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Abridgment

Development of Transit District Boundaries for an Areawide Small Bus Program

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The development of a feasible transportation program within a metropolitan area requires the consideration of community needs, demand potential, and the system's impact on the community life-style and environment.

The population of a metropolitan area is not homogeneous; therefore, it is difficult to justify a fixed-time, fixed-schedule, line-haul system throughout an entire metropolitan area. The requirements for secondary trips, such as shopping, social, and recreational trips, are even more difficult to determine because of the peculiar nature of these trips. Yet, although such trips are secondary in nature, they are extremely important in order to maintain a proper level of service in an area as well as for the economic growth of a community. The needs of a community, therefore, require careful investigation.

The Southeastern Michigan Transportation Authority (SEMTA) is responsible for the coordination and operation of public transit in the Detroit metropolitan area. The total public transportation system in this area is primarily divided between SEMTA, which serves the entire area, and the Detroit Department of Transportation, which provides service within the limits of the city of Detroit. The current bus service program consists primarily of fixed-route, fixed-schedule buses that operate along major corridors in and out of the Detroit central business district (CBD) as well as cross-town line-haul systems. In addition, several small bus programs operate as dial-a-ride systems or feeder systems to the line-haul system in some suburban communities.

In 1976 we were involved in a study to determine the transportation service needs for the secondary trips in a three-county study area (Wayne, Oakland, and Macomb Counties) within the SEMTA region. The objective was development of a comprehensive small bus program based on this information. Determination of the service needs necessitated addressing questions related to (a) the logical boundary for the service area, (b) public transportation needs within each community, and (c) the relative priority of various service areas within the region.

A review and analysis of all the existing small programs in Michigan provided the rationale for transit district boundaries. The three-county study area consisted of an approximately 4823-km^2 (1862-mile^2) area with a population of 2.7 million; it encompassed 73 cities and 58 townships and villages.

DEVELOPMENT OF TRANSIT DISTRICTS

The criteria for transit district boundaries include service area, population of the service area, natural boundaries, continuity between adjacent areas, other geographical considerations, similarities between the socioeconomic characteristics, demographic considerations, and land use considerations. The study was conducted in a three-stage process:

1. Transit districts were developed by using the service area, with primary emphasis on the consideration of optimal service area and population density.
2. The primary candidate districts established in the first stage were tested for sufficient travel demand; nonwork trips as a percentage of total daily person trips were used as the measure of travel demand potential.
3. The different geographical units were analyzed to establish transit districts.

The nonhomogeneity of the socioeconomic, demographic, and land use characteristics were considered in this stage to arrive at the final transit district boundaries.

Data Base

The study used the available data on small bus programs for the entire state of Michigan, regional travel and socioeconomic data available from Southeast Michigan Council of Governments (SEMCOG), and census information.

The travel data used were approximately 10 years old. However, in the absence of more recent or updated data, they were sufficient for making some preliminary judgments in terms of determining the transit districts and potential for transit demand.

Development of Service-Area Criteria

In order to develop service areas that can be used to

delineate transit districts in the three-county region in the Detroit metropolitan area, data and operating characteristics were collected for 25 small urban areas. Several operating characteristics of these systems were plotted against corresponding service areas and population density. Hand-fitted curves were drawn in order to review the trend of the various operating characteristics. The data used for the analysis were from various communities in Michigan that had all used small bus systems for special transit service. The curves drawn on the basis of these data were analyzed and general trends were identified.

Figure 1. Frequency of percentage of nonwork trips (internal to internal).

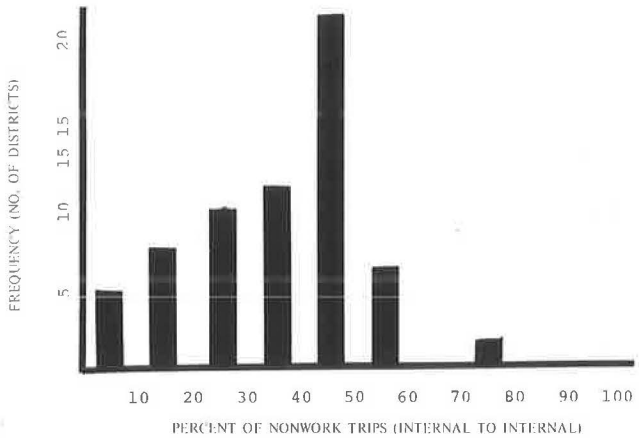
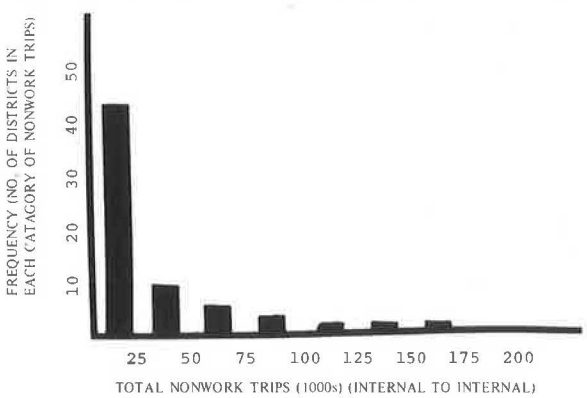


Figure 2. Frequency of total nonwork trips (internal to internal).



