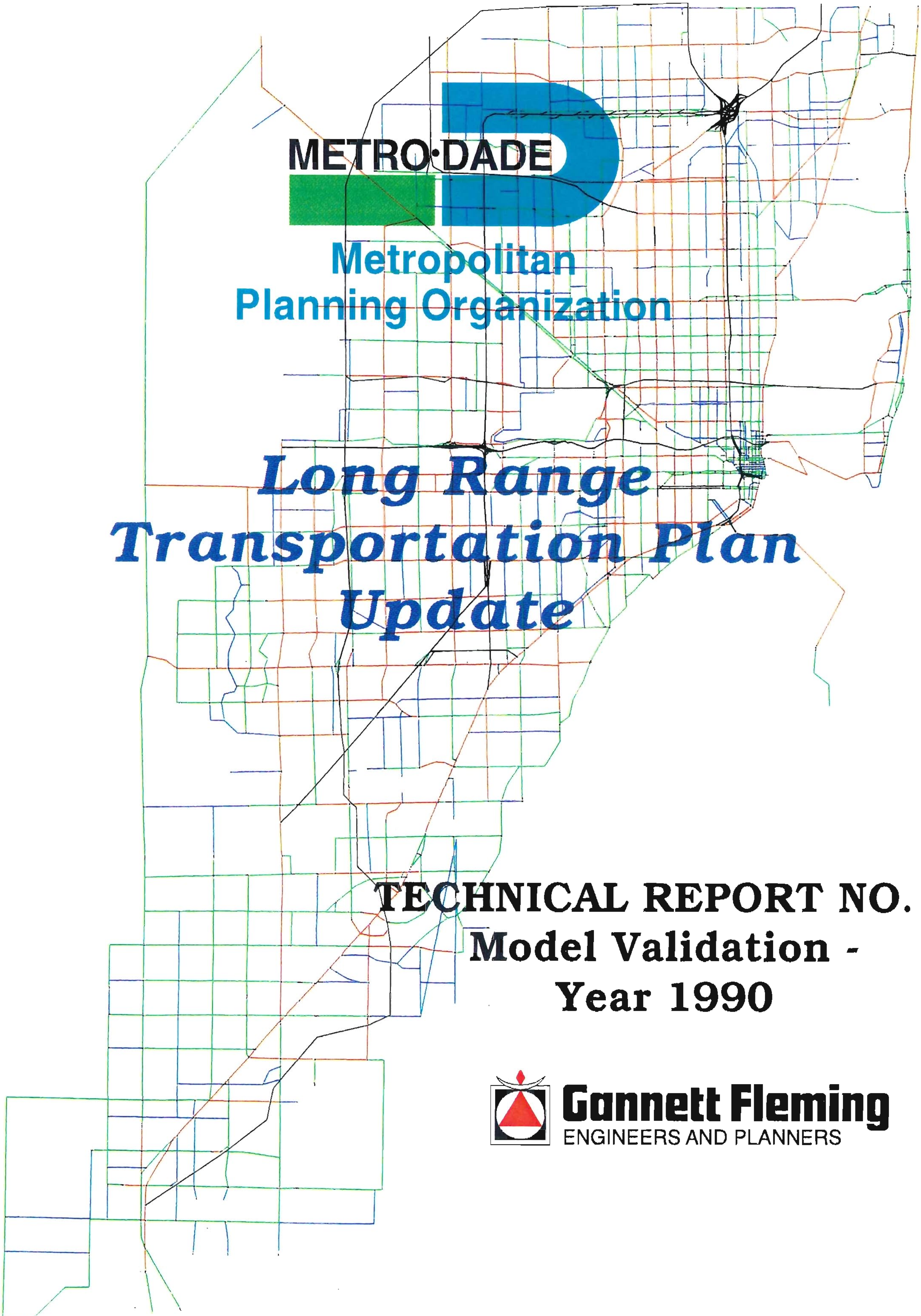

METRO·DADE

Metropolitan Planning Organization

Long Range Transportation Plan Update

TECHNICAL REPORT NO. 2
Model Validation - Year 1990

Gannett Fleming
ENGINEERS AND PLANNERS

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CHAPTER 1

TRAVEL DEMAND MODELING AND LONG RANGE PLANNING

1.0 Introduction

This document describes the model development and validation component of the ***Metro-Dade Transportation Plan: Long Range Plan Element to the Year 2015*** planning process. The process, as depicted in **Figure 1.1**, requires planning officials to identify future deficiencies in their transportation infrastructure. Computerized travel demand models, such as the 1990 Miami Transportation Planning Model (MTPM), assist local decision makers to forecast future mobility requirements and changes in travel patterns resulting from development.

Because the product of this effort is an update to the 2010 long range plan, the model validation process is founded on a lineage of models developed for previous long range plans and planning studies. To begin this model update, 1990 land use, highway and transit network characteristics are collected. Then, iterative adjustments to model parameters are performed until, using reasonable and (where possible) empirically collected parameters and data, the model can replicate 1990 base year conditions. The process by which the MTPM is calibrated and refined until it closely replicates actual, observed travel patterns is called validation. After updating the land use, highway and transit improvements in the model to reflect future baseline conditions, the validated model is ready to be applied. The resulting application yields a preliminary forecast of 2015 travel demand.

1.1 FSUTMS

The modeling software used for the MTPM is the Florida Standard Urban Transportation Model Structure (FSUTMS). FSUTMS is an adaptation of TRANPLAN travel demand modeling software that is standardized for use throughout Florida. All long range transportation planning efforts in the state that hope to make use of State or Federal funds must use FSUTMS for travel demand forecasting.

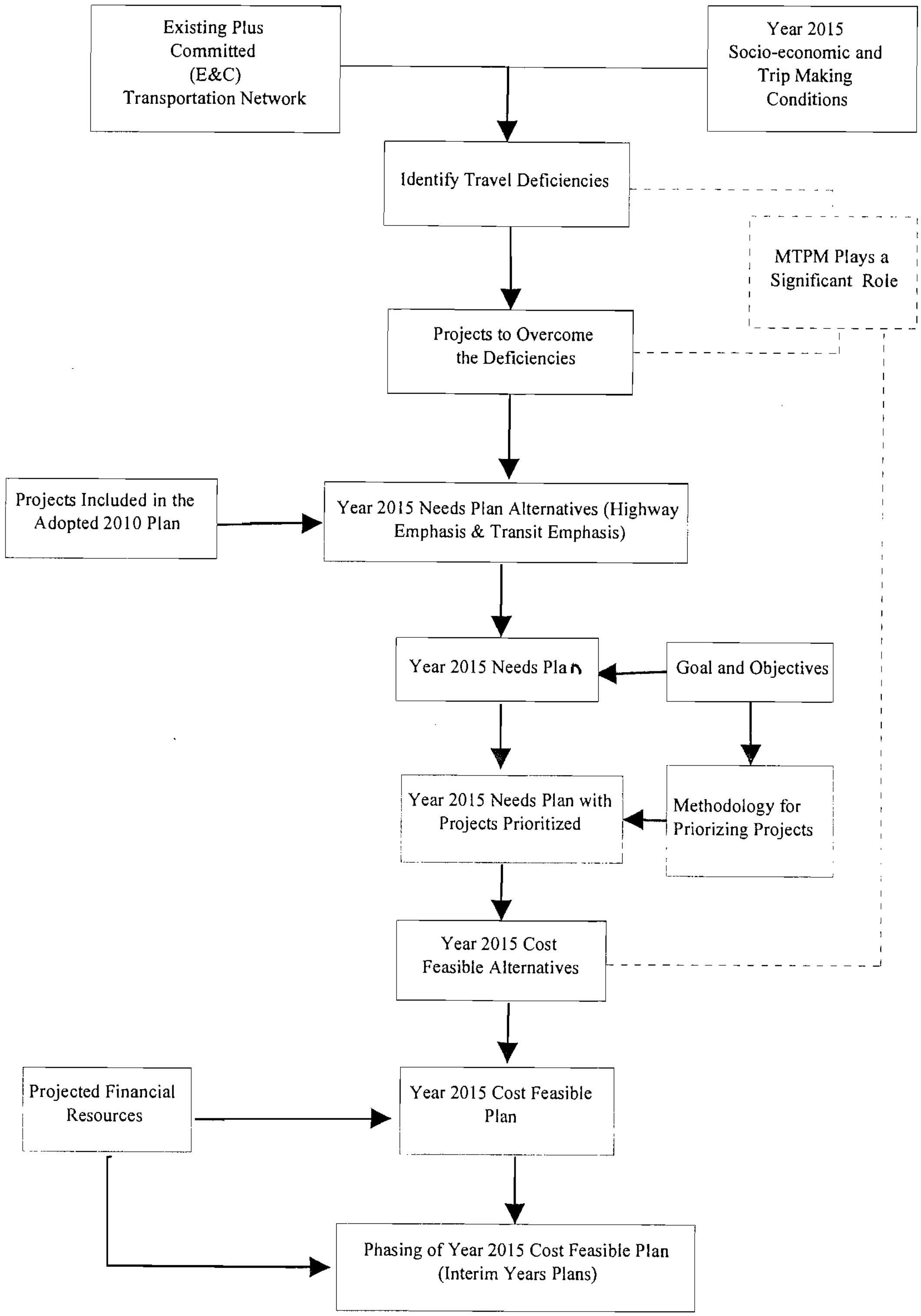

Figure 1.1 Long Range Plan Development Process

Prior to the advent of FSUTMS, planning studies in Florida often used differing software which required differing input data. More often than not, these data were not transferable between software packages and were not easily verified. To expedite the review of model input data, parameters, and outputs, the Florida Department of Transportation (FDOT) promoted the creation of a standard model for use in all of the states metropolitan planning areas.

1.1.1 The Modeling Process

To forecast future highway and transit traffic, the FSUTMS model reflects a standard "Four Step" approach. These steps are comprised of the following:

- Trip Generation,
- Trip Distribution,
- Modal Split, and
- Traffic Assignment.

Through *trip generation* equations in the model, a certain number of trips per home (and/or per employee) are generated for each geographic area of analysis in the model. The smallest geographic unit in the demographic database is the traffic analysis zone, also called a TAZ. Once the generated trips are calculated for each TAZ, the model has to determine to what other TAZ(s) the trips are going. This is performed in a step called *trip distribution* by means of a gravity model. The gravity model distributes trips among TAZs based on the two principals of the classic Newtonian theory- the larger a mass of an entity, the stronger its gravitational pull (attractiveness), and the further apart two entities are, the weaker their attractiveness. The model assumes that a given TAZ is *more* attractive (in terms of a trip potentially traveling to it) if it has more land use activities, such as homes or employees. It is relatively *less* attractive the longer the distance - in terms of either trip length or time - the potential destination zone is from the TAZ of origin. By applying this principal, all of the trips are distributed among pairs of TAZs.

The means by which the trips will travel among TAZs is determined in FSUTMS's *modal split* module. The model calculates the probability of a traveler choosing any one of the alternate modes available. Unlike the distribution model which considers mass and distance, the mode choice model considers the relative usefulness, or utility, of each mode. Utility is determined based on the service and cost characteristics unique to each mode.

Likewise, in the *trip assignment* module, FSUTMS evaluates the relative attractiveness of routes between pairs of zones. Trips are assigned to the most attractive (i.e., shortest in time or distance) route. The end product of these steps is a set of simulated traffic volumes on highways and future year ridership figures for the various modes of transit available in Dade County.

1.1.2 Model Enhancements

Though FSUTMS provides a standard structure for travel demand models, it maintains flexibility for enhancement procedures and new data. The Metro-Dade Metropolitan Planning Organization (MDMPO) has traditionally been among the leaders in FSUTMS innovations and enhancements and this study is not different. Though the MTPM is based on the 1986 MUATS model, several major efforts were undertaken to enhance the long range planning model based on recent data and studies.

First, data became available from the 1990 Census of Population and Housing. These data were the foundation for 1990 base year demographic inventories as well as 2015 projections. In addition, the U.S. Department, Bureau of the Census published the 1990 Census Transportation Planning Package. These data permitted an evaluation of the models trip generation and trip distribution models for home-based work trips.

Second, recent studies added a new mode choice model to the MTPM. The Miami nested logit model was first developed and adopted for the Transitional Corridors Study. It was later refined for use in the East-West (SR 836) Multi-Modal Corridor Study and was subsequently adapted for the MTPM. The nested logit model builds on the multi-path, multi-period model originally developed for an earlier MUATS study by replacing the walk access to transit, auto access to transit, and mode choice model with the latest thinking in mode choice model formulation.

As part of the updated mode choice model, the MTPM is the first long range planning model in the State to consider private transit service in competition with public transit. Separate peak period and off-peak period jitney networks are included in the model. They represent all legally licensed jitney providers in Dade County.

Another enhancement to the MTPM is the additional ability to forecast the demand for high occupancy vehicle (HOV) expressway facilities. Many of the improvements to the existing expressways in Dade County will be in the form of HOV lanes. As part of this Update, the MTPM includes the ability to identify daily demand for HOV lanes. Future MTPM development efforts will likely include the ability to forecast HOV demand for peak-periods as well.

The final major enhancement to the model is the replacement of its external trip handling routines. As Dade County and Broward County grow together, it is noted that travel patterns for external travelers become similar to those of travelers who remain in Dade County. The availability of the Southeast Regional Planning Model -2 (SERPM-2) permits this study to take advantage of that effort and consider intercounty trip movements in a different manner. The result is that the MTPM now considers external travel demand based not only on the characteristics of Dade County, but also on the characteristics (and growth) of the entire Southeast Florida area.

1.2 Model Application and The Long Range Plan Process

The enhanced MTPM is a tool that plays an integral part in the long range plan development process. When the impact of aforementioned 2015 demographic characteristics is "modeled" for the Miami urbanized area, it is evident that, as expected, existing transportation system infrastructure becomes greatly overburdened. The application of the MTPM permits various alternate transportation network improvements to be tested for impact on overall and even corridor level mobility.

The goal of model application is to define the set of transportation system improvements that will best satisfy the mobility requirements of Dade County. The solution to future mobility deficiencies is to add capacity to the simulated transportation system. To this end, roadways are widened or otherwise improved and transit service is augmented until, to the extent feasible, the system can accommodate the projected travel demand. The recommended set of improvements required to accommodate growth through the Year 2015 is then called a needs plan.

Concurrent with the development of the needs plan is the development of financial resource projections. The purpose of projections is to ascertain all of the sources and amounts of funding that can reasonably be expected to be available for transportation infrastructure maintenance and improvements through the year 2015. This financial resources document is crucial to the development of the Long Range Plan, as both the Intermodal Surface Transportation Efficiency Act (ISTEA) and the Clean Air Act Amendments of 1991 (CAAA) mandate that the Plan be cost affordable, or cost feasible.

Ultimately, based on the goals and objectives that begin the Long Range Plan development process, public involvement, financial feasibility and other considerations, a cost feasible Long Range Transportation Plan to the year 2015 is developed. The resulting Plan is the optimal mix of mobility, as determined through the modeling process, and all other considerations as outlined in *Technical Report #3, Long Range Plan Development.* The model then provides estimates of how well the cost feasible plan meets the mobility needs of Dade County.

1.3 Summary

The above outline of the plan development process illustrates the extent to which the model is integral to the entire process. The model is used to ascertain needed improvements to the transportation system, and then to evaluate various cost feasible alternatives for accommodating those needs.

Because the model plays such an important roll in the Long Range Plan Development process, it is equally important that it reliably answer the policy questions that are the basis of the process. Recent enhancements to the FSUTMS model, in concert with quality demographic forecasts and the best possible validation, insure that Dade County policy makers have a useful tool for forecasting travel demand through the year 2015. This document, *Technical Report 2 - Model Validation*, describes the model validation and calibration efforts that were undertaken.

CHAPTER 2

EXTERNAL TRIP MODEL

2.0 Introduction

The first step in the Florida Standard Urban Transportation Model Structure (FSUTMS) is the external trip model. External trips are vehicle trips with at least one trip end (origin or destination) outside the study area boundary. The relationship of the external trip model to the other FSUTMS modeling components is shown in **Figure 2.1**. Standard FSUTMS modeling practices consider two types of external trips: external-internal (E-I) trips and external-external (E-E) trips. The external-internal trip originates outside the study area and ends inside the study area. The external-external trips, or through trips, have both trip ends outside the study area. These trips are differentiated from internal to internal (I-I) trips which have both trips ends within the Dade County study area and are discussed in Chapter 3. A third type of external trip, internal-to-external(I-E) is not considered in the FSUTMS standard trip generation routines. **Figure 2.2** illustrates the relationship among the four categories of trips.

The location where a roadway leaves the study area is referred to as an external traffic analysis zone (TAZ) or external station. Volumes of E-E and E-I trips at each external station are developed from a variety of sources including: Florida Department of Transportation (FDOT) traffic count summaries, Dade County traffic count data, Broward County traffic count data, and data collected for the Southeast Regional Planing Model-2 (SERPM-2). Regardless of the source, traffic count data for each external station are adjusted to reflect average weekday peak season travel.

The purpose of the external trip model is to produce a trip table that specifies the number of daily vehicle trips to or from each external station. For the Miami urbanized area, the vast majority of external trips are E-I trips. This chapter documents the process employed to develop the 1990 E-E and the E-I trip tables that are input into the 1990 Miami Transportation Planning Model (MTPM) validation.

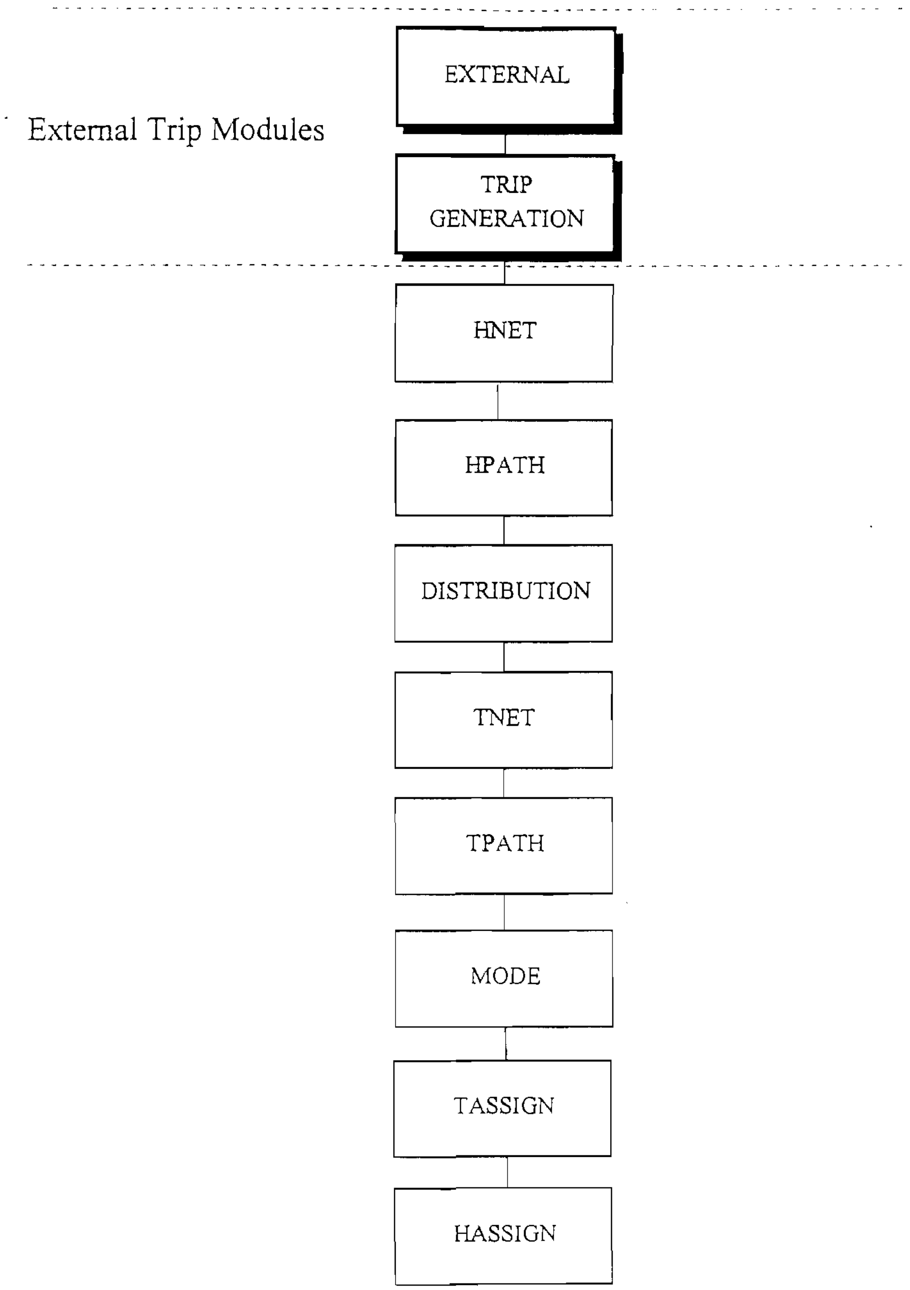

Figure 2.1 External Trip Modules in the FSUTMS Model Chain

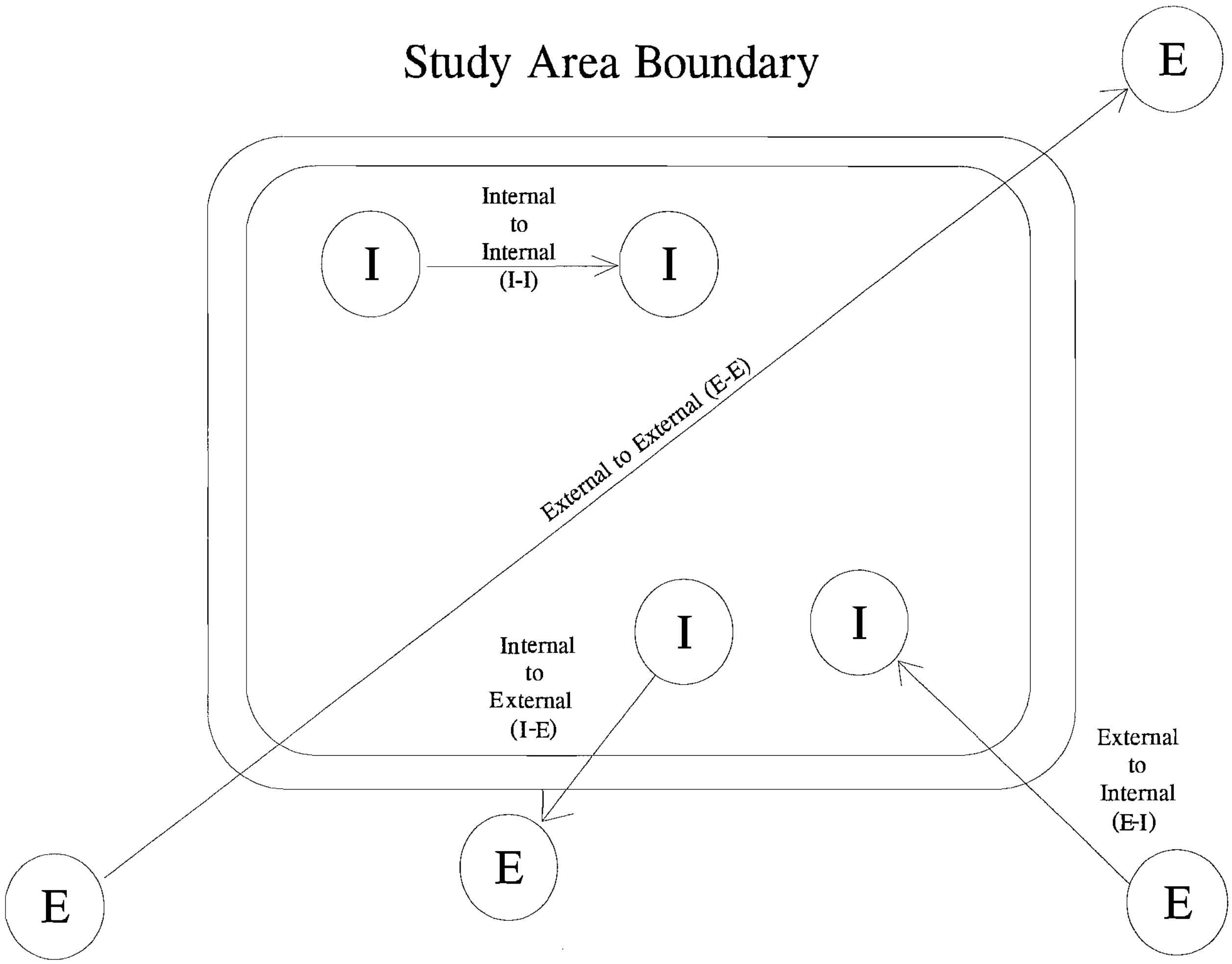

Figure 2.2 Trip Categories

2.1 Development of External Trip Model

Early in the validation process, it was found that the standard external trip model did not accurately simulate E-I and E-E travel patterns. Initial attempts at validation highlighted the significant impact of E-I trips, particularly from stations in Broward County. After several attempts to validate the distribution of these trips within the context of the Miami Transportation Planning Model, the consultant developed a procedure for implementing the E-I and E-E trip tables from the Southeast Regional Planning Model-2 (SERPM-2). This regional model includes Dade, Broward and Palm Beach Counties. The SERPM-2 model estimates travel within the region including travel to and from Dade County.

2.1.1 Standard External Trip Model

Standard FSUTMS procedures employ two input files with which to build E-I and E-E trip tables. The first input is EETRIPS.90A. This file identifies an origin external zone, a destination external zone, and the number of vehicle trips traveling between them. It defines all E-E movements in Production/Attraction (PA) format and is traditionally developed as the result of survey data collected at external station locations. The EXTERNAL module of FSUTMS then reads this file and builds a simple trip table in origin/destination (O/D) format containing all the input E-E trips.

During the GENERATION module, the remainder of the external trips, the E-I trips, are developed. Input as total E-I trips by external station, ZDATA4.90A contains the remaining external trips that were not captured in the EETRIPS.90A input file. Attractions for these trips are calculated as equal to productions and are allocated by assigning a proportion of the total E-I productions at each external station to each internal zone based upon the total I-I attractions of that zone. The resulting trip table is balanced and assures E-I productions equal E-I attractions. The summation of the E-I and E-E trips now equals assumed peak season, average weekday traffic (PSAWT) volumes at all external stations.

The standard trip generation model calculates E-I attraction values for each internal zone using the following equation:

$$Ax_z = \sum_{z=1180}^{1200} Px_z * \frac{Ai_z}{\sum_{z=1}^{1179} Ai_z}$$

where:

Ax = External-to-Internal Attractions
z = traffic analysis zone
Px = External-to-Internal Productions
Ai = Internal-to-Internal Attractions for all trip purposes

The ZDATA4 file is developed based on the estimates of external trips from the O/D survey data. The percentage of E-I trips at each external station is applied to the1990 PSAWT traffic counts.

The standard FSUTMS methodology, as outlined above, works well in the context of an urban area with a limited number of external-internal trips. However, the nature of the Miami urbanized area and its travel interaction with Broward County to the north suggests that the standard FSUTMS external trip handling procedures may not be sufficient for handling the unique external trip characteristics of the the study area. As part of the validation of the Miami Transportation Planning Model (MTPM), the consultant undertook a review of the issues and potential remedies for the complexities of external trip travel demand modeling in the context of the study area.

2.1.2 Regional Approach

As was stated in the introduction to this section, the standard FSUTMS external trip model does not perform well in the context of the MTPM model. Five issues arise when employing the standard external trip approach to the MTPM model:

❶	Source Data-	Traffic counts at external sites by themselves do not support the identification of the two components of external travel. Historically, Dade County models assumed that the E-E component of external trip making was small. The result is that no E-E trips are included in the model. All external trips are E-I. This assumption was necessary due to the lack of a recent survey of all the external sites.
❷	I-E Trips-	To this point in this text, I-E trips have not been mentioned. This is because FSUTMS has no default means for estimating internal to external (I-E) productions. The model only considers external to internal (E-I) productions. The model does not consider the possibility that traffic produced in Dade County can be attracted to Broward.
❸	Trip Distribution-	Even with the assumption that all external trips are E-I, the model has difficulty estimating the correct distribution of these trips. This is due in large part to the proximity and magnitude of traffic related to Broward County.
❹	Transit Demand-	Travel by non-auto modes between Dade and Broward Counties is not considered.
❺	Forecasts-	Consistent, reasonable and reliable assumptions regarding E-I and E-E traffic volumes are difficult to develop and do not lend themselves well to simple extrapolations.

To help overcome the most problematic of these deficiencies, a new methodology was adopted for the E-I/E-E trips components of the MTPM model. The new method permits the operation of the standard treatment of external trips (to maintain the integrity of the standard model chain), but replaces those trips with a specially developed set of trip tables from the SERPM-2 model. As such, the model now accommodates and estimates the relationship of E-I productions, I-E productions and E-E trips by using the forecasting power of the entire southeast Florida area as an input. Unfortunately, FSUTMS and TRANPLAN routines were not validated nor available to derive transit trip tables for inter-county travel demand at the time this validation was completed. As such, inter-county transit trips are not forecast as part of the MTPM.

External trips are currently assumed to be produced in zones that are connected directly to points where the roadways in Dade County cross the study area boundary, as is standard procedure. External stations are assigned to specific external traffic zones during the development of the zonal structure. In the Dade County TAZ numbering scheme, there are 1164 internal TAZs (1 to 1164), fifteen spare zones (1165-1179), which could be used as internal zones for future efforts, and twenty-one external zones (1180-1200). These external stations are numbered counterclockwise starting from the northeast corner of the study area at A1A at the Broward County line. **Figure 2.3** cartographically depicts external TAZ locations while **Table 2.1** presents the external station TAZ numbers with their corresponding total traffic volumes and labels.

The procedure for developing external trips using the SERPM-2 is outlined as follows:

❶ Identify Peak Season Average Weekday Traffic (PSAWT) for each site.

❷ Develop vehicle trip tables for trips crossing each external site based on SERPM-2 selected link analysis.

❸ Adjust trip tables resulting from the previous step to be consistent with the 1990 PSAWT traffic identified in Step 1

❹ Replace external trip tables developed by standard FSUTMS process with SERPM-2 enhanced trip tables.

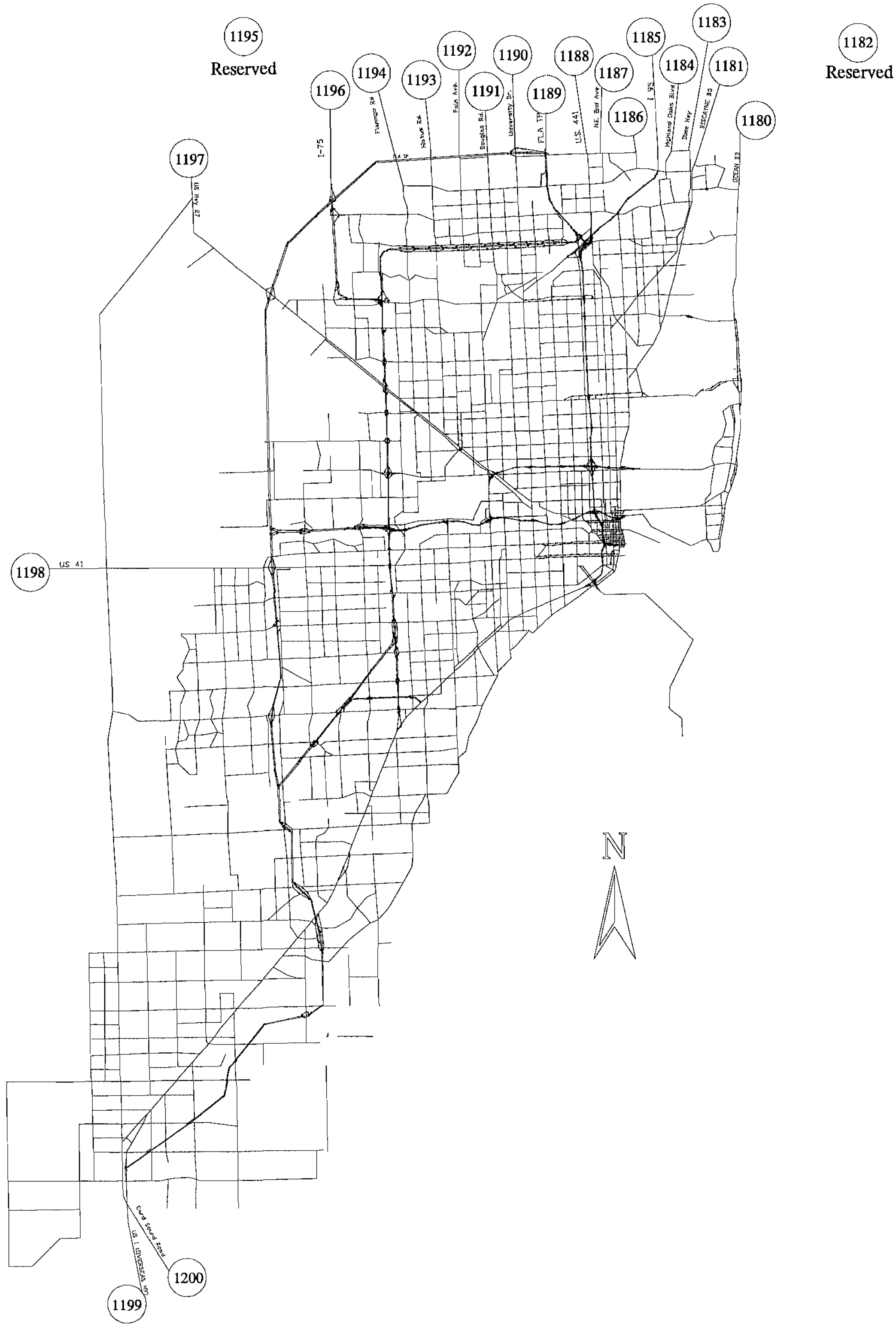

Figure 2.3 MTPM 1990 External Station Locations

MIAMI TRANSPORTATION PLANNING MODEL
Table 2.1 External Station Descriptions

External Station Number (TAZ)	Description	Peak Season Avg Weekday Traffic
1180	Collins Ave/A1A @ Broward County Line	21,600
1181	Biscayne Blvd/U.S. 1 @ Broward County Line	35,400
1182	Reserved	0
1183	West Dixie Hwy @ Broward County Line	14,400
1184	Highland Oaks Blvd @ Broward County Line	6,300
1185	I-95 @ Broward County Line	146,700
1186	N.E. 12th Ave @ Broward County Line	5,900
1187	N.E. 2nd Ave @ Broward County Line	6,100
1188	U.S. 441/N.W. 2nd Ave @ Broward County Line	40,700
1189	Florida's Turnpike @ Broward County Line	61,200
1190	N.W. 27th Ave @ Broward County Line	45,400
1191	N.W. 37th Ave @ Broward County Line	9,400
1192	N.W. 47th Ave @ Broward County Line	13,500
1193	N.W. 57th Ave @ Broward County Line	17,200
1194	N.W. 67th Ave @ Broward County Line	12,200
1195	Reserved	0
1196	I-75 @ Broward County Line	53,600
1197	U.S. 27 @ Broward County Line	7,600
1198	U.S. 41 West of Krome Ave	4,300
1199	U.S. 1 @ Monroe County Line	12,100
1200	Card Sound Road @ Monroe County Line	3,100

2.1.2.1 Identify PSAWT Traffic

Traffic data development for external sites concentrated on identifying FDOT, Dade County and Broward County sources. Due to the number of data providers and the inherent variation in count development methodologies, multiple traffic counts at any specific site by different providers could be in conflict with one another. As a result, the first attempt to identify control PSAWT totals for each site was based on a review of FDOT and Dade County data. Where duplicate counts occurred, the count which was most consistent with historical and surrounding counts was selected.

