■ 論 文 ■

Estimating Walk Access and Auto Access Ridership for Transit Demand Forecast

대중교통수요예측을 위한 보행접근 및 승용차접근 잠재수요의 추정

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요 약

본 연구에서는 대중교통 수요예측과정에서 교통존(TAZ)내의 거주인구, 직장인 등 대중교통이용가능 잠재수요 추정을 개선하기 위한 새로운 방법이 제시되었다. 대중교통을 이용하기 위해서는 보행 또는 승용차(Park & Ride or Kiss & Ride)로 대중교통에 접근하는 바, 제시된 방법이 보행에 의한 대중교통 잠재수요 및 승용차에 의한 대중교통 잠재수요를 추정하는 데 있어 기존의 buffer method 및 network ratio method보다 합리적이고 개선된 방법임을 보여주고 있다. 본 연구에서 제시된 방법은 교통수단선택모형(mode choice model)의 적용과정에서 대중교통 수요예측을 개선할 수 있을 것으로 기대된다.

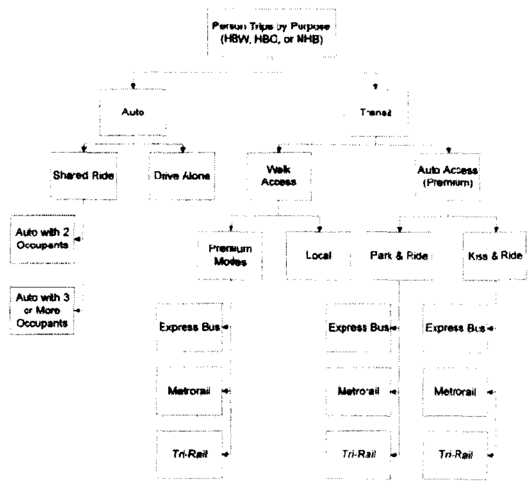
Ⅰ. Introduction

The residential population and number of employees within walking distance of transit stops or routes have long been considered significant contributing factors of transit use. Traditional methods to estimate the potential transit ridership are based on the buffer zone analysis, which assumes that population and employment are evenly distributed throughout a traffic analysis zone(TAZ). Several studies have shown that the buffer analysis method usually overestimates the accessibility to transit, resulting in inaccurate transit ridership forecasts.

The purpose of this study is to develop a method more accurate than the traditional buffer method for estimation of population and employees that have access to transit services. Also of interest is if any new measures developed will have predictive power on transit use. The development of methods for estimating transit service population and employees will be presented in this paper. The goal is to recommend the new method that may be incorporated into the Florida Standard Urban Transportation Model Structure(FSUTMS) modal split procedure to improve its transit forecasting capability.

The FSUTMS mode choice model employs Nested Logit Model which consists of a nested structure as illustrated in ⟨Figure 1⟩. In the primary nest, total person trips are divided into Auto trips and Transit trips. In the secondary nest, the auto trips are split into Drive Alone trips and Shared Ride trips, and the transit trips are split into "Walk Access" trips and "Auto Access" trips. In the third nest, shared ride trips are further divided into One Passenger and Two+ Passengers. On the transit side, the walk access trips are split into Local Bus trips and Premium Modes trips, and the auto access trips are divided into Park-and-Ride trips and Kiss-and-Ride trips.

This paper presents methodologies for estimating transit accessibility in terms of population and



⟨Figure 1⟩ FSUTMS Nested Logit Mode Choice Model Structure

employees served by transit. These estimates will be used to determine the "Walk Access" transit trips and "Auto Access" transit trips in the FSUTMS Nested Logit Model. For "Walk Access", the percentage walk file(PCWALK) in the FSUTMS Nested Logit Model is used as the input file that designates the availability of walk access to the transit network. It identifies, on a percentage basis, the short- and long-walk access available to the transit system for each TAZ on a percentage basis. For "Auto Access", the STATDATA file is used. It contains the characteristics of transit station/stop information for the fixed guideway systems, the park-and-ride(PNR), kiss-and-ride(KNR) lots and major transit centers. This file is the basic inputs for building auto access connection from each zone to one or more stations or PNR lots. The analysis results are compared with those from the traditional buffer method as well as the network ratio method. This paper is organized into following sections:

- An overview to obtain a good understanding of the current state-of-the-art and state-of-the-practice in estimating transit accessibility in terms of potential transit ridership(population and employment) for transit ridership forecasting;

- Development of a standard procedure of estimating population accessibility to transit that can be used to determine transit demand;
- Development of a standard procedure of estimating employee accessibility to transit that can be used to determine transit demand;
- Development of a standard procedure of estimating percentages of trip ends(productions and attractions) with transit accessibility;
- Development of a standard procedure of estimating auto accessibility to transit that can be used to determine transit demand;
- Discussions and practical recommendations with regards to incorporating improvements into FSUTMS.

