RELATION BETWEEN TRANSIT RIDERSHIP AND WALKING DISTANCES IN A LOW-DENSITY FLORIDA RETIREMENT AREA

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In response to demands from senior citizens in central Pinellas County for economical public transportation, the Florida Department of Transportation initiated a demonstration project to study the ridership characteristics and costs of operating five 29-passenger buses in October 1970. This paper examines the trip characteristics and the service limitations of fixed-route bus operation in scattered residential developments that contain a high percentage of senior citizens. Most trips made by senior citizens were for shopping and social-recreational purposes. Results indicated that most riders traveled 2 to 4 days per week and that, prior to the initiation of the system, 90 percent of the elderly riders had no form of independent transportation. About 70 percent of the elderly riders lived within 1/8 mile of the bus route, and 90 percent of all riders were bound for destinations located within 1/8 mile walking distance of the route. Transit usage at a total walking distance of 1/8 mile was 3 times greater than the usage at a distance of 1/4 mile.

•TYPICAL urban public transportation research has been focused on the home-to-work-and-return trip with its twice daily peak traffic. Such research, both analytical and experimental, has concentrated on ways and means of luring the commuter out of his automobile and onto public transit. It has been concerned with relieving congestion, reducing travel time, optimizing the use of existing roadway lanes, and postponing the need for new highway lanes. So far, these efforts have not been very successful, especially in low density, automobile-oriented cities such as those in Florida.

There is another aspect of public transportation, however, that is more difficult to measure and has received less attention from research groups. This is the service aspect of transit.

The Florida Department of Transportation recognized the role of the state in the research and demonstration of service-oriented transit free from the pressures of the fare box. The department, likewise, accepted the responsibility of testing a transit service that was designed primarily to operate within the socioeconomic conditions typical of Florida cities and suburbs. These conditions are characterized by scattered residential development, high-density pockets of low- to middle-income residents, and a large percentage of retirees living on fixed incomes.

Consequently, the department selected the area under the jurisdiction of the Central Pinellas Transit Authority (1), in the vicinity of Clearwater, to institute a demonstration project in October 1970.

The experiment was intended to test user reaction to the following major changes: basic service; fare changes; route and schedule changes; new, attractive, comfortable equipment; advertising campaign; and acclaimed need versus actual use.

The experiment also was intended to provide the department with insight into the actual costs of providing bus service, the user and nonuser reaction to methods of

Sponsored by Committee on Social, Economic and Environmental Factors of Transportation.

financing such a service, and the role of the state and local governments in extending mobility to a large segment of the population that is currently not served or served poorly.

PROJECT DESCRIPTION

The overall strategy of the project was to establish a certain route configuration and fare structure and then to alter the level of service on a route or change the fare. In this way, the impact of each change could be isolated.

The service was started with 5 new 29-passenger Twin Coach buses, of which 4 operated over fixed routes and 1 was retained as a spare. The buses had a large Department of Transportation (DOT) sign on the side and therefore became known locally as the DOT bus. This terminology will be retained throughout this paper. The routes were designed to cover areas previously without bus service and to complement and connect with the private operator in the area, Clearwater Transit, Inc. Figure 1 shows Clearwater Transit routes and all DOT routes that were operated from October 19, 1970, through July 1, 1971. On July 1, St. Petersburg Transit initiated a connecting link from Seminole Mall to Crossroads Shopping Center, thereby creating a county-wide network.

The buses operated on 1-hour headways, 12 hours per day, 7 days per week. The fare was set low (10 cents) initially in order to attract riders and allow for a reasonable fare increase at a later date.

At the time this report was written, the major changes to the system as given above were being analyzed and evaluated. However, with the current interest in increasing the mobility of the elderly, it was felt that the information gained to date might provide useful input to the design of transit facilities. For this reason, the limitations of a fixed-route transit system in serving the needs of typical low-density area with a high percentage of retirees are brought forth at this time.

TRIP CHARACTERISTICS

If a transit system is to satisfy the needs of the area that it serves, it must be sensitive and responsive to these needs. In the case of this demonstration project, which serves low-density areas with a high percentage of retirees, the service area population does not have the normal time constraints associated with the 5-day workweek. A selection of trip characteristics obtained from on-board interviews is presented below.