This completed the initial inventory of traffic at all external sites. To ensure consistency with other transportation planning efforts, these values were then compared to counts input into the 1986 MUATS Model as well as the 1990 SERPM-2 Model. Finally, counts for stations at the Broward County line were compared with Broward data sources as well as the 1990 Broward Model. Differences between the two models, it was felt by the Long Range Transportation Plan (LRTP) Steering Committee, should be rectified wherever possible. This resulted in a set of traffic volumes, synthesized from many sources, that would be consistent with the counts employed in the Broward Model, though not necessarily based on one specific methodology or existing count from either county. For a complete discussion of traffic count and peak season factor development, refer to *Metro Dade Long Range Transportation Plan Update: Technical Report Number 1, Data Compilation and Review.*

2.1.2.2 Develop Trip Tables

Where a facility serves as an external station, SERPM-2 HASSIGN routines are modified to generate a selected link trip table. A selected link trip table identifies the origin zone and destination zone of all trips crossing a particular highway link. Information from this analysis permits SERPM-2 trips to be classified for the MTPM model. Trips crossing one of the Dade external station links are classified into one of three different tables. If a trip produced in Dade ends outside of Dade, the trip is internal-to-external. Similarly, if a trip originates outside of Dade and ends inside, the trip is external-to-internal. Any trip crossing the external station originating and ending outside of Dade is considered an E-E trip. Because the SERPM-2 employs the 1986 MUATS validation zone number scheme, special attention is required to allocate the trips identified in the selected link analysis to the MTPM's 1200 TAZ structure.

For 1990 MTPM zones with one equivalent 1986 MUATS zone, a simple zone renumbering is possible. For zones that either split or are aggregated between the two zonal structures, trips are allocated in proportion to the total number of households or employment in each of the original new zones, depending on whether the trip is I-E or E-I respectively. Once this process is completed, all the vehicular trips to and from each external station have been classified into one of the three external trip purposes: I-E, E-I, or E-E. Later, in the DISTRIBUTION step, these vehicular trips are classified into various auto occupancy categories.

2.1.2.2 Trip Table Adjustment

The resulting trip tables are adjusted to the match estimate PSAWT volumes. SERPM-2 adjustment factors for each station are developed by the following formula:

$$AdjustmentFactor = \frac{Vol_{1990\ Target,\ zone}}{Vol_{1990\ SERPM\text{-}II,\ zone}}$$

where:
Vol = total traffic volume
1990 = validation year (1990)
Target = 1990 PSAWT traffic estimate
SERPM-II = SERPM Selected Link Trip Table Total Volume
zone = a single external TAZ

A summary of the adjustment factors developed for each external station is presented in **Table 2.2.** The application of these factors to each table results in the total trips for each external site being within two percent of target traffic volumes.

MIAMI TRANSPORTATION PLANNING MODEL
Table 2.2 1990 SERPM-2 TO 1990 MTPM I-E/E-I Trip Table Adjustment Factors

Zone	Description	Adjustment Factor
1180	Collins Ave/A1A @ Broward County Line	1.0628
1181	Biscayne Blvd/U.S. 1 @ Broward County Line	0.7114
1183	West Dixie Hwy @ Broward County Line	1.0971
1184	Highland Oaks Blvd @ Broward County Line	0.8225
1185	I-95 @ Broward County Line	0.7725
1186	N.E. 12th Ave @ Broward County Line	0.8699
1187	N.E. 2nd Ave @ Broward County Line	0.6028
1188	U.S. 441/N.W. 2nd Ave @ Broward County Line	1.0349
1189	Florida's Turnpike @ Broward County Line	0.8420
1190	N.W. 27th Ave @ Broward County Line	0.7359
1191	N.W. 37th Ave @ Broward County Line	0.6930
1192	N.W. 47th Ave @ Broward County Line	1.0251
1193	N.W. 57th Ave @ Broward County Line	0.8565
1194	N.W. 67th Ave @ Broward County Line	1.0324
1196	I-75 @ Broward County Line	1.0319
1197	U.S. 27 @ Broward County Line	0.7506
1198	U.S. 41 West of Krome Ave	1.0788
1199	U.S. 1 @ Monroe County Line	1.0783
1200	Card Sound Road @ Monroe County Line	0.7626

Unfortunately, most of the corridors connecting Dade and Broward Counties were under construction during 1989-1991. This resulted in a wide variance in the assumed AADT and PSAWT traffic volumes on most facilities. For example, estimates AADT traffic volumes on Interstate 95 vary from 120,000 to 168,000 vehicles for 1990. As a result, calibration of the SERPM-2 model for intercounty crossings is particularly difficult. However, the general pattern suggests that the SERPM-2 model overestimates intercounty travel demand. This is due, in part, to the high amount of industrial/commercial employment in Dade County as compared to Broward and Palm Beach Counties. Some adjustment factors, such as the 0.7626 for Card Sound Road at the Monroe County line (zone 1200), are due to a difference in the traffic count for SERPM-2 and the 1990 MTPM.

2.1.2.3 Replace FSUTMS External Trip Tables

After the final target values have been achieved for the SERPM-2 distributed trip tables, the new external trip tables are ready to be implemented. The finalized trip table developed from this process is named IEEIEE.90A, and is stored in TRANPLAN file format. It contains three tables: I-E trips (table 1), E-I trips (table 2) and E-E trips (table 3). Tables 1 and 2 comprise what the FSUTMS model considers as I-E trips, and are added together at this time. In the DISTRIB module, this table replaces the trip table developed by the standard external trip model procedure outlined earlier in this chapter. Trips in the I-E, E-I and E-E tables are set aside at this point and are available for further processing later in the model chain.

2.2 External-External Trips

E-E trips are defined as trips with both ends outside the Dade County area. Previous modeling efforts in Miami have assumed that these trips are few in number and could, therefore, be considered in the context of the I-E trips. Data simply did not support the development of an E-E trip table. The use of the SERPM-2 trip tables, however, does permit the development of an E-E trip table.

MIAMI TRANSPORTATION PLANNING MODEL
Table 2.3 External Trip Classification Comparison: SERPM-2 AND 1990 MTPM Models

Origin	Destination					
	Model (1)	N of Palm Beach (2)	Palm Beach (3)	Broward (4)	Dade (5)	S. of Dade (6)
N. Of Palm Beach County	SERPM	n/a	E-I	E-I	E-I	E-E
	MTPM	**n/a**	**n/a**	**n/a**	**E-I**	**E-E**
Palm Beach	SERPM	I-E	I-I	I-I	I-I	I-E
	MTPM	**n/a**	**n/a**	**n/a**	**E-I**	**E-E**
Broward	SERPM	I-E	I-I	I-I	I-I	I-E
	MTPM	**n/a**	**n/a**	**n/a**	**E-I**	**E-E**
Dade	SERPM	I-E	I-I	I-I	I-I	I-E
	MTPM	**I-E**	**I-E**	**I-E**	**I-I**	**I-E**
S. Of Dade County	SERPM	E-E	E-I	E-I	E-I	n/a
	MTPM	**E-E**	**E-E**	**E-E**	**E-I**	**n/a**

n/a- trips which are not applicable or are illogical in the model.
I-I- internal to internal trip
I-E- internal to external trip
E-I- external to internal trip
E-E- external to external trip

Though SERPM-2 does not include E-E trips for the southeast region, it does provide a means for estimating E-E trips for Dade County. Trips that originate inside the SERPM-2 study area, but not in Dade County, and end either to the west or south of Dade County are considered, for the MTPM, to be E-E. **Table 2.3** demonstrates the relationship of trip classification in the SERPM-2 model to the same movement in the MTPM model. Though additional movements to the west of each county are possible, the table is intended to demonstrate how E-E and I-E movements can be derived for the MTPM from those that are I-I in the SERPM-2. **Table 2.4** presents the summary of E-E trips identified through this process as input into the model.

The small number of trips in Table 2.4 substantiates previous assumptions about the minor impact of E-E travel on the Miami model. However, for the sake of completeness, these trips are included in the final assignment as E-E.

2.3 Development of I-E/E-I Trips

Identical to the procedure developed for estimating E-E trips, the I-E/E-I trip matrix is composed of trips that, based on the SERPM-2 distribution, have one trip end inside and one outside of the Dade County area. To develop the I-E/E-I trip table, the same selected link functions used on the E-E trip table are employed. The only difference is that trips that originate inside Dade County and end elsewhere are classified as I-E while trips that originate outside Dade County and end inside are classified E-I. Separate tables are created by performing a selected link analysis of each of the model's external station locations in the SERPM-2 model. Because trips are distributed to all the internal zones, there are approximately 1.4 million possible interchange combinations (as compared with the 400 or so in the E-E table). A summary of the I-E/E-I total trips is presented in **Table 2.5**.

MIAMI TRANSPORTATION PLANNING MODEL
Table 2.4 External-to-External Trip Table As Developed From SERPM-2

Origin	Destination Zone																					
Zone	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	**TOTAL**
1180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1181	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
1182	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1183	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1184	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	**2**
1185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	6	**30**
1186	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1187	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
1188	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	**4**
1189	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99	80	20	**199**
1190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	37	12	**78**
1191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1193	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	41	12	**71**
1194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
1196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59	97	24	**180**
1197	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	**2**
1198	0	1	0	0	0	0	0	1	0	94	28	0	0	8	0	0	75	2	0	0	0	**209**
1199	0	1	0	0	1	25	1	2	3	76	42	0	0	19	0	0	120	1	0	0	0	**291**
1200	0	0	0	0	1	5	0	0	1	17	11	0	0	4	0	0	29	1	0	0	0	**69**
TOTAL	**0**	**2**	**0**	**0**	**2**	**30**	**1**	**3**	**4**	**187**	**81**	**0**	**0**	**31**	**0**	**0**	**224**	**4**	**206**	**287**	**75**	**1137**

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Table 2.5 Internal-to-External Trip Table As Developed From SERPM-2

TAZ	I-E Trips	E-I Trips	Total I-E/E-I
1180	10,745	10,830	21,575
1181	17,421	18,018	35,439
1182	0	0	0
1183	6,939	7,542	14,481
1184	2,990	3,331	6,321
1185	74,638	71,968	146,606
1186	2,290	3,607	5,897
1187	2,742	3,263	6,005
1188	19,732	20,956	40,688
1189	32,301	28,517	60,818
1190	22,375	22,877	45,252
1191	4,762	4,632	9,394
1192	6,789	6,709	13,498
1193	9,403	7,686	17,089
1194	6,248	5,945	12,193
1195	0	0	0
1196	25,124	28,080	53,204
1197	3,713	3,932	7,645
1198	1,915	1,857	3,772
1199	5,725	5,658	11,383
1200	1,460	1,561	3,021
TOTAL	257,312	256,969	514,281

It should be noted that, though the trips developed using the SERPM-2 model are based on separate estimates of I-E and E-I trips for Dade County in production and attraction (P&A) format, the final assigned trips on which the selected link trip tables are built for each of the external stations are in origin and destination (O/D) format. As such, trips are identified directionally, but tend to be reasonably balanced. In some instances, however, some traffic volumes are not balanced. This is because, for some trips, the shortest way one way is not necessarily the shortest way for the opposite direction. The balancing routines insure that the total traffic volumes for inter-county crossings will closely balance in both the north-to-south and south-to-north directions. The difference (of 343 trips) in total intercounty I-E and E-I volumes is attributable to centroid connections on the county line in concert with rounding error associated with TRANPLAN internal balancing routines.

2.4 External Trips by Transit

The SERPM-2 model includes estimates of travel for transit services as well as highway demand. Transit service continues to play an expanding role in inter-county travel in southeast Florida. Unfortunately, the FSUTMS/TRANPLAN programs do not include the ability to build trip tables for transit links in a way similar to highway selected links. Only with such an ability would it be possible to create transit trip tables using the SERPM-2 model.

Application of inter-county transit travel forecasts using the SERPM-2 or other regional models should be considered when evaluating transit routes or modes that either cross into Broward County or are dependent on ridership from intercounty transit routes. Any proposed change in transit service would require the reapplication of such models and, therefore, such models should be used independently, without an interface to the MTPM.

2.5 Future Year External Travel Forecasts

To forecast external travel demand for the Miami Long Range Transportation Plan Update, the process developed for the 1990 validation can be easily applied. A single run of the SERPM-2 for any interim year can result in a selected link assignment. Using the same script file routines developed for the base year, selected link volumes can be converted to trip tables. By applying the factors developed for the 1990 model, the I-E/E-I/E-E traffic volumes will be adjusted to account for potential model assignment biases. Resulting volumes are sensitive to regional land use, congestion and toll delays. Similarly, I-E/E-I trip forecasts will be sensitive to transportation system capacity and land use changes.

Initial applications of this methodology suggest it works well for most stations. However, due to the construction that occurred in 1990 and resulting fluctuation in traffic volumes (and therefore SERPM-2 adjustment parameters), future volumes should be measured against observed trends in traffic as well as more recent, post construction observed traffic. Adjustment factors may need to be modified to reflect more recent traffic trends.

2.6 Summary

External traffic volumes for all stations in the Dade study area for 1990 exceed 500,000 vehicle trips. Initial runs of the 1990 model suggest the standard external trip methodologies employed in FSUTMS may not sufficiently explain variation and distribution of this demand in the context of the southeast Florida region. As a result, the 1990 MTPM validation of the EXTERNAL trip module of FSUTMS implemented a new procedure for forecasting I-E/E-I/E-E traffic volumes. This procedure is based on the SERPM-2 model and yields a substantially improved distribution of external trip distribution that is sensitive to variables such as speed and capacity for travel outside the Dade study area.

This procedure also provides a new means by which future year external travel demand can be estimated. Forecasts will be sensitive to the issues that effect travel demand such as land use, roadway capacity, speed and facility classification improvements. Additionally, the model will now be able to more accurately replicate the distribution of I-E travel patterns. By adjusting future SERPM-2 volumes based on 1990 SERPM-2 / Dade relationships, travel characteristics unaccounted for in the regional model will be considered. The result is a greatly enhanced external travel demand model.

CHAPTER 3
TRIP GENERATION MODEL

3.0 Introduction

Trip generation is the process used to determine the number of person trips that originate (productions) in any specific zone and the number of trips that terminate (attractions) in that zone. Through research conducted by the Florida Department of Transportation (FDOT), it is observed that the demographic character of a zone has a direct impact on its trip making potential. The third step of the Florida Standard Urban Transportation Modeling Structure (FSUTMS), as shown in **Figure 3.1**, provides a generalized trip generation model to be used in any urban area in Florida. A detailed description of the model can be found in *Florida Department of Transportation, Urban Transportation Model Update- Task B; Review and Refinement of Standard Trip Generation Model.*

3.1 Trip Generation Model

Recent transportation modeling efforts in other parts of Florida and elsewhere in the country recognize that there are many phenomena that effect trip generation. Trip chaining; number of workers in a household; employment status of a household (e.g. retired, unemployed); and number and age of children all can have a significant impact on trip generation. Each of these variables can impact trip making. Research underway in Florida (e.g. Tampa Bay Regional Transportation Analysis, Lee County Urban Travel Characteristics Study) indicates that retirement status, as well as the presence or absence of children has a significant role to play in forecasting work trips. While these are recognized as important variables in the determination of household trip generation, few data exist to incorporate these variables into the Miami Transportation Planning Model (MTPM). Further testing of data and estimation of trip generation algorithms will be necessary before such variables should be included in the MTPM.

The FSUTMS standard trip generation model used in the MTPM employs cross-classification techniques to determine home-based trip productions while linear trip rate equations determine all trip attractions. Trips are calculated as person trips for all purposes except truck/taxi and external

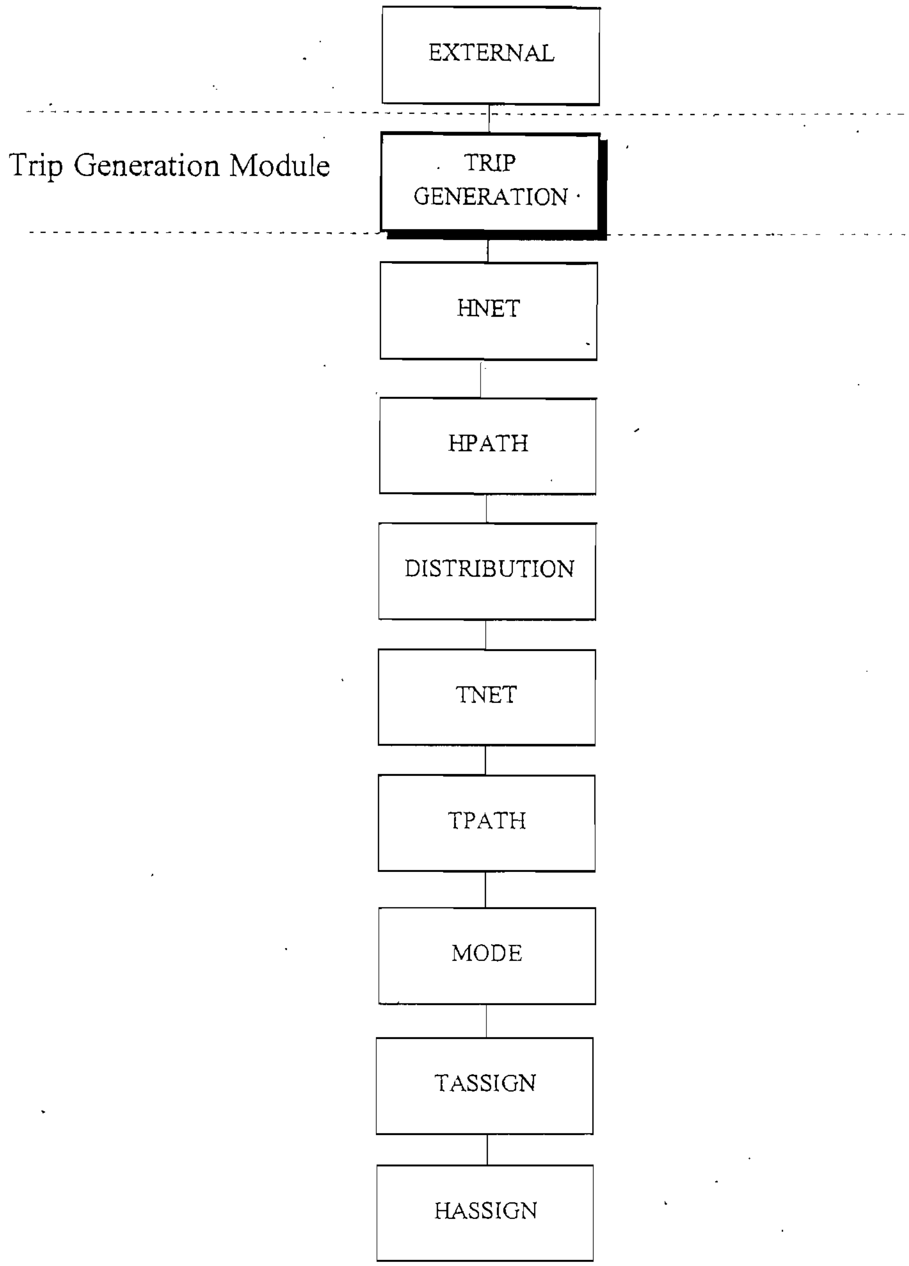


Figure 3.1 Trip Generation Process in the FSUTMS Model Chain

trips which are calculated as vehicle trips. Zones which have unique land uses that are not well represented in the standard generation model are adjusted by special generators.

3.1.1 Trip Productions

Trip production rates for all home-based person trips (Home-based Work, Home-based Shop, Home-based Social/Recreation and Home-based Other) are stratified by dwelling unit type, trip purpose, auto ownership, and persons per dwelling unit. Because model input zonal data sets describe only total number of dwellings as stratified into three structure categories, estimates of average persons per occupied dwelling unit per zone must be disaggregated into dwelling units based upon assumed categories of household size. The standard FSUTMS approach is to estimate the number of households in each category based on a set of household stratification values. These values appear in a file called DUWEIGHT.SYN and are presented in **Table 3.1**.

After calculating the number of households of each particular size, Home-based trip productions are estimated. The strata used for the model are as follows:

A) *Household Size:*

- ❶ 1 Person per Dwelling Unit
- ❷ 2 Persons per Dwelling Unit
- ❸ 3 Persons per Dwelling Unit
- ❹ 4 Persons per Dwelling Unit
- ❺ 5 or more Persons per Dwelling Unit

B) *Trip Purpose:*

- ❶ Home-Based Work (HBW)
- ❷ Home-Based Shopping (HBSH)
- ❸ Home-Based Social/Recreation (HBSR)
- ❹ Home-Based Other (HBO)
- ❺ Non-Home-Based (NHB)
- ❻ Truck/Taxi (T/T)
- ❼ Internal/External (I/E) trips

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.1 Standard Model Persons Per Dwelling Unit Conversion Matrix

Average Persons/ Dwelling Unit	Persons/Dwelling Unit (DU) Percentage Makeup				
	1	2	3	4	5
1.00-1.12	89%	11%	0%	0%	0%
1.13-1.37	76%	22%	2%	0%	0%
1.38-1.62	59%	34%	5%	1%	1%
1.63-1.87	45%	42%	7%	3%	3%
1.88-2.12	32%	50%	9%	5%	4%
2.13-2.37	28%	44%	13%	8%	7%
2.38-2.62	22%	40%	17%	11%	10%
2.63-2.87	18%	37%	18%	13%	14%
2.88-3.12	13%	34%	18%	16%	19%
3.13-3.37	12%	29%	18%	17%	24%
3.38-3.62	8%	24%	20%	20%	28%
3.63-3.87	5%	20%	19%	23%	33%
3.88-4.12	4%	16%	17%	24%	39%
4.13-4.37	2%	15%	14%	21%	48%
4.38-4.62	1%	15%	13%	17%	54%
4.63-5.99	0%	5%	7%	14%	74%
6.00-UP	0%	0%	2%	5%	93%

C) *Type of Dwelling Unit (DU):*
- ❶ Single Family Unit
- ❷ Multi-Family Unit
- ❸ Hotel/Motel Unit

D) *Auto Ownership Characteristics of Household:*
- ❶ 0 Auto per Dwelling Unit
- ❷ 1 Auto per Dwelling Unit
- ❸ 2 or more Autos per Dwelling Unit

The total number of home-based trips produced for a given zone is determined by applying the appropriate trip generation rate to the number of occupied dwelling units in each classification and summing the trips for each class of dwelling unit in the zone. **Table 3.2** shows the cross-classification rates used in the 1990 Dade County trip generation model for the four (4) home-based trip production types; Home-Based Work (HBW), Home-Based Shopping (HBSH), Home-Based Social/Recreation (HBSR), and Home-Based Other (HBO). These rates are all standard FSUTMS rates except for HBW. Unique HBW rates were established based on 1980 Census data during the 1986 validation. These are described in the 1986 report *Miami Urbanized area Transportation Study Technical Report #2, Model Validation.* This set of rates was adopted for the 1990 Miami Transportation Planning Model (MTPM).

As non-home-based person trip productions are not a function of households, they are not calculated based on the same independent variables as home-based trip purposes. Rather, the trip generation model first calculates non-home based trip attractions and assumes that, for each zone, non-home-based productions are equal to attractions. Further explanation of this calculation is provided in the section that follows.

Unlike the first five purposes which are calculated as person trips, Truck/Taxi (T/T) and E/I trips represent vehicle trips. T/T trips are determined as vehicle trips and are calculated as a function of total dwelling units and total employment within each zone. Like non-home-based trips, the trip generation model calculates total T/T trip attractions and assumes that T/T trip productions are equal to attractions for each zone in the network.

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.2 Trip Production Rates For Home-based Trip Purposes

Home-based WORK

PERS/DU	Single Family AUTOS/DU 0	Single Family AUTOS/DU 1	Single Family AUTOS/DU 2+	Multi-Family AUTOS/DU 0	Multi-Family AUTOS/DU 1	Multi-Family AUTOS/DU 2+	Hotel/Motel AUTOS/DU 0	Hotel/Motel AUTOS/DU 1	Hotel/Motel AUTOS/DU 2+
1	0.45	1.01	1.35	0.40	1.21	1.48	0.25	0.25	0.25
2	1.01	1.60	2.45	0.70	1.55	2.75	0.20	0.20	0.20
3	1.53	2.36	3.30	1.40	2.36	3.20	0.15	0.15	0.15
4	1.93	2.72	3.44	1.67	2.61	3.71	0.10	0.10	0.10
5	2.45	3.22	4.25	1.89	2.88	4.18	0.10	0.10	0.10

Home-based SHOPPING

PERS/DU	Single Family AUTOS/DU 0	Single Family AUTOS/DU 1	Single Family AUTOS/DU 2+	Multi-Family AUTOS/DU 0	Multi-Family AUTOS/DU 1	Multi-Family AUTOS/DU 2+	Hotel/Motel AUTOS/DU 0	Hotel/Motel AUTOS/DU 1	Hotel/Motel AUTOS/DU 2+
1	0.30	0.80	0.90	0.30	0.50	0.65	0.30	0.30	0.30
2	0.35	1.05	1.25	0.35	1.25	1.40	1.30	1.30	1.30
3	0.40	1.20	1.45	0.40	1.50	1.65	2.00	2.00	2.00
4	0.45	1.30	1.60	0.45	1.65	1.85	2.50	2.50	2.50
5	0.45	1.30	1.70	0.45	1.70	1.95	2.90	2.90	2.90

Home-based SOCIAL/RECREATION

PERS/DU	Single Family AUTOS/DU 0	Single Family AUTOS/DU 1	Single Family AUTOS/DU 2+	Multi-Family AUTOS/DU 0	Multi-Family AUTOS/DU 1	Multi-Family AUTOS/DU 2+	Hotel/Motel AUTOS/DU 0	Hotel/Motel AUTOS/DU 1	Hotel/Motel AUTOS/DU 2+
1	0.20	0.65	0.85	0.30	0.65	0.75	0.60	0.60	0.60
2	0.25	0.85	1.05	0.35	1.05	1.20	1.65	1.65	1.65
3	0.30	1.10	1.30	0.40	1.45	1.65	2.70	2.70	2.70
4	0.40	1.35	1.65	0.45	1.90	2.20	3.90	3.90	3.90
5	0.45	1.70	2.10	0.55	2.65	3.05	5.90	5.90	5.90

Home-based OTHER

PERS/DU	Single Family AUTOS/DU 0	Single Family AUTOS/DU 1	Single Family AUTOS/DU 2+	Multi-Family AUTOS/DU 0	Multi-Family AUTOS/DU 1	Multi-Family AUTOS/DU 2+	Hotel/Motel AUTOS/DU 0	Hotel/Motel AUTOS/DU 1	Hotel/Motel AUTOS/DU 2+
1	0.20	0.60	0.70	0.25	0.80	0.95	0.50	0.50	0.50
2	0.30	1.10	1.20	0.45	1.20	1.50	1.20	1.20	1.20
3	0.55	1.85	2.20	0.70	1.60	2.30	2.10	2.10	2.10
4	1.00	2.75	3.55	1.10	2.10	3.40	3.30	3.30	3.30
5	1.60	3.95	5.35	1.70	3.00	4.65	4.40	4.40	4.40

E-I vehicle trip productions for each external station (zone), are equal to the total vehicles entering and leaving at each station with the destination or origin of the trips outside the study area, as discussed in *Chapter 2, External Trip Models*. However, the inclusion of the SERPM-2 trip distribution for external trips supercedes any E-I trip calculations that occur in the standard trip production model.

3.1.2 Trip Attractions

The trip attraction model for FSUTMS uses trip rate equations, as exhibited in **Table 3.3**. All trip attraction formulae used in the MTPM conform with the FSUTMS default rates. Variables used in the model include employees by category, dwelling units, and school enrollment. After attractions for all other purposes are calculated, attractions for I-E trips are allocated to all internal zones in proportion to their total attractions for all standard purposes.

After the productions and attractions are calculated for each zone, the total productions and attractions for the study area are summed for all zones by purpose. Ratios of total productions and attractions are computed for each trip purpose by dividing the total productions by the total attractions. In the standard model, trip productions are the controlling totals for the four home-based trips purposes and E-I trips. Only non-home based and T/T use attractions as the control total. Because, for FSUTMS, the zonal production for the non-home-based trips and T/T trips are assumed to be the same as the zonal attractions calculated by the trip attraction equations, no adjustment to these purposes is required. Finally, attractions and productions are balanced for the study area; hence, each of the zonal attractions is adjusted uniformly for all zones by purpose to ensure that the study area total trip productions and trip attractions are equal.

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.3 Trip Attraction Equations

Trip Purpose	Rate		Independent Variable
Home-based Work Trip	= 1.80	*	Total Employment
Home-based Shopping Trip	= 6.10	*	Commercial Employment
Home-based Social/Recreation Trip	= 0.50 1.50 1.50	* * *	Total Dwelling Units + Commercial Employment + Service Employment
Home-based Other Trip	= 0.20 1.30 1.30 1.30	* * * *	Total Dwelling Units + Commercial Employment + Service Employment + School Enrollment
Non-home based Trip	= 0.30 2.90 1.40	* * *	Total Dwelling Units + Commercial Employment + Service Employment
Truck and Taxi (T/T) Trip	= 0.30 0.45	* *	Dwelling Units + Total Employment
I-E Attractions for Each Zone *Where: R =*	= Total I-E Productions * (R) <u>*Total Zonal Internal Trip Attractions*</u> *Total Study Area Trip Attraction*		

Source: *Florida Department of Transportation, Urban Transportation Model Update- Task B; Review and Refinement of Standard Trip Generation Model*

3.1.3 Special Generators

To replicate trip generation for zones with unusual trip rates, FSUTMS uses the "special generator" concept. Special generators are major activity centers that have a rate of activity significantly different from the standard trip generation rate utilized in FSUTMS. The Review & Refinement of Standard Trip Generation Model, Task B Report, June 1980 defines special generators as "*... activity centers where the standard trip generation equations estimate the trip attractions significantly greater or less than the rate of activity associated with the land use such as regional parks, beaches, regional shopping malls, major colleges, and the regional airport.*" . Procedures for the development and implementation of special generators are discussed in detail in the FSUTMS trip generation model documentation. Two major considerations guide the development of special generators and reflected in the validated 1990 MTPM.

First, if a zone includes a special generator that adds home-based trip attractions, the number of attractions for all the other zones are adjusted lower in order to match the total attractions since the trip productions serve as the control for the home-based trips within FSUTMS. Significant additions or deletions of home-based trip attractions for the special generators will impact trip attraction rates used in the model for zones without special generators.

Second, standard FSUTMS special generator handling procedures suggest special generator trips should be kept constant for future year models. Since there is little reliable projected data available for the future year trip generation independent variables (such as employees) at these sites, projections can be highly inaccurate. Standard trip generation for a zone based on the socio-economic characteristics of the zone represents "average" generation characteristics for the urban area. For the majority of zones in the network, this average will yield accurate future trip generation estimates. For these reasons, it is desirable to minimize the number of special generators.

Special generators used in the 1990 MTPM validation were developed by Metropolitan Planning Organization (MPO), Metro Dade Transit Authority (MDTA), and Metro-Dade Planning Department (MDPD) staff and represent the key specialized trip generators in the Miami Urbanized area. As part of the validation process, traffic volumes around special generator sites were reviewed. All special generators suggested by the MPO were found to be reasonable and were used as part of the validation. For a complete list of special generators used in the 1990 validation, see **Table 3.4.**

3.2 Modeling Process

Four user-supplied data sets are provided as inputs to the GEN model. These are the zonal trip production data (ZDATA1), trip attraction data (ZDATA2), special trip generators (ZDATA3), and internal/external trip productions (ZDATA4). ZDATA files are input into the model in ASCII format and contain all of the variables used in trip generation. **Table 3.5** presents the variables included in each of the ZDATA files along with their column format in the file.

ZDATA files contain all the information necessary to calculate total trip productions and attractions for Dade County. Particular care and local knowledge must be employed in their development. The MDPD, in consultation with the MPO, U.S. Department of Commerce, Bureau of the Census and other agencies worked to develop a ZDATA set that contains accurate, thoroughly reviewed data. The daily, "hands on" working of the MDPD with all the demographic and economic indicators of the county provided not only reliable 1990 data, but a strong foundation for the development of future year data projections.

Each of the ZDATA sets developed by the MDPD describes particular characteristics of the county. The zonal production data (ZDATA1) consist of the number of single family and multi-family dwelling units in each zone, as well as vacancy rates, resident population, and auto ownership characteristics. The data set also contains the number of hotel/motel units in each of the zones, their occupancy rates, and number of guests during the peak season. The zonal attraction data (ZDATA2) consists of the employment and school enrollment within each zone. Employment data are supplied categorically by industrial, commercial, service, and total employment.

