme caution. Also, responses have not been weighted to account for potential biases arising from the differing levels of transit modeling expertise of the respondents. As such, in this paper, the results of the survey are interpreted and used in a qualitative manner, while keeping quantitative figures as supporting elements. The remainder of this section provides a summary of the results of the survey. A comprehensive presentation of the survey results is beyond the scope of this paper. Complete tabulations of survey responses by respondent group (FDOT, MPO, or transit agency) can be found in Pendyala (1996). The discussion in this paper is limited to major findings and implications of the survey results as they relate specifically to transit system modeling.

The transit modeling survey conducted in this study clearly showed that there is a need for enhancing transit modeling in the state. Planners from around the state perceive current transit modeling processes to be inadequate in addressing several key issues related to transit system planning. Table 2 provides a few key indications of this widespread perception. Overall, less than 50 percent of the respondents feel that current modeling procedures are adequate in addressing transit related issues.

- In general, modeling activities tend to be concentrated at MPO's and FDOT districts. Only two transit agencies indicated the use of FSUTMS for transit modeling and forecasting. Those transit agencies that do not currently have in-house modeling activities indicated no plans to introduce such activities in the near future.

- MPO's also exhibit the greatest level of sophistication in the development, use, and application of FSUTMS for various purposes (transit or highway modeling). However, highway modeling activities form the bulk of modeling activities undertaken at these agencies.

- Interestingly, more than one-half of the urban areas indicated a travel data collection effort undertaken within the last five years. It is uncertain, however, as to the utility of these data sets for FSUTMS-based transit modeling. Further investigation into the nature of the data sets needs to be undertaken to determine their applicability to transit modeling.

- In general, respondents indicated that FSUTMS type modeling efforts are not necessary for short range planning. Respondents felt that FSUTMS lends itself to long-range planning efforts; simpler methods are sufficient for short range planning efforts. However, FSUTMS does not incorporate any modules that support such short-range planning methods.

- Only two agencies are implementing the nested logit model of mode choice. Concerns were expressed regarding the updating of coefficients for these models and optimal structure of the mode choice decision process. It was felt that, until the nested logit is fully implemented in the state, further enhancements of the mode choice modeling process are not an immediate need.

- There is a widespread perception that transit models perform well at the system-wide level, but lose their accuracy and reliability at individual route, corridor, or link levels, thus making them difficult to use for most transit planning purposes.

- Several transit agencies are interested in implementing in-house transit modeling activities; but their efforts are hindered by the perception that transit models are difficult to use (not user-friendly) and very data-intensive. More than one-half of the agencies indicated the lack of adequate data for estimating and calibrating elaborate transit demand models; the cost of data collection is another major deterrent to model usage.

- There was a tremendous amount of interest and support in integrating land use models into the transportation planning process, and more so into the transit modeling process; however, concerns were raised regarding the potential added complexity that this would bring to the modeling process. Concerns were also raised that standard land use models such as ITLUP (DRAM and EMPAL) are not very sensitive to transportation system changes and do not necessarily reflect the behavior of individuals and firms in making location decisions; customized improvements may have to be made to these models for implementation in Florida.

- There was almost unanimous agreement that the transit modeling process does not allow rigorous analysis of park-and-ride, kiss-and-ride, and other more innovative transit policies (e.g., bikes on buses); methods should be introduced to allow for impact analysis of such innovative transportation policies. The modeling process was also felt to be poor in its ability to provide cross-elasticities of transit demand, for example, the percent change in transit demand due to a change in automobile parking costs; procedures need to be incorporated to provide decision-makers with such information.

- All of the respondents indicated that improvements should be made to the determination of land use and transportation system attributes (say, parking costs, gas prices, etc.) of the future. They indicated the need for a more rigorous process to determine these values and added that the process does not have to be a quantitative one (qualitative Delphi type approaches may prove adequate).