The travel patterns by day of the week and hour of the day are shown in Figures 2 and 3 respectively. It is immediately obvious that these results are totally different from those of a customary transit operation; here, Saturday has the highest daily ridership and each remaining day, including Sunday, has a uniformly lower passenger count. There are no morning or evening peaks, simply a gradual buildup with the maximum ridership occurring around 3:00 p. m. Although the system was intended and primarily designed as a service for the senior citizens of the area, it has been established that the latent demand for transportation is equally great in the teen-age sector of the population. This is especially true on weekends and school holidays when the under-20 ridership constitutes about 70 percent of the total (Table 1).

Another significant difference between the DOT bus system and the accepted norms for transit lies in the trip purpose distribution, shown in Figure 4. Work trips, normally the backbone of transit, account for a mere 9 percent of the total trips. Shopping and social-recreational trips are the major purposes for the elderly and the under-20 groups respectively. Bus routes 1 and 4 are shopping-oriented and primarily serve large shopping centers. As a result of the optional nature of the trips, the average trip frequency for each age group is 2 to 4 times per week (Fig. 5). Figure 6 shows the mode of travel used prior to the DOT bus service. The majority of the teen-agers made no similar trip, and almost half the elderly made the trip by automobile. Since only 10 percent of the latter group had both a license and access to an automobile, this clearly suggests that the majority were dependent on other persons to provide transportation for them.

Figure 1. Bus routes.

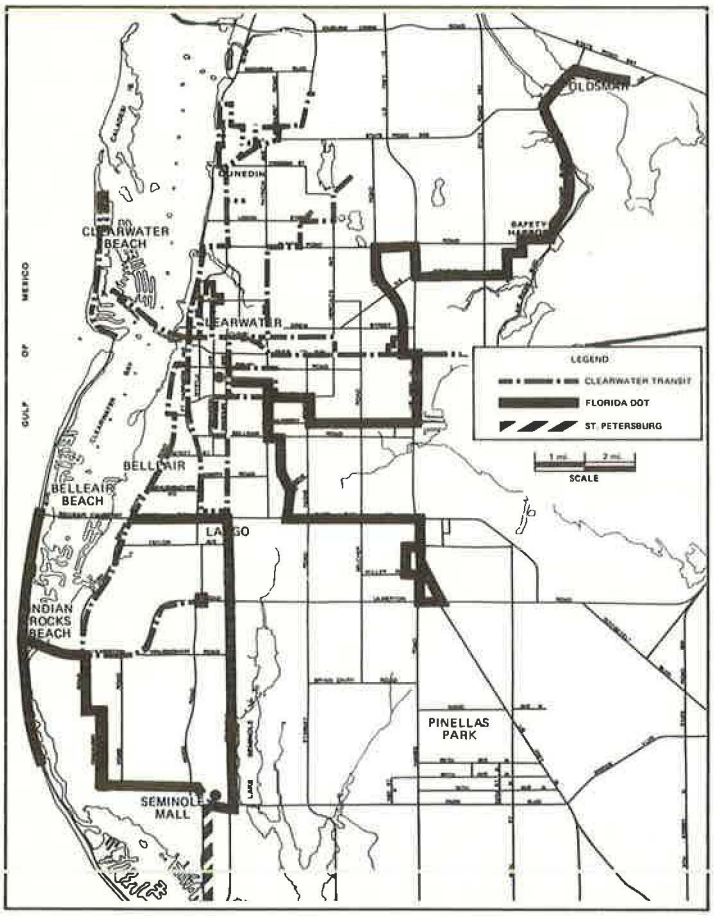


Figure 2. Average daily ridership.

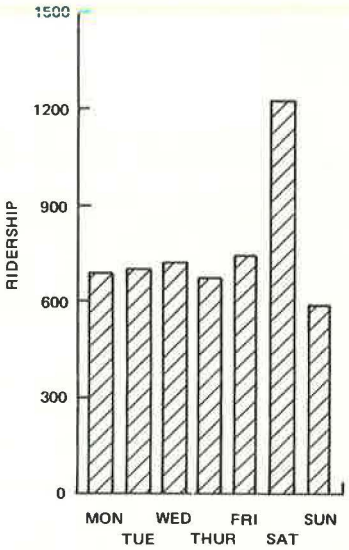


Figure 3. Average hourly ridership.