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.4 Special Generators

Zone	District	Description	PTA	Trip Type
		ACTIVITY CENTERS		
517	42	Miami Int'l Airport	172,500	MIX
2	37	Port of Miami	22,300	MIX
21	2	M.B. Convention Center	5,900	MIX
1071	77	South Dade Landfill	2,000	NHB
		RECREATIONAL AREAS		
616	38	Miami Arena	13,300	HBSR
999	70	Metro Zoo	24,600	HBSR
1163	1	Crandon Park	12,300	HBSR
126	11	Calder/Tropical Track	12,600	HBSR
3	2	South Beach Pointe	9,800	HBSR
12	2	Lummus Park	10,200	HBSR
256	21	Amelia Earhart Park	9,800	HBSR
1164	1	Seaquarium Key Marina	8,800	HBSR
778	49	Tropical Park	7,300	HBSR
921	74	Matheson & Fairchild	7,400	HBSR
1100	83	Everglades National Park	6,100	HBSR
6	2	South Beach	5,100	HBSR
13	2	Lummus Park	10,100	HBSR
48	5	Haulover Beach	5,000	HBSR
614	37	Watson Island	4,900	HBSR
531	51	Mel Reese Golf Course	3,700	HBSR
633	37	Bayfront Park	2,400	HBSR
1072	77	Black Point Marina	2,400	HBSR
1156	88	Biscayne National Park	2,400	HBSR
1160	1	Cape Florida State Park	1,200	HBSR
615	37	Bicentennial Park	1,000	HBSR
182	11	Pensuco	10,300	HBSR

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.4 Special Generators

Zone	District	Description	PTA	Trip Type
		MAJOR RETAIL CENTERS		
66	7	Aventura Mall	362,000	HBSH
903	73	Dadeland Mall	344,900	HBSH
483	17	Miami Int'l Mall	268,200	HBSH
947	72	Falls Shopping Center	188,900	HBSH
1042	78	Cutler Ridge Mall	211,400	HBSH
324	23	163 St. Shopping Center	173,600	HBSH
495	43	Midway Mall	138,200	HBSH
632	37	Bayside Shopping Center	91,900	MIX
202	29	Westland Shopping Center	133,500	HBSH
278	26	Northside Shopping Center	79,200	HBSH
605	37	Omni Int'l Mall	94,700	HBSH
876	71	Kendall Town & Country	87,800	HBSH
41	4	Bal Harbor Shops	84,900	HBSH
223	29	Palm Sp. Mile-N Shops	69,500	HBSH
80	8	Skylake Mall	58,700	HBSH
767	49	Westchester Mall	49,000	HBSH
222	29	Palm Sp. Mile-South Shops	40,300	HBSH
803	49	Concord Shopping Plaza	44,300	HBSH
773	49	Westchester Shopping Center	35,000	HBSH

PTA = Trips Addition
HBSH = Home based Shopping Trip
HBSR = Home based Social/Recreation Trip
NHB = Non-Home based Trip
MIX = Combination of HBSH, HBSR, and NHB

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.5 ZDATA File Formats

Variable	FILE	Columns
	ZDATA 1	
Card		1
Sector		2-4
Zone		5-8
Total Single Family Dwelling Units		9-13
Percent Single Family Dwelling Units not Occupied by Permanent Residents		14-16
Percent Single Family Dwelling Units Vacant		17-19
Population in Single Family Dwelling Units		20-24
Percent Single Family Households with No Automobiles		25-27
Percent Single Family Households with One Automobile		28-30
Percent Single Family Households with Two or More Automobiles		31-33
Total Multi Family Dwelling Units		34-38
Percent Multi Family Dwelling Units not Occupied by Permanent Residents		39-41
Percent Multi Family Dwelling Units Vacant		42-44
Population in Multi Family Dwelling Units		45-49
Percent Multi Family Households with No Automobiles		50-52
Percent Multi Family Households with One Automobile		53-55
Percent Multi Family Households with Two or More Automobiles		56-58
Total Hotel/Motel Units		59-63
Percent Hotel/Motel Units Occupied		64-66
Total Population in Hotel/Motel Units		67-71
	ZDATA2	
Card		1
Sector		2-4
Zone		5-8
Industrial Employment		9-14
Commercial Employment		15-20

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.5 ZDATA File Formats

Variable	FILE	Columns
	(**ZDATA2** continued)	
Service Employment		21-26
Total Employment		27-32
School Enrollment		33-38
Short-Term Parking Cost		39-42
Long-Term Parking Cost		43-46
	ZDATA3	
Card		1
Sector		2-4
Zone		5-8
Generator Type		9
Function Code		10
Trips		11-16
Percent HBW		17-19
Percent HBSH		20-22
Percent HBSR		23-25
Percent HBO		26-28
Percent NHB		29-31
Total Employment		32-36
Commercial Employment		37-41
Service Employment		42-46
School Enrollment		47-51
Total Dwelling Units		52-56
Description		57-80
	ZDATA4	
Card		1
Sector		2-4
Zone		5-8
I-E Productions		9-14

The special generators data (ZDATA3) contains the trip production and/or attraction characteristics of special trip generators in each zone. These data are generally associated with trip attractors and are utilized to correct for major activity centers that have significantly different rates of trip generation than standard rates provided by FSUTMS. Special generators developed by MPO, MDTA and MDPD staff were included in initial applications of the trip generation model. However, as part of the traffic assignment model validation, travel simulation results were studied to assess the need for special generators.

Initial trip generation validation procedures consisted of inputting the Dade County base year data sets to the GEN model and reviewing the results for reasonableness. The GEN model creates two program-generated data sets designated as PRODS.90A and ATTRS.90A. These files, consisting of daily trip productions and attractions per zone by trip purpose, are used as inputs to the trip distribution modeling component.

3.3 Trip Generation Model Results

The 1990 Dade County trip generation model simulated a travel demand of approximately 6.6 million person trips and 1.2 million additional vehicle trips. All of the trip purposes represent daily person trips, except T/T and I-E trip purposes which represent vehicle trips. Reasonableness of the distribution of trip productions among the seven trip purposes is assessed by comparing Dade County results with those from other model validation studies in Florida. Examination of the ranges shown in **Table 3.6** indicate the typical maximum and minimum values of percent trip production by trip purpose for urban study areas in Florida. MTPM results generally fit within those ranges.

Another test of the reasonableness of the Dade County results is to compare the number of trip productions to socioeconomic characteristics. The GEN model provides summary statistics for this purpose. The statistics for the Dade County 1990 base year are shown in **Table 3.7**. Comparison with model validation results from elsewhere in Florida and other national sources in **Table 3.8** indicates that MTPM results are reasonable and similar to those of other urbanized areas.

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.6 1990 Daily Trip Productions By Purpose

Trip Purpose	Trips	Percent	Range*
Home-based Work	1,591,000	20.2%	13 - 19
Home-based Shop	824,000	10.5%	10 - 13
Home-based Soc/Rec	869,000	11.0%	7 - 13
Home-based Other	1,336,000	17.0%	17 - 34
Non-Home based	2,009,000	25.5%	13 - 32
Total Person Trips	6,629,000	84.2%	
Truck/Taxi	723,000	9.2%	7 - 9
Internal-External	518,000	6.6%	4 - 24
Total Trips	7,870,000	100.0%	

*Range of percentages from other selected Florida urban area studies

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.7 Trip Generation Statistics

Trip Generation Variable	1990 Value
Total Permanent Population	1,901,856
Total Transient Population	97,164
Total Population (Permanent + Transient)	1,999,020
Total Permanent Occupied Dwelling Units (DU)	691,447
Total Transient Dwelling Units	55,944
Total Occupied (Permanent + Transient) DU	747,391
Total Service Employment	678,289
Total Employment	1,104,788
Permanent Population Per Permanent Occupied DU	2.75
Transient Population Per Transient DU	1.74
Total Population Per Total Occupied DU	2.67
Total Employment Per Permanent Population	0.58
Service to Total Employment	0.61
Total Home-based Trip Productions	4,620,000
Total Trip Productions	7,870,000
Internal Person Trips Per Total Occupied DU	8.87
Internal Person Trips Per Employee	6.00

MIAMI TRANSPORTATION PLANNING MODEL
Table 3.8 Comparison of Percent Trips Generated By Purpose

TRIP PURPOSE	MTPM		Hillsborough 1988	(1) ITE	(2) QRS
	1986	1990			
HBW	25%	24%	19%	24%	25%
HBNW: HBSH	13%	12%	15%	14%	-
HBSR	14%	13%	16%	17%	-
HBO	21%	20%	23%	24%	-
HBNW Subtotal	48%	45%	54%	55%	54%
NHB	27%	30%	27%	21%	21%

Note: Calculation of percent trips generated by purpose do not include T/T, IE and EE.

(1) Values derived from Table 10-13, Transportation and Traffic Engineering Handbook, ITE, 1982

(2) NCHRP REPORT 187, PP. 13-14

3.4 Summary

The standard FSUTMS trip generation model and methodologies generally estimate trip productions and attractions in Dade County with a high degree of confidence. Special generators are utilized only where the trip generation formulae underestimate travel demand for specific, intensive land uses. Based on the 1986 trip production rate set, the 1990 MTPM trip generation model is consistent with previous validations while reflecting post 1990 Census land use data.

CHAPTER 4
HIGHWAY NETWORK

4.0 Introduction

Highway network development, as presented in **Figure 4.1**, is the third step in the FSUTMS model chain. It is in this module that highway system characteristics are described and summary statistics are computed. Characteristics such as number of highway links, system miles, roadway classification, laneage, speed, and capacity are each input into the model where they determine the capacity of the highway system to satisfy travel demand.

The highway network is represented by connected link segments and is developed from the highway link (LINKS) file and node coordinate data (XY) file. The LINKS and XY datasets for the 1990 MTPM base year were developed by the Metro Dade Metropolitan Planning Organization (MPO), the Metro Dade Transit Agency (MDTA), the Florida Department of Transportation (FDOT) District 6, and the consultant. The highway network was reviewed by the Metro Dade Long Range Transportation Plan Steering Committee for accuracy and completeness. After thorough review, the 1990 highway network topology and link characterization were finalized.

The highway network is built from over 8,000 links. Highway links have attributes of facility type, area type and number of lanes. These are the attributes by which link characteristics of speed and capacity are determined. The facility types of the highway links are developed according to the functional classifications of the roadways. They are categorized as freeway, divided arterial, undivided arterial, collector, centroid connector (local streets) or one-way street. The area types of the highway links depend on the land use fronting the highway links and are categorized into Central Business District (CBD), CBD fringe, Residential, Outlying Business District (OBD) and Rural Area. Standard FSUTMS definitions of the facility types and area types are presented in **Table 4.1** and **Table 4.2**, respectively.

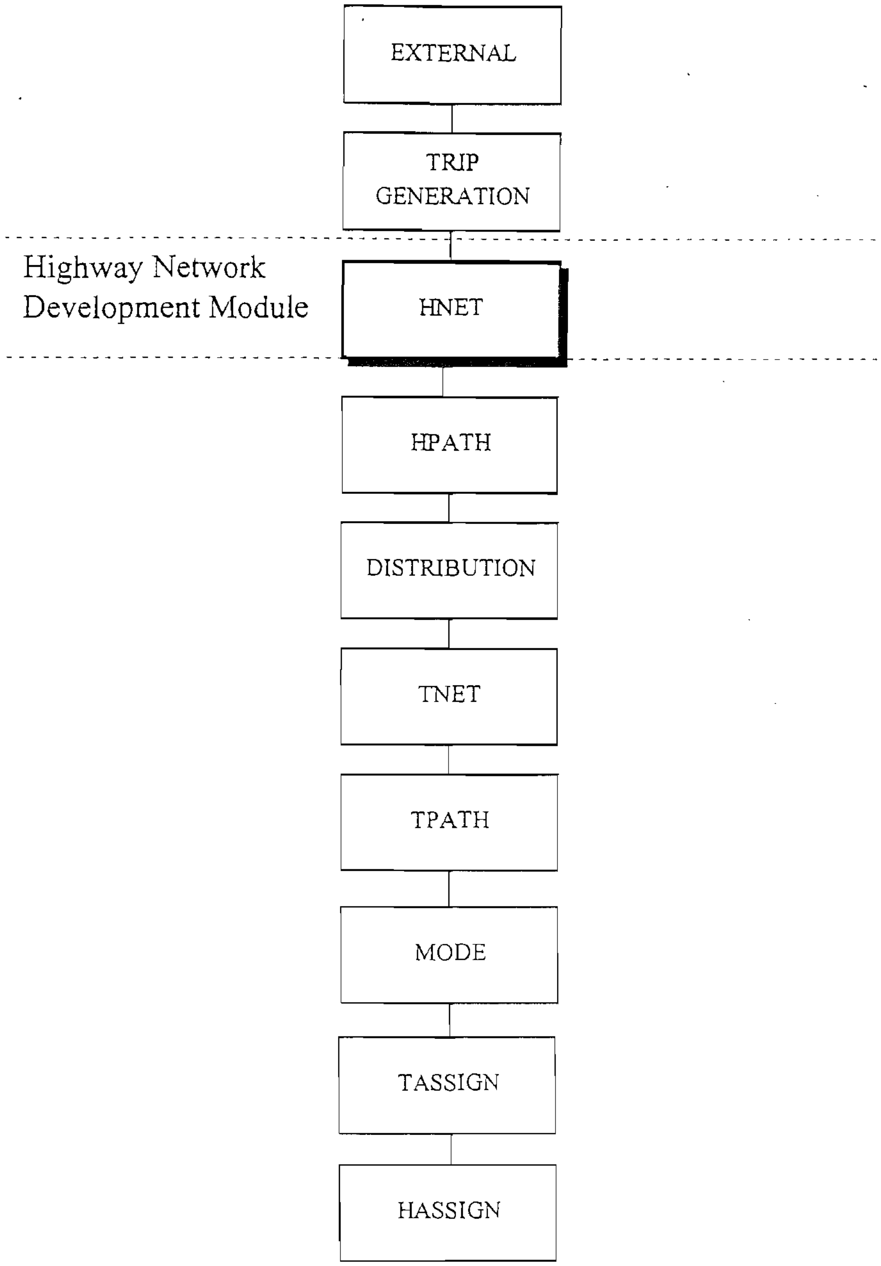


Figure 4.1 Position of Highway Network Development in FSUTMS Model Chain

MIAMI TRANSPORTATION PLANNING MODEL
Table 4.1 Area Type Definitions

Area Type	Definitions of Area Type
1 - Central Business District (CBD)	An area where the predominant land use is intense business activity. Characterized by large numbers of pedestrians, commercial vehicles, loadings of goods and people, a large demand for parking space, and a high degree of turnover in parking.
2 - CBD Fringe	The portion of a municipality immediately outside the CBD. Exhibits a wide range of business activities (small businesses, light industry, warehousing, automobile service centers, and intermediate strip development, with some concentrated residential areas). Traffic in these areas generally involves trips that do not have an origin or destination within the area. Less pedestrian traffic and lower parking turnover than in the CBD. However, large parking areas servicing the CBD might be present.
3 - Residential	An area within the influence of a municipality in which the predominant land use is residential development (small businesses may be present). Characterized by few pedestrians and low parking turnover.
4 - Outlying Business District (OBD)	An area within the influence of a municipality that is normally separated by some distance from the CBD and its fringe area, but that has the intense activity characteristic of a central area. The principal land use is business, and there may be heavy traffic or through movements, causing vehicles to operate at lower speeds than in fringe areas. Also characterized by large demand for parking and high turnover, and moderate pedestrian traffic. This category does not include off-street shopping on one side of a street only. Moderate to heavy strip development on both sides of a street should be coded OBD.
5 - Rural	A sparsely developed area within the influence of a municipality in which the predominant land use is other than those described in the four preceding categories.
Source: Florida Department of Transportation	

MIAMI TRANSPORTATION PLANNING MODEL
Table 4.2 Facility Type Definitions

Facility Type	Definitions of Facility Type
1 - Freeway/ Expressway	A facility with full control of access to give preference to through traffic (i.e., interstate and turnpike).
2 - Divided Arterial and Expressway	A facility with a painted area wide enough to protect a left-turning vehicle, or with barrier or median (raised or depressed) separating opposing traffic flows, carrying most of the long trips made within and through an urban area, emphasizing traffic movement rather than land access, and carrying higher volumes than any facility except freeways. Expressways have some grade-separated intersections, fewer signals per mile than arterials, and some frontage roads.
3 - Undivided Arterials	Similar to a divided arterial, except no painted area or physical barrier separates opposing traffic flows. Generally has more signals per mile and fewer frontage roads, serves fewer through trips, and serves more land access than divided arterials.
4 - Collector	Street that "collects" traffic from local streets in neighborhoods and channels it into the arterial system. A small amount of through traffic may be carried on collector streets, but the system primarily provides access to abutting land by carrying local traffic between or within residential neighborhoods and commercial areas, or to roadways with more capacity.
5 - Centroid Connector	Local streets are represented by centroid connectors.
6- One Way	An arterial road that has uni-directional traffic. Usually these roads have opposing direction traffic traveling on a facility one or more city blocks away.
8 - HOV	Any facility on which traffic is restricted to a specific trip purpose, or to vehicles with a particular number of passengers.
Source: Florida Department of Transportation	

4.1 Input Speeds and Capacities

After all highway links have been identified, the FSUTMS HNET program internally computes and adds attributes of distance, capacity and free flow travel time. Distance is based upon the coordinates of the termini of each link and is computed using the Pythagorean Theorem. Travel time and capacity values are a function of facility type, area type, and number of lanes of each link. The highway link uncongested travel speeds in miles per hour (MPH) and capacity are input into the HNET model through a lookup speed/capacity (SPDCAP) table. These speeds are used in the determination of interzonal travel times and represent the uncongested conditions for highway links under each combination of facility type, area type, and number of lanes.

The SPDCAP table is one of the key model parameters adjusted during the validation process. Speeds and capacities are developed based upon differing criteria. Speeds are based on uncongested average travel speeds which are adjusted to replicate observed travel patterns during the assignment process. Capacities are developed to represent the hourly capacity of various facility types at approximately level of service "D". However, because the only place in the model stream that considers capacity is the equilibrium assignment model (which uses capacity to derive congested travel time on highway links), input capacities should yield, after assignment, a realistic appraisal of congested network speeds. The adjustment of speeds and capacities is an iterative process designed to yield estimates of traffic volumes that reflect observed traffic flows. The final validated SPDCAP table is included in **Table 4.3**.

The transportation network descriptions (LINKS, XY, and SPDCAP) are processed by the FSUTMS highway network (HNET) model. These highway network attributes will determine the shortest travel time paths through the highway network between all pairs of zone and are calculated by the next step in the FSUTMS model chain, the highway path (HPATH) model.

MIAMI TRANSPORTATION PLANNING MODEL
Table 4.3 Highway Network Input Speed and Capacity Table

AT	FT	Number of Lanes							
		1		2		3-4		5+	
		Speed	Cap	Speed	Cap	Speed	Cap	Speed	Cap
1	1	38.4	1,391	38.4	1,391	38.4	1,391	38.4	1,391
	2	28.2	773	28.2	773	28.2	773	28.2	773
	3	26.2	474	26.2	474	26.2	474	26.2	474
	4	24.9	361	24.9	361	24.9	361	24.9	361
	5	8.5	10,000	8.5	10,000	8.5	10,000	8.5	10,000
	8	39.0	1,391	39.0	1,391	39.0	1,391	39.0	1,391
2	1	41.0	1,751	41.0	1,751	41.0	1,751	41.0	1,751
	2	30.5	773	30.5	773	30.5	773	30.5	773
	3	29.6	577	29.6	594	29.6	594	29.6	594
	4	27.1	464	27.1	464	27.1	464	27.1	464
	5	10.5	10,000	10.5	10,000	10.5	10,000	10.5	10,000
	8	44.2	1,751	44.2	1,751	44.2	1,751	44.2	1,751
3	1	47.4	1,957	47.4	1,957	47.4	1,957	47.4	1,957
	2	36.8	927	36.8	927	36.8	927	36.8	927
	3	35.3	721	35.3	721	35.3	721	35.3	721
	4	33.9	743	33.9	743	33.9	743	33.9	743
	5	11.0	10,000	11.0	10,000	11.0	10,000	11.0	10,000
	8	48.0	1,957	48.0	1,957	48.0	1,957	48.0	1,957
4	1	48.0	1,957	48.0	1,957	48.0	1,957	48.0	1,957
	2	37.4	979	37.4	979	37.4	979	37.4	979
	3	36.9	824	36.9	824	36.9	824	36.9	824
	4	35.6	721	35.6	721	35.6	721	35.6	721
	5	11.0	10,000	11.0	19,000	11.0	10,000	11.0	10,000
	8	48.6	1,957	48.6	1,957	48.6	1,957	48.6	1,957
5	1	53.8	1,957	53.8	1,957	53.8	1,957	53.8	1,957
	2	41.4	979	41.4	979	41.4	979	41.4	979
	3	40.5	824	40.5	824	40.5	824	40.5	824
	4	39.6	721	39.6	721	39.6	721	39.6	721
	5	14.0	10,000	14.0	10,000	14.0	10,000	14.0	10,000
	8	54.4	1,957	54.4	1,957	54.4	1,957	54.4	1,957

AT: Area Type
- 1: CBD
- 2: FRINGE
- 3: RESIDENTIAL
- 4: OBD
- 5: RURAL

FT: Facility Type
- 1: FREEWAY
- 2: DIVIDED ARTERIAL
- 3: UNDIVIDED ARTERIAL
- 4: COLLECTOR
- 5: CENTROID CONNECTOR
- 8: HOV FACILITY

4.2 Highway Network Description

The 1990 Miami model highway network contains 4,756 lane miles of roadway. **Table 4.4** presents the lane mile summary for the 1990 highway network and identifies the category of roadway with the highest number of lane miles as divided arterial. By far the largest number of lane miles for an area type is attributable to residential. This is typical for most urban models in Florida. **Table 4.5** and **Table 4.6** present the number of highway links in the 1990 network by facility type/area type and by facility type/number of lanes. The residential area type accounts for over half the total number of links in the highway network.

The MPO, FDOT, and other impacted agencies felt that facility type 6 (one-way) should not used to represent one way facilities. This is due to the high number of one-way streets that serve collector, local road and arterial functions; a single roadway classification could not describe this range of functions. Therefore, all one way roads in the MTPM are coded to match intended function.

New to FSUTMS is facility type 8 which represents HOV facilities. The 1990 base year network does not include any HOV facilities, but most future year MTPM networks, including the existing plus committed (E+C), do. Therefore, included in the validated SPDCAP file are entries for this new facility type. As a rule, a facility type 8 roadway has the same input capacity as facility type 1 (expressway/freeway), but with slightly higher speeds.

4.3 Summary

The MTPM is the single most complex urban area model in the State of Florida. Containing over 8,000 highway links and 5,400 nodes, the Miami highway network accurately describes the characteristics of the transportation system elements that affect the majority of all surface travel demand. The topography of the simulated network, in concert with the input highway speeds and capacities, provides an accurate simulation of the highway traffic volumes estimated by later modeling steps.

MIAMI TRANSPORTATION PLANNING MODEL
Table 4.4 Highway Lane Miles

	CBD	Fringe	Residential	OBD	Rural	Total
Freeway	5	65	500	145	100	815
Divided Arterial	7	29	872	697	78	1,682
Undiv. Arterial	24	48	721	289	258	1,341
Collector	11	22	579	132	173	918
TOTAL	47	165	2,672	1,264	608	4,756

MIAMI TRANSPORTATION PLANNING MODEL
Table 4.5 Number of Links By Facility Type and by Area Type

	CBD	Fringe	Residential	OBD	Rural	Total
Freeway	28	131	554	209	61	983
Divided Arterial	13	46	755	642	49	1,505
Undiv. Arterial	122	136	922	405	199	1,784
Collector		85	894	201	163	1,343
TOTAL	163	398	3,125	1,457	472	5,615

MIAMI TRANSPORTATION PLANNING MODEL
Table 4.6 Number of Links by Facility Type and by Number of Lanes

	NUMBER OF LANES									
	1	2	3	4	5	6	7	8	9+	TOTAL
Freeway	337	256	180	158	49	3	0	0	0	983
Divided Arterial	74	104	15	953	4	345	0	10	0	1,505
Undiv. Arterial	34	983	188	544	2	24	0	9	0	1,784
Collector	38	1,202	11	168	0	3	0	0	0	1,422
TOTAL	483	2,545	394	1,823	55	375	0	19	0	5,694

CHAPTER 5
HIGHWAY PATHS

5.0 Introduction

As presented in **Figure 5.1**, the fourth module in the FSUTMS model chain is interzonal highway path isolation (HPATH). The HPATH module identifies the minimum uncongested travel time path between every pair of zones in the highway network for use in modules later in the model chain. This is the first place in the model chain that the concept of impedance is applied. Path selection is important to the modeling process as it has a significant impact on the final distribution of trips generated by the GEN step of the model.

Though the standard FSUTMS path building module has not been replaced for the 1990 Miami model, it has been augmented. Newly introduced to the 1990 Miami Transportation Planning Model (MTPM) FSUTMS model chain, is the differentiation of low occupancy vehicle (LOV) and high occupancy vehicle (HOV) travel paths. Separate LOV and HOV paths are built for later use in the mode choice model.

5.1 Low Occupancy Vehicle (LOV) Highway Path Determination

Paths in FSUTMS are determined using a vine building algorithm. Vine building algorithms are one method of determining minimum paths and are intended to assure that paths are built in such a way that any impedance variables introduced as significant in the model are considered. In the 1990 MTPM model, three variables are considered to determine the minimum path between any given pair of zones. These variables are:

❶ in-vehicle travel time,

❷ prohibited and penalized movements, and

❸ toll cost and service time.

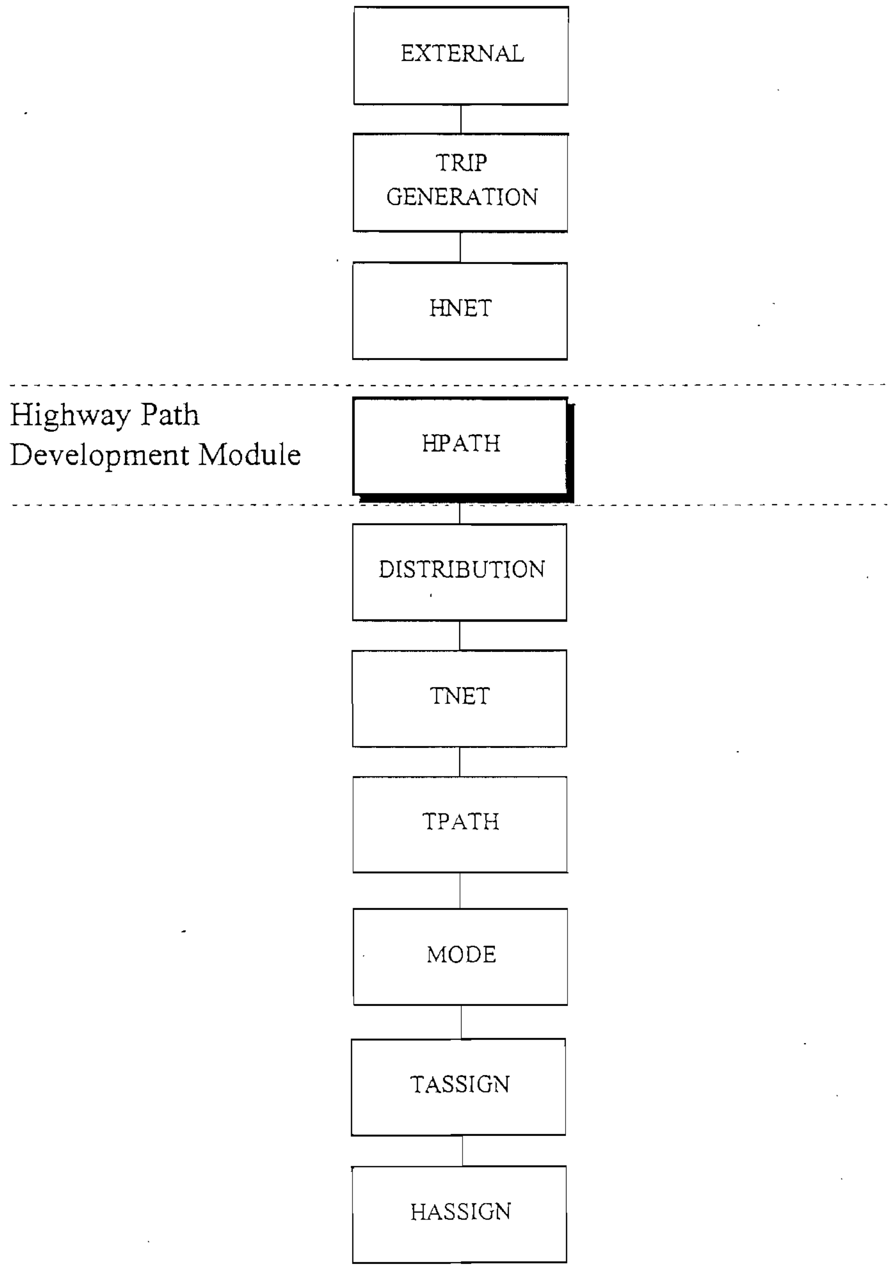


Figure 5.1 Position of Highway Path Development in FSUTMS Model Chain

5.1.1 In-Vehicle Travel Time

During highway network construction, all highway links are assigned travel time. This is determined as a function of distance (calculated by the HNET program) and input speed as developed in the SPDCAP file. If no other variables are introduced, the minimum path between a pair of zones is developed based strictly on this criteria.

5.1.2 Turn Prohibitions and Penalties

During the highway network development phase of the validation process, movements which are legally prohibited or extremely difficult are identified for inclusion in the turn penalties/prohibitors FSUTMS input file TCARDS.90A. The 1990 MTPM model includes 173 such prohibitors. These prohibitors are included, for the most part, on freeway links and prohibit illegal U-turns, left turns, or illogical movements.

Time penalties are introduced to a highway network for two reasons. They can represent movements which are unusually difficult such as left turns where no signal exists. These type penalties are minimized during model validation as they are difficult to assign when developing future year highway network scenarios for forecasting. A second use of time penalties is to reflect psychological impediments to travel. Examples of such impediments include large bodies of water or large stretches of undeveloped, rural land use. The 1990 MTPM model employs 14 such penalties all of which are on bridges crossing Biscayne Bay. **Table 5.1** lists the penalties used in the 1990 network along with their locations. No penalty is less than 2 nor more than 5 minutes. These penalties serve to estimate the perceived additional "distance" between the beaches and the mainland.

A tertiary use for turn prohibitors is currently being examined. It has been noted that the introduction of HOV facilities into a network may result in assignment of trips to HOV facilities which would not ordinarily use it. Examples include trips that use an expressway for one or two interchanges only. The difficulty in weaving across three lanes of traffic to get to an HOV lane and then weaving back across three lanes to exit the facility for a short distance on the roadway

MIAMI TRANSPORTATION PLANNING MODEL

Table 5.1 Turn Penalties

Description	From Node	Through Node	To Node	Penalty (minutes)
Tuttle Causeway Eastbound	3457	1572	1574	2
Tuttle Causeway Westbound	1574	1572	3457	2
Venetian Causeway Eastbound	3973	1543	1544	5
Venetian Causeway Westbound	1544	1543	3973	5
North Bay Causeway (W. of North Bay Island) Eastbound	3069	1608	1609	2
North Bay Causeway (W. of North Bay Island) Westbound	1609	1608	3069	2
Broad Causeway Eastbound	3974	1636	1637	2
Broad Causeway Westbound	1637	1636	3974	2
Sunny Isles Causeway Eastbound	2350	2351	2352	2
Sunny Isles Causeway Westbound	2352	2351	2350	2
192nd Street Causeway Eastbound	2207	1656	1657	2
192nd Street Causeway Westbound	1657	1656	2207	2
North Bay Causeway (W. of Normandy Island) Westbound	1619	1618	1616	5
North Bay Causeway (W. of Normandy Island) Eastbound	1617	1618	1619	5

would discourage many potential HOV users from switching from the general use lane. The introduction of a time penalty on the entrance and/or exit ramp to the HOV facility can suppress the assignment of trips to the HOV facility unless they will remain on the facility for sufficient distance to overcome the time imposed by a penalty. This is because the model assigns trips to the minimum travel time path between a pair of zones.

Caution should be employed when using this approach however. Detailed analyses of average trip length of HOV users should be understood and evaluated prior to implementing time penalties on such facilities. Because HOV lanes often parallel freeway/expressway facilities, exaggerating the travel time costs to HOV users must be used in concert with a detailed calibration of corresponding speeds or gross over/underestimates of travel demand may result.

5.1.3 Toll Impedance

To this point in the path determination process, the only consideration in determining path is in vehicle travel time as constrained by available (non-prohibited) movements. For urbanized areas such as Miami, however, travel time alone is not a sufficient measure of impedance between a pair of zones. When a path contains a toll facility, travelers may not be willing to pay the cost of the toll. To replicate this phenomenon, identified toll links in the highway network have a set of attributes. These include cost, number of toll collection lanes, and service time. The toll facilities model converts dollars, or units of toll, to equivalent units of time. In the Miami network, there are 29 identified toll collection facilities. Most of these are located on Florida Turnpike operated facilities. Toll costs are converted to travel time and factored by a parameter called a CTOLL. In the 1990 MTPM the value of CTOLL is .06.

Service times and monetary costs for the toll facility are converted to travel time, and this value is added to the regular travel time for toll links, based upon their speeds. The 1990 MTPM toll link characteristics are presented in **Table 5.2**. At this point in the process, a single composite measure of impedance, represented by adjusted travel time, can be used to determine the minimum path between all pairs of zones.

MIAMI TRANSPORTATION PLANNING MODEL
Table 5.2 Toll Links

Description	A Node	B Node	Toll Booths	Toll
Eastbound Airport Expressway	4202	2002	6	$0.25
Eastbound Dolphin Expressway	1988	1989	10	$0.25
Eastbound Broad Causeway	1982	1947	4	$0.25
Westbound Broad Causeway	1981	1946	4	$0.25
Eastbound Rickenbacker Causeway	1984	1943	4	$1.00
Eastbound Venetian Causeway	1986	1945	4	$0.35
Westbound Venetian Causeway	1985	1944	4	$0.35
Northbound Don Shula Expressway	1956	1957	9	$0.50
Southbound Don Shula Expressway	1959	1958	9	$0.50
Northbound HEFT Homestead Barrier	1953	1952	7	$0.75
Southbound HEFT Homestead Barrier	1954	1955	7	$0.75
Northbound HEFT Kendall Dr Off Ramp	1961	3992	2	$0.25
Southbound HEFT Kendall Dr On Ramp	3990	1960	2	$0.25
Northbound HEFT Tamiami Barrier	1967	1966	9	$0.75
Southbound HEFT Tamiami Barrier	1964	1965	9	$0.75
Northbound HEFT U.S. 41 On Ramp	3987	1963	2	$0.25
Southbound HEFT U.S. 41 Off Ramp	1962	3983	2	$0.25
Northbound HEFT Okeechobee Barrier	2705	2468	5	$0.75
Southbound HEFT Okeechobee Barrier	1921	1905	5	$0.75
Eastbound HEFT NW 27TH AV. Off Ramp	1970	1971	3	$0.25
Westbound HEFT NW 27TH AV. On Ramp	1968	1969	3	$0.25
Westbound HEFT NW 27TH AV. Off Ramp	1973	1972	5	$0.50
Eastbound HEFT Miramar Barrier	1976	1977	3	$0.50
Westbound HEFT Miramar Barrier	1975	1974	5	$0.50
Northbound Turnpike County Line Road On Ramp	3978	1978	1	$0.50
Northbound Turnpike Golden Glades Barrier	1979	2166	6	$0.75
Southbound Turnpike Golden Glades Barrier	1941	1980	6	$0.75
Northbound Turnpike Allapattah Road Off Ramp	1891	1892	2	$0.50
Southbound Turnpike Allapattah Road On Ramp	1922	1948	2	$0.50

One last consideration is included in the LOV path building process, however. Because the highway network may contain HOV lanes which are not available for LOV travel, HOV links are temporarily removed from eligibility for travel. At this point LOV paths are computed and travel times between zonal pairs can be computed.