II. Transit Accessibility: An Overview

Accessibility has been recognized as one of the most important factors that affect both land use and travel behavior. How to define and measure accessibility has attracted the attention of many researchers and many forms of accessibility measures have been developed, which Richardson and Young (1982) classified into a spectrum of accessibility measures as shown in ⟨Table 1⟩. "*Opportunity Accessibility*" is the measure used in this study, which is defined as number of opportunities(e.g., population, employees, etc.) reachable within a predefined distance or travel time.

A critical factor in transit planning and modeling is the level of accessibility to transit services by population and employment. "Transit accessibility" here refers to the ability of residents and workers to reach transit facilities, including bus stops and/or rail stations. Transit accessibility is affected by many factors including safe, pleasant, and comfortable streets for walking to transit facilities, parking facilities for cars and bicycles, handicap access, and so on. The majority of transit users access transit systems by walking. Walking distance is an important factor in the choice of transit use. The TOB(Transit On-Board) survey results indicated that individuals walk for over 75% of all trips from point of origin to transit station and from station to destination.[1] It is commonly accepted that most people are willing to walk up to 0.25 mile to use transit, and the farther away from the transit stops/stations, the less likely it is for people to use transit. In this context, easy

⟨Table 1⟩ Accessibility Measures

Accessibility Measures	Features
Opportunity accessibility	Number of opportunities(e.g., population, employees, etc.) reachable within a predefined distance or travel time
Modal accessibility	The degree of connectivity of two places depending on the modes available.
Temporal accessibility	Accessibility varying during different time periods(e.g. transit service is available only part of a day).
Topological accessibility	Indicates if two points are connected by a transportation link
Legal accessibility	Limitations or restrictions to accessibility by legal or regulatory rules(e.g. special permits issued to allow access to a certain area, one-way traffic rules, and denial of access to the transportation system to certain population groups).
Place accessibility	Only spatial separation between one place and other places accounted for
Gravity type measures	Sum of opportunities weighted by travel time or cost
Logit model log-sum term	Based on Logit model, log-sum of expected value of the maximum utility to be gained in destination choice situation

1) The TOB survey results showed that 79.8% of the 4,152 surveyed trips involved walking to transit stops/stations from an origin, while 75.2% of the 4,159 trips involved walking to destinations after leaving the transit systems.

access to transit means proximity.

Typically, transit accessibility is estimated using the geographic information system(GIS) buffer method to calculate the proportion of population or employees that are close to transit facilities such as bus stops or rail stations. The buffer method assumes that population and employment are evenly distributed across the spatial unit of analysis, usually in terms of traffic analysis zones (TAZs), census tracts, or block groups. Buffers around transit stops or stations are then created with a given size and are defined as the "service area". The percentage of population and employment that have access to transit facilities in a zone is assumed to be the same as the ratio of the buffer area falling within the zone to the total area of the zone. Therefore, if a zone has a population of 1,000 and buffers created around transit stops/stations cover 20% of its total area, the proportion of the population that is served by transit, or the service population, is assumed to be 1,000× 20%=200. Everything else being equal, the larger the proportion of population and employees that fall in the service area, transit is more accessible, and it is more likely that transit ridership will be higher.

The buffer method, while used in FSUTMS as well as widely used by transit properties in their planning applications, is flawed in its fundamental assumption that population or employment in a zone is evenly distributed across the zone. In reality, this assumption only holds occasionally when land use in a zone is uniform with the same density. In most cases, a zone may have the same land use but density varies, or it may have different land uses with significant variations in density. Another problem with the buffer method is the assumption that the walking distance for a transit user accessing a transit stop or a station is the same as Euclidian distance(also referred to as straight line or air distance). The actual walking distance is, in fact, usually longer due to the "crookedness" of streets. A person may live near a transit stop; however, if no streets or walking paths connect his or her residence to the transit stop, the person does not have access to that transit stop. Other problems that cannot be handled by the buffer zone method include natural or man-made barriers such as highways with limited access, canals, and community walls or fences that surround a development that prevent people from accessing transit facilities in a direct manner.

Recognizing the problems underlying the buffer method, various researchers have looked for ways to improve the estimation of the transit service population. O'Neill et al.(1995) developed the network ratio method, which assumes pedestrian travel occurs on streets, therefore lines of equal travel time or distance were constructed around a transit line defining its service area. Additionally, it is assumed that population is evenly distributed along streets. Therefore, the proportion of population within the transit service area was calculated as the ratio of total length of streets that are within the 1/4-mile walking distance to that of all streets.