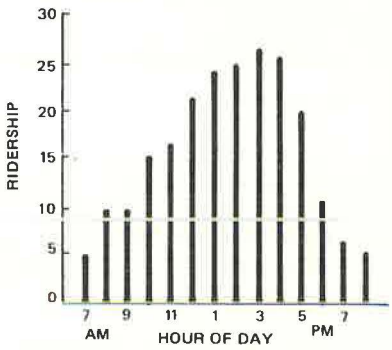


Table 1. Ridership by age group.

	Weekday		Saturday		Sunday		School Holiday	
Age	Number	Percent	Number	Percent	Number	Percent	Number	Percent
< 20	219	38	530	69	276	66	809	72
20 to 59	121	21	82	11	55	13	91	8
> 59	230	41	153	20	84	21	222	20
Total	570	100	765	100	415	100	1,022	100

Figure 4. Trip purpose by age group.

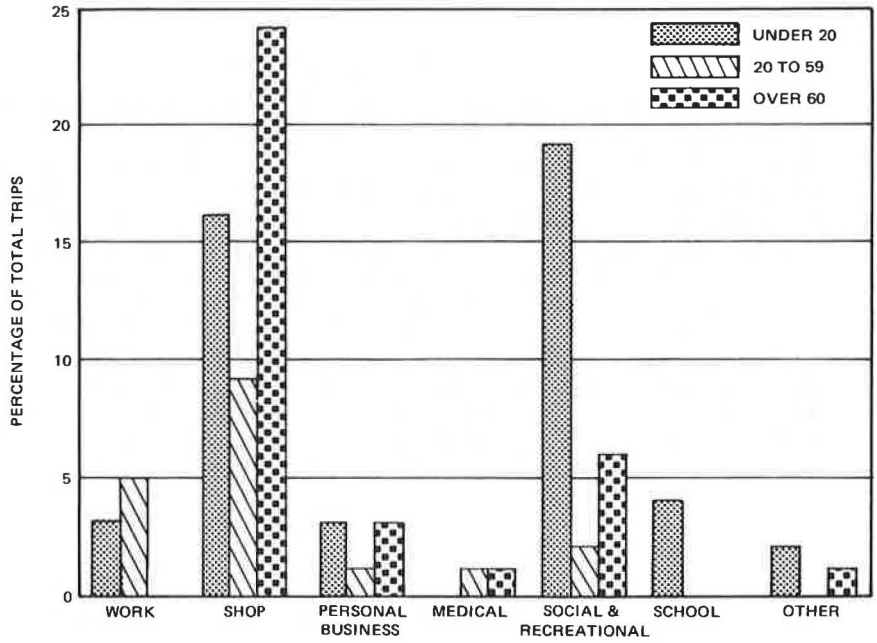


Figure 5. Trip frequency by age group.

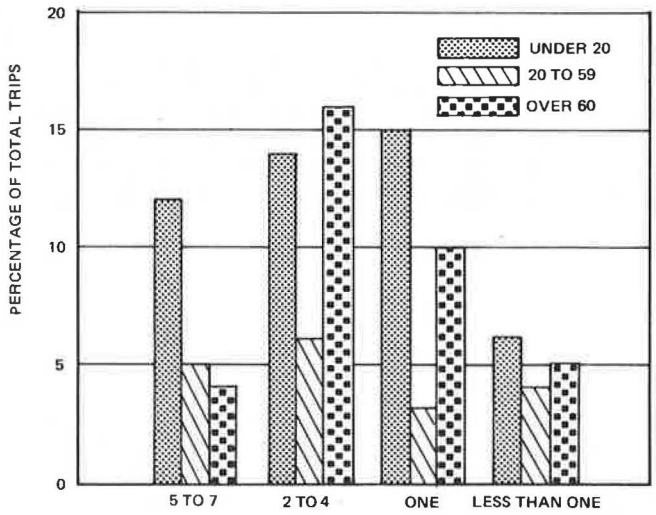
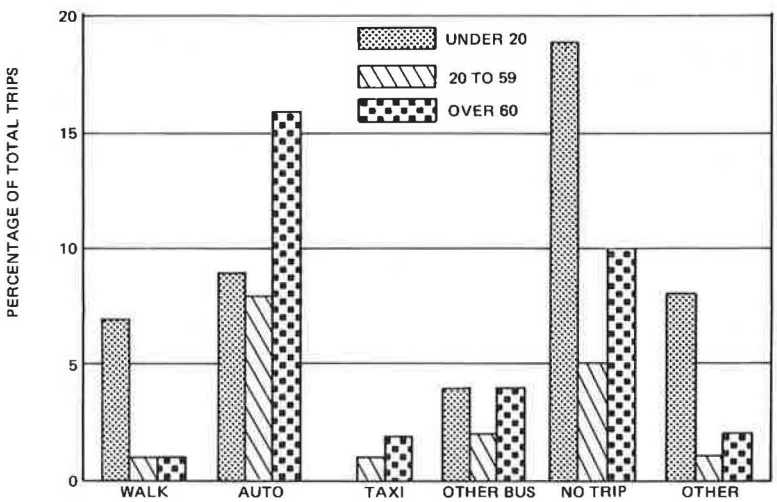