5.2 High Occupancy Vehicle Highway Path Determination

Minimum travel paths for HOV travelers follow the same process of travel time computation outlined above, except that HOV facilities are not removed from consideration. For zonal pairs that can realize a travel time savings by using HOV facilities, paths are calculated that use these facilities.

5.3 Summary

Highway paths are built based on travel time, travel cost and available paths functioning to calculate the path of least impedance. New to the MTPM, separate paths for LOV and HOV travel are developed for input into the mode choice modules. These paths are key to the distribution of trips and permit detailed measures of network attributes such as speed and cost.

Path development is one of the most critical components of the FSUTMS model stream. Paths not only proscribe the roadways and mode to which trips are assigned, they also provide input into mode choice and transit speed programs. As such, care should be used when developing parameters, such as turn penalties and turn prohibitors, which act to modify the paths selected by FSUTMS. Similarly, a thorough understanding of the dynamic of a particular facility or type of facility (such as HOV) , can allow the user to modify the path development process to yield paths which closely reflect what drivers perceive as the minimum path between zonal pairs.

CHAPTER 6
TRIP DISTRIBUTION

6.0 Introduction

As presented in **Figure 6.1**, the fifth module in the FSUTMS model chain is trip distribution (DISTRIB). In multi-path, multi-period models, such as the 1990 Miami Transportation Planning Model (MTPM), the DISTRIB module serves primarily to create the person trip tables for all trip purposes. However, it also performs many additional functions, including computation of intrazonal and terminal times, pre-loading of the highway network, and development of congested travel time skims.

6.1 Final Free Flow Time Skim Determination

Based on the interzonal highway path calculations outlined in the previous chapter, in-vehicle interzonal travel time can be determined for trips between any pair of zones. However two additional measures of time must be developed prior to trip distribution: intrazonal travel time and out-of-vehicle travel time (terminal time).

6.1.1 Intrazonal Travel Time

Intrazonal travel time is the time it takes for a trip between two sites within the same zone. Little information is available for intrazonal travel times, but it is reasonable to assume that they are lower than times computed for traveling to another zone. FSUTMS estimates intrazonal travel time based upon the Nearest Neighbor Theory. The theory states that intrazonal travel time is a proportion of the amount of time it takes to get to the nearest adjacent zone or zones. The MTPM assumes that intrazonal travel time is equal to the following:

$$IZ_i = \frac{IVTT_a}{2}$$

where:
IZ_i = intrazonal travel time for zone i, and $IVTT_a$ = in vehicle travel time to nearest adjacent zone.

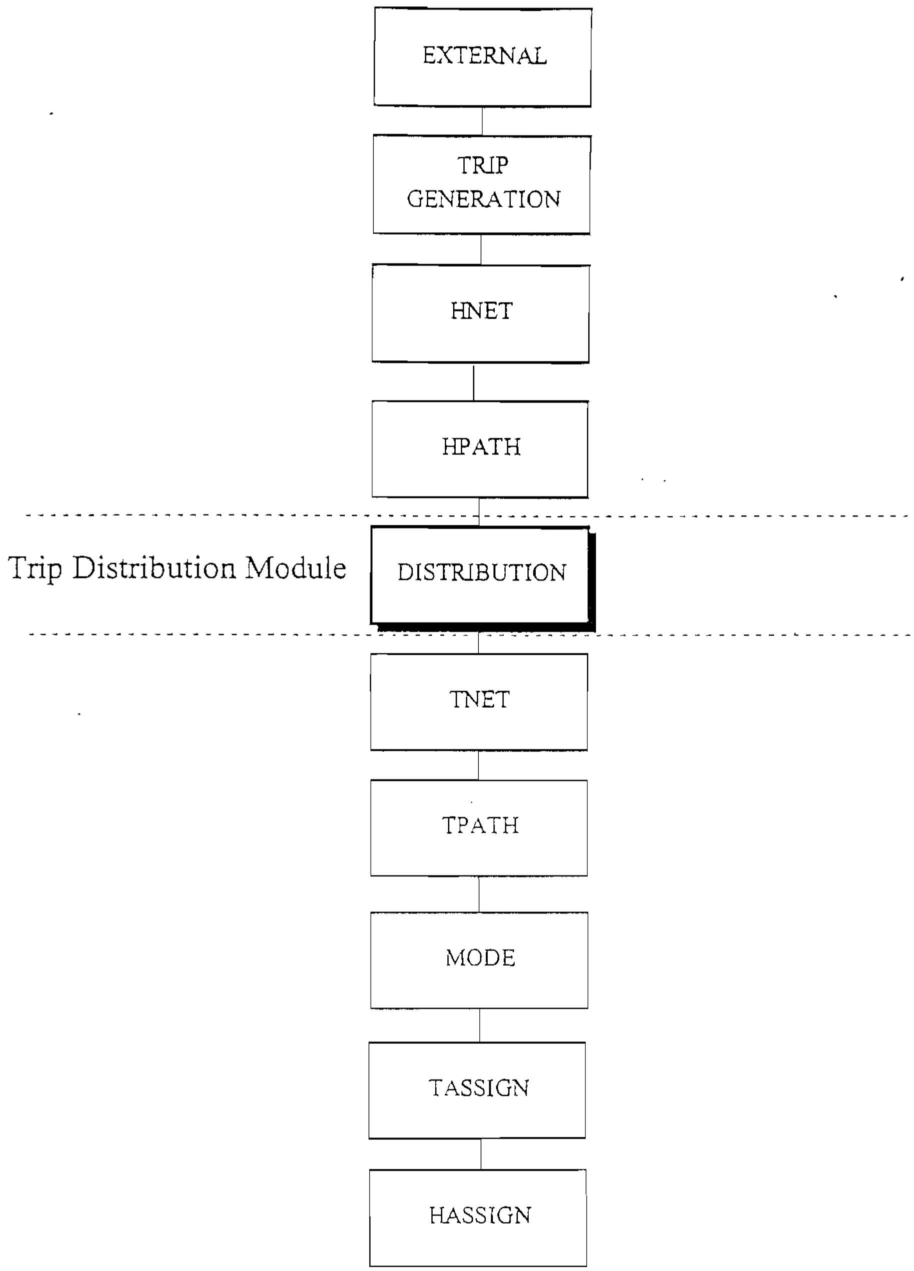


Figure 6.1 Position of the Distribution Module in the FSUTMS Model Stream

6.1.2 Terminal Times

Terminal times are the average times required to either get to a vehicle from a house or other structure, and go from the driveway or parking facility to the street at the origin (production) end of the trip, or the average time required to park the vehicle and reach the final destination point at the destination (attraction) end of the trips. Terminal time varies according to the area type in which a zone is located. The values applied for terminal times in the 1990 MTPM model are as follows:

1. CBD, 5 Minutes.
2. CBD Fringe, 2 Minutes.
3. Residential, 1 Minute.
4. Outlying Business District, 3 Minutes.
5. Rural, 1 Minute.

Terminal times are added to the interzonal in-vehicle travel time for both the origin and destination end of a trip, resulting in total travel time between a pair of zones. After these times have been calculated, they are added to the travel times calculated by the HPATH module. The resulting travel times are ready for input into the gravity model.

6.2 Trip Distribution Model

Trip distribution is the "matching up" of trip productions with trip attractions. In FSUTMS this is accomplished through the use of a gravity model. The FSUTMS gravity model is an adaptation of the classic Newtonian model and is mathematically expressed as:

$$T_{ij} = P_i \frac{A_j \; F_{ij} \; K_{ij}}{\sum_{j=1}^{n} A_j \; F_{ij} \; K_{ij}}$$

where:
T_{ij} = trip produced in zone i and attracted to zone j;
P_i = total trip production at i;
A_j = total trip attraction at j;
F_{ij} = friction factor for trip interchange ij;
K_{ij} = socioeconomic adjustment factor for interchange ij;
i = origin zone number, $i = 1,2,3 \ldots n$;
j = destination zone number $j = 1,2,3 \ldots n$;
n = number of zones.

The gravity distribution model is based on the concept that the desirability of traveling to a particular zone is directly related to the amount of activity in each potential destination zone, and inversely related to the perceived spatial separation (the highway impedance) between the production and the attraction zones. This spatial separation is measured in terms of travel time. The inverse relationship to highway impedance is not linear and is modified by friction factors. The friction factor is an exponent of highway impedance analogous to the square of the distance that appears in the formula for the gravity model equation.

The trip distribution validation procedure is an iterative process, where a set of travel time factors is developed for each trip purpose. For the MTPM, only friction factors were employed. K-factors, or socioeconomic adjustment factors were considered, but were not used due to the reasonable aggregate performance of the gravity model with friction factors alone. **Table 6.1** presents the final friction factors developed for the 1990 MTPM.

6.2.1 Home-Based Work Trip Distribution

In many ways, the distribution of home-based work trips is the most important in the transportation modeling process. It is the largest single purpose for which trips are made. It is the purpose which usually determines peak-hour usage, and is often the trip for which facilities are designed. Fortunately, it is also the purpose about which most data are collected.

MIAMI TRANSPORTATION PLANNING MODEL

Table 6.1 Final Friction Factor Set

Time	HBW	HBSH	HBSR	HBO	NHB	TRUCK /TAXI
1	939180	923732	999945	999884	999201	999735
2	856783	826139	902589	894790	912900	911068
3	774386	728547	805234	789698	826599	822400
4	536427	640954	707878	684605	740297	733733
5	428175	563361	6e+05	579512	693997	665066
6	406244	485768	513166	474418	667696	576398
7	294855	408176	415810	369325	551395	467731
8	231231	320583	318455	264232	475093	379063
9	190472	252990	221099	159139	358791	290396
10	162004	155098	159610	107363	287390	220315
11	124782	95646	117425	74221	174616	169230
12	103069	74884	87970	52524	110186	131558
13	92012	55804	67054	38013	95420	103468
14	75821	31982	51963	28107	86721	82294
15	71939	19523	40905	21211	79242	66166
16	63588	12388	32683	16322	71656	53759
17	59007	8280	26484	12793	65000	41120
18	51185	7008	21747	10205	59568	33563
19	46454	3516	18081	8275	52840	30583
20	41748	2632	15210	6815	46427	25810
21	38375	1939	12934	5695	38038	21969
22	34775	1257	11109	4824	33552	18853
23	31405	930	9630	4138	28500	16304
24	30033	817	8418	3590	22054	14205
25	26585	790	7415	3148	18012	12463
26	23779	728	6576	2787	17297	11007
27	21090	656	5867	2489	15846	9782
28	19901	623	5261	2240	13611	8745
29	18478	599	4739	2029	11554	7860
30	16378	580	4284	1848	10143	7100
31	15206	479	3882	1692	9553	6445
32	13944	394	3526	1554	8904	5874
33	13236	320	3205	1431	7859	5376
34	12092	256	2915	1320	6826	4937
35	10627	200	2649	1219	4752	4549
36	10502	150	2405	1125	3629	4202
37	10098	105	2178	1037	2549	3891
38	8977	85	1967	954	1505	3611
39	8575	68	1770	874	982	3356
40	8493	54	1586	798	856	3123
41	6865	42	1413	725	623	2908
42	5754	32	1251	654	499	2710
43	5150	24	1100	586	373	2525
44	5076	18	959	521	361	2352
45	4929	12	830	459	283	2190
46	4875	8	711	400	275	2036
47	4572	5	603	345	238	1891
48	4397	0	506	294	190	1752
49	4208	0	419	247	170	1621
50	4032	0	343	205	158	1495
51	3922	0	277	167	133	1374
52	3831	0	221	134	124	1260
53	3720	0	173	106	103	1150
54	3593	0	133	82	97	1046
55	3438	0	101	63	78	947
56	3425	0	76	47	66	853
57	3291	0	55	34	59	764
58	3224	0	40	24	49	680
59	3155	0	28	17	36	603
60	2983	0	19	12	29	530
61	2954	0	13	8	18	463
62	2892	0	9	5	14	402
63	2658	0	6	3	8	346
64	2574	0	4	2	3	295
65	2297	0	2	1	2	250
66	2284	0	1	1	1	210
67	2280	0	1	1	1	175
68	2154	0	1	1	1	144
69	2008	0	1	1	1	117
70	1945	0	1	1	1	95

During the MTPM validation process, an important data set became available upon which to estimate the home-based work trip distribution, the Census Transportation Planning Package (CTPP). The CTPP is a subset of the 1990 Census of Population and Housing prepared by the Department of Commerce, Bureau of the Census. Approximately one in eight households in Dade County received the form as part of their 1990 census package. In it, questions were asked which identified a person's TAZ of residence and employment. From this information, an estimate of home-based work trip distribution can be developed and is the foundation for the validation of the home-based work friction factor set.

6.2.1.1 CTPP Observed Home-Based Work Travel Patterns

The 1990 CTPP data set identifies over 60,000 pairs of home zone to work zone combinations for all modes of travel for residents of Dade County. With the application of a few simple assumptions, these data provide the basis for estimating worker travel between all pairs of zones. Remembering that the CTPP only identifies the home zone and work zone of workers, the following assumptions are necessary to estimate work trip travel flows:

1. For the home-to-work trip, the origin zone is the home TAZ and the destination zone is the work TAZ identified in the CTPP.
2. For the work to home trip, the origin zone is the work zone and the destination zone is the residence zone identified in the CTPP.
3. After excluding vacation and sick time, approximately 9 out of 10 workers will make a work trip on any given weekday.

Given these assumptions, the process to develop a FSUTMS equivalent HBW trip table is as follows:

1. Build a FSUTMS/TRANPLAN trip table based on the BUILD TRIP TABLE function.
2. Create a new trip table by transposing the previously built trip table.
3. Add the trip tables created by steps 1 and 2 together.
4. Factor the resulting trip table by 0.9.

The result of this process is an estimate of all home-based work trips that can be derived from the CTPP. From this table, a wealth of data can be inferred, including the geographic distribution of home-based work trips. This is the output of the gravity model and is one goal of validation.

6.2.1.2 HBW Distribution Model Calibration

Once the HBW trip table, based on the CTPP work travel flows is developed, the process of validating the travel time trip length frequency distribution is relatively simple. To validate the gravity model to the CTPP observed distribution, the CTPP table is analyzed against the free flow travel times derived from the travel time skims developed in the beginning of the distribution module. The output of this step is a trip length frequency distribution for CTPP estimated trips.

Next, an initial run of the gravity model is required using trips estimated by the generation model and distributed based on a trial set of friction factors. One of the outputs of the gravity model process is the trip length frequency distribution for home-based work trips. At this point, the two trip length frequency distributions are compared. To calibrate the gravity model to replicate the CTPP observed trip length frequency distribution, friction factors are adjusted via an iterative process based on the following formula:

$$F_n = F_{n-1} \frac{PW_o}{PW_e}$$

where:
F_n = Friction Factor for iteration n
PW_o = Observed percent of work trips at that minute of travel time
PW_e = Estimated percent of work trips at that minute of travel time

During the validation of the HBW trip distribution model, the 1990 MTPM required three passes through this calibration process before it approximated the observed CTPP distribution. Figure 6.2 compares the observed CTPP temporal trip distribution with the 1990 MTPM estimated distribution. As observed in **Figure 6.2**, the 1990 model replicates the shape and pattern of the CTPP. The average uncongested travel time for work trips is 17 minutes with a standard deviation of 10 minutes. Once the trip length frequency distribution of trips mimicked the CTPP, the geographical distribution was measured.

To determine how well the gravity model replicates CTPP observed travel patterns, every origin zone to destination zone trip can be measured for accuracy. However, there are over 1.4 million possible origin zone/destination zone combinations. To make the comparison more reasonable and to overcome possible errors associated with any one cell in the matrix, six planning areas were identified in the Miami Urbanized area. These districts were developed by Metro Dade MPO staff and permit a reasonable evaluation of thirty-six cells for home-based work travel to and from the major areas of Dade County. **Figure 6.3** identifies the six planning areas identified by the MPO.

Table 6.2 presents the planning area to planning area travel summaries for home-based work trips based on the CTPP and estimated from the trip distribution model. Differences in the absolute number of total trips from the two estimates are due to a lack of CTPP information regarding employees with more than one job and transient employment. These trips are accounted for in the model estimate and suggest the primary cause for the totals to disagree. To account for these differences, the lower two tables convert the upper tables from absolute values to percentages. Apparent from the tables is the high degree of correlation between the observed geographic distribution of trips and the simulated distribution. In both cases, the work trips beginning and ending in District 1 are the most common. On the whole, the observed and estimated proportions of trips beginning and ending in the same district are the largest movements. For extra-district travel demand, the combinations of 1-2, 5-1, 2-1, 3-1 and 5-3 are the most frequent travel patterns.

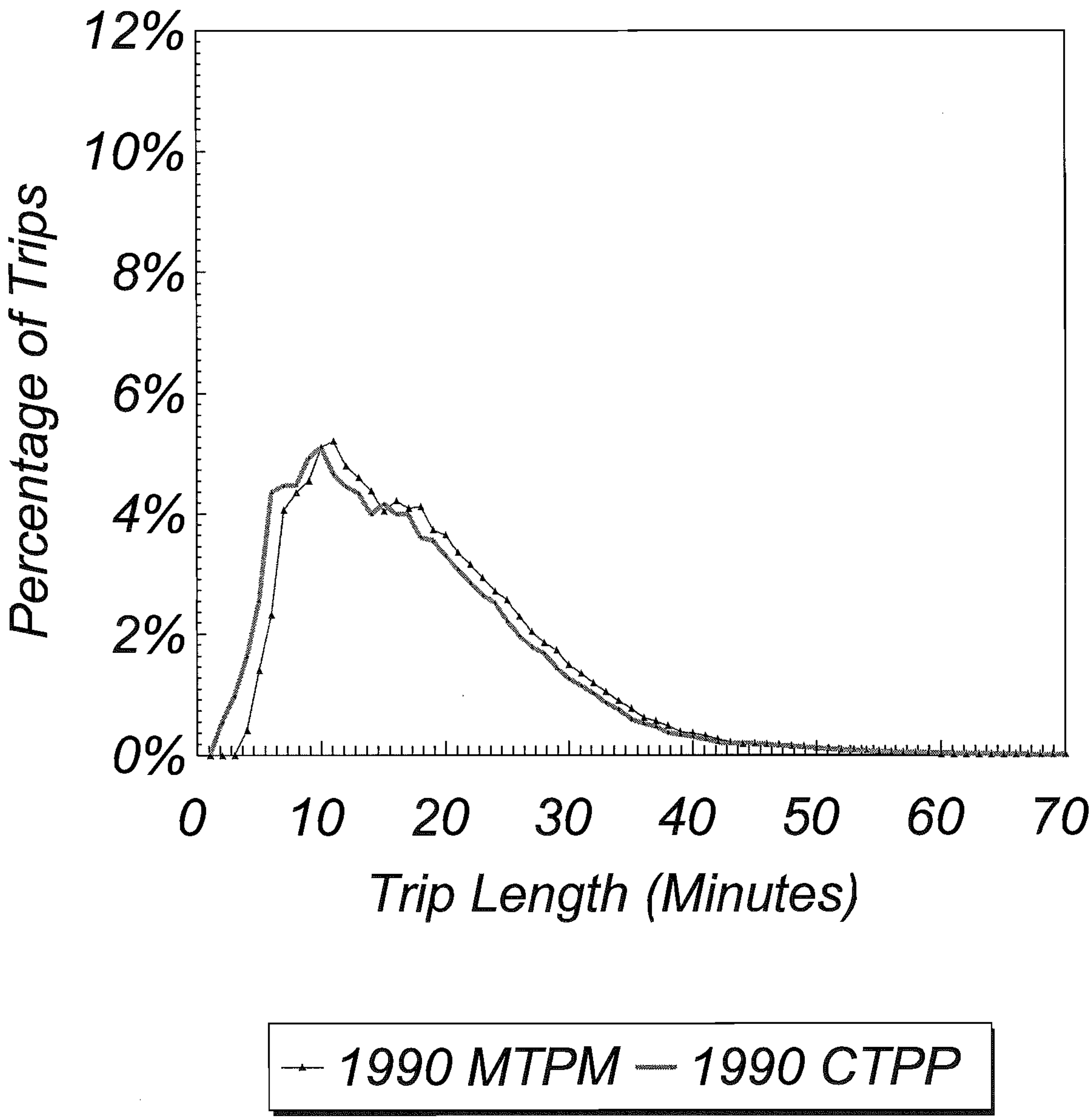


Figure 6.2 1990 CTPP/MTPM Travel Time Trip Length Frequency Comparison

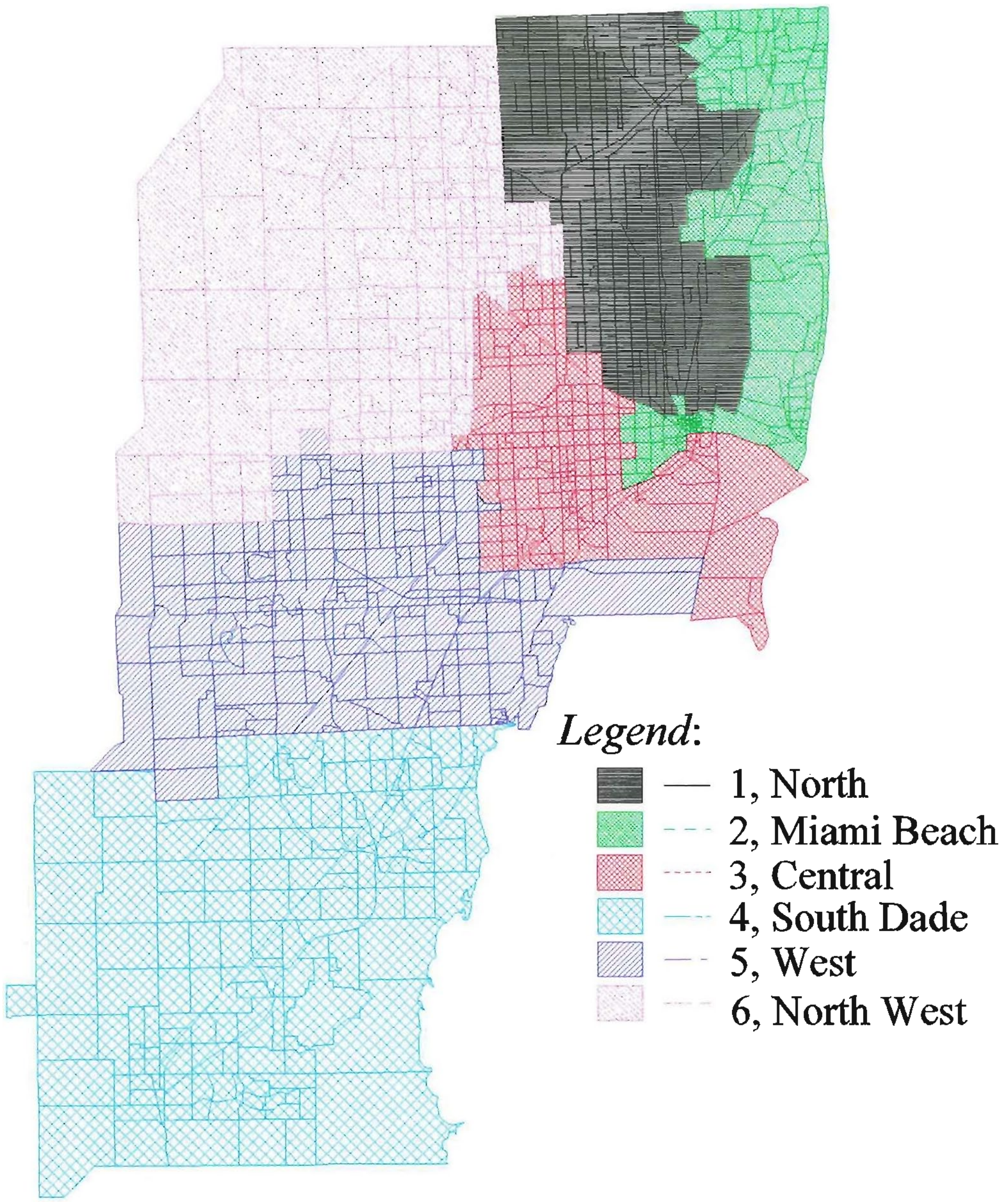


Figure 6.3 MTPM Planning Areas

MIAMI TRANSPORTATION PLANNING MODEL
Table 6.2 Estimated Vs Observed Home based Work Internal Trips By Planning Area

Observed (1990 CTPP)

	1	2	3	4	5	6	Total
1	120000	59900	55500	14100	33100	47900	338500
2	59900	90100	35000	8600	23600	19900	237100
3	55500	35000	92600	21800	59300	46200	310400
4	14100	8600	21800	59500	19400	10500	133900
5	33100	23600	59300	19400	65200	27400	228000
6	47900	19900	46200	10500	27400	83100	235000
Total	338500	237100	310400	133900	228000	235000	1482900

Percent of Table

	1	2	3	4	5	6	Total
1	8.63%	4.04%	3.74%	0.95%	2.23%	3.23%	22.83%
2	4.04%	6.08%	2.36%	0.58%	1.59%	1.34%	15.99%
3	3.74%	2.36%	6.25%	1.47%	4.00%	3.12%	20.93%
4	0.95%	0.58%	1.47%	4.01%	1.31%	0.71%	9.03%
5	2.23%	1.59%	4.00%	1.31%	4.40%	1.85%	15.38%
6	3.23%	1.34%	3.12%	0.71%	1.85%	5.60%	15.85%
Total	22.83%	15.99%	20.94%	9.03%	15.38%	15.85%	100.00%

Estimated (1990 MTPM)

	1	2	3	4	5	6	Total
1	147000	75500	49300	8300	19500	52700	352300
2	75500	107300	40800	9200	19800	24300	276900
3	49300	40800	92900	15600	47700	42600	288900
4	8300	9200	15600	74300	29100	12500	149000
5	19500	19800	47700	29100	88400	43200	247700
6	52700	24300	42600	12500	43200	100900	276200
Total	352300	276900	288900	149000	247700	276200	1591000

Percent of Table

	1	2	3	4	5	6	Total
1	9.24%	4.75%	3.10%	0.52%	1.23%	3.31%	22.14%
2	4.75%	6.74%	2.56%	0.58%	1.24%	1.53%	17.40%
3	3.10%	2.56%	5.84%	0.98%	3.00%	2.68%	18.16%
4	0.52%	0.58%	0.98%	4.67%	1.83%	0.79%	9.37%
5	1.23%	1.24%	3.00%	1.83%	5.56%	2.72%	15.57%
6	3.31%	1.53%	2.68%	0.79%	2.72%	6.34%	17.36%
Total	22.14%	17.40%	18.16%	9.37%	15.57%	17.36%	100.00%

In addition to mimicking cell-by-cell travel demand patterns, comparisons of row totals in the two tables also compare favorably. No estimated row total is off by more than three percent. This reinforces the accuracy of both the home-based work trip generation and distribution models. From this distribution, District 1, representing north central Miami along the I-95 corridor, accounts for the single largest number of trips, while District 4, representing southern Dade County, accounts for the least.

Evaluation of the home-based work trip distribution at the planning area level suggests that the standard FSUTMS gravity model specification replicates the observed geographic distribution of trips without the inclusion of K-factors. CTPP home-based work travel patterns are replicated with a high degree of accuracy.

6.2.2 Home-Based Shopping Trip Distribution

Unfortunately, for all the non-work trips, very little data exist to support their distribution. The best distribution information by purpose is relative to home-based work. On the whole, it is expected that home-based shopping trips are shorter in duration than home-based work trips. Additionally, these trips should have a much smaller variance, or deviation, from the mean travel time than work trips. The MTPM mean travel time for home-based shopping trips is 11 minutes with a standard deviation of 5 minutes. This is shorter than those of work trips. **Figure 6.4** presents the home-based shopping trip length frequency distribution.

6.2.3 Home-Based Social/Recreation Trip Distribution

Similar to the home-based shopping purpose, very little information exists regarding home-based social/recreation trip distribution in Dade County. As urban development patterns and transportation infrastructure are unique to each urban area, trip length frequency distributions are unique to each urbanized area as well. On the whole, it is expected that, like home-based shopping trips, home-based social/recreation trips are shorter in duration than home-based work trips. However, they should be longer than general shopping trips. Additionally, these trips should have a much smaller variance or deviation from the mean travel time than work. The 1990 MTPM mean

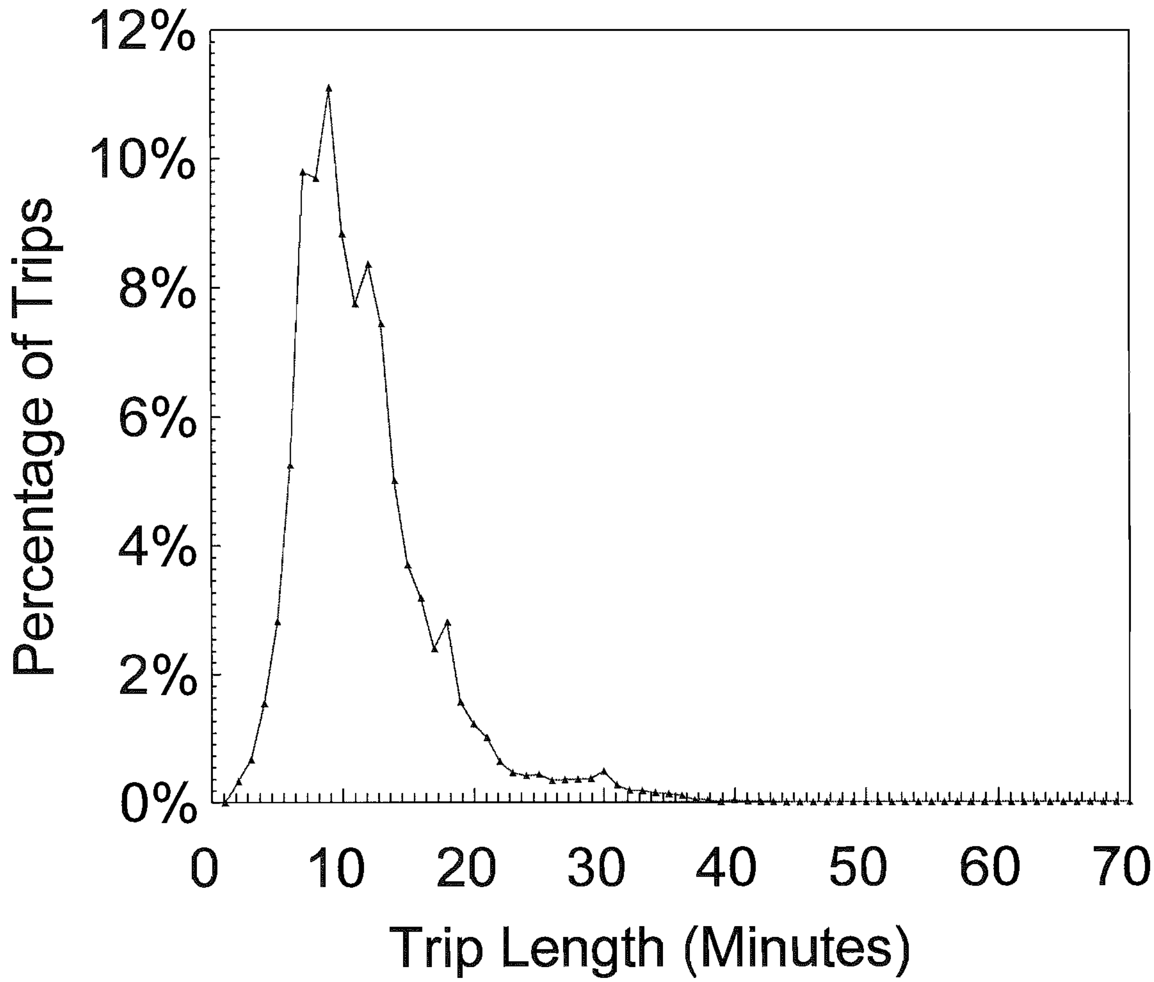


Figure 6.4 1990 MTPM Home-Based Shopping Travel Time Trip Length Frequency

uncongested travel time for home-based social/recreation trips is 14 minutes with a standard deviation of 8 minutes. As expected, the mean trip length for these trips is indeed shorter than that of work trips. **Figure 6.5** presents the 1990 MTPM home-based social/recreation trip length frequency distribution.

6.2.4 Home-Based Other Trip Distribution

Home-based other trips represent the third largest number of trips generated in the 1990 model, only exceeded by home-based work and non-home based trips. The 1990 MTPM mean travel time for home-based other trips is 12 minutes with a standard deviation of 8 minutes. As expected, this travel time is shorter than that of work trips. **Figure 6.6** presents the home-based other trip length frequency distribution as estimated by the 1990 MTPM.

6.2.5 Non-Home-Based Trip Distribution

Non-home-based trips represent the largest number of trips generated in the 1990 model. The 1990 MTPM mean travel time for non-home-based trips is 12 minutes with a standard deviation of 7 minutes. As expected, this travel time is shorter than that of work trips. **Figure 6.7** presents the non-home-based trip length frequency distribution.

6.2.6 Truck/Taxi Trip Distribution

Truck/taxi trips are estimated to account for over 700 thousand daily trips. The mean travel time for these trips is 12 minutes with a standard deviation of 7 minutes. As is typical for most transportation models in Florida, this purpose has one of the lowest average travel times. **Figure 6.8** presents the trip length frequency distribution as estimated by the 1990 MTPM.

6.2.7 External to Internal Trip Distribution

As stated in *Chapter 2, External Trips,* the standard distribution of external trips as calculated by the gravity model is replaced with the distribution of external trips downloaded from the SERPM-2 model. The use of the SERPM-2 distribution allows the model to replicate I-E as well as the standard E-I trip productions.