The network ratio method would perform well in an area with a single density residential development(e.g. single family or multi-family housing), but could not account for land uses with different densities and could not handle barriers. In order to improve the network ratio method, Zhao(1998) considered the population distribution in areas that include single- and multi-family land use. The effect of barriers was also investigated. Land use data were helpful in better depicting the population distribution, especially in cases when multi-family housing was concentrated in areas close to transit stops and that barriers could have significant negative impact on transit accessibility.

Ⅲ. Estimation of Population Walk Access Ridership

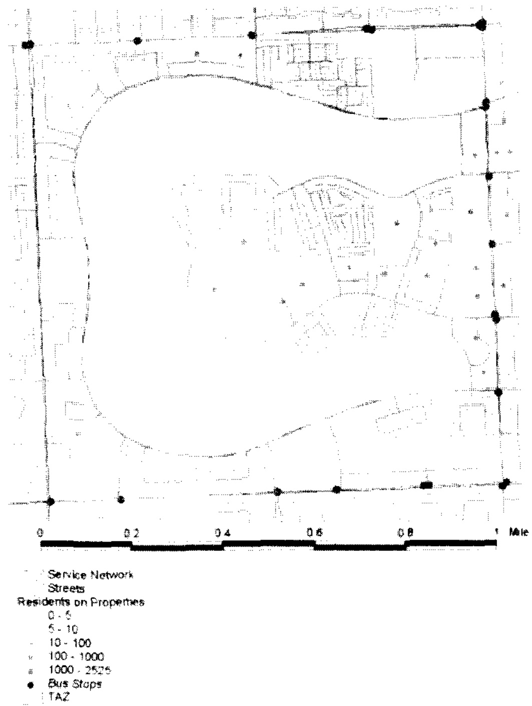
One problem associated with the network ratio method was the assumption that properties were evenly distributed along all streets. However, some streets do not have properties on them, such as when it is merely an access road into a community or when there is a barrier like a community wall along one side or both sides of the street.

To address the issue of population distribution, more detailed information on the spatial distribution of dwelling units than land uses is desired. Such information can be obtained if parcel level GIS data are available. For the purpose of calculating the walking distance from a property to a transit stop, parcel boundary data are not necessary. Only a point representing the location of a property is needed.

The Miami-Dade County's property tax database provides detailed information on each property, including the number of bedrooms. While we do not have information on the household size for each residential property, the number of bedrooms in a dwelling unit may be considered a proxy indicator of the household size, which allows for a better estimation of population distribution.

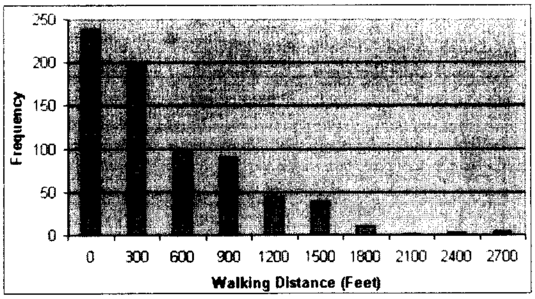
To determine on which street a property is located requires matching that property's address with a street using GIS. This, in turn, requires that addresses in the property tax database and the street attribute database must be formatted in a consistent manner. The following steps describe the methodology for estimating population with walk accessibility to transit services.

- **Step 1**: Based on the transit stop locations, a transit service catchment area was determined by identifying street segments that were connected to a bus stop and were within a distance of 0.5mile of the bus stop. Here, "within a distance of 0.5mile" means the walking distance along streets starting from a bus stop. An example of the transit catchment area is shown in 〈Figure 2〉, together with the street network, bus stop locations, and location of properties. The size of a point representing properties indicates the estimated number of residents at that location. Expressways, freeways, and ramps have been excluded from the street network since pedestrians are not able to use them.