Figure 6. Previous mode of travel by age group.



WALKING DISTANCES

From an appraisal of the first on-board interviews that were completed, it was obvious that the distance between origin or destination and the bus route was an extremely significant factor in determining ridership. Since more than 90 percent of the riders walked to and from the bus, the following aspects of walking distances were examined in greater detail: distance from place of residence to bus route, distance from bus route to ultimate destination, and impact of total walking distance on modal split.

Since detailed questions on origin and destination were asked in the on-board surveys, all the information necessary to identify locations was available. Therefore, a zoning and coding system was required that would enable the data to be manipulated in such a manner that walking distances, or locations on the bus routes, could be easily obtained. Such a system, which was sensitive to the bus lines, was developed by dividing each route into 9 sections. Each section, in turn, was subdivided into 5 bands paralleling the bus route at distances of ⅛, ¼, ½, 1, and more than 1 mile (Fig. 7). Each zone therefore had a 3-digit code composed of the following:

Item	Position	Code
Bus route	1	1 or 4
Section	2	1 through 9
Bandwidth	3	1 through 5

Specific attractors such as Sunshine Mall/Sears Town, which are located directly on a route, were coded 0 in position 3. Thus, by grouping the results by the third digit, the walking distances at either the origin or destination end of the trip could be obtained.

Trip information on the base population was obtained by means of 640 interviews conducted at dwelling units within 1 mile on either side of routes 1 and 4. The units were selected from 1 in. = 200 ft land use maps (1970) in such a manner that a cumulative count of the dwelling units in each bandwidth was kept while a systematic 2 percent sample was selected. Dwelling units in each bandwidth were as follows:

Bandwidth	Dwelling Units
0 to ⅛	3,922
⅛ to ¼	6,132
¼ to ½	11,100
½ to 1	10,308

The trips that were reported in the on-board survey were grouped by origin bandwidth and then subdivided by age and mode of travel to the bus route as given in Table 2. Since the total number of dwelling units in each bandwidth had been established, it was possible to normalize the number of trips from each bandwidth, i.e., adjust the total to give trips per 10,000 dwelling units. The percentage of normalized trips represents the transit trips originating from the bandwidth expressed as a percentage of the total transit trips made by that age group. The cumulative percentage results in a straight-line relation when plotted on semi-logarithmic graph paper as shown in Figure 8. The vertical axis represents the percentage of riders who live a greater distance from the bus route than the corresponding distance shown on the horizontal axis. Thus, if there is a uniform number of dwelling units in each bandwidth, about 30 percent of the elderly riders live at a distance greater than ⅛ mile, or, conversely, 70 percent of the elderly live within ⅛ mile of the bus route. The normal assumption that transit serves ¼ mile on either side of the route is shown to be questionable in this instance since the vast majority of the elderly—for whom the system was primarily intended—consider half this distance to be their limit.