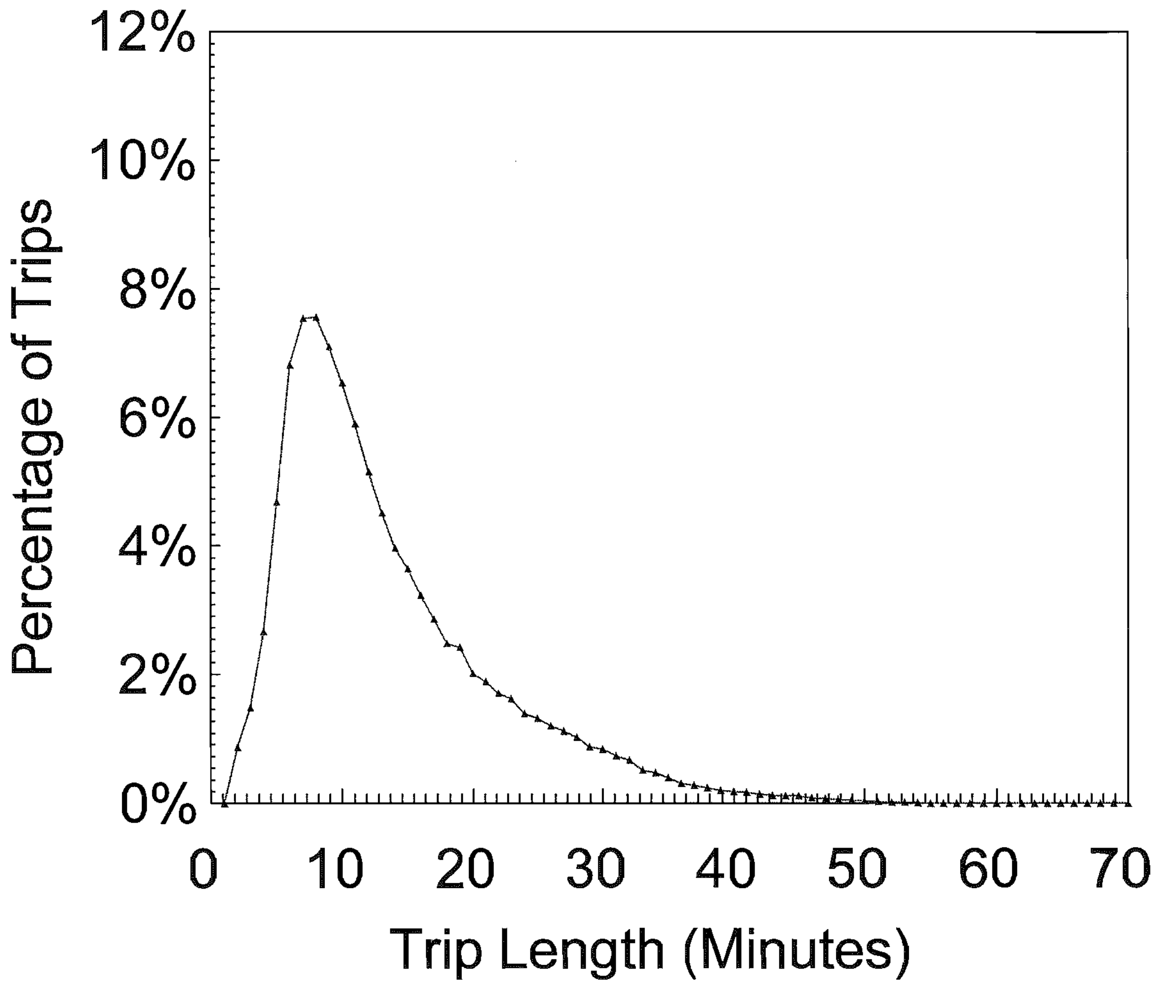


Figure 6.5 1990 MTPM Home-Based Social/Recreation Travel Time Trip Length Frequency

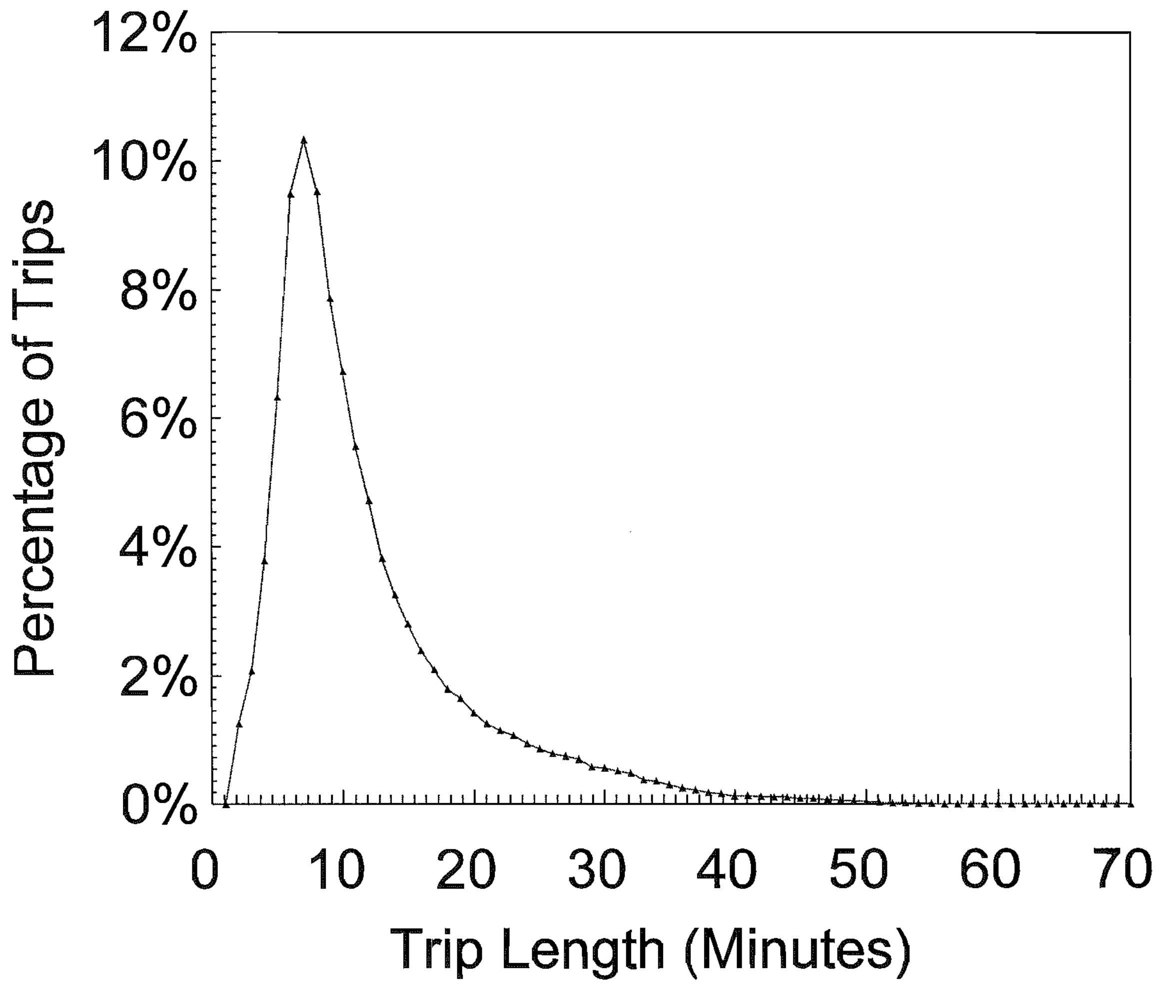


Figure 6.6 1990 MTPM Home-Based Other Travel Time Trip Length Frequency

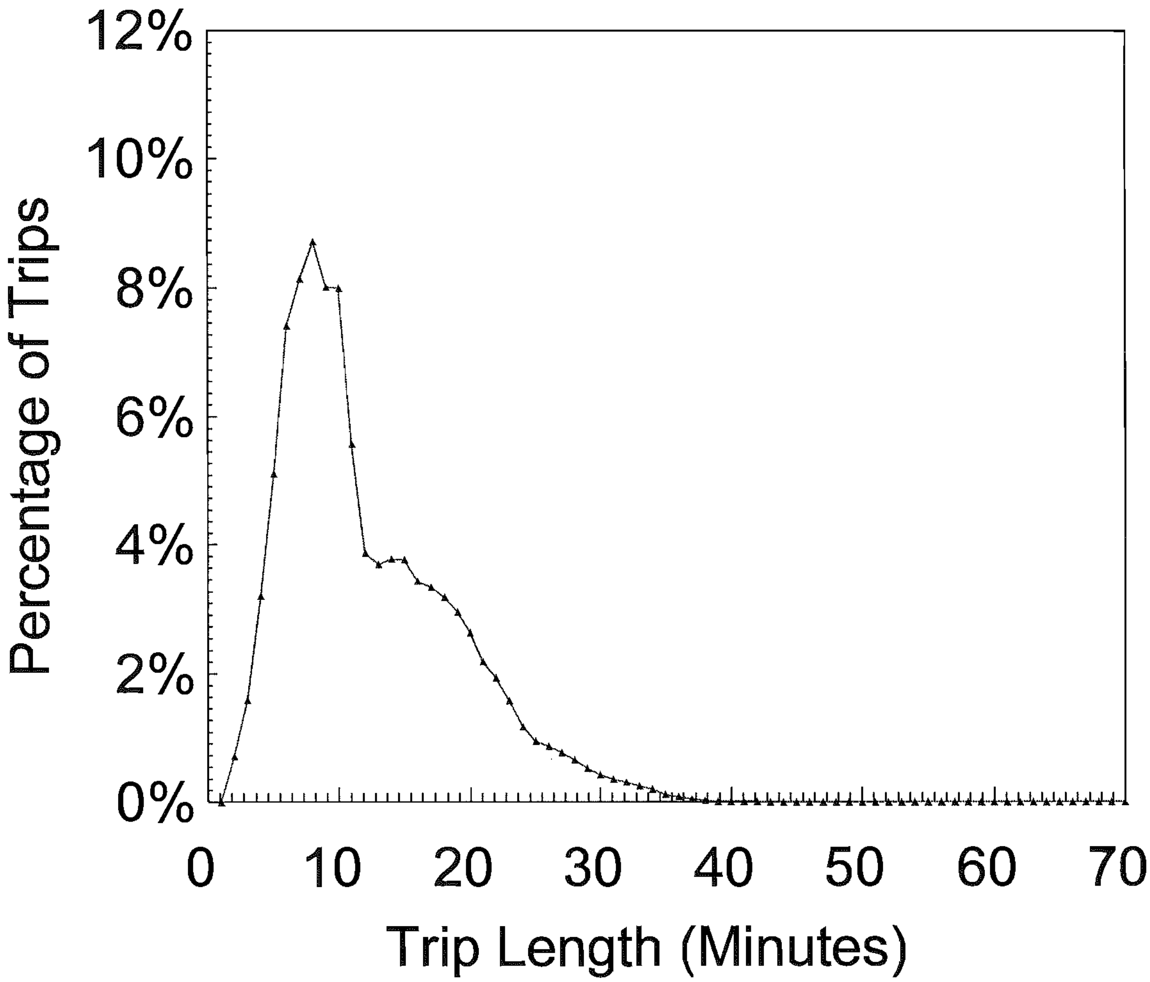


Figure 6.7 1990 MTPM Non-Home Based Travel Time Trip Length Frequency

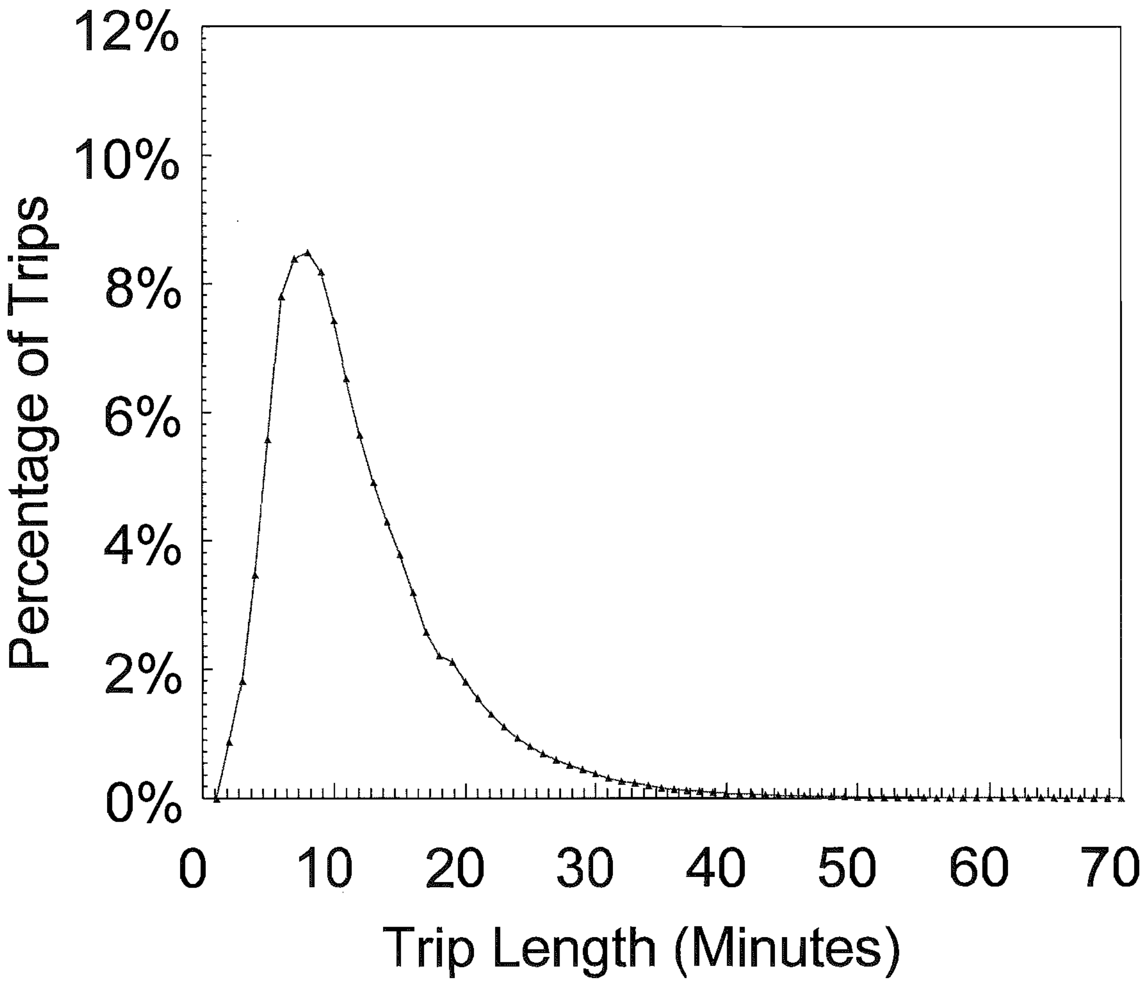


Figure 6.8 1990 MTPM Truck/Taxi Travel Time Trip Length Frequency

The mean trip length for SERPM-2 E-I/I-E trips in the MTPM network is 18 minutes with a standard deviation of 10 minutes. The mean trip length for E-E trips is 54 minutes with a standard deviation of 17 minutes. **Figure 6.9** presents the E-I/I-E trip length frequency distribution.

6.2.8 Intrazonal Travel

Intrazonal trips are trips that do not leave their origin zone. These trips are never loaded onto the network and are effectively subtracted from total trips before assignment. **Table 6.3** presents a comparison between intrazonal travel from the 1986 model and the 1990 MTPM. For all purposes, the percent of trips classified as intrazonal decreased in 1990. This is attributable to an increase in the number of TAZs (more potential attractions), changes in the land use pattern of the urbanized area, increased development, and additional socioeconomic data from the 1990 Census of Population and Housing. The result of this decrease in intrazonal travel coupled with the increase in total trips generated, is that substantially more trips are loaded onto the highway and transit networks than in the 1986 model.

6.3 Preloading

Preloading is the process that attempts to develop the preliminary estimate of congestion on the highway network. This data is required for subsequent steps in the model chain including peak period transit speed development and mode choice. Assumptions regarding auto occupancy and transit mode share are exercised in this step and two vehicle trip tables are created. One table includes LOV vehicle trips, and the other includes HOV vehicle trips. These trip tables are loaded on the highway network, resulting in congested travel times for both LOV and HOV highway links. These congested times are input into the peak period (AM) transit network for vehicle speed determination and, subsequently, number of vehicle calculations.

This step has been modified from the standard FSUTMS preloading process. In this step, the standard model would implement a simple trip table factoring process to reduce person trips to vehicle trips for all zone pairs by a single auto occupancy factor for trips generated by each purpose.

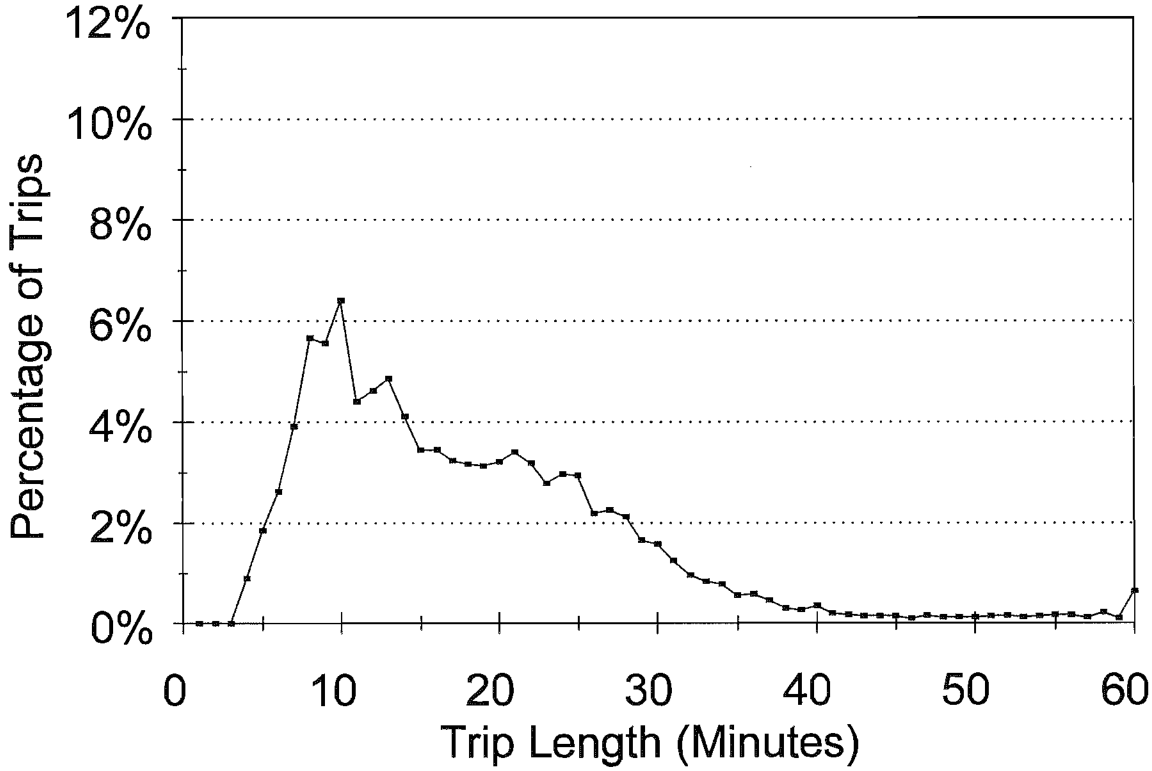


Figure 6.9 1990 MTPM External-Internal/Internal-External Travel Time Trip Length Frequency

MIAMI TRANSPORTATION PLANNING MODEL
Table 6.3 Percent of Trips Intrazonal Comparison- 1986 and 1990 MTPM

1986 MUATS Model

Purpose	Total Trips	Intrazonal Trips		Avg. Trip Length in Minutes
		Trips	Percentage	
HBW	1,461,700	20,900	1.4	18.3
HBSH	769,000	12,400	1.6	12.0
HBSR	805,000	23,000	2.9	16.2
HBO	1,224,300	48,500	4.0	14.2
NHB	1,589,900	74,300	4.7	13.8
T/T	619,900	23,300	3.8	14.0
I-E	403,400	n/a	n/a	n/a

1990 MTPM Model

Purpose	Total Trips	Intrazonal Trips		Avg. Trip Length in Minutes
		Trips	Percentage	
HBW	1,590,900	17,800	1.1	18.6
HBSH	823,700	7,800	0.9	12.9
HBSR	869,200	21,000	2.4	15.1
HBO	1,335,900	46,100	3.5	13.3
NHB	2,009,200	78,200	3.9	14.7
T/T	728,300	26,000	3.6	14.1
I-E	516,700	n/a	n/a	18.6

n/a = not applicable or not available

The 1990 MTPM instead runs a preliminary mode choice model which is sensitive to input variables such as the uncongested speed of the highway network as well as estimates of input mode shares. The result is a refined preloading process that can measure the impact of various automobile occupancies in the network and preliminarily assign HOV facilities with reasonable estimates of HOV demand.

6.4 Summary

The 1990 MTPM DISTRIB module performs three important tasks. First it completes estimates of travel time initiated in the HPATH module. It then matches trip attractions to productions based on impedances of travel time, turn penalties/prohibitors and tolls, thereby creating trip tables for each of the seven standard purposes. Once the trips are allocated, the model performs a preliminary highway network loading to determine congested travel times for input into transit network construction and the mode choice model.

With data sources from the 1990 Census of Population and Housing, trip length frequency distribution was estimated and evaluated as part of the model chain validation process. A high degree of confidence was established in the performance of the gravity model without the need to introduce socio-economic correction factors (K-factors). The average trip length for home-based work trips is the longest of all purposes, while that for home-based shopping trips is the shortest.

The addition of a preliminary mode choice model to the MTPM model stream permits detailed information regarding travel time savings realized by HOV facilities to be input into the model at later stages. Congested travel time skims for both LOV and HOV facilities are output from this process.

CHAPTER 7

TRANSIT NETWORKS

7.0 Introduction

As presented in **Figure 7.1**, the sixth module in the FSUTMS model chain is transit network development (TNET). It is the function of the TNET module to build transit networks based on a set of files that describe individual transit routes, including means of access. As such, the TNET module builds four different transit networks which describe the conditions outlined below:

❶ Peak Period Transit
❷ Off-Peak Period Transit
❸ Peak Period Jitney
❹ Off-Peak Period Jitney

Perhaps the most complex multimodal system in the United States, five transit modes have been identified for modeling in the Miami Transportation Planning Model (MTPM). They include a mix of technologies including:

❶ Mode 4, Local Bus (or Jitney),
❷ Mode 5, Metrorail,
❸ Mode 6, Express Bus,
❹ Mode 7, Tri-Rail, and
❺ Mode 8, Metromover (DPM).

In addition, three transit access modes have been identified. They are:

❶ Mode 1, Walk Access from Origin or Destination (centroid connector),
❷ Mode 2, Automobile Access via Park & Ride or Kiss & Ride (auto connector), and
❸ Mode 3, Sidewalks connecting various modes of travel (sidewalk connector).

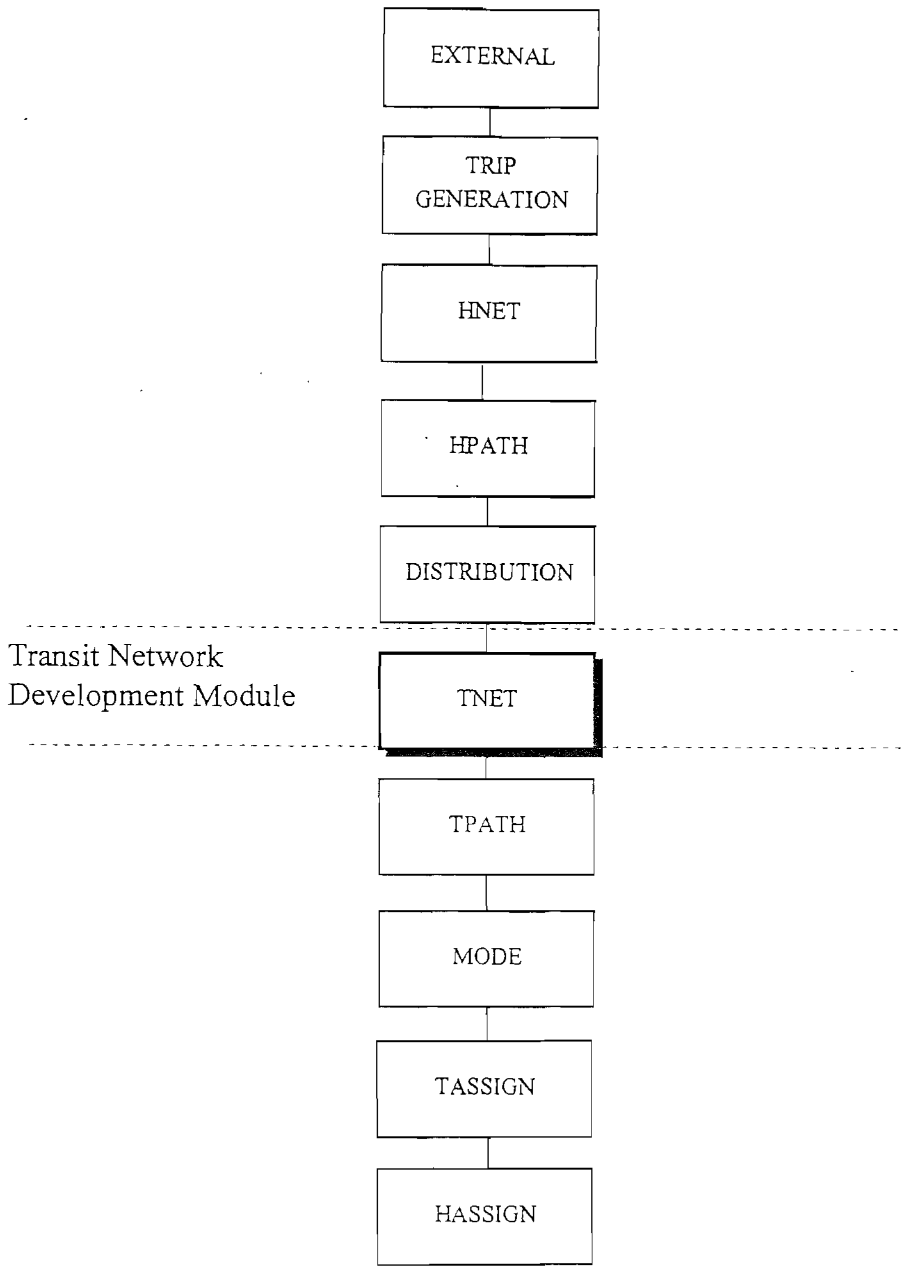


Figure 7.1 Position of Transit Network Development in the FSUTMS Model Chain

7.1 Peak Period Public Transit Network

The 1990 Miami Transportation Planning Model (MTPM) peak period *public* transit network primarily represents the journey-to-work transit system available from 7 - 9 am. The network was developed by Metro-Dade Transit Agency (MDTA) staff and contains the following number of lines:

90 Local Bus,
1 Metrorail,
15 Express Bus,
1 Tri-Rail, and
2 Metromover lines.

Several files are required to successfully develop the 1990 peak period transit network. **Table 7.1** lists all the input files required for peak period transit simulation, and includes brief descriptions and the data source. Most of the transit network files include the same type of information as the 1986 model developed for the standard Miami multi-path/multi-period (MPMP) model. The key difference in the file handling routines between the two models is that the previous model combined several of the transit route files into one large input. The current process still uses large, combined network files, but they are compiled as part of the model macro flow so the process is transparent to the user. In addition to the changes in the transit modeling process, however, there are two additional pieces of information that play a key role in network building as well as subsequent mode choice determination in later MTPM steps.

First is the BARRIERS.90A file. This file identifies physical barriers to transit access. Examples of such barriers include freeways, expressways and bodies of water such as the Miami River. The automated walk access program does not build connectors through such barriers.

Second is the PCWALK.90A file. This file describes what percentage of a zone is served by transit service within a short walking distance (0.3 miles or less) and what percentage is served within a long walking distance (0.3-1.0 miles). In mode choice, the short versus long walk for a zone is one of the variables that helps determine the probability of a trip using transit.

MIAMI TRANSPORTATION PLANNING MODEL
Table 7.1 Peak Period Transit Network User Supplied Input Files

Input File	Description	Source
BARRIERS.90A	File describing physical barriers to transit access.	Modified from Transitional Study
HRLDXY.A90	Loaded Highway Network for Congested Travel Times	Output from DISTRIB Module
LINK3AM.90A	Optional Walk Connectors	Developed for Network
LINK46AM.90A	Optional Bus Links	MDTA
LINK5AM.90A	Optional Metrorail Links	MDTA
LINK7AM.90A	Optional Tri-Rail Links	MDTA
LINK8AM.90A	Optional DPM Links	MDTA
MODE3AM.90A	Sidewalk Route File	MDTA
MODE4AM.90A	Local Bus Route File	MDTA
MODE5AM.90A	Metrorail Route File	MDTA
MODE6AM.90A	Express Bus Route File	MDTA
MODE7AM.90A	Tri-Rail Route File	MDTA
MODE8AM.90A	DPM Route File	MDTA
PCWALK.90A	Percent of Walk File. Identifies what percentage of a zone is within short and long walking distances to transit service	MPO. Reviewed by consultant.
SDLAYAM.90A	Highway to Transit Speed Conversion Curve Data	Developed by consultant after review of MDTA data.
STATDATA.90A	Station specific data (cost, parking spaces, etc)	MDTA
TINETAM.SYN	Mode specific technology codes and parameters	MDTA

7.2 Off-Peak Period Public Transit Network

The 1990 MTPM off-peak period transit network represents the system intended to serve typical passengers for non-work purposes. The system is coded as available from 9 am to 4 pm. This network was also developed by Metro-Dade Transit Agency (MDTA) staff and contains the following number of lines:

79 Local Bus,

1 Metrorail,

3 Express Bus,

1 Tri-Rail, and

2 Metromover lines.

Several files are required for the successful development of the 1990 off-peak period transit network. **Table 7.2** lists all the input files required for off-peak period transit simulation including descriptions and the data source. Most of the transit network files include the same information as the 1986 model developed for the standard Miami multi path/multi period (MPMP) model. The key difference in the file handling routines between the two models is that the previous model combined several of the transit route files into one large input. The current process does the same, but it occurs as part of the model macro flow and is, therefore, transparent to the user.

7.3 Transit Speeds

Key files used to determine all transit network speeds are SDLAYAM.90A and SDLAYMD.90A. While speeds for modes that have exclusive right-of-way are "hard-wired" into transit links as an attribute, modes that share right-of-way with vehicular traffic are estimated based on a relationship to highway speed. These relationships are determined by a set of curves based on the area type and facility type of the shared roadway facility. As part of the validation of the transit network input files, the relationship between highway and transit speeds were compared and the SDLAY input files for both transit networks were modified to reflect observed relationships. Curve specification used for peak and off-peak transit networks is presented in **Table 7.3**. Graphical representations of these curves are shown in **Figure 7.3**, **Figure 7.4**, and **Figure 7.5** respectively.