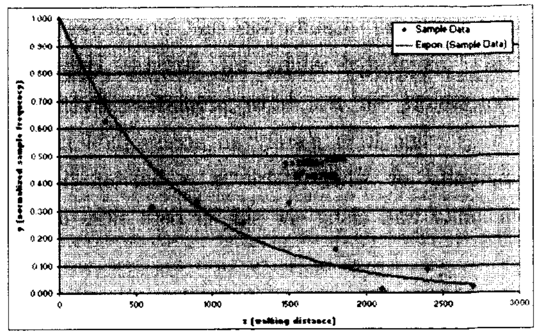


〈Figure 2〉 Transit Catchment Area, Streets, and Property Distribution

- **Step 2**: The street network in the catchment area was intersected with TAZ to assign street segments to each TAZ.
- **Step 3**: Using the TAZ population information from ZDATA1 file, which included single-family and multi-family population, the average household sizes for the two types of residential properties (single- and multi-family) were calculated.
- **Step 4**: The average household sizes within a TAZ, calculated in Step 3, were then used to estimate how many people might live on each property.
- **Step 5**: Match residential properties in the property label point(LPROP) file with street segments based on their addresses. To do so,



〈Figure 3〉 Frequency Distribution of Transit Trips versus Walking Distance



〈Figure 4〉 Estimation of the Decay Function

address formats in both street network and property database were standardized.

- **Step 6**: Determine the negative impact of walking distance on transit accessibility. The TOB survey data have indicated that the number of transit users decreases with the increase in walking distance to transit stops. 〈Figure 3〉 shows the distribution of survey samples from the transit-onboard survey based on walking distance from or to home.

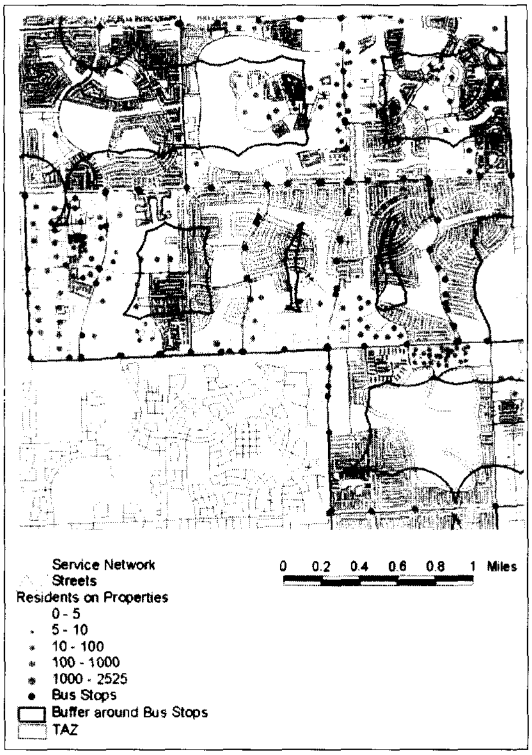
To reflect the deterioration of transit use due to increasing walking distance to transit services, a decay function was estimated based on the data from the transit onboard survey when the TAZ's population within walking distance was calculated. The procedure for estimating the decay function is described below.

(1) Select samples of transit users walking to transit stops from their homes or walking to their homes from transit stops from TOB survey data.
(2) Calculate the walking distances from the homes of those transit users to the closest transit stops based on shortest path algorithms.
(3) Calculate the frequencies of the samples based on walking distances based on equal intervals with a minimum five samples in each interval.
(4) Normalize the frequencies by the population living within each interval contour. To estimate the population living inside each interval contour, the walking distance between each property and the closest transit stop was calculated based on network analysis.
(5) Fit the weighted frequency with an exponential curve. The decay function has the following form: Decay function=exp(-0.0013 x), where x is the walking distance from a transit stop. The fitted curve is shown in 〈Figure 4〉.

- **Step 7**: The total population served by transit in a TAZ was obtained by summing the estimated household size along the street segments in the catchment area within 0.5 mile of walking distance, weighted by the decay function.
- **Step 8**: The percentage of population with walk access to transit services in a TAZ was the ratio of the total population served by transit in the TAZ to the total population in the TAZ.

To compare the result from the above procedure with those of the traditional buffer method and the network ratio method, a 0.25 mile buffer size and walking distance were assumed and a selected area was examined(see 〈Figure 5〉). For the area shown in 〈Figure 5〉, the populations served by transit based on each of the three methods are compared in 〈Table 2〉.

It may be seen that while the network ratio method in most cases results in a reduction in



〈Figure 5〉 Transit Catchment Area, 0.25 mile Buffer, Streets, and Property Distribution

the service population when compared to the buffer method, the distance decayed method reduces the service population significantly and consistently, a result due mainly to the application of the decay function.

Ⅳ. Estimation of Workers' Walk Access Ridership

Currently in FSUTMS, workers' accessibility to transit services is estimated by the buffer method with some modification based on the consideration that most commercial developments are located near the main streets where transit services are provided. Improving the estimation of workers' access to transit services requires that location of employers and size of employment at each establishment be known.