A similar pattern was observed at the destination end of the trip. Almost 90 percent of all trips on routes 1 and 4 were bound for destinations within ⅛ mile of the route as shown in Figure 9. There are 2 distinct portions to these curves: an elastic region for the first ⅛ mile and a relatively inelastic portion that suggests that the last few percent are essential trips to specific locations made by truly captive riders.

Figure 7. Zoning scheme.

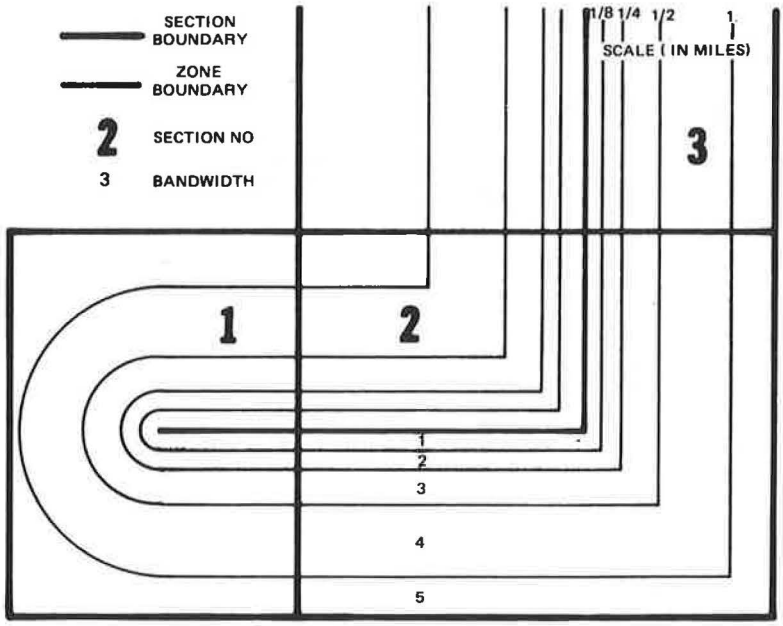


Table 2. Normalized transit trips by bandwidth at origin.

Age	Bandwidth (miles)	Survey Trips	Normalized Trips		
			Number	Percent	Cumulative Percent
<20	0 to 1/8	55	62	50	100
	1/8 to 1/4	22	36	29	50
	1/4 to 1/2	17	15	13	21
	1/2 to 1	7	7	6	8
	>1	3	3	2	2
20 to 59	0 to 1/8	46	52	59	100
	1/8 to 1/4	16	26	29	41
	1/4 to 1/2	8	7	9	12
	1/2 to 1	2	2	2	3
	>1	1	1	1	1
>59	0 to 1/8	90	102	75	100
	1/8 to 1/4	13	21	15	25
	1/4 to 1/2	9	8	6	10
	1/2 to 1	5	5	4	4
	>1	0	0	0	0

Figure 8. Rider origins for total walking distance.

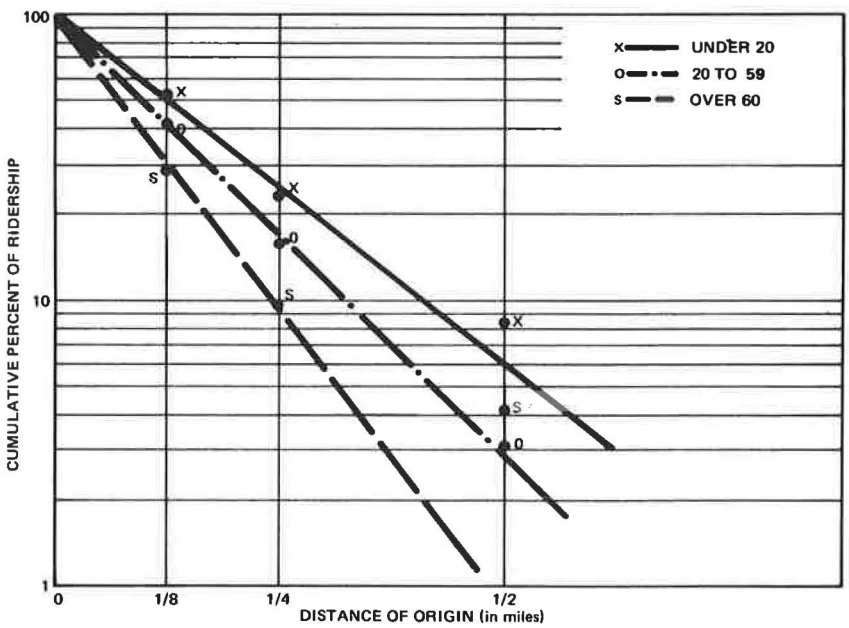


Figure 9. Rider destinations for routes 1 and 4.