MIAMI TRANSPORTATION PLANNING MODEL
Table 7.2 Off Peak Period Transit Network User Supplied Input Files

Input File	Description	Source
BARRIERS.90A	File describing physical barriers to transit access.	Modified from Transitional Study
HRLDXY.A90	Loaded Highway Network for Congested Travel Times	Output from DISTRIB Module
LINK3MD.90A	Optional Walk Connectors	Developed for Network
LINK46MD.90A	Optional Bus Links	MDTA
LINK5MD.90A	Optional Metrorail Links	MDTA
LINK7MD.90A	Optional Tri-Rail Links	MDTA
LINK8MD.90A	Optional DPM Links	MDTA
MODE3MD.90A	Sidewalk Link File	MDTA
MODE4MD.90A	Local Bus Route File	MDTA
MODE5MD.90A	Metrorail Route File	MDTA
MODE6MD.90A	Express Bus Route File	MDTA
MODE7MD.90A	Tri-Rail Route File	MDTA
MODE8MD.90A	DPM Route File	MDTA
PCWALK.90A	Percent of Walk File. Identifies what percentage of a zone is within short and long walking distances to transit service	MPO. Reviewed by consultant.
SDLAYMD.90A	Highway to Transit Speed Conversion Curve Data	Developed by consultant after review of MDTA data.
STATDATA.90A	Station specific data (cost, parking spaces, etc)	MDTA
TINETMD.SYN	Mode specific technology codes and parameters	MDTA

MIAMI TRANSPORTATION PLANNING MODEL

Table 7.3 Highway to Transit Speed Conversion Table for Peak and Off Peak Networks

Curve Number	Low Speed		High Speed		Transit Mode	Area Type	Highway Facility Type
	Auto	Transit	Auto	Transit			
1	30	2.5	70	2.5	1,3	1-5	1-6
2	30	30	70	70	2	1-5	1-6
3	26	26	43	35	4 6	1 1	1 1
4	26	26	50	45	4 6	2-4 2-4	1 1
5	42	42	55	50	4 6	5 5	1 1
6	22	12	27	16	4 4 4 6 6	2 2 1-2 1 1	2-3 4 6 2-3 6
7	22	13	35	22	6 6	2 2	2-3 6
8	27	23	47	43	4 4 6	3 3 2	2-4 6 4
9	18	14	36	24	6 6	3-4 3-4	2-4 6
10	25	21	55	50	4 4	4 4	2-4 6
11	10	6	20	11	6 6 4	5 5 1	2-4 6 2-3
12	25	23	55	52	4 4	5 5	2-4 6
13	18	14	30	23	4 6	1 1	4 4

Facility Type:
1: FREEWAY
2: DIVIDED ARTERIAL
3: UNDIVIDED ARTERIAL
4: COLLECTOR
5: CENTROID CONNECTOR
6: ONE-WAY

Area Type:
1: CBD
2: CBD FRINGE
3: RESIDENTIAL
4: OBD
5: RURAL

Transit Mode
1: WALK ACCESS
2: AUTO ACCESS
4: METROBUS (LOCAL)
6: METROBUS (EXPRESS)

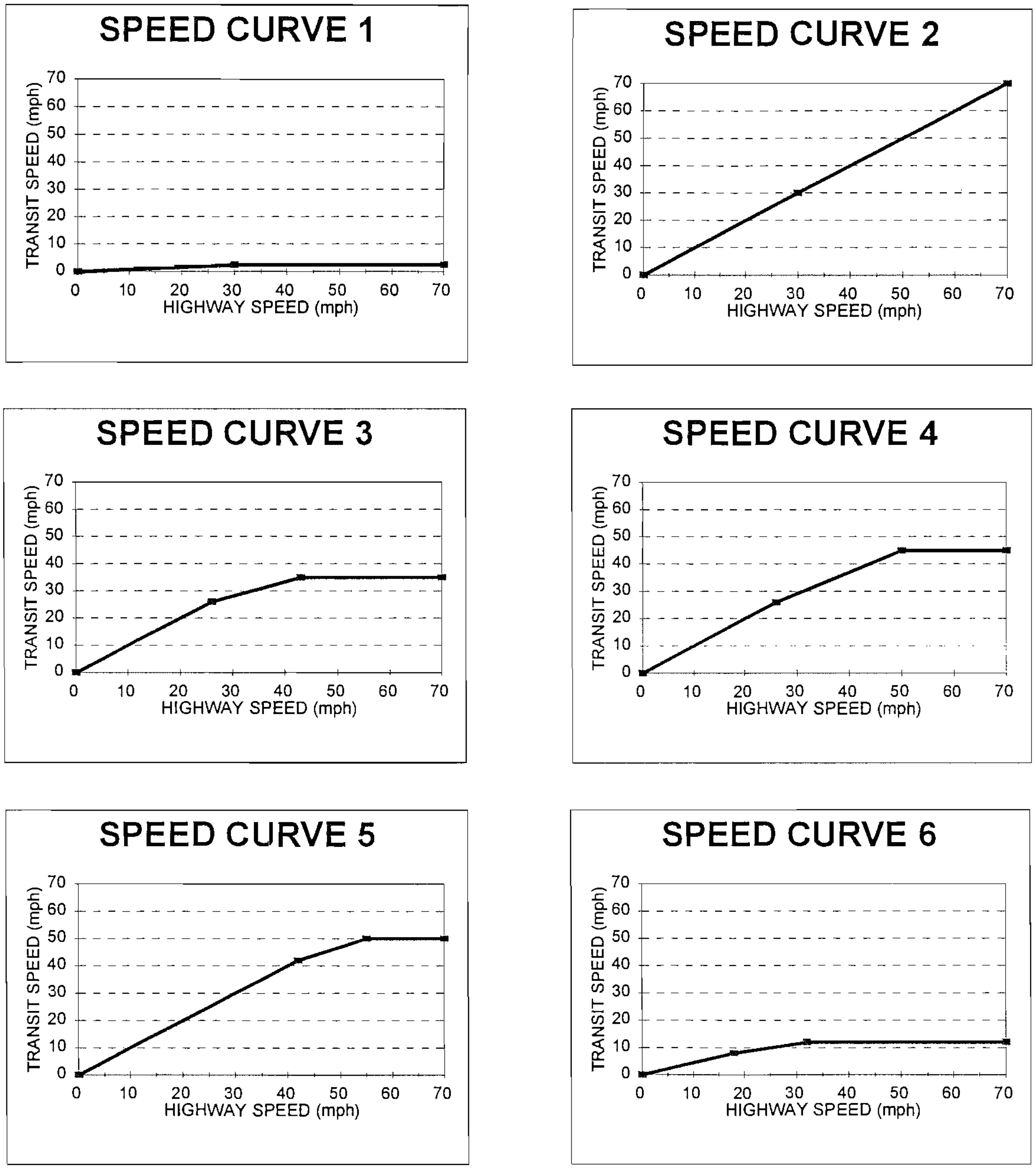


Figure 7.2 Highway to Transit Speed Conversion Curves 1-6

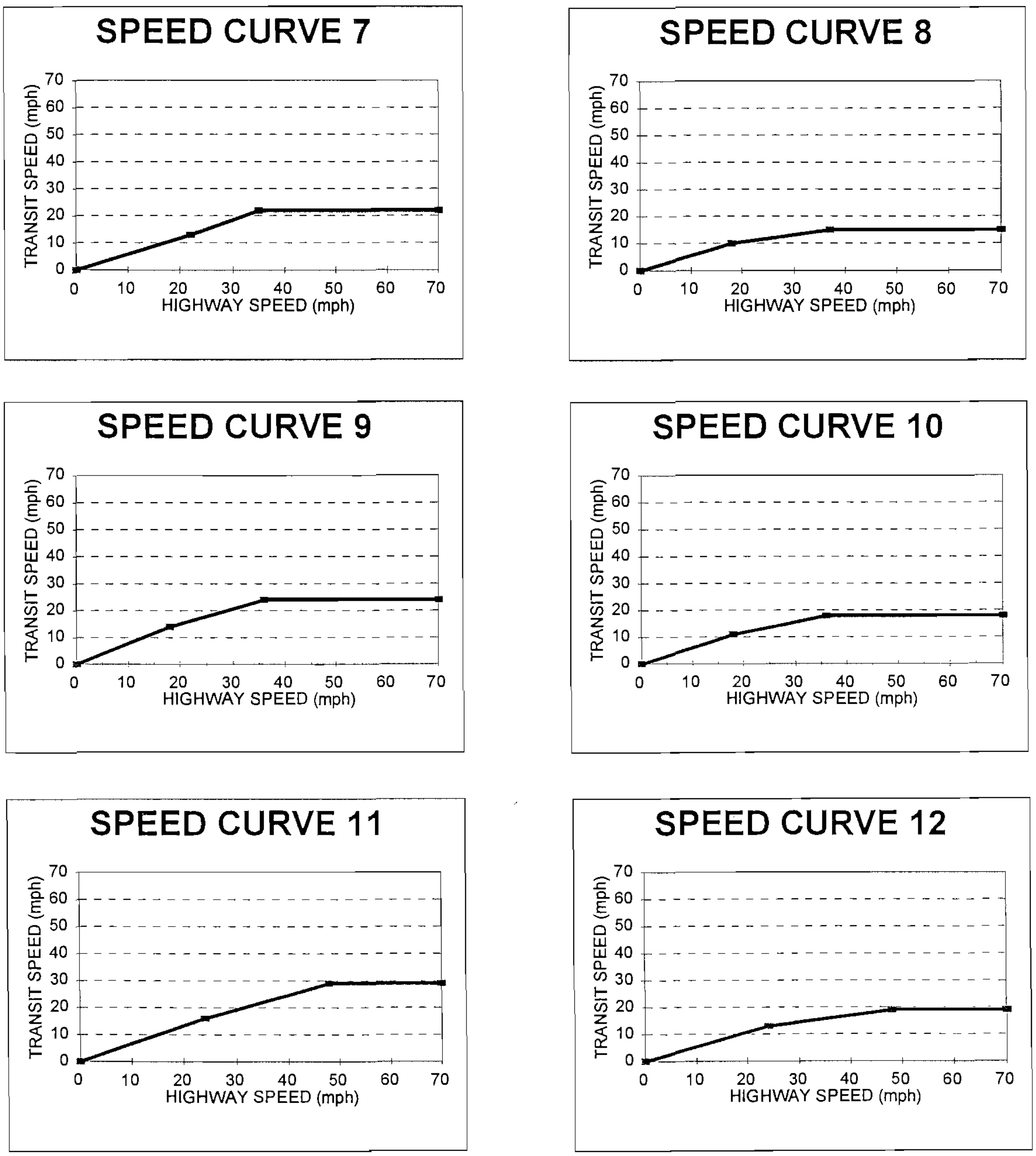


Figure 7.3 Highway to Transit Speed Conversion Curves 7-12

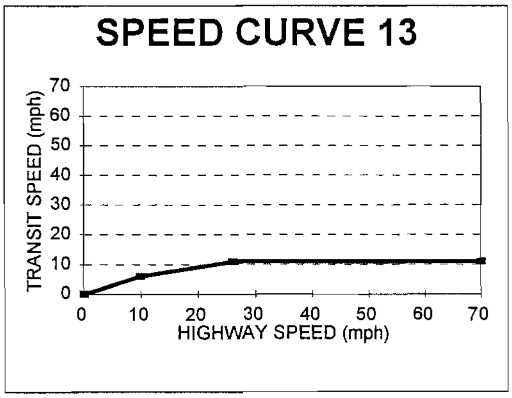


Figure 7.4 Highway to Transit Speed Conversion Curve 13

7.4 Peak Period Jitney Network

As a result of previous studies, the 1990 MTPM transit network simulation has evolved to include jitney handling routines. This is due to jitney competition with local bus service in a few highly utilized corridors. The 1990 MTPM peak period jitney network represents legally owned and operated jitney services operating from 7 am to 9 am and available for commuters. Though some jitney operators have been observed to be operating in Dade County without proper licenses, it was felt by the LRTP Steering Committee that such activity should not be considered in the model. The jitney network developed by the MDTA staff contains 50 jitney routes.

Because the technology used by jitney most resembles local shuttle buses, mode 4, typically reserved for local buses, was chosen to represent jitneys. This assumption is necessary for jitney simulations to fit in the FSUTMS model stream. Several files are required for the development of the 1990 peak period jitney network in the FSUTMS model structure. **Table 7.4** lists all the input files required for peak period jitney simulation including descriptions and the data source.

7.5 Off-Peak Period Jitney Network

Parallel to the development of the peak period jitney network, the off-peak period jitney network was developed to represent legally owned and operated jitney services typically intended for non-commuters during the hours of 9 am to 4 pm. The network was developed by MDTA staff and also contains 50 jitney routes.

Similar to the peak period jitney network, mode 4 represents jitney service in the off- peak period. This assumption is necessary for jitney simulations to fit in the FSUTMS model stream. Several files are required for the development of the 1990 off-peak period jitney network in the FSUTMS model structure. **Table 7.5** lists all the input files required for off-peak period jitney simulation including descriptions and the data source.

MIAMI TRANSPORTATION PLANNING MODEL
Table 7.4 Peak Period Jitney Network User Supplied Input Files

Input File	Description	Source
BARRIERS.90A	File describing physical barriers to transit access.	Modified from Transitional Study
HRLDXY.A90	Loaded Highway Network for Congested Travel Times	Output from DISTRIB Module
JITAM.90A	Jitney Route File	MDTA
LINK3AM.90A	Optional Walk Connectors	Developed for Network
LINK46AM.90A	Optional Bus Links	MDTA
MODE3AM.90A	Sidewalk Link File	MDTA
PCWALK.90A	Percent of Walk File. Identifies what proportion of a zone is within one of two walking distances to transit service	MPO. Reviewed by consultant.
SDLAYAM.JIT	Jitney Speed Conversion Curve Data	MDTA
TJITAM.SYN	Mode technology and period specification	MDTA

MIAMI TRANSPORTATION PLANNING MODEL
Table 7.5 Off-Peak Period Jitney Network User Supplied Input Files

Input File	Description	Source
BARRIERS.90A	File describing physical barriers to transit access.	Modified from Transitional Study
HNET.A90	Unloaded Highway Network for Free Flow Travel Times	Output from DISTRIB Module
JITMD.90A	Jitney Route File	MDTA
LINK3MD.90A	Optional Walk Connectors	Developed for Network
LINK46MD.90A	Optional Bus Links	MDTA
MODE3MD.90A	Sidewalk Link File	MDTA
PCWALK.90A	Percent of Walk File. Identifies what proportion of a zone is within one of two walking distances to transit service	MPO. Reviewed by consultant.
SDLAYMD.JIT	Jitney Speed Conversion Curve Data	MDTA
TJITMD.SYN	Mode technology and period specification	MDTA

7.6 Summary

Peak period transit service in the Miami Urbanized area is highly pronounced, providing over 2,800 route miles of service. **Table 7.6** summarizes the 1990 transit network attributes for local bus, express bus, Metrorail and Metromover. Tri-Rail is not included in the network summaries as most of the route miles and distance are not attributable to travel in Dade County. Most of Tri-Rail's route miles are in Broward and Palm Beach Counties. Express bus miles are four fold greater in the peak period compared to the off-peak, attesting to the strong peak service provided by MDTA.

Jitney network summary statistics are presented in **Table 7.7**. Comparison of Table 7.6 to Table 7.7 confirms that jitneys provide considerably faster service than local buses with which they compete in both the peak and off-peak periods. Express buses are faster than jitneys in both time periods. However, express buses and jitneys rarely compete for passengers. Total jitney service does not vary considerably by period. Jitney speeds, however, are significantly higher in the off-peak period due to the relative lack of congestion.

The 1990 MTPM transit networks represent perhaps the most complex multimodal system in the United States. One private transit mode and five public transit modes are simulated, including a mix of technologies ranging from jitney shuttle vans and minibuses to diesel powered commuter rail. Transit model development requires the identification of separate networks, representing peak period transit, peak period jitney service, off-peak period transit, and off-peak period jitney service. Together with the highway network, these transit networks represent the mode choice set available for local travelers in the Miami urbanized area.

MIAMI TRANSPORTATION PLANNING MODEL
Table 7.6 Transit Network Summary

Mode	ROUTE			VEHICLE		
	Miles	Min.	Speed	NO.	Miles	Runs
PEAK PERIOD (2 HOURS)						
Local Bus	2,534.4	10,533.3	14.44	449	10156.8	4.0
Metrorail	42.1	81.0	31.19	12	668.6	15.9
Express Bus	280.3	706.7	23.80	41	1414.3	5.0
Metromover	3.9	21.4	10.93	12	231.2	59.3
OFF PEAK PERIOD (7 HOURS)						
Local Bus	2,340.8	7,966.0	17.63	312	2594.3	1.1
Metrorail	42.1	81.0	31.19	6	1177.1	28.0
Express Bus	59.0	122.6	28.87	4	373.9	6.3
Metromover	3.9	21.4	10.93	4	235.2	60.3

MIAMI TRANSPORTATION PLANNING MODEL
Table 7.7 Jitney Network Summary

Mode	ROUTE			VEHICLE		
	MILES	MIN.	SPEED	NO.	MILES	Runs
PEAK PERIOD (2 HOURS)						
Jitney	1,208.5	3,373.6	21.49	153	4725.3	3.9
OFF PEAK PERIOD (7 HOURS)						
Jitney	1,147.8	2,635.6	26.13	117	14635.5	12.8

CHAPTER 8
TRANSIT PATHS

8.0 Introduction

The seventh module in the FSUTMS model chain is transit path development (TPATH), as presented in **Figure 8.1**. A transit path is, as its name implies, the way a passenger would get between two points - the zone of origin and the destination zone - on a particular mode. There are three different options for running FSUTMS using transit. They include the following:

❶ Single Path/Single Period,
❷ Multi-Path/Single Period, and
❸ Multi-Path/Multi-Period.

Single path transit identifies one path using one transit mode between a pair of zones. No more than one path, the minimum impedance path, can be identified between any pair of zones. A multi-path model is one that, through several iterations, develops a set of paths with each path representing particular mode of travel. As the name implies, multi-path, single period FSUTMS applications identify a set of paths, by mode of travel, between each pair of zones in a peak period. For off-peak travel, one set of paths is identified, implying that one transit mode of travel is available.

Multi-path/multi-period models identify a set of mode specific paths in both the peak and off-peak service periods. These models are used when travelers have a full set of modal options available all day, as is the case in the Miami Urbanized area. The Miami Transportation Planning Model (MTPM) is a multi-path/multi-period (MPMP) model.

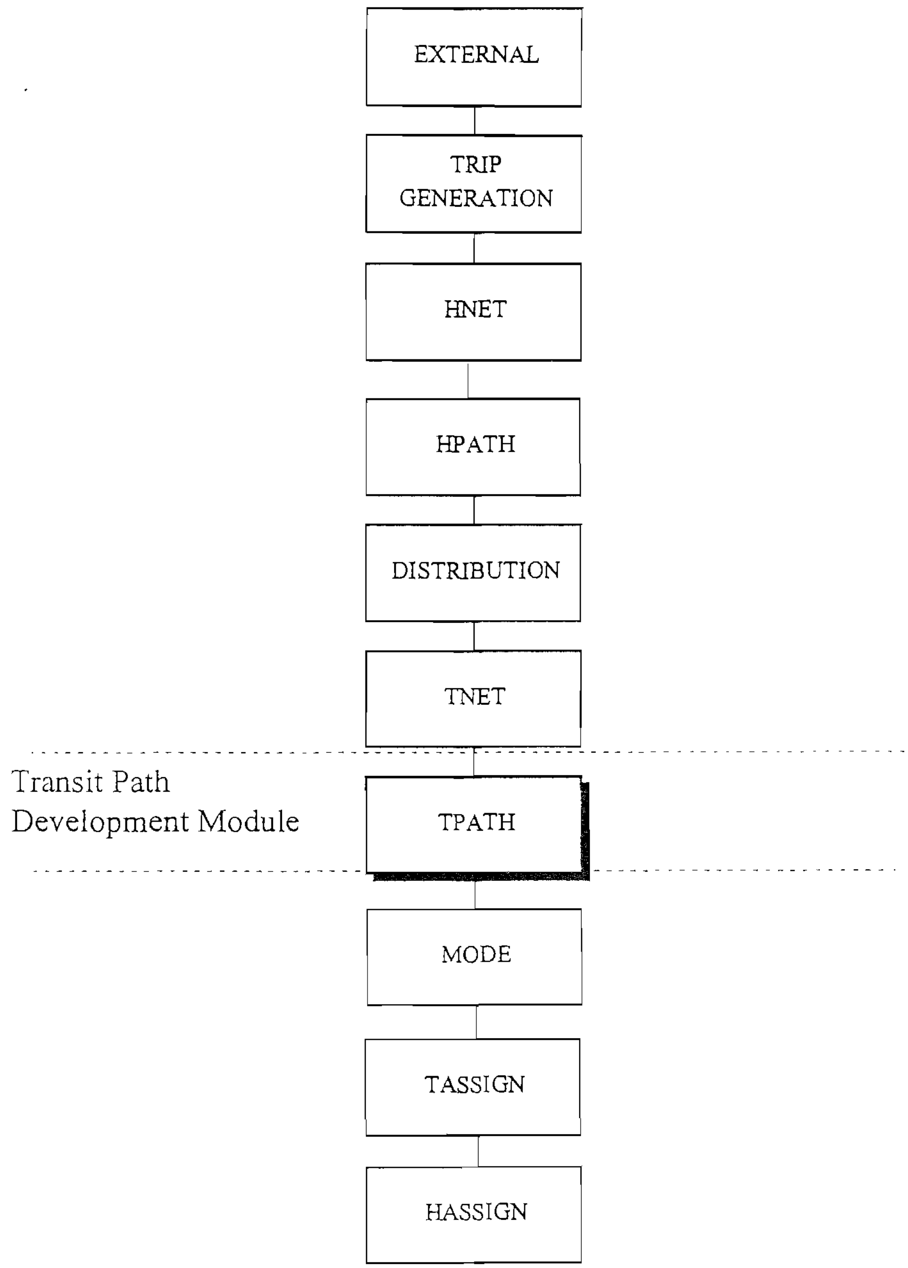


Figure 8.1 Position of Transit Path Development Module in FSUTMS Model Chain

The TPATH module accomplishes several tasks. First, it identifies the minimum paths between all pairs of zones by all available modes of transit. It also summarizes the travel times along identified paths for input into the mode choice model. Then, based upon the selected path, it calculates traveler costs based on boarding and transfer fares.

8.8.1 Transit Path Construction Process

Eight sets of paths are developed during the TPATH module, four for peak period and four for off-peak period service. These paths include:

❶	TPATHAM1-	Walk Access, Peak Period, Local Bus and Metromover (DPM)
❷	TPATHAM2-	Walk and Local Bus Access, Peak Period, Premium Transit (Metrorail, Express Bus and Tri-Rail)
❸	TPATHAM3-	Auto Access, Peak Period, All Modes
❹	TPATHAM4-	Walk Access, Peak Period, Jitney
❺	TPATHMD1-	Walk Access, Off-Peak Period, Local Bus and Metromover (DPM)
❻	TPATHMD2-	Walk and Local Bus Access, Off-Peak Period, Premium Transit (Metrorail, Express Bus and Tri-Rail)
❼	TPATHMD3-	Auto Access, Off-Peak Period, All Modes
❽	TPATHMD4-	Walk Access, Off-Peak Period, Jitney

Paths are developed by parameters intended to isolate a mode, or a submode, such as walk or auto access. This is accomplished by deleting illogical paths or by factoring in-vehicle travel time, out-of-vehicle travel time and transfer time to reflect a prefered path. During path development, local bus, Metromover, and jitney services are all considered non-premium transit. Tri-Rail, Metrorail, and express bus services are all considered premium transit. Where premium transit services compete in one corridor, only one premium path is constructed for each mode of access. **Table 8.1** presents the public transit path development parameters used in the 1990 MTPM.

MIAMI TRANSPORTATION PLANNING MODEL

Table 8.1 Peak and Off Peak Periods Public Transit Path Construction Parameters

(refer to UTPS "UPATH" documentation for an explanation of parameters)

		Walk Access		Auto Access	
Parameters	To Mode	Local Bus/ Metromover	Premium	Local Bus/ Metromover	Premium
Maximum Transfer		4	4	4	4
Maximum Time (min)	255	255	255	255	255
CWTIME (Wait Time Weight)	4	2.25	2.25	2.25	2.25
	5	N/A	2.25	2.25	2.25
	6	N/A	2.25	2.25	2.25
	7	N/A	2.25	2.25	2.25
	8	2.25	2.25	2.25	2.25
CXTIME (Transfer Wait Time Weight)	4	2.25	2.25	2.25	2.25
	5	N/A	2.25	2.25	2.25
	6	N/A	2.25	2.25	2.25
	7	N/A	2.25	2.25	2.25
	8	2.25	2.25	2.25	2.25
Minimum Wait Penalty (min)	4	2.00	2.00	2.00	2.00
	5	N/A	-	-	-
	6	N/A	2.00	2.00	2.00
	7	N/A	-	-	-
	8	N/A	-	-	-
Maximum Wait Penalty (min)	4	30.00	30.00	30.00	30.00
	5	N/A	30.00	30.00	30.00
	6	N/A	30.00	30.00	30.00
	7	N/A	30.00	30.00	30.00
	8	30.00	30.00	30.00	30.00
Run Time Factor	1	2.25	2.25	2.25	2.25
	2	N/A	N/A	1.00	1.00
	3	2.25	2.25	2.25	2.25
	4	1.00	1.00	1.00	1.00
	5	N/A	0.10	0.10	0.10
	6	N/A	0.10	0.10	0.10
	7	N/A	0.10	0.10	0.10
	8	1.00	1.00	1.00	1.00
Transfer Penalty	4	1.00	1.00	1.00	1.00
	5	N/A	1.00	1.00	1.00
	6	N/A	1.00	1.00	1.00
	7	N/A	1.00	1.00	1.00
	8	1.00	1.00	1.00	1.00
Delete Mode		2,5,6,7	2	1	1

LEGEND:

Mode 1: Walk (Centroid Connector)
Mode 2: Auto Connector
Mode 3: Sidewalk
Mode 4: Local Bus
Mode 5: Metro-Rail
Mode 6: Express Bus
Mode 7: Tri-Rail
Mode 8: Metromover

Although six separate transit paths and resulting skim files are developed based on the parameters outlined in Table 8.1, peak and off-peak paths are defined by the same process and use the same set of parameters. Differences in peak and off-peak paths are attributable to changes in headways, route structures, and other level of service characteristics unique to the peak and off-peak transit networks. For a complete explanation of these parameters, refer to UTPS documentation regarding the UPATH program.

Because private jitney services are in a different network file than public transit services, jitney paths need not be isolated from alternative modes available in the same network. Jitney paths are established like local bus paths using the same set of parameters as local bus. Because jitney service is in a separate network file, jitney to local bus or premium transit transfers are prohibited in the path building process.

8.2 Transit Fares

After minimum transit travel time paths have been identified, total fares for each path are calculated. Transit fares are a function of boarding and transfer costs. **Table 8.2** presents the 1990 MTPM fare matrix. The most expensive mode of travel based on initial boarding cost is Tri-Rail at $1.50. Conversely, Metromover is the least expensive mode based on initial boarding cost at $0.25. However, it is most expensive in terms of transfer costs relative to intial boarding costs. The relationship between initial boarding cost and transfer cost is a function of public policy, giving preference to the higher cost modes of travel. It reflects actual boarding cost values based on 1990 transit fare schedules.

Jitney fare matrices are based on jitney boarding fares input as $1.00 with a $1.00 charge to transfer. This is consistent with private market pricing strategies in 1990. Observed jitney fares, like fares on the public transit system, are flat rate with no marginal cost for distance traveled.

MIAMI TRANSPORTATION PLANNING MODEL

Table 8.2 Transit Fare Matrix

From Mode	To Mode					
	Direct Access*	Metrobus	Metrorail	Express Bus	Tri-Rail	Metromover
Direct Access*	n/a	$1.00	$1.00	$1.25	$1.50	$0.25
Metrobus	n/a	$0.25	$0.25	$0.50	$0.25	$0.25
Metrorail	n/a	$0.25	$0.00	$0.25	$0.25	$0.00
Express Bus	n/a	$0.25	$0.25	$0.25	$0.25	$0.25
Tri-Rail	n/a	$0.00	$0.00	$0.25	$0.00	$0.00
Metromover	n/a	$1.00	$1.00	$1.25	$1.00	$0.00

* Direct access represents walk or auto access to a mode without transfering from another transit mode.

8.3 Transit Path Evaluation

Given the complexity of the transit path development process, it is necessary to review the paths calculated by the model for each zone in the network. As part of the validation process transit travel time and fare calculations were reviewed for reasonableness and consistency with other data published by MDTA. As part of the review, **Figure 8.2** and **Figure 8.3** were created. These Figures present transit in-vehicle travel time and total one-way fare respectively for transit travelers going to the Miami Downtown area. Both graphics demonstrate reasonable transit accessibility.

8.3 Summary

Transit paths are created to isolate travel times and costs by types of transit service based on access mode. Walk, local bus, and auto access are paths identified for peak and off-peak service periods for public transit service. Walk paths are identified for peak and off-peak period jitney access. After paths are constructed and travel time skims are summarized, transits cost for each prefered path are calculated based on 1990 fares and transfer costs.

The multi-path/multi-period transit process is necessary to identify the comprehensive mode choice options available to travelers in the Miami Urbanized area. This process highlights mode of access as well as level of service variables. Local bus, Metromover, and jitney are all considered to be non-premium transit by the model. Tri-Rail, Metrorail and express bus services are all considered premium transit. Where premium transit services compete in one corridor, only one premium path is constructed for each mode of access.

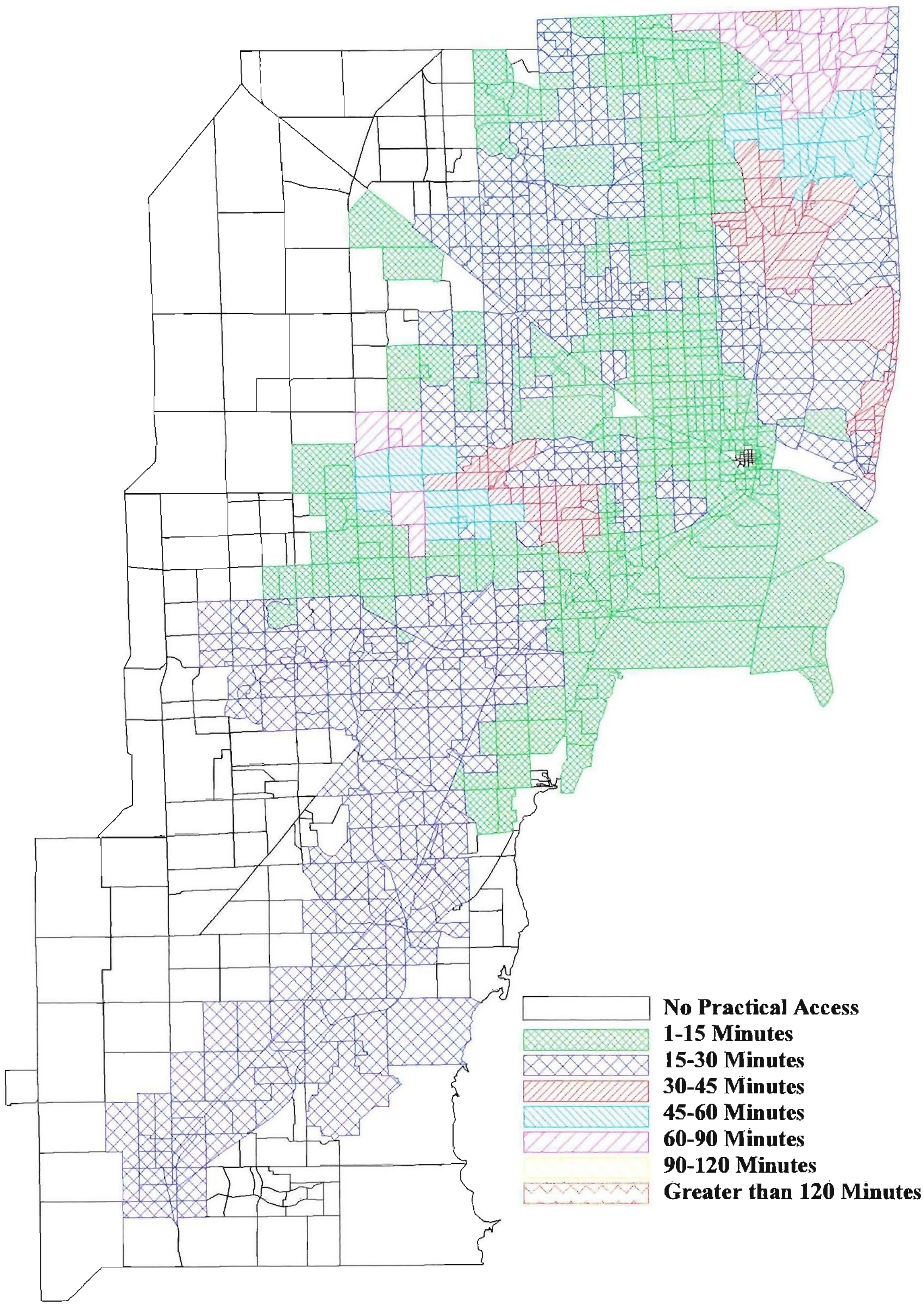


Figure 8.2 Public Transit In-Vehicle Travel Time to the Miami CBD

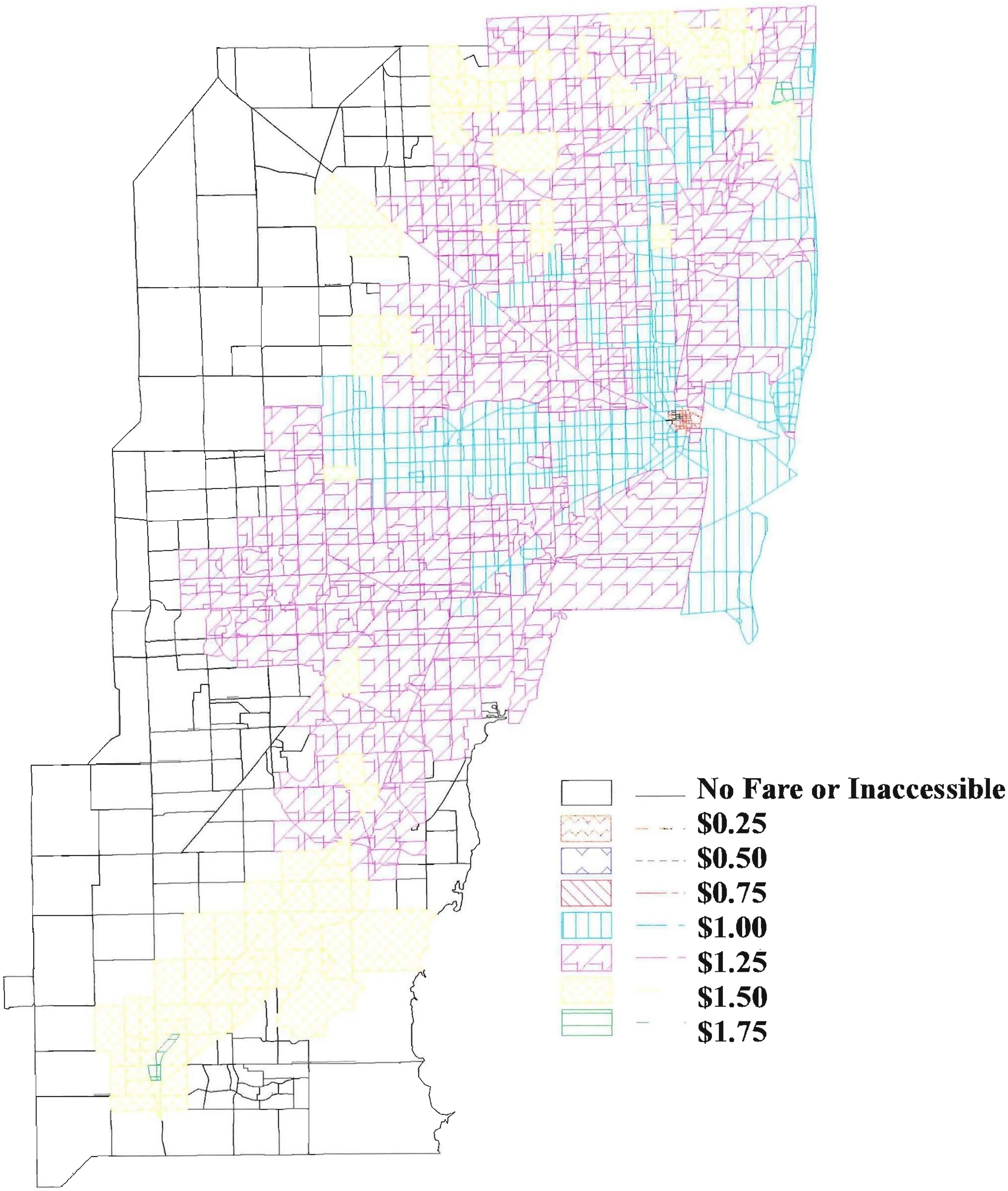


Figure 8.3 Public Transit Path Minimum Fare to Miami CBD by Least Expensive Mode

CHAPTER 9

MODE CHOICE

9.0 Introduction

As presented in **Figure 9.1**, the eighth module in the FSUTMS model chain is mode choice (MODE). The function of the mode choice module is to identify the mode, or means of travel, for trips generated by the generation (GEN) module and distributed by the trip distribution (DISTRIB) module. Modal options are defined as ways by which a traveler can get from one zone to another. Examples from Dade County would include driving alone, riding with someone else (shared ride), taking a bus or jitney, or by driving to an express bus or Metrorail station.

9.1 Available Modal Options

Travelers in the Dade County truly have a multitude of mode choices available. The choices as presented in the Miami Transportation Planning Model (MTPM) include:

- Drive Alone in Auto
- Drive with 1 Passenger in Auto
- Drive with 2 or more Passengers in Auto
- Local Bus
- Express Bus
- Metrorail
- Tri-Rail
- Metromover (DPM)
- Private Jitney Service
- Select combinations of the above.

For modeling purposes, a mode choice is a single, primary means of transportation used to arrive at a destination. Transfer is possible between all transit modes, however transfer is not permitted between auto modes such as from Drive Alone to Drive with 2 passengers in a vehicle.