One possible improvement to the estimation of employment accessibility to transit may be by using the land use(employment type) GIS data, which provide information of spatial extent of employment. Miami-Dade County has land use (employment type) GIS data created based on parcel data. 〈Table 3〉 establishes the equivalency between the employment type and the FSUTMS employment category.

The percentage of a given type of employment (industrial, commercial, and service) with access

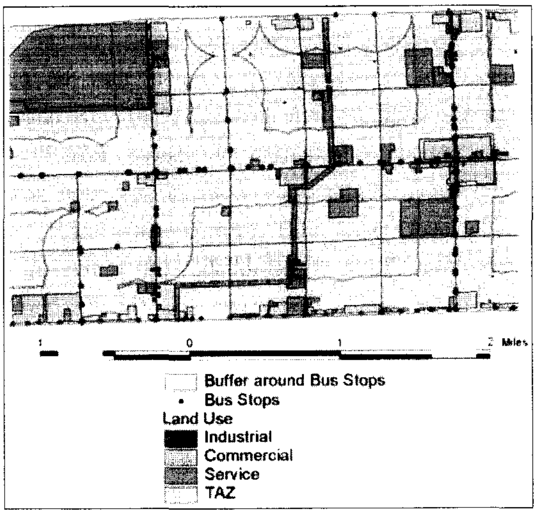
〈Table 2〉 Comparison of Transit Service Population(1/4-Mile Distance)

TAZ	Population	Buffer Method (1)		Network Ratio Method (2)		Distance Decayed Method (3)		Difference(%)	
		Pop. Served	%	Pop. Served	%	Pop. Served	%	(3)-(1)	(3)-(2)
867	4550	4550	100.0	3655	80.3	1490	32.8	-67.2	-47.6
870	5045	4918	97.5	2643	52.4	1210	24.0	-73.5	-28.4
873	2935	2034	69.3	1424	48.5	634	21.6	-47.7	-26.9
874	3070	2257	73.5	1302	42.4	724	23.6	-49.9	-18.8
875	1524	1296	85.0	1385	90.9	552	36.2	-48.8	-54.7
876	2527	2409	95.3	2033	80.4	677	26.8	-68.5	-53.6
877	3741	3537	94.6	1387	37.1	806	21.5	-73.0	-15.5
878	1211	1026	84.8	624	51.5	199	16.4	-68.4	-35.1
879	1938	1689	87.1	1282	66.1	596	30.8	-56.4	-35.4
880	1696	1604	94.6	785	46.3	326	19.2	-75.4	-27.1
881	1367	1312	95.9	703	51.4	245	17.9	-78.0	-33.5
882	1119	942	84.2	299	26.7	147	13.1	-71.0	-13.6
Total	30723	27574	89.8	17520	57.0	7605	24.8	-65.0	-32.3

〈Table 3〉 Employment Type and FSUTMS Employment Category

Employment Type	FSUTMS Employment Category
Agriculture, Industrial, Industrial Extraction	Industrial
Office, Airports/Ports, Communications, Utilities, Terminals, Plants, Institutions	Service
Shopping Centers, Commercial, Stadiums, Tracks	Commercial

to transit service in a TAZ was estimated as the ratio between the area of the corresponding land use that fall within the transit buffer and the total area of that land use in the TAZ. In this calculation, workers of each type were assumed to be evenly distributed in areas of the corresponding land use. 〈Figure 6〉 illustrates that for TAZs that do not fall into the 0.25 mile buffer of the bus stops, it is possible that some of the workers will not have transit access.



〈Figure 6〉 Transit Buffer and Distribution of Non-residential Land Use

〈Table 4〉 Cumulative Percentages of Transit Trips by Walking Distance

Walking Distance(ft)	Number of Samples	%	Cumulative %
0~100	71	10.36	10.36
100~200	309	45.11	55.47
200~300	100	14.60	70.07
300~400	38	5.55	75.62
400~500	41	5.99	81.61
500~1000	92	13.43	95.04
100~1320	17	2.48	97.52
〉 1320	17	2.48	100.00
Total	685	100.00	100.00

The choice of 0.25 mile buffer size was based on the TOB survey data, which showed that 97.5 of the transit trips were with 0.25 mile of a transit stop/station for non-home-based trips. 〈Table 4〉 gives the cumulative percentages of transit trips from the TOB survey by walking distance.

Ⅴ. Estimation of Percentages of Trips with Transit Accessibility

In Section 3, transit service population, defined as people that are likely to use transit within the transit catchment area, has been estimated using the detailed street network to calculate walking distance and property information to estimate population distribution in a zone. In this section, the number of trips in a zone that may be made by transit mode is considered.