- Interestingly, transit agencies differed from planning agencies in their opinions regarding the abilities of current transit modeling procedures. Key examples include:

  - 33% of transit agencies feel that the process is capable of forecasting future ridership for new modes, while more than 50% of MPO's and FDOT planning divisions feel the same.

  - Transit agencies feel that FSUTMS does not even meet one-half of the transit planning needs in the state. On the other hand, MPO's and FDOT planning divisions offered a higher rating for FSUTMS.

  - With respect to various other aspects, such as identifying capacity deficiencies, analyzing new transit routes and individual transit corridors, providing optimal transit schedules and routes, performing transit network analysis, evaluating transit performance, and integrating land use and transit models, only about one-half as many transit agencies as MPO's feel that FSUTMS does an adequate job.

- Many agencies were in favor of the use of GIS databases and procedures for transit modeling; several agencies have already acquired or are in the process of acquiring GIS for transit planning purposes

- In general, all agencies recognized the need to improve the transit modeling process in the state. Improvements related to the estimation of captive and choice rider markets, integration of land use models, incorporation of trip chaining, ability to analyze various transit policies, and the incorporation of economic analyses routines received high importance scores from respondents.

- Several survey respondents (about 10%) were extremely critical of the traditional four-step modeling system and indicated a need to completely replace current modeling procedures. They were highly supportive of developing the next generation of travel demand models that would better support transit related decision-making. However, they expressed concern about data requirements and indicated that federal and state support would be needed for data collection.

In summary, transit modeling is still in a state of infancy in the state of Florida despite being undertaken by a vast majority of the MPO's and FDOT Districts in the state. There are opportunities for enhancing and improving the transit modeling process in the state.

## Data Needs for Transit Modeling

This section aims at providing an assessment of data needs and availability for transit modeling in Florida. The assessment is done based on the input variables that are currently used by most urban areas for transit modeling. Information regarding inputs was obtained from the transit modeling survey conducted as part of this project, the review of TDP’s and MTE’s of comprehensive plans, and an examination of FSUTMS modules.

This section identifies the types of data that should be part of any transit modeling process and discusses the availability of these types of data. Issues surrounding the collection of additional data is also addressed at a broad level. First, an attempt is made to evaluate data currently used by most urban areas for transit modeling and planning. Second, information on various types of data that may enhance the accuracy and sensitivity of transit models is provided.

The most relevant finding with respect to data is that information required for accurate transit demand modeling is not available in the state. Data collection efforts conducted in the state have generally been targeted towards highway modeling and planning applications. On the other hand, many specific transit surveys (on-board or otherwise) are unable to support comprehensive transit modeling applications such as those available in FSUTMS. Either way, the poor performance of transit models is substantially attributable to the lack of detailed data required to describe transit choice behavior.

In this regard, the research team feels that the state should place the highest priority in collecting comprehensive travel behavior data with specific data items for transit modeling. These include access and egress information, transfer information, wait times, trip chaining information, parking cost and availability, transit availability, attitudes and perceptions towards transit, and reasons why transit may or may not have been chosen for a certain trip. Data need to be collected on how people may respond to changes in transit system attributes. All of these data items will greatly enhance the ability to accurately model transit choice behavior. In addition, this data can be used to update and re-calibrate some of the existing modules in FSUTMS. For example, the mode choice (logit) model coefficients, nested logit model coefficients, and alternative specific constants in the MODE module of FSUTMS need to be updated to reflect local conditions. Currently, several areas in Florida are using coefficient values from models estimated in other parts of the United States due to the lack of data upon which models can be calibrated locally. While the use of such borrowed coefficients may meet regulatory requirements governing planning processes, it is not likely to provide accurate transit forecasts.

In addition, other types of data may merit consideration depending on the types of model enhancements and applications that may be carried out in the state. Stated preference data, where people indicate their likely behavior in response to a hypothetical situation, may provide rich information for generating alternative transit scenarios that are likely to meet with success. The objective of modeling efforts should be to provide useful information for planning transit systems that would meet with high ridership and performance levels; stated preference data may provide the basis for undertaking such planning efforts.