9.2 Mode Choice Determination

Most urban transportation planning models, including the 1990 MTPM, employ logit models to determine the probability of a traveler choosing a particular mode of travel. A logit model is

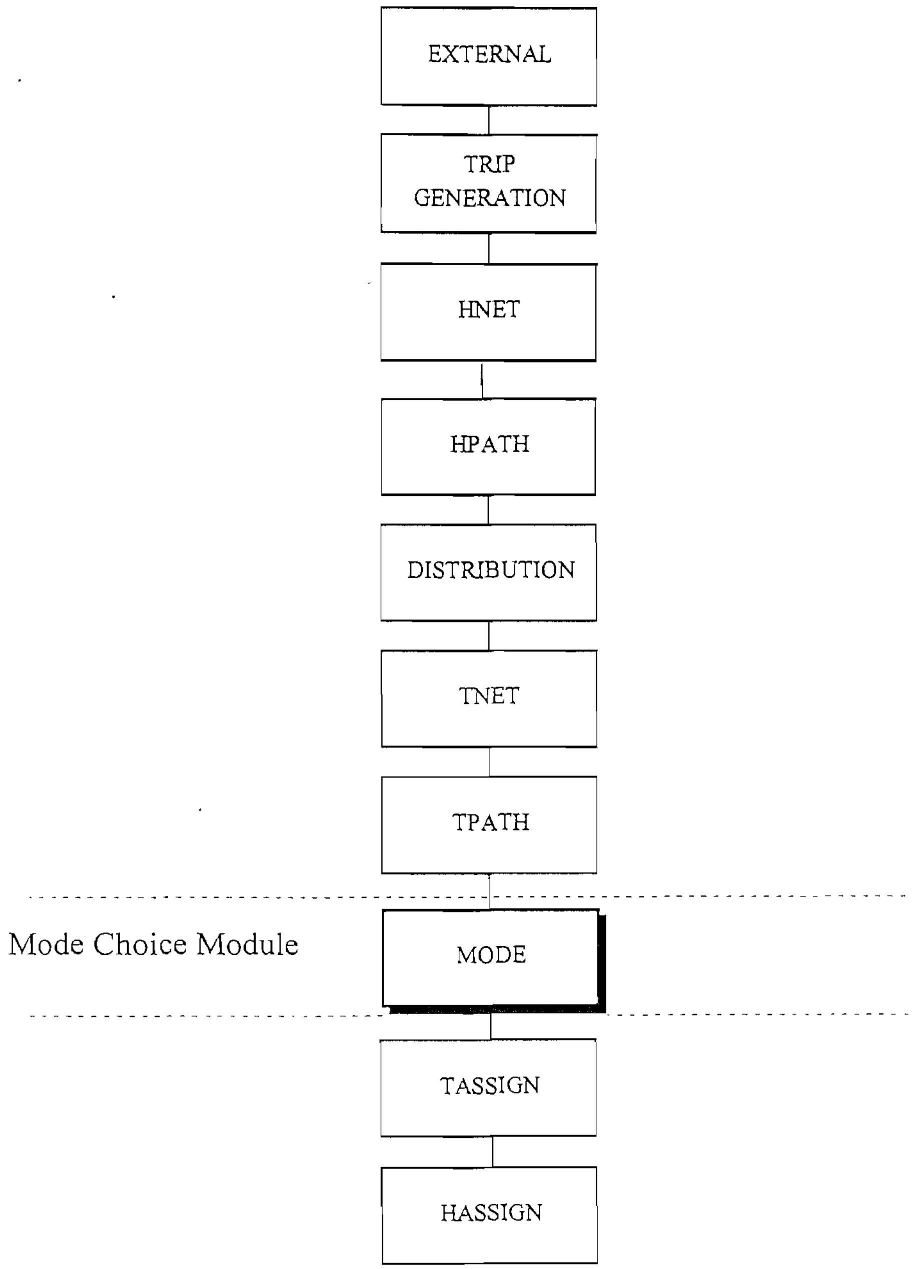


Figure 9.1 The Position of the Mode Choice Module in the FSUTMS Model Stream

a mathematical expression that calculates the convenience, or utility, of a particular mode compared to other possible choices. Logit models are founded in microeconomic theory and assume that a person will choose the transportation alternative that is most convenient (e.g. least time consuming, least expensive and perceived most amenable) to him or her. Travelers do not always have perfect knowledge of the costs and benefits of a particular mode of travel and, even if they do, they do not consistently exhibit the same choices given the same criteria upon which to choose. Therefore, it is the task of logit models to estimate the probability of any traveler choosing one mode over another.

As presented in **Figure 9.2**, logit models can take four different forms or structures. These include binomial, multinomial, nested and heirarchical. The diffference between these structures depend on assumptions regarding how a traveler perceives the modal choices available. A binomial structure assumes that a person has two choices available. A case of this type of model would be one that determines the probability using either private auto or transit. The model only needs to determine the probability of using one mode. The remaining trips are allocated to the alternative mode.

Multinomial models have three or more modal options available all of which compete equally. The implicit assumption with a multinomial model is that the probability of choosing a single mode is a simultaneous function of all available modes. This is the standard FSUTMS mode choice model which was used in the 1986 Miami Urbanized Area Transportation Study (MUATS).

Nested and heirarchical mode choice models both assume that all available modes do not compete equally with one another. These models group modes choices together and assume that a traveler does not choose from all modes simultaneously, but, rather chooses from a subset of available modes. In a nested logit model, the subset of modes is always composed of two choices. The nested logit model implicitly assumes that travelers always make binary decisions. In a heirarchical model, subsets of modes can be of two or more choices for each subset. The degree to which the subsets of available modes are grouped suggests how travelers perceive their choice set.

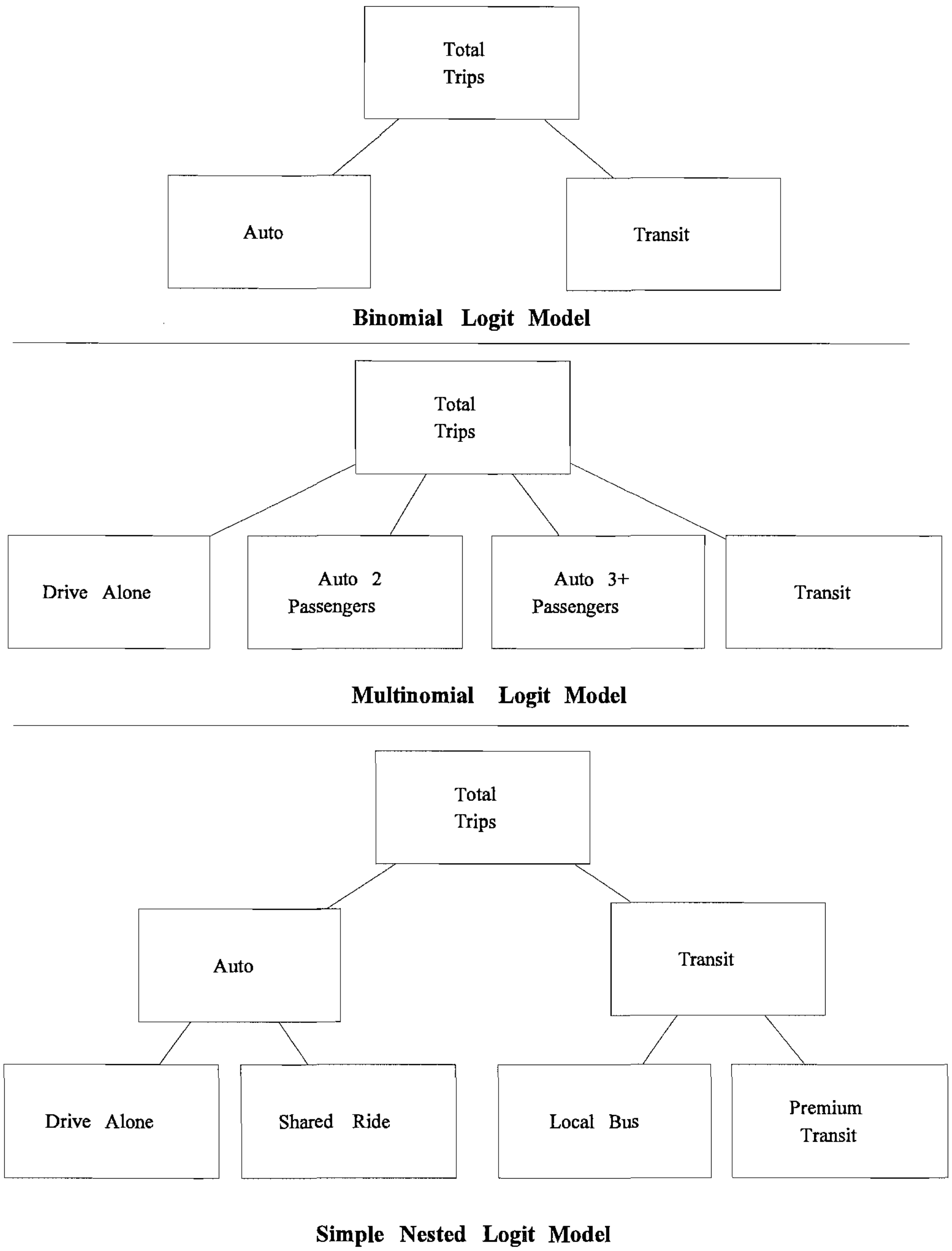
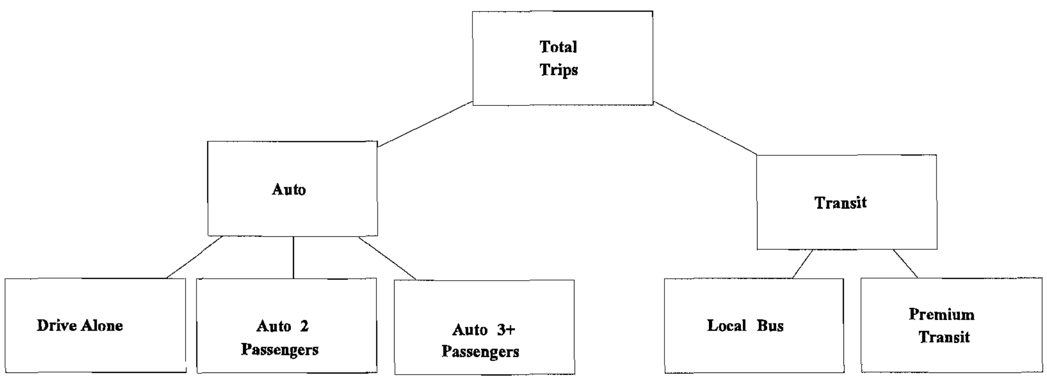


Figure 9.2 Various Logit Model Structures



Simple Heirarchical Logit Model

Figure 9.2 Various Logit Model Structures (continued)

A heirarchical model might assume that only one subset, auto or transit, is the way travelers perceive their major mode choices. After the major mode decision is made, all submodes in auto and transit compete equally with one another just as in the multinomial model. Depending on how the choice set is perceived, the heirarchial model can assume many different structures. Unlike binomial, multinomial and nested logit formulations, heirarchical models can embody a variety of assumptions regarding how travelers make mode choice decisions.

The 1990 MTPM uses the nested logit structure. This structure, as presented in **Figure 9.3**, was adopted for this study from the *Dade County Transit Corridors Transitional Analysis* and represents the currently prefered approach to mode choice modeling. Nested logit models reduce one of the shortcomings of multinomial models, the lack of independence of irrelevant alternatives. Independence of irrelevant alternatives (IIA) means that, when modes compete for travelers, competition should primarily occur between similar modes. Multinomial models, by their mathematical formulation, dictate that as a share of a particular mode increases, competing modes will each lose trips in proportion to their original mode shares. IIA theory states that some modes should lose trips disproportionately as increases in the demand for a single mode doesn't represent actual competition for, and therefore will not effect, all modes equally.

9.2.1 Mode Choice Input Variables and Coefficients

The probability of a traveler choosing a particular mode of transportation is a function of level of service and cost variables and how a traveler perceives them. Variables considered to determine mode choice in the MTPM include walk access time, auto access time, out-of-vehicle wait time, transfer time, number of transfers, transit fare, vehicle operating cost, parking cost and HOV time savings. Such variables represent how pleasurable, or amenable (or, more specifically, how unamenable), a particular mode is to a traveler. Earlier in the FSUTMS model stream, the values of these variables are determined for each of the 1.4 million zone-to-zone combinations in the study area for each mode by the HPATH, DISTRIB, and TPATH modules.

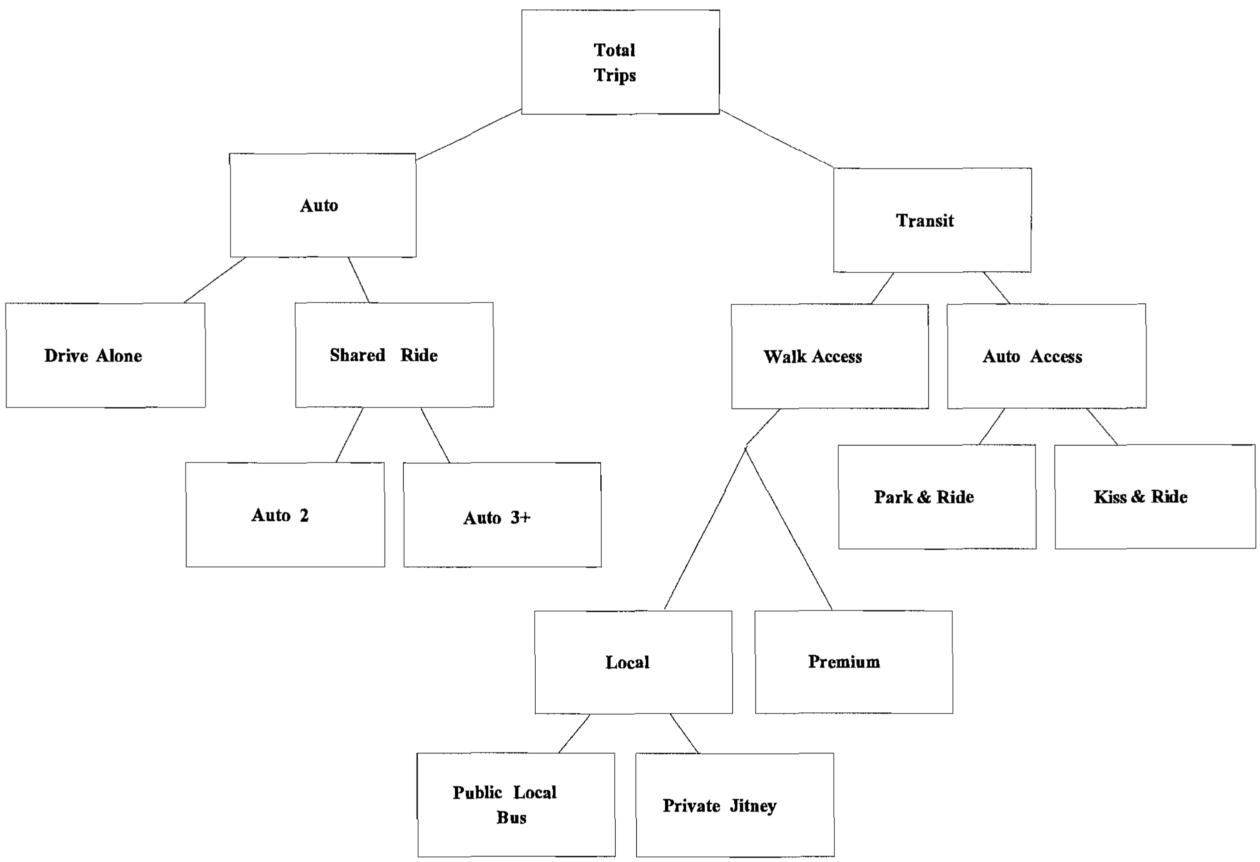


Figure 9.3 1990 Miami Transportation Planning Model Logit Model Structure

In a logit model, the degree to which the model is sensitive to input variables is contingent on the coefficients, or elasticities, of the model. The coefficients for the MTPM are adopted from the *Dade County Transit Corridors Transitional Analysis* and are presented in **Table 9.1**. Sensitivity tests confirm the model is sensitive to changes in level of service variables such as transit fares, parking costs and in vehicle travel time. **Figure 9.4** presents the results of transit sensitivity to key mode choice highway variables. **Figure 9.5** and **Figure 9.6** show transit mode share sensitivity to transit variables. All elasticities are within reasonable ranges. From these six tables it is apparent the model is sensitive to all highway and transit input variables, and that changes in headway, which affects transit waiting times, have the greatest impact on ridership.

9.2.2 Mode Specific Constants

Also known as mode bias coefficients, mode specific constants are the adjustment parameters for the nested logit model. Mode specific constants account for qualitative variables that are not empirically measured in the model. As presented in **Table 9.2**, unique mode specific constants validated for the 1990 MTPM are expressed for each mode and stratified by household auto ownership characteristics. Separate constants allow the model to reflect the differing perpensities of households with differing auto ownership characteristics to use transit and autos.

Because constants represent the unknown, they should rarely be lower than -3.0 or greater than to +3.0. Values outside this range cause the model to be insensitive to changes in the level of service and costs associated with a particular mode. All constants in the MTPM are within this range except for zero car households using park-and-ride access. These constants are less than -3.0 to suppress illogical and unrealistic estimates of park and ride trips that might otherwise be generated by zero car households.

9.3 Mode Choice Results

Estimates of mode shares as determined by the nested logit model are evaluated by comparing estimated trips with observed trips by mode. After adjustment, the nested logit mode choice produces estimates of mode share for each of the available modes. Based on input from the

MIAMI TRANSPORTATION PLANNING MODEL
Table 9.1 1990 MTPM Nested Logit Model Input Variable Coefficients

Variable	Auto Modes			Transit Modes				Coefficients		
				Walk Access		Auto Access				
	DA	SR2	SR3+	LB	PM	P&R	K&R	HBW	HBNW	NHB
Walk Time	X	X	X	X	X	X	X	-0.0450	-0.0350	-0.0450
Auto Access Time						X	X	-0.0200	-0.0150	-0.0180
Run Time	X	X	X	X	X	X	X	-0.0200	-0.0150	-0.0180
First Wait (<7min)				X	X	X	X	-0.0450	-0.0350	-0.0450
First Wait (>7min)				X	X	X	X	-0.0230	-0.0350	-0.0450
Transfer Time				X	X	X	X	-0.0450	-0.0350	-0.0450
Number of Transfers				X	X	X	X	-0.0450	-0.0350	-0.0450
Transit Fare				X	X	X	X	-0.0032	-0.0048	-0.0048
Auto Operating Costs	X	X	X			X	X	-0.0025	-0.0048	-0.0048
Parking Costs	X	X	X			X		-0.0032	-0.0048	-0.0048
HOV Time Difference		X	X					-0.0180	-0.0150	-0.0180

LEGEND:

Mode:

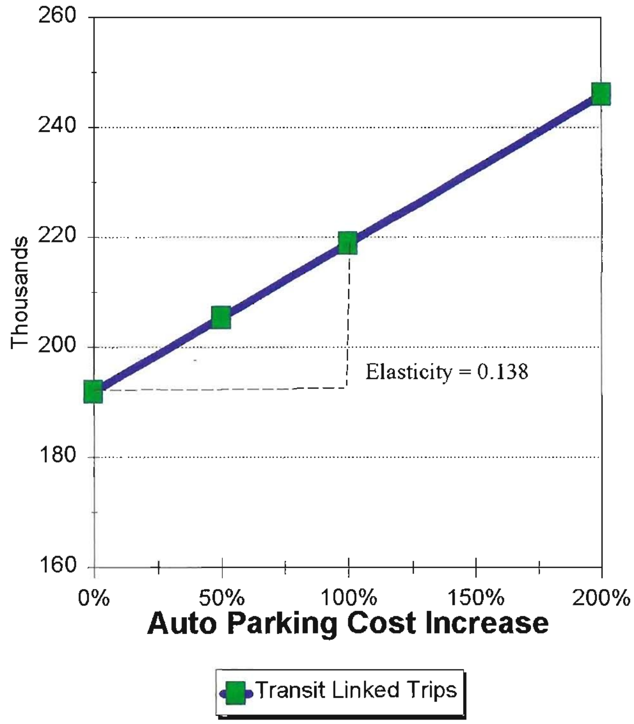
DA -Drive Alone
SR2 -Shared Ride with two occupants
SR3+ -Shared Ride with three or more occupants
LB -Local Bus
PM -Premium Modes: Express Bus, Tri-Rail and Metrorail
P&R -Park and Ride to Premium Modes
K&R -Kiss and Ride to Premium Modes

Purpose:

HBW -Home-Based Work trips
HBNW-Home-Based Non-Work trips
NHB -Non-Home-Based trips

Note: Travel times and costs are in minutes and cents, respectively.

Source: "Dade County Transit Corridors Transitional Analysis -- Transit Forecasting Methodology and Results," Technical Memorandum Task 5, Prepared by KPMG Peat Marwick, February 1993.



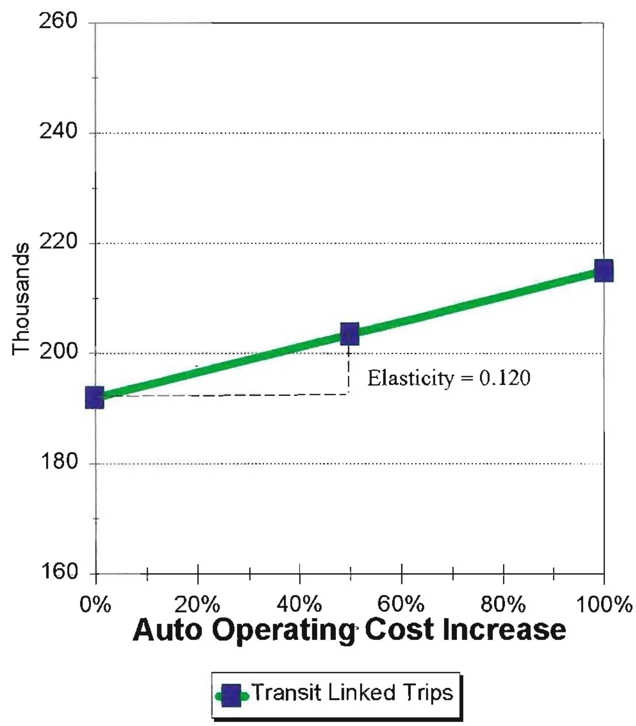
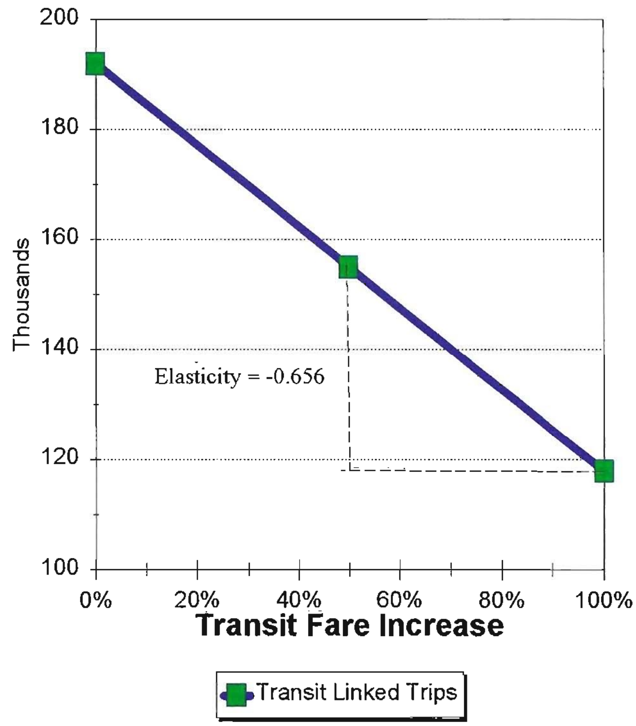


Figure 9.4 Mode Choice Model Transit Sensitivity to Highway Variables



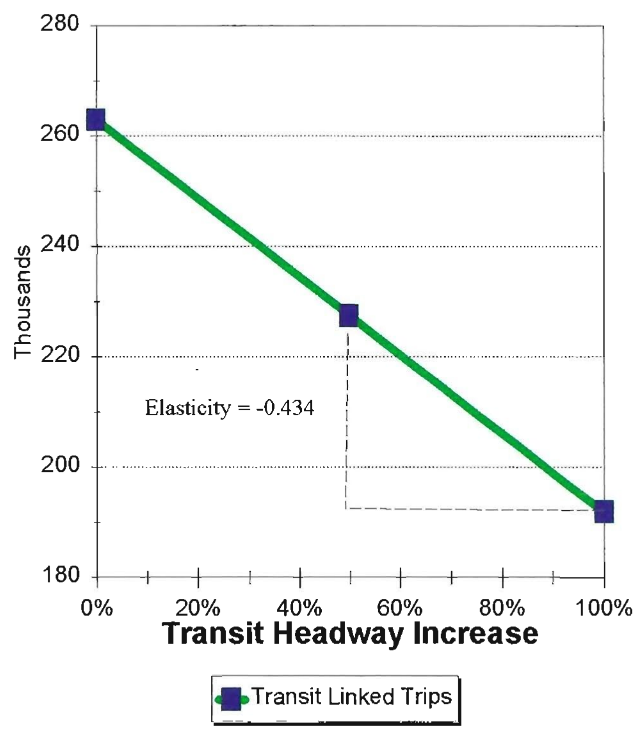
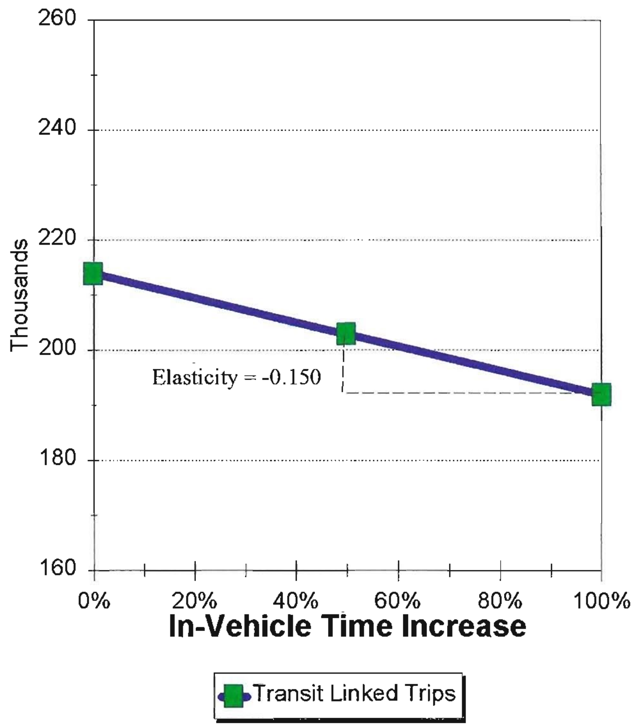


Figure 9.5 Mode Choice Model Transit Sensitivity to Transit Variables



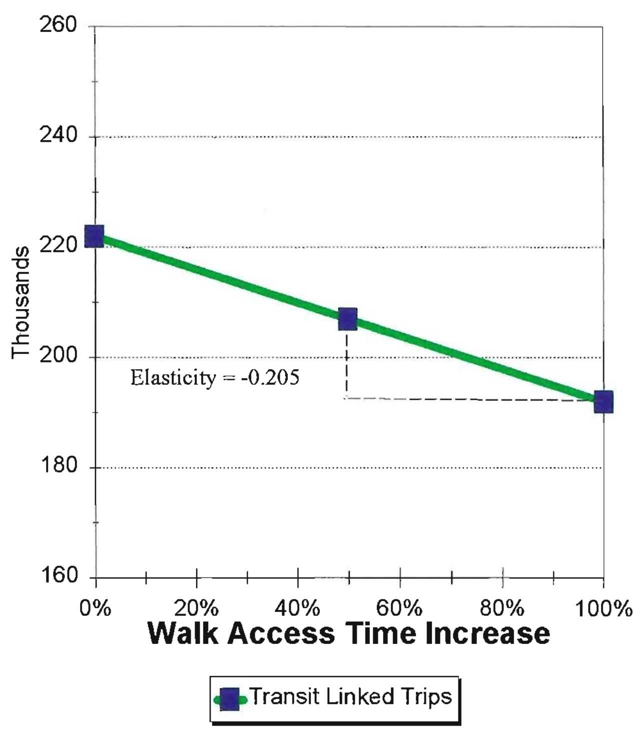


Figure 9.6 Mode Choice Model Transit Sensitivity to Transit Variables (continued)

MIAMI TRANSPORTATION PLANNING MODEL
Table 9.2 1990 MTPM Mode Specific Constants

Mode	Car Ownership Classification	Purpose		
		HBW	HBNW	NHB
Drive Alone (DA)	0-Car Households	0.0000	0.0000	0.0000
	1-Car Households	0.0000	0.0000	0.0000
	2+Car Households	0.0000	0.0000	0.0000
	Downtown Attraction			
Shared Ride 2-Person (SR2)	0-Car Households	1.0885	0.2840	0.6252
	1-Car Households	-0.8972	0.4642	0.6252
	2+Car Households	-1.1483	1.0493	0.6252
	Downtown Attraction	0.5000	0.0000	0.0000
Shared Ride 3+Person (SR3+)	0-Car Households	0.8042	-0.7328	0.4364
	1-Car Households	-1.1121	-0.1624	0.4364
	2+Car Households	-1.3619	1.1276	0.4364
	Downtown Attraction	0.5000	0.0000	0.0000
Walk to Local Bus (LB)	0-Car Households	1.5694	1.4671	-1.3948
	1-Car Households	-0.7243	-1.4655	-1.3948
	2+Car Households	-1.5656	-1.9302	-1.3948
	Downtown Attraction	1.1000	1.1000	1.0000
Walk to Premium (Tri-Rail, Metrorail & Express Bus)	0-Car Households	1.7716	2.1399	-1.0253
	1-Car Households	-0.6415	-0.6964	-1.0253
	2+Car Households	-1.4918	-1.5068	-1.0253
	Downtown Attraction	1.1000	1.1000	1.0000
Park-and-Ride to Premium(Tri-Rail, Metrorail & Express Bus)	0-Car Households	-5.6364	-5.6364	-1.6166
	1-Car Households	-1.3500	-1.3566	-1.6166
	2+Car Households	-1.6993	-2.1385	-1.6166
	Downtown Attraction	1.2000	1.2000	1.1000
Kiss-and-Ride (Tri-Rail, Metrorail & Express Bus)	0-Car Households	-5.6364	-5.6364	-2.1200
	1-Car Households	-1.5749	-1.6667	-2.1200
	2+Car Households	-2.0750	-2.4089	-2.1200
	Downtown Attraction	1.2000	1.2000	1.1000
Walk to Jitney	0-Car Households	1.4964	1.3731	-1.5175
	1-Car Households	-0.6974	-1.3500	-1.5175
	2+Car Households	-1.4462	-1.8853	-1.5175
	Downtown Attraction	1.1000	1.1000	1.0000

trip distribution model, travel patterns by mode are compared with observed patterns as an indicator of overall mode choice model performance.

The mode choice model provides estimates of linked trips by mode. **Table 9.3**, **Table 9.4**, **Table 9.5** and **Table 9.6** present comparisons of observed linked trips by mode for HBW, HBNW, NHB and total trips respectively. Observed mode share estimates are derived from a variety of sources including MDTA ridership data, the Census Transportation Planning Package and the onboard rail surveys. Estimates of mode share compare favorably with observed mode shares for work trips.

9.4 Summary

One of the most significant changes to the Miami Transportation Planning model is the inclusion of a nested logit mode choice model. The nested logit model, adopted from the *Dade County Transit Corridors Transitional Analysis*, calculates the probability of travelers using any one of Dade County's multitude of modal options. This nested logit model reduces one of the recognized shortcomings of other mode choice models, the independence of irrelevant alternatives (IIA).

The calibrated 1990 Miami Transportation Planning Model estimates mode shares based on input from cost and time variables. Based on sensitivity to these variables, the number of person trips attracted to each mode of travel is estimated. Mode choice model estimates of auto and transit mode shares compare favorably with observed values. The MTPM mode choice model should prove useful for long range planning purposes as well as for project level analyses.

MIAMI TRANSPORTATION PLANNING MODEL
Table 9.3 Home-Based Work Mode Choice Summary

			(1) Observed	(2) Estimated	(2)/(1)
AUTO	Drive Alone		1,040,000	104,1000	1.00
	2 Persons		331,000	329,000	.99
	3+ Persons		123,000	124,000	1.01
	SUBTOTAL		**1,494,000**	**1,485,000**	**1.01**
TRANSIT	Walk Access	Premium	19,000	19,000	1.00
		Local	50,000	50,000	1.00
		Jitney	15,000	15,000	1.00
	Auto Access	Park-N-Ride	10,000	10,000	1.00
		Kiss-N-Ride	3,000	3,000	1.00
	SUBTOTAL		**97,000**	**97,000**	**1.00**
TOTAL			**1,591,000**	**1,591,000**	**1.00**

MIAMI TRANSPORTATION PLANNING MODEL
Table 9.4 Home-Based Non-Work Mode Choice Summary

			(1) Observed	(2) Estimated	(2)/(1)
AUTO	Drive Alone		653,000	635,000	.97
	2 Persons		1,534,000	1,544,000	1.01
	3+ Persons		769,000	772,000	1.00
	SUBTOTAL		**2,956,000**	**2,931,000**	**1.00**
TRANSIT	Walk Access	Premium	9,000	9,000	1.00
		Local	51,000	53,000	1.04
		Jitney	10,000	12,000	1.20
	Auto Access	Park-N-Ride	2,000	2,000	1.00
		Kiss-N-Ride	1,000	1,000	1.00
	SUBTOTAL		**73,000**	**98,000**	**1.05**
TOTAL			**3,029,000**	**3,029,000**	**1.00**

MIAMI TRANSPORTATION PLANNING MODEL
Table 9.5 Non-Home Based Mode Choice Summary

			(1) Observed	(2) Estimated	(2)/(1)
AUTO	Drive Alone		483,000	478,000	.99
	2 Persons		981,000	954,000	.97
	3+ Persons		506,000	541,000	1.07
	SUBTOTAL		**1,970,000**	**1,973,000**	**1.00**
TRANSIT	Walk Access	Premium	4,000	5,000	1.25
		Local	29,000	27,000	.93
		Jitney	4,000	4,000	1.00
	Auto Access	Park-N-Ride	1,000	1,000	1.00
		Kiss-N-Ride	0	0	0
	SUBTOTAL		**38,000**	**37,000**	**.97**
TOTAL			**2,009,000**	**2,009,000**	**1.00**

MIAMI TRANSPORTATION PLANNING MODEL
Table 9.6 All Purposes Mode Choice Summary

			(1) Observed	(2) Estimated	(2)/(1)
AUTO	Drive Alone		2,177,000	2,154,000	.99
	2 Persons		2,846,000	2,827,000	.99
	3+ Persons		1,397,000	1,437,000	1.03
	SUBTOTAL		**6,420,000**	**6,418,000**	**1.00**
TRANSIT	Walk Access	Premium	32,000	33,000	1.03
		Local	130,000	130,000	1.00
		Jitney	29,000	31,000	1.07
	Auto Access	Park-N-Ride	13,000	13,000	1.00
		Kiss-N-Ride	4,000	4,000	1.00
	SUBTOTAL		**208,000**	**211,000**	**1.01**
TOTAL			**6,628,000**	**6,629,000**	**1.00**

CHAPTER 10

TRANSIT ASSIGNMENT

10.0 Introduction

Transit assignment is the process of allocating transit trips estimated in the mode choice model to the transit network. Unlike trips estimated during the mode choice step, assigned transit trips can be identified by all modes which they must use to get to a destination. For example, a trip that uses walks to an express bus stop, goes to the Miami Downtown area, and transfers to the Metromover will show up as two trips in transit assignment summaries. Transit trips are measured by route and represent unlinked trips by mode. Transit trips are allocated independently of highway trips. The relationship of the transit assignment module to the FSUTMS model chain is shown in **Figure 10.1**.