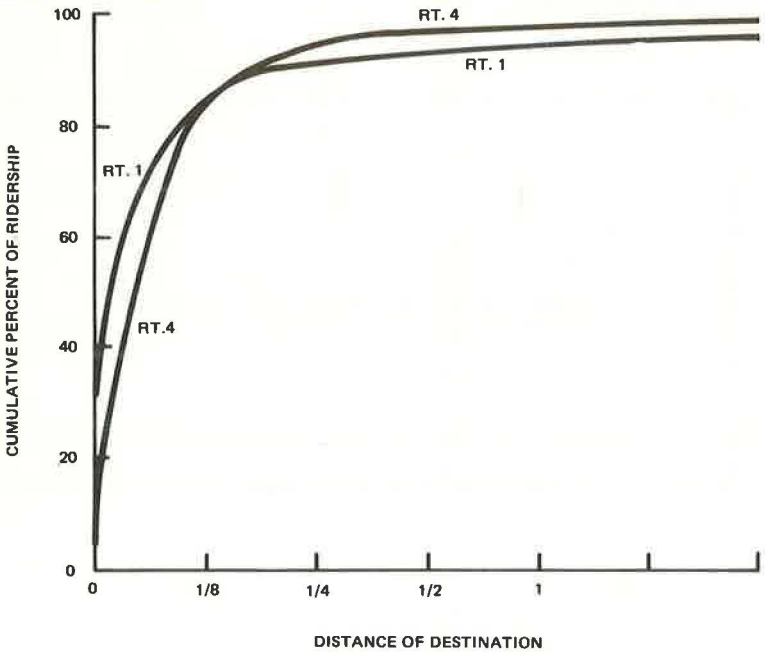


Figure 10. Transit usage by total walking distance.

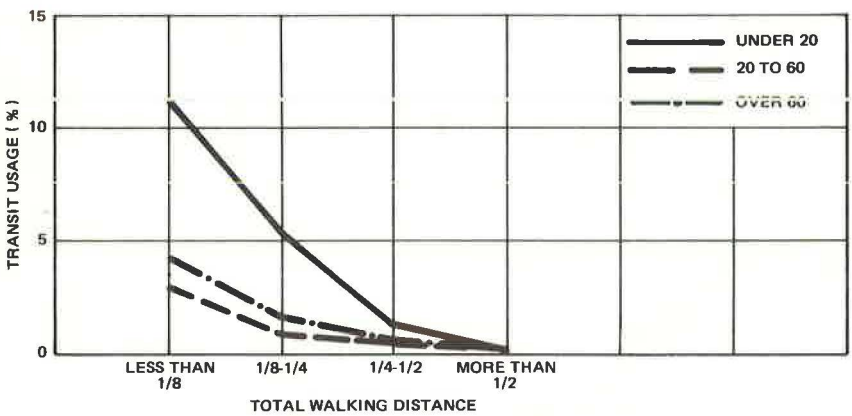


Table 3. Route characteristics.

Route	DU	WDU	Average Weekly Ridership	Trips per WDU per Week
1	10,941	5,124	2,083	0.406
3	8,068	3,777	983	0.26
4	15,119	8,377	2,751	0.314

The final aspect studied was the effect of walking distances on the modal split, i.e., the relation between total walking distance and transit usage. Since the total number of dwelling units in each bandwidth was known, the trips by all modes for the base population, obtained from the home interviews, were expanded by distance from the route. The reported trips were zoned according to the system previously explained and subsequently classified by equivalent walking distance, i.e., the total distance that would have been walked had the trip been made by transit. The decrease in transit travel due to the negative impact of walking distance is clearly shown by the curves in Figure 10. The percentage of transit usage in the adult age groups fell by about 70 percent as a result of the total walking distance increasing from $\frac{1}{8}$ mile to $\frac{1}{4}$ mile. The initial high percentage of transit usage in the under-20 age group is due to the low number of total trips (by all modes) going to the shopping malls reported in the home interviews sample. This is supported by the results of the on-board survey in which more than 40 percent of the teenagers stated that, prior to inception of the bus system, they had made no similar trip.