In FSUTMS, the transit walk accessibility in a zone is estimated as the percentages of trips within a short walk distance of 1/3 of a mile and a long walk distance of one mile. The buffer method is applied to create buffers of 1/3 of a mile and one mile around transit routes. With the assumption that trips are evenly distributed throughout a zone, the percentage of the area of a zone covered by the buffer area becomes the percentage of trips that are candidates for transit mode.

To convert the percentage of population with walk access to transit stops to the percentage of trips that may have a walk link to transit, the production trips must be first split between single-family and multi-family households. Trips by household type can then be assigned to each household according to the household size. The five-step procedure is described below.

- **Step 1**: Split production trips between single-family and multi-family households.
- **Step 2**: Assign Home-Based Non Work(HBNW) trips to single-family households by household size. The HBNW trip purpose includes the trip purposes of HBSHOP(Home-Based Shop), HBSOC (Home-Based Social-Recreation), HBSCH(Home-Based School), and HBO(Home-Based Other).
- **Step 3**: Assign HBNW trips to multi-family households by household size.

To assign trips to these records, the number of households and the average household size in these complexes must be estimated. From the survey data, the average household size was derived for different complex types:

MF Housing Type	Average Household Size
Duplex	2.66
Apartment	2.32
Condo	1.81
Mobile Home	2.51

The number of units of each complex was determined by dividing the number of residents by the average household size.

- **Step 4**: Assign Home-Based Work(HBW) trips to single-family households by household size.
- **Step 5**: Assign HBW trips to multi-family households using the same method as for single-family households.

⟨Table 5⟩ illustrates for the same TAZs as in ⟨Table 2⟩ the differences in percentage of population served and percentages of trips served by transit. For the trip purposes considered, including HBW and HBNW purposes, these percentages were virtually the same. These small differences may be explained by the fact that household size is the main variable based on which the spatial distribution of trips is determined, as in the case of population. Therefore, we may conclude that without detailed information of the spatial distribution of households of different types as specified in the FSUTMS trip generation model, the population estimate may suffice and an estimation of percentage of trips with transit service area may be unnecessary.

⟨Table 5⟩ Comparison of Percentage of Population and Percentage of Trips Served by Transit within a 0.5Mile Distance

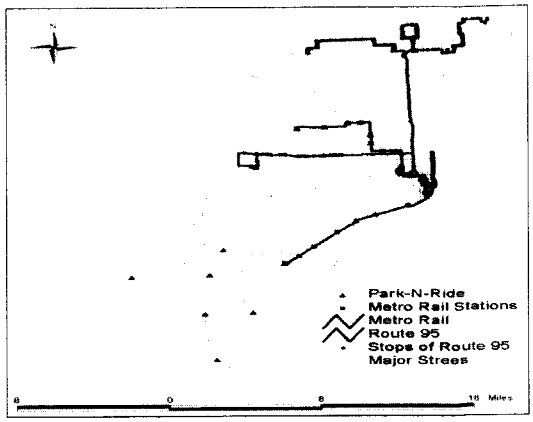
TAZ	Population	Pop. Served	%	HBW Trips	HBW Trips Served	%	HBNW Trips	HBNW Trips Served	%
867	4550	1514	33.3	4033	1308	32.4	2052	6384	32.1
870	5045	1426	28.3	4296	1192	27.7	1838	6672	27.5
873	2935	795	27.1	2478	643	25.9	994	3929	25.3
874	3070	816	26.6	2619	717	27.4	1150	4202	27.4
875	1524	568	37.3	879	323	36.7	603	1645	36.6
876	2527	735	29.1	1469	414	28.2	781	2776	28.1
877	3741	1128	30.1	2603	781	30.0	1437	4782	30.0
878	1211	244	20.2	1209	245	20.3	509	2503	20.3
879	1938	659	34.0	1933	664	34.4	1385	4023	34.4
880	1696	412	24.3	1678	405	24.1	853	3508	24.3
881	1367	317	23.2	1482	342	23.1	681	2939	23.2
882	1119	205	18.3	1210	222	18.3	444	2418	18.4
Total	30723	8819	28.7	25887	7257	28.0	12724	45781	27.8

Ⅵ. Estimation of Auto Access Ridership

Some transit users access transit stations/stops by automobiles. In FSUTMS, a certain distance (e.g., 10 miles) is assumed to be the distance limit for auto access. Here we examine the auto access mode in terms of distance traveled by auto and the distance traveled by transit. For this purpose, the TOB survey data collected in Miami-Dade County were used. Survey samples were selected based on the following criteria:

- The sample involved a tour that began or ended at home.
- The sample involved the use of automobile to access transit station/stop at the home end of the tour. The transit user could be a driver or a passenger during the trip to a transit stop/station by car.
- The origin and destination of the tour were geocoded.
- The non-home end of the tour was accessed by walk mode.