Longitudinal panel data, where information is collected from the same people at regular intervals, are useful for assessing modal turnover and for determining the factors that influence mode switching. Policies that encourage riders to continue using transit may be devised when such information is available. Activity-based and time-use data provide a framework for analyzing how people allocate time to various activities in a day. Such information can help transit planners provide transit service that caters to the activities that people need to pursue out-of-home. The state should also consider collecting specialized transit network and facility data on a regular basis. This data can be conveniently stored, retrieved, and used for modeling purposes if maintained in a GIS framework.

While the costs associated with data collection may appear large, the benefits realized through improved decision-making will far exceed the apparent costs. While even the most sophisticated models can not provide good forecasts with poor data, even rather simple models can provide reliable forecasts with good data. The implications are serious as policy decisions made on the basis of poor forecasts can cost the state billions of dollars. The few hundred thousands of dollars that data collection efforts are likely to cost pale in comparison.

## Conclusions and Recommendations

The results of the transit modeling survey were combined with the detailed analysis of FSUTMS as a transit modeling tool to develop specific recommendations for enhancing transit modeling procedures in Florida. The recommendations may be grouped into three distinct time horizons for implementation purposes depending on the effort and extent of change involved in implementing a recommendation. This section summarizes the key recommendations in each time horizon in bullet form.

Among all of the information obtained in this research effort, one specific finding stood out as unique and interesting. This finding related to the extent of transit modeling that is undertaken in various states. It was found that the extent to which transit modeling is performed in Florida is greater than in most other states in the country. This finding is supported by the transit modeling survey conducted in this study which showed that 10 out of 12 MPO's surveyed undertook elaborate transit modeling activities.

The high level of transit modeling activity in Florida is extremely commendable and it is strongly recommended that these activities continue and be further enhanced over time. Even though the survey and analysis conducted in this paper identifies several areas for improvement, that is not an indication that transit modeling is not useful. Transportation planners and policy makers must continue to use the best tools that are available to them, while exercising caution in interpreting outputs that such tools provide. As further research efforts are undertaken and modeling tools are improved, so will the accuracy and precision of forecasts and policy predictions obtained. The recommendations made in this section should be considered in this context.

*Short Term Recommendations*: These recommendations are best implemented in a 1-3 year time horizon. The recommendations are as follows:

- Collect comprehensive travel demand data with specific emphasis on transit choice behavior so that various FSUTMS modules can be enhanced to more accurately reflect transit demand, for example, the mode choice model can be improved by including demographic and socio-economic characteristics of the trip maker as explanatory variables in the utility formulations
- Improve trip generation models so that they are more sensitive to demographic, land use, and transportation system dynamics
- Incorporate short range transit planning methods that may be used by small urban areas (such as elasticity based and trend projection methods)

- Incorporate feedback loops from the shortest path modules to the trip distribution module so that congestion and the presence of multiple modes can be adequately represented
- Improve transit network coding procedures so that park-and-ride, kiss-and-ride, access and egress, and other transit specific issues are represented more accurately
- Develop trip generation, distribution, and mode choice models for special transit market segments such as the elderly and the tourist population to reflect their special transportation needs
- Improve transit plotting features to increase the user-friendliness of the transit modeling process
- Investigate use of alternative software packages and their modules for transit modeling in Florida so that any unique features they provide may be taken advantage of

Other short term recommendations including the development of an integrated highway and transit network information system and the calibration of nested logit models of mode choice appear to be already underway. These enhancements will have significant positive impacts on transit modeling in the state.