SERVICE AREA

One question that constantly arises when a transit system is evaluated is, How can one determine which areas are in fact being given adequate service?

In this study, an index of the dwelling units (DU) around the bus line was used as a measure to reflect the relative accessibility to the route as perceived by the riders. This measure, the weighted dwelling unit (WDU), was obtained from data shown in Figure 8. These data show that an average of 60 percent of the riders live within $\frac{1}{8}$ mile, 25 percent live between $\frac{1}{8}$ and $\frac{1}{4}$ mile, and 10 percent live between $\frac{1}{4}$ and $\frac{1}{2}$ mile. Therefore, assuming that the 0-$\frac{1}{8}$ mile band has a saturation trip generation rate, it was weighted at unity; and the dwelling units were weighted in the ratio of 1.0:0.4:0.2 for the 0-$\frac{1}{8}$, $\frac{1}{8}$-$\frac{1}{4}$, and $\frac{1}{4}$-$\frac{1}{2}$ bands respectively.

Although routes 1 and 4 formed the data base for this paper, one other route, route 3, was operated at the start of the project but was discontinued before the home interviews were conducted. However, sufficient ridership and dwelling unit data are available to be included for discussion at this point.

The total weighted dwelling unit and the ridership at 10-cent fare for the routes are given in Table 3.

The trip generation rates indicate which of the routes is receiving the highest utilization from the service area population. Also, expressing the sum of the weighted dwelling units for all routes as a percentage of the total number of dwelling units in the tax base gives an idea of the coverage being provided.

CONCLUSIONS

The problem facing Clearwater and other similar communities, in Florida and elsewhere, is how to design transit service that meets all reasonable transportation needs in the most economical fashion. There is still much to be learned, but the information presented here may provide some input for the design of future transit routes serving similar areas.

Many parallels have been drawn between transit service and other services such as police, street lighting, and health clinics. However, there is one basic difference between transit and other services. Although those who pay for the major share of other services do not necessarily make the most use of them, each service is available to all when, and if, it is required. In comparison, the same cannot be said of a fixed-route transit system.

There has been a recent trend toward the creation of transit authorities as a result of the local private operator either providing inadequate service or going out of business voluntarily. It would appear that the authority has one additional problem that private company did not have. The public authority must surely make an attempt to provide as equitable a distribution of transit facilities throughout the tax base as possible. Although there will be districts whose need for transit is much less than others, this should not entirely preclude the latter districts from service.

A second responsibility in a tax-supported system is optimizing revenues for a given set of operating costs. Figure 10 shows the change in transit usage with distance from the bus route and shows that only a very narrow corridor is adequately served.

The elderly frequently complained that the distance of ¼ mile to and from the bus route was too far for them to walk, especially when they were carrying groceries. Also, many voiced apprehension about crossing major arterial routes to get to the bus; some riders commented that they rode to the end of the route and back again to avoid having to cross US-19, a 4-lane divided highway. In some instances this caused an increase in travel time of almost ½ hour. Therefore, despite the fact that on paper an area appears to be served, in effect, the limitations on the resident's physical abilities render the bus service totally inadequate. In the case of a public authority operating the transit service with fares subsidized through some form of taxation, the system that attempts to provide an equal level of service to each individual must represent a more equitable distribution of public funds than a system that favors one group of the population, in this instance those persons living right beside the bus line.

The case for a demand-actuated system operating up to, say, ¼ mile from the basic route, is a strong one. The cost of communications equipment represents a very minor part of the overall costs, yet Figure 10 shows that the ridership could be almost doubled by such a service.

The Central Pinellas Transit Authority, which was given taxation powers in December 1971, is considering a demand-actuated service for some of the areas that were discussed. Further information may result that will test the validity of the conclusions presented in this paper.

REFERENCE

1. Transit in Central Pinellas County. Simpson and Curtin, 1971.