Here a transit tour means a series of trips that begin at the home and end at a non-home destination, or vice versa, with one or more trips accomplished using transit. The last condition was to ensure that the transit trip length could be estimated. It was assumed that a transit user would not switch to a non-transit mode before completing all trip segments that involved the use of transit. (Any walking occurring during transfers was assumed to be short and negligible). If the user did not access the non-home-based end of a tour by walk mode, it would be impossible most of the time to determine where the transit user completed the transit portion of the tour. On the other hand, if the non-home end of the tour was accessed by walk mode, the walking distance was reported in the survey, and the transit tour length could be estimated. To estimate the auto access distance,

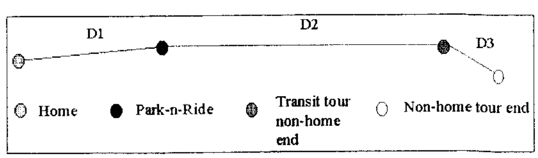


〈Figure 7〉 Metrorail Alignment, Bus 95 Routes, an Park-n-Ride Sites

park-n-ride locations were geocoded.

The length of the auto access trip and the length of the transit portion of the tour(D1 as shown in 〈Figure 8〉) were estimated as follows. Since the survey samples did not provide information as to which park-n-ride site the transit user drove to or was dropped off, it was assumed that the closest park-n-ride site to a user's home was the one that was used. Therefore, the auto access trip length was the shortest network distance between home and the closest park-n-ride location. The walking distance was estimated as the shortest distance from a Metrorail station or a 95 express bus stop in downtown to the non-home tour end (D3 in 〈Figure 8〉). The transit tour length(D2 in 〈Figure 8〉), which could include several linked transit trips if transfers were involved, was calculated as the route distance between the park-n-ride site and the transit tour non-home end. The tour might involve the use of multiple transit routes.

〈Table 6〉 provides the auto access distance, the transit trip distance, the walk access distance,



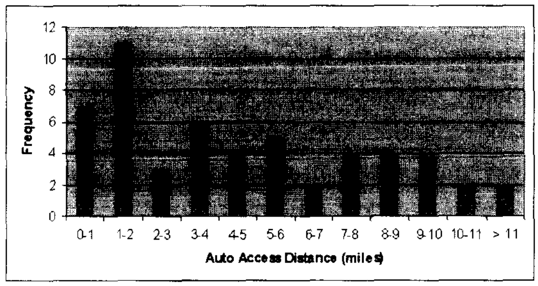
〈Figure 8〉 Transit Tours

〈Table 6〉 Home-Based Transit Linked Trips

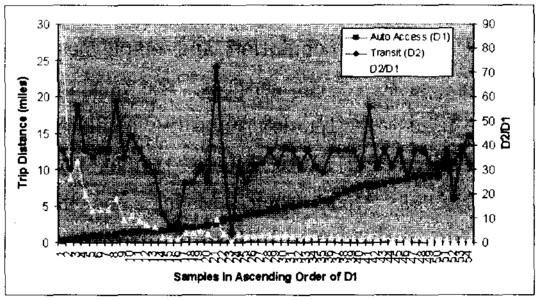
ID	D1 (mile)	D2 (mile)	D3 (mile)	D2/D1
51385	2.548	24.114	0.053	9.464
50512	1.057	19.455	0.055	18.410
51351	0.564	18.866	0.539	33.455
51395	7.730	18.589	0.187	2.405
50310	1.349	14.673	0.401	10.879
50478	4.653	13.072	0.068	2.809
50663	12.940	12.648	0.048	0.977
50553	10.571	12.648	0.055	1.196
50516	9.122	12.648	0.055	1.387
50521	9.037	12.648	0.371	1.400
50515	8.512	12.648	0.340	1.486
51398	8.004	12.841	0.509	1.604
50513	7.324	12.648	0.035	1.727
50669	6.929	12.648	0.048	1.825
50511	6.492	12.648	0.055	1.948
50524	5.759	12.648	0.340	2.196
50499	5.216	12.648	0.055	2.425
50468	4.909	12.648	0.055	2.576
50469	4.481	12.648	0.055	2.822
50543	1.398	12.648	0.048	9.049
50425	0.924	12.648	0.472	13.683
50473	0.922	12.648	0.457	13.714
50505	0.642	12.648	0.055	19.711
50452	0.152	12.648	0.055	83.360
50508	1.263	11.711	0.340	9.274
50642	0.894	11.711	0.145	13.102
50572	3.992	10.893	0.697	2.729
50501	14.566	10.773	0.311	0.740
50546	9.158	10.773	0.311	1.176
50559	4.598	10.773	0.372	2.343
58144	1.490	10.540	0.060	7.074
58157	5.160	10.510	0.120	2.037