*Medium Term Recommendations*: These recommendations are best implemented in a 3-6 year time frame. The recommendations are as follows:

- Develop statistical models of trip generation and trip chaining that can more accurately represent travel behavior
- Integrate land use models into the travel demand forecasting process so that land use/transportation relationships are explicitly recognized
- Incorporate a tool that can evaluate the impacts of travel demand management strategies and transportation control measures on travel behavior, and in particular, transit use
- Develop a GIS-based transit route analysis model that can provide for more detailed analysis of transit networks and more sophisticated assignment routines
- Improve the method by which future year inputs are determined so that a more rigorous process is in place, thus minimizing confusion caused by alternative input assumptions
- Develop an integrated transit demand and supply model so that the optimal (or near optimal) transit service configuration needed to service transit demand patterns may be derived
- Estimate time-of-day models of transit demand so that transit service attributes (schedules, routes, etc.) may be made more sensitive to the temporal variation in travel demand
- Incorporate a modeling tool that can analyze flexible transit services so that they may be analyzed in conjunction with fixed-route transit services

*Long Term Recommendations*: These recommendations are best implemented in a time horizon that exceeds 5 years. The recommendations are:

- Develop and implement activity-based travel demand forecasting tools that explicitly recognize the derived nature of travel demand
- Develop dynamic models of travel demand that capture the behavioral dynamics involved in mode switching, vehicle acquisition and disposal, and other household characteristics

- Transition to a TRANSIMS-type modeling process through a series of incremental improvements; an urban area in Florida should be considered as a site for the next test of TRANSIMS' interim operational capability.

It is envisaged that the implementation of these recommendations in a phased manner will provide for enhanced transit modeling in Florida. The implementation of these recommendations will require the collection of additional data, development and implementation of new software modules and interfaces, and potentially the development and implementation of new methodological techniques. As all of these aspects of the model enhancement process require substantial resources, the state should play both a major role and a lead role in carrying out these recommendations. The state should allocate resources for model enhancement on a high priority basis; benefits realized will far outweigh resources consumed.

## Acknowledgments

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October 3, 1996

Mr. Aage Schroder III, P.E.
Florida Department of Transportation
District 2
Planning Department, MS 2812
2250 Irene Street
Jacksonville, FL 32204

Dear Mr. Schroder:

Enclosed please find three copies of a paper titled "A Survey of Transit System Modeling in the State of Florida" that I would like to submit in consideration for the Florida Section Institute of Transportation Engineers Best Paper - Young Member Award. This paper reports on a study of transit modeling that was conducted for the Public Transit Office of the Florida Department of Transportation. In submitting this paper for the Young Member Award competition, I hereby certify that I am under 35 years of age.

I look forward to hearing from you regarding the outcome of the competition and hope to meet you in person at the Annual Meeting in Jacksonville later this year. Please do not hesitate to call me at (813) 974-1084 if I can help in any way.

Thank you for your time and consideration.

Sincerely,

Ram M. Pendyala, Ph.D.
Assistant Professor, Transportation

Encl.

| Table 2. Key Indicators of Transit Modeling Deficiencies | | | | | |
|---|---|---|---|---|---|
| Survey Question | Transit Agency (n=11) | MPO (n=12) | FDOT Planning (n=8) | FDOT Transit (n=7) | Total (n=38) |
| Rate the extent to which current transit models meets transit planning needs (average for each group where, 1=not at all; 2=slightly; 3=neutral; 4=substantially; 5=completely) | 2.55 | 3.22 | 3.29 | 2.60 | 2.93 |
| Percent indicating current transit models adequate in identifying transit capacity deficiencies | 36% | 50% | 38% | 14% | 37% |
| Percent indicating current transit models adequate in analyzing impacts of new transit mode | 27% | 25% | 38% | 14% | 26% |
| Percent indicating current transit models adequate in analyzing individual transit corridors | 27% | 50% | 50% | 29% | 39% |
| Percent indicating current transit models adequate in performing optimal routing and scheduling | 0% | 17% | 13% | 0% | 8% |
| Percent indicating current transit models adequate in evaluating transit performance | 9% | 17% | 25% | 14% | 16% |
| Percent indicating current transit models adequate in integrating land use-transit interactions | 18% | 33% | 38% | 29% | 29% |
| Percent indicating current transit models adequate in analyzing flexible transit services | 0% | 0% | 0% | 0% | 0% |