10.1 Transit Ridership

Daily transit assignments by trip purpose are used for the MTPM. the home-based work trips are assigned to the peak period, or AM network. This network contains all the transit service routes and associated characteristics for transit services provided during peak commuting periods. The non-work trips (home-based non-work and non-home based purposes) are assigned to the non-peak, or midday network. This network describes the average off-peak period transit service characteristics typically associated with late morning and afternoon schedules. Transit unlinked trips are summarized by the TASSIGN module based on output from the TNET, TPATH and MODE modules. As explained in the chapter on mode choice, transit trips are estimated for local bus, premium transit with walk/local bus access and all transit with auto access. These three types of transit trips are estimated for both work and non-work trip purposes.

To assign the three different types of transit trips for both work and non-work trip purposes, a total of six transit assignments are necessary. The model assigns the six identified transit trip tables and reports combined ridership by trip purpose. **Table 10.1** summarizes the estimated and observed daily transit linked trips by transit mode. The model estimates daily ridership for local bus

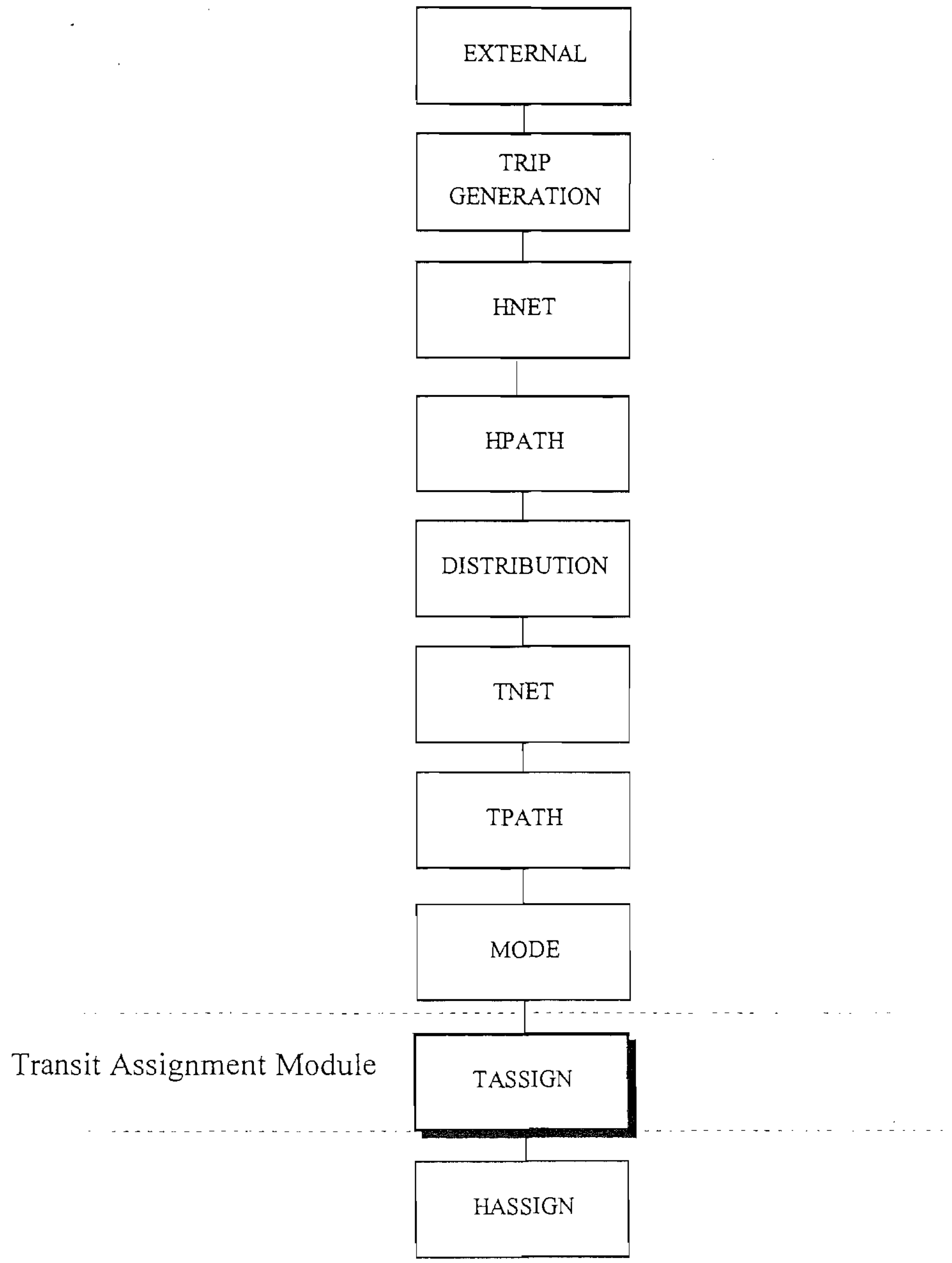


Figure 10.1 Transit Assignment Module in FSUTMS Model Stream

MIAMI TRANSPORTATION PLANNING MODEL

Table 10.1 Transit Assignment Summary

Mode	Estimated			Observed	Estimated/ Observed
	Work	Non-Work	Total		
Bus	112,800	134,800	247,600	203,600	1.22
Metromover	8,200	2,300	10,500	12,100	0.87
Metrorail	34,300	17,600	51,900	46,800	1.11
Total	155,300	154,700	310,000	262,500	1.18

at 247,000. Observed local bus patronage is 204,000 passengers. Local bus is overestimated suggesting that further examination of mode choice sensitivity for transfers may be required. However, some overestimation of transfers was expected since interlining of routes has not been considered in the TNET step.

The model estimates total Metromover mode ridership at 10,500. Observed ridership is 12,100. Bus trips are overestimated while Metromover trips are overestimated because, in part, the specification of the mode choice model does not distinguish between similar modes. Although consistent with Federal Transit Administration guidelines that suggest that transit modes that provide similar service should be estimated together, the over and under estimation of local bus and Metromover trips respectively suggests that independent estimation of each of the available transit modes may be necessary in future model updates.

Metrorail station volumes were compared with average observed boardings. As shown in **Table 10.2**, total estimated volumes approximate total boardings reasonably well. However, station volumes for the south leg of Metrorail are somewhat over estimated while volumes for the north leg are somewhat underestimated. Total estimated volumes for stations in the center of the line most closely match observed boardings. Based upon the Metrorail station evaluation, the model replicates total Metrorail boardings within observed daily variation- the data upon which the station boarding comparison is based vary, depending on the source, by at least ten percent. However, further evaluation and microcalibration of the transit assignment model will be necessary before it is applied for station level analyses such as proposed individual station design and site selection.

10.2 Summary

Overall, the transit assignment process results in estimations of peak season weekday travel by transit. Although the mode choice model accurately estimates mode shares for all of the Dade County's types of transit service, estimates for individual modes vary from observed ridership. As additional data become available, respecification of the mode choice model should be considered so that each of Miami's premium modes can be estimated individually.

MIAMI TRANSPORTATION PLANNING MODEL
Table 10.2 Metrorail Station Loading Summary

STATION	Estimated Volume	1990 Observed	Ratio (Vol/Obs)
Dadeland South	5,413	4,800	1.13
Dadeland North	3,461	4,400	0.79
South Miami	1,551	2,600	0.60
University	782	1,600	0.49
Subtotal	11,207	13,400	0.84
Douglas Road	3,841	2,300	1.67
Coconut Grove	1,887	1,200	1.57
Vizcaya	345	900	0.38
Subtotal	6,073	4,400	1.38
Brickell	3,088	1,800	1.72
Government Center	7,700	10,700	0.72
Overtown	1,174	1,500	0.78
Culmer	748	500	1.50
Civic Center	3,478	4,500	0.77
Santa Clara	1,399	500	2.80
Subtotal	17,587	19,500	0.90
Allapattah	2,720	1,200	2.27
Earlington Heights	1,042	900	1.16
Brownsville	1,071	600	1.79
Martin Luther King	2,558	900	2.84
Subtotal	7,391	3,600	2.05
Northside	2,361	1,600	1.48
Trirail	942	1,100	0.86
Haileah	2,514	1,200	2.10
Ockeechobee	3,828	2,000	1.91
Subtotal	9,645	5,900	1.63
TOTAL	51,903	46,800	1.11

CHAPTER 11
HIGHWAY ASSIGNMENT

11.0 Introduction

As presented in **Figure 11.1**, the tenth module in the standard FSUTMS model chain is highway trip assignment (HASSIGN). The HASSIGN module, by means of an equilibrium assignment process, allocates vehicle trips to the minimum impedance path between each pair of zones in the study area. Evaluation of the highway assignment model is based on comparisons of observed traffic counts to model estimated volumes.

Simulated traffic volumes are compared to traffic counts in several different ways to determine if the coded highway network accurately represents the highway system, and to determine if the assumptions used throughout the model chain to simulate travel characteristics produce reasonable results. The highway evaluation program (HEVAL), developed by FDOT, is the primary tool in comparing the simulated volumes with the traffic counts. A detailed description of this program can be found in the FSUTMS procedure documentation, Task D: Develop Standardized Systems Evaluation Model, October, 1981.

11.1 Traffic Counts

As outlined in *Technical Report Number 1*, traffic counts for the Miami Transportation Planning Model (MTPM) were identified through a variety of sources. These counts provide the basis for highway assignment evaluation. Counts are input into the model as a link attribute.

A key to a successful highway model validation is that accurate traffic counts are available in sufficient quantity. During the 1990 Miami Transportation Planning Model (MTPM) development process, traffic count data were reviewed both before input into the model as well as during model validation. Counts that were inconsistent with historical trends or were otherwise illogical were reviewed to see if a possible explanation might provide insight into potential problems. Most suspect counts could be re-estimated based on trend analyses. However, if no

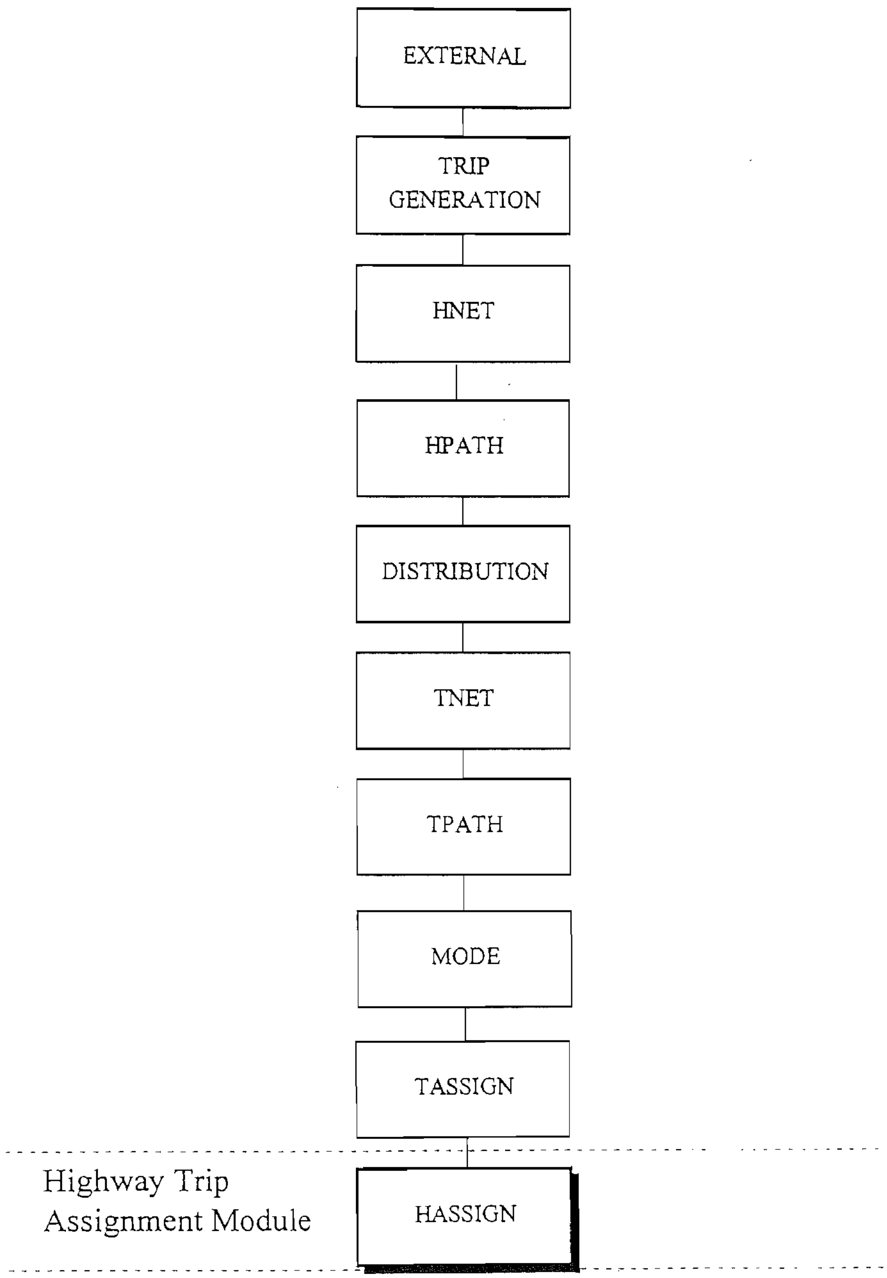


Figure 11.1 Highway Assignment Module in FSUTMS Model Stream

means could be found to reconcile a traffic count with surrounding counts or historical trends, the count was disgarded.

Attempts were made to insure sufficient counts were included in the model for all available area type and facility type combinations. **Table 11.1** and **Table 11.2** present the percentage and number of links with counts for all area type and facility type combinations respectively. A total of 887 links include traffic counts representing 15.6% of the 5,694 links in the highway network. Residential facilities account for over half of the total number of counts in the network. The fewest number of counts in the network are for the CBD area type links. The CBD generally has short link distances and is therefore difficult to measure with conventional traffic counting devices resulting in fewer reliable traffic counts than for other area types. The OBD area type has the highest percentage of links with counts.

11.2 Highway Network Operating Speeds

Comparisons of uncongested and congested highway operating speeds provide reliable indicators of congestion and associated delays. **Table 11.3** presents the summary of uncongested and congested network operating speeds. Post-assignment network speeds reflect a substantial decrease in operating speeds for all facility and area type combinations. In particular, fringe, residential and OBD area type all are substantially effected with each suffering approximately a 25% decrease in average operating speeds due to congestion.

11.3 Model Results

Several indicators are available for determining the overall performance of the highway assignment model. These include volume to count ratios by area type and facility type, screenline volume to count ratios and root mean square error. Each measure estimated versus observed traffic volumes. Results of these comparisons suggest the highway assignment generally reflects observed vehicular traffic patterns.

MIAMI TRANSPORTATION PLANNING MODEL
Table 11.1 Percentage of Links with Counts by Facility and Area Type

	CBD	Fringe	Residential	OBD	Rural	Total
Freeway	0.0%	7.6%	18.4%	16.3%	31.1%	16.8%
Divided Arterial	7.7%	17.4%	21.6%	24.1%	22.4%	22.5%
Undivided Arterial	5.7%	5.9%	15.5%	19.5%	19.1%	15.4%
Collector	0.0%	2.4%	8.2%	11.4%	6.7%	7.7%
AVERAGE	3.3%	7.0%	15.4%	20.0%	16.7%	15.6%

MIAMI TRANSPORTATION PLANNING MODEL
Table 11.2 Number of Links with Counts by Facility and Area Type

	CBD	Fringe	Residential	OBD	Rural	Total
Freeway	0	10	102	34	19	165
Divided Arterial	1	8	163	155	11	338
Undivided Arterial	7	8	143	79	38	275
Collector	0	2	73	23	11	109
TOTAL	8	28	481	291	79	887

MIAMI TRANSPORTATION PLANNING MODEL
Table 11.3 Original Highway Speed vs. Congested Highway Speed

Area Type (AT)	Facility Type (FT)	Original Speed (MPH)	Congested Speed (MPH)
1	1	38.47	35.00
	2	28.12	24.29
	3	26.19	18.18
	4	24.99	18.81
2	1	40.88	31.14
	2	30.39	19.97
	3	29.78	22.35
	4	27.24	24.79
3	1	47.37	36.13
	2	36.78	30.74
	3	35.36	28.52
	4	33.93	30.64
4	1	47.78	37.04
	2	37.36	28.04
	3	37.00	27.88
	4	35.57	27.36
5	1	53.79	43.97
	2	41.37	39.52
	3	40.45	39.73
	4	39.58	39.22

FACILITY TYPE 1: FREEWAY
FACILITY TYPE 2: DIVIDED ARTERIAL
FACILITY TYPE 3: UNDIVIDED ARTERIAL
FACILITY TYPE 4: COLLECTOR

AREA TYPE 1: CBD
AREA TYPE 2: FRINGE
AREA TYPE 3: RESIDENTIAL
AREA TYPE 4: OBD
AREA TYPE 5: RURAL

11.3.1 Aggregate Volume to Count Ratio

Volume to count ratios by area type and facility type provide measures of trip generation as well as trip distribution characteristics of the highway assignment. Volume to count ratios by area type and stratified by facility type are presented in **Table 11.4**. The overall volume to count ratio is lowest for the residential area type. The highest is for OBD. However, the range is from .97 to 1.06 indicating both the extremes are well within expected model performance measures.

11.3.2 Screenlines

In addition to aggregate summaries by area type and facility type, screenline summaries are produced by the highway assignment evaluation module. Screenlines are collections of counts that summarize selected traffic movements. In the MTPM, there are 13 screenlines that describe a variety of movements. Screenline volume to count ratios are presented in **Table 11.5**. **Figure 11.2** identifies screenline locations.

FDOT screenline standards proscribe that screenlines should be within 10% of observed volumes for screenlines with volumes over 50,000 vehicles per day (VPD). Screenlines with less 50,000 VPD should be within 20% of observed traffic volumes. Eleven of the thirteen screenlines are within 10% observed traffic volumes. Screenline thirteen is 16% over estimated volume but is within acceptable limits due the low volume of observed traffic. Only screenline number 7 which describes north/south movements to the south of the Miami International Airport is outside of the desirable range for estimated versus observed volumes as proscribed by FDOT.

11.3.3 Vehicle Miles Traveled and Vehicle Hours Traveled

Assigned volumes multiplied by link distance equals vehicle miles traveled (VMT). Similarly, assigned volumes multiplied by travel time equals vehicle hours traveled (VHT). These are useful measures of system demand and provide insight into other network attributes such as fuel consumption and emissions. **Table 11.6** shows VMT and VHT by facility type and area type. Accounting for over 90% of VMT and VHT are the residential and OBD area type classifications.

MIAMI TRANSPORTATION PLANNING MODEL
Table 11.4 Estimated Highway Volume/Count Ratio by Area Type and Facility Type

Area Type	Facility Type	Estimated Volume	Count	Volume/ Count
1	1	-	-	N/A
	2	37,172	32,130	1.16
	3	114,528	119,004	0.96
	4	-	-	N/A
	SUBTOTAL	151,700	151,134	1.00
2	1	607,918	630,407	0.96
	2	298,110	277,407	1.07
	3	143,318	130,908	1.09
	4	8,228	7,384	1.11
	SUBTOTAL	1,057,573	1,046,106	1.01
3	1	5,310,042	5,501,232	0.97
	2	5,361,597	5,459,401	0.98
	3	2,408,274	2,449,885	0.98
	4	651,921	682,642	0.95
	SUBTOTAL	13,731,835	14,093,160	0.97
4	1	2,309,432	2,318,026	1.00
	2	6,589,638	6,186,547	1.07
	3	1,956,636	1,713,086	1.14
	4	399,037	355,253	1.12
	SUBTOTAL	11,254,741	10,572,912	1.06
5	1	611,790	658,241	0.93
	2	235,797	217,110	1.09
	3	294,267	278,252	1.06
	4	102,389	111,946	0.91
	SUBTOTAL	1,244,243	1,265,549	0.98
TOTAL	1	8,839,182	9,107,906	0.97
	2	12,522,314	12,172,595	1.03
	3	4,917,023	4,691,135	1.05
	4	1,161,571	1,157,225	1.00
	TOTAL	27,440,092	27,128,864	1.01

Facility Type:
1 Freeway
2 Divided Arterial
3 Undivided Arterial
4 Collector

Area Type:
1 CBD
2 Fringe
3 Residential
4 OBD
5 Rural

MIAMI TRANSPORTATION PLANNING MODEL
Table 11.5 Estimated Highway Volume/Highway Count Ratio by Screenline

Screenline Number	Estimated Volume	Count	Volume/ Count
1	544,841	579,461	0.94
2	545,896	605,234	0.90
3	680,979	699,182	0.97
4	759,132	751,128	1.01
5	857,206	804,945	1.06
6	741,999	748,407	0.99
7	975,943	830,701	1.17
8	261,708	281,381	0.93
9	434,373	464,937	0.93
10	498,173	487,444	1.02
11	214,755	214,617	1.00
12	332,290	304,861	1.09
13	55,623	47,985	1.16
SUBTOTAL	6,929,738	6,847,283	1.01
99*	20,020,790	19,791,870	1.01
TOTAL	26,950,528	26,639,153	1.01

* Represents miscellaneous links throughout the area where counts are available.

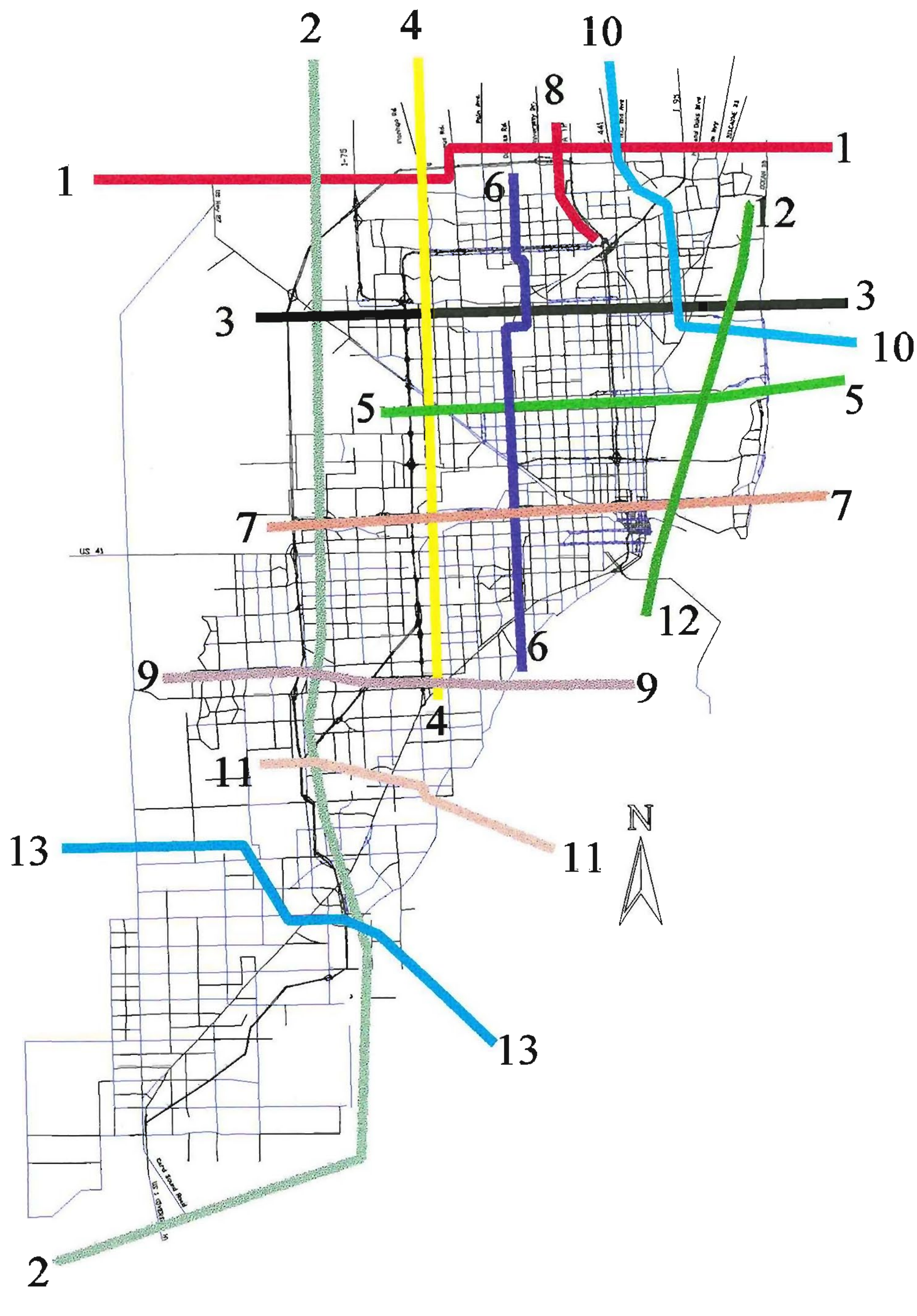


Figure 11.2 Screenline Locations

MIAMI TRANSPORTATION PLANNING MODEL
Table 11.6 Estimated Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT)

Area Type	Facility Type	VMT	VHT
1	1	44,000	1,300
	2	45,000	2,000
	3	109,000	6,400
	4	38,000	2,100
	SUBTOTAL	236,000	11,800
2	1	922,000	27,300
	2	186,000	11,200
	3	233,000	12,400
	4	63,000	2,700
	SUBTOTAL	1,404,000	53,600
3	1	6,569,000	175,400
	2	6,201,000	210,100
	3	3,850,000	144,200
	4	2,220,000	79,800
	SUBTOTAL	18,841,000	609,600
4	1	2,794,000	80,900
	2	5,946,000	226,500
	3	2,059,000	75,800
	4	721,000	29,500
	SUBTOTAL	11,519,000	412,700
5	1	750,000	19,400
	2	241,000	6,800
	3	460,000	12,000
	4	203,000	5,700
	SUBTOTAL	1,654,000	44,000
TOTAL	1	11,078,000	304,400
	2	12,619,000	456,600
	3	6,710,000	250,800
	4	3,246,000	119,900
	TOTAL	33,654,000	1,132,000

Facility Type:
1 Freeway
2 Divided Arterial
3 Undivided Arterial
4 Collector

Area Type:
1 CBD
2 Fringe
3 Residential
4 OBD
5 Rural

11.3.4 Root Mean Square Error

Percent Root Mean Square Error (RMSE), is an aggregate measure of how well the total model chain has been validated relative to traffic counts representing total area wide assignment. Percent RMSE provides a comparison of estimated traffic volumes to observed counts by volume group, of different ranges (i.e.: 0 - 5,000; 5,000 - 10,000; 100,000 - 400,000) that occur for all links for which traffic counts are available. The smaller the percent RMSE in the model, the higher the level of confidence of the model as an indicator of the existing traffic. RMSE is the standard measure of error in a system planning model, such as the MTPM, promoted by the Florida Department of Transportation. A summary of RMSE as well as maximum desirable percent error are presented in **Table 11.7**.

As can be observed from Table 11.7, the overall 1990 MTPM is well below the maximum desirable percent root mean square error established by FDOT. However, on low traffic volume facilities (<5,000 vpd), the percent error is above the established maximum desirable percent error. This is due largely to the limited number of traffic counts on these facilities in combination with traffic count variability in general, and specifically, as found in south Dade County. Future validation efforts will require additional traffic counts for these facilities.

11.4 Summary

Overall highway evaluation measures indicate a high degree of correlation between observed and estimated traffic volumes as forecast by the 1990 MTPM. Input and output model speeds are reasonable and reflect appropriate relationships to one another. Screenline summaries, volume to count ratios by facility type and area type, and root mean square error summaries all indicate the model is a reliable tool for system level transportation planning analyses.

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Table 11.7 Root Mean Square Error (RMSE) Summary

Volume Group	RMSE	Maximum Desirable	Number of Links
< 5,000	62%	55%	249
5,001 - 10,000	42%	45%	364
10,001 - 20,000	33%	35%	565
20,001 - 30,000	23%	27%	223
30,001 - 40,000	17%	24%	41
40,001 - 50,000	20%	22%	36
50,001 - 60,000	14%	20%	19
60,001 - 70,000	22%	18%	11
70,001 - 80,000	15%	17%	22
80,001 - 90,000	12%	16%	11
> 90,001	8%	15%	28
Overall	**28%**	**32-39%**	1,569

CHAPTER 12
RECOMMENDATIONS AND CONCLUSIONS

12.1 Recommendations

While several major enhancements have been included in the Miami Transportation Planning Model (MTPM), there is still room to include some modeling concepts that are now being developed throughout the county. Many of these concepts will require new data to support them before they could be considered for inclusion in the MTPM. Nevertheless, each of the four basic steps of the model can be enhanced as improved data and methodologies become available.

12.1.1 Trip Generation

Ongoing research in Florida indicates that the standard cross-classification trip production model used may be enhanced in coming years. Household trip making characteristics, it has been suggested, may be a function of lifestyle or lifecycle variables. Research in the Tampa Bay area indicates that the employment status of a household as well as the presence or absence of children can have an impact on the type and quantity of trips produced by a household. Other concepts that have been put forth include a measure of trip chaining as well as activity based trip forecasting.

Land use projections play as significant a role in trip forecasting models as the modeling approach. Though Dade County is largely developed, future Updates might benefit from a means of forecasting land use. Research conducted throughout the nation indicates that travel demand models, such as the MTPM, will likely need to consider a link with their land use counterparts, land use allocation models. The primary benefit of this approach is that future land use characteristics assumed in the transportation model will be sensitive to the available transportation infrastructure.

12.1.2 Trip Distribution

Dade County has two characteristics that directly impact trip distribution which are not considered in the MTPM trip distribution model; high transit availability and heavy peak period congestion. Future model validations may consider the use of a composite impedance measure, similar to that used in the Southeast Regional Planning Model-2 (SERPM-2) in concert with congested travel times to estimate trip distribution.

12.1.3 Mode Choice

Mode choice is one of the most quickly evolving modeling subject areas. Promoted by ISTEA, non-motorized modes of transportation are one area not considered by the standard modeling approach. If data become available with which to forecast bicycle and pedestrian demand, future efforts may consider including a mechanism for their estimation.

In addition to including new modes, the understanding of demand for modes currently modeled would be benefitted by local data. While the nested logit model has been added to the MTPM and includes all locally significant travel modes, the coefficients have been borrowed largely from a study conducted in the Minneapolis/St. Paul area. Climate and cultural differences in the Miami area may vary enough from those of Minneapolis to include an original mode choice model estimation based on observed local data in future model updates.

12.1.4 Assignment Modules

Assignment occurs in the MTPM in two discrete steps, transit and highway assignment. Future model update efforts may benefit from recent research into both these processes.

One of the recognized shortcomings of the FSUTMS approach to modeling is that it considers a 24 hour period. While useful for system level planning, many other applications of the model attempt to forecast demand for shorter periods of time. HOV analyses, for example, would benefit from the ability to forecast peak period, if not peak hour traffic. Other model applications, such as forecasts of design hour traffic have similar demands.

The transit assignment models also would benefit from the ability to analyze peak period and/or peak period demand. Additionally, transit assignment process, adopted from UTPS methodologies, may be enhanced by some of the research into revised transit assignment processes.

For example, stochastic transit path estimation may prove useful to refine the transit assignment process so that it can produce estimates of transit travel demand on a route by route basis.

12.2 Conclusions

The 1990 Miami Transportation Planning Model (MTPM) is a specialized tool to help local decision makers forecast future mobility requirements and changes in travel patterns resulting from development. This role mandates that the model yield reliable forecasts and provide insight into all aspects of surface mobility.

The process by which the MTPM is calibrated and refined until it closely replicates actual, observed travel patterns is called validation. The 1990 MTPM, as an update of previous models and studies, includes the most recent data and forecasting methodologies while maintaining the high standards of a long lineage of models. The validation process insures the MTPM uses reasonable and (where possible) empirically collected parameters and data, to replicate 1990 base year conditions.

The modeling software used for the MTPM is the Florida Standard Urban Transportation Model Structure (FSUTMS). FSUTMS is an adaptation of TRANPLAN travel demand modeling software that is standardized for use throughout Florida. Though FSUTMS provides a standard structure for travel demand models, it maintains flexibility to incorporate enhanced procedures and new data. The role of the Metro-Dade Metropolitan Planning Organization, as one of the traditional leaders in FSUTMS innovations and enhancements, continues in this study. Though the MTPM is based on the 1986 MUATS model, several major efforts were undertaken to enhance the long range planning model based on recent data and studies.

First, data became available from the 1990 Census of Population and Housing. These data were the foundation for 1990 base year demographic inventories as well as 2015 projections. Second, recent studies added a different mode choice model to the MTPM. The Miami nested logit model was first developed and adopted for the Transitional Corridors Study. It was later refined for use in the East-West (SR 836) Multi-Modal Corridor Study and was subsequently adapted for the MTPM. The nested logit model builds on the multi-path, multi-period model originally developed for an earlier MUATS study by replacing the walk access to transit, auto access to transit, and mode choice model with the latest focus in mode choice model formulation.

Unique local conditions and policy questions are reflected in the MTPM. As part of the updated mode choice model, the MTPM now considers private transit (jitney) service in competition with public transit. The MTPM also has the ability to forecast demand for high occupancy vehicle (HOV) expressway facilities. Many of the improvements to the existing expressways in Dade County will be in the form of HOV lanes. As part of this Update, the MTPM includes the ability to identify daily demand for HOV lanes. Another major enhancement to the model is the replacement of its external trip handling routines. As Dade County and Broward County grow together, travel patterns for external travelers become similar to those of travelers who remain in Dade County. The result is that the MTPM now considers external travel demand based not only on the characteristics of Dade County, but also on the characteristics (and growth) of the entire Southeast Florida area.

The combination of new data, new methodologies, and an understanding of the history of planning studies and models in Dade County yields a model with the highly desirable qualities of a good validation and the tools to answer the tough questions put forth by policy makers. The enhanced MTPM is a useful tool that will continue to play an integral part in the long range plan development process.