and the ratio between the transit trip distance to auto access distance for the samples. In 〈Figure 9〉, the distribution of trip samples by auto access distance is plotted. The average driving distance was 4.8 miles. Most samples(92%) involved an auto access distance of less than 10 miles. Therefore, the 10-mile limit assumption used in FSUTMS appears to be reasonable.

〈Figure 10〉 plots the data in 〈Table 6〉, including the auto access distance, linked transit trip distance, and the ratio between the two. While the auto access trip distance ($D1$) is plotted in an ascending order, the transit trip length ($D2$) does not reveal any trend, suggesting that transit trip length is not related to the auto access distance



〈Figure 9〉 Distribution of Transit Tours by Auto Access Distance



〈Figure 10〉 Comparison of Auto Access Distance and Linked Transit Trip Distance

in Miami-Dade County.

The analysis results in this section can be used to update AUTOCON9 program in FSUTMS mode choice model for building auto access connection. The AUTOCON9 program builds auto connectors(minimum drive paths) from each zone to one or more stations or park-and-ride(PNR) lots flagged appropriately in the station data file. In this program, auto connectors are created if total distance, derived from the highway skims from a zone to the zone nearest the station that are within a specified maximum distance. Generally, this maximum distance has been set at 10 miles for end-of-line fixed guideway stations, and 5 miles for other fixed guideway and most park-and-ride lots, and shorter distances for small neighborhood lots.

The program generally creates the shortest and second shortest connector to any given transit facility. The program uses network topology to eliminate the second connector if it does not provide reasonably different transit service. The program will also eliminate auto connectors that involve extensive "backtracking" relative to the CBD, the primary destination for most park-and-ride trips. Backtracking is when automobiles actually travel away from a final destination(such as the CBD) to get to a park-and-ride lot.

Ⅶ. Findings and Conclusions

This paper presented a new method which is more accurate than the traditional buffer method for estimation of population and employees that have access to transit services. The new method can be used to better determine the "Walk Access" transit trips and "Auto Access" transit trips in the FSUTMS Mode Choice Model. The method takes into consideration walking distance to transit stops, population distribution, and existence of barriers to pedestrians. Data included the detailed street network, bus stop locations, bus routes, population and dwelling unit information by TAZ, property locations as represented by their label points, and property tax database. The transit onboard survey data were used to determine the effect of walking distance on transit use. The analysis results suggest that transit use deteriorates exponentially with walking distance to transit stops.

A decay function was determined based on the survey data reflecting this deteriorating trend in transit use with respect to walk distance, and transit walk accessibility was measured by the percentage of the population, weighted by the decay function, in a zone that was within 0.5 mile of walking distance from transit stops. This population is referred to as "distance decayed transit service population". Increasing the limit of walking distance beyond 0.5 mile produced no noticeable increase in accessibility. Because of the decay in transit use due to increases in walking distance, transit accessibility is much lower than the traditional buffer method or the network ratio method will estimate.

Results from analysis also showed that there was no significant difference between the percentage of population with transit access and the percentage of production trips with transit access in a given zone. This means that the percentage of population with transit access can be used directly in place of percentage production trips with transit access as required as input by FSUTMS mode choice model.

Employment accessibility to transit was defined as the percentage of employees in a zone within 0.25 mile air distance of transit stops. Most commercial developments are located along arterials and thus are rather accessible to transit, and the spatial distribution of employees in a zone is difficult to determine. Employing land use data improves the information on the spatial distribution of employees in a zone as opposed to assuming employees are evenly distributed across the entire zone or they are evenly distributed along all arterials, although on a few occasions land use data have not been consistent with employment data from the zonal input data(ZDATA) file.

Auto access of transit was analyzed using the TOB data of transit trips that involved accessing a transit station/stop either by park-and-ride or kiss-and-ride. Analysis results show that while there was no relationship between auto access trip distance and the transit trip length, most transit trips were longer than the auto access trips. Therefore, we conclude that auto access distance in a zone may be assumed to be up to the longest transit trips likely from that zone(by considering premium transit modes and major activity centers) up to 14 miles. This upper limit depends on the route length of the rapid transit services and may change if the route configuration or length changes.

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