Based on this analysis a set of criteria were developed, which included:

1. A size of 26-44 km^2 (10-17 miles^2) of service area seems to have the most potential for transit success for a small bus program;
2. Service areas should not be less than 16.8 km^2 (6.5 miles^2);
3. Service areas should be generally less than 62 km^2 (24 miles^2);
4. The service area population should not be under 18 000; and
5. The population density of the service area should not be less than 772/km^2 (2000/mile^2).

The determination of district boundaries also included an examination of nonwork intradistrict trip behavior in each service area. This part of the study involved analysis of the frequency distribution of percentages and absolute numbers of nonwork trips based on 1965 SEMCOG trip tables (Figures 1 and 2). This distribution showed that approximately 48 percent of the 62 candidate districts showed 40 percent of their total daily nonwork trips to be within their own district boundaries. A necessary prerequisite to any transit system is the existence of substantial travel demand, both as a percentage on an absolute basis. Approximately 30 percent of the 62 districts were then cross-classified into 1 of 12 possible categories by using a two-directional matrix according to percentage and number of nonwork trips. For 17 districts within the study area, nonwork trips accounted for more than 30 percent of these internal trips, and this percentage was a number in excess of 25 000 total daily trips. When the percentage figures were raised to 40 percent, the number of districts dropped to about 15.

It was necessary to establish a threshold value in order to determine the district boundaries for the study

Table 1. Classification of transit districts on the basis of volume and percentages of nonwork trips, service area population, and service area density.

Internal Network Trips (%)	Population Density	0-24 999 Internal Nonwork Trips Daily			25 000-49 999 Internal Nonwork Trips Daily			50 000-74 999 Internal Nonwork Trips Daily[a]		75 000 Internal Nonwork Trips Daily[a]	
		26 km^2	26-39 km^2	39 km^2	26 km^2	26-39 km^2	39 km^2	26-39 km^2	39 km^2	26-39 km^2	39 km^2
30	<2000		30	1, 3, 39, 43, 51, 60 33, 47, 53, 57, 61 4, 9, 18, 23, 25, 32 35, 44, 45, 56, 59			35, 23		47		47
	2000-4000			22, 7, 34, 17			22,34,7,17		34, 17		34, 17
	4000-6000	11	6	12, 14, 50	11	6	12,14,50	6	14, 12, 50		14, 50, 12
	>6000	19	10, 20, 21, 16	49	19	10, 20, 21, 16	49	10, 16, 21, 48, 20	49	20	49
40	<2000			4, 9, 18, 23, 25 32, 35, 44, 45 56, 59, 60, 33, 47			35, 23				
	2000-4000			7, 34, 17			34, 7, 17		34, 17		34, 17
	4000-6000	11	6	12, 14, 50	11	6	12, 14, 50	6	14, 50, 12		14, 50, 12
	>6000		10, 20, 21, 16	49		10, 20, 21, 16	49	10, 16, 21, 48, 20, 49		20	49
50	<2000			33					47		
	2000-4000			17			17		17		17
	4000-6000			50, 14, 12			14, 50, 12		50, 14, 12		12, 14, 50
	>6000		16		16			16			

Note: 1 km^2 = 0.386 mile^2; cell entry is transit district identification number.
[a]No cell entries for 26-km^2 service area.

area. An increase in internal nonwork trips and population density increases the probability of transit success. At this point, it was hypothesized that transit success is a function of the percentage of internal nonwork trips, density of population in the service area, and service-area size. Next, the transit districts were cross-classified by using a stratification of all four factors mentioned above (Table 1).

Minimizing Socioeconomic Variability

The final criteria used in the delineation of transit districts was to check the variability in the socioeconomic characteristics of the individual minor civil division (MCD) units that had been combined to create candidate transit districts. This task was accomplished by comparing the candidate districts on the basis of relevant socioeconomic indicators (such as automobile ownership) and land use indicators (such as percentage of land area devoted to different types of activities). It was found that the individual MCDs, which had been combined to form the 62 districts, did not have widely varying socioeconomic and land use characteristics.

PRIORITY ANALYSIS

In order to make the best use of limited resources, the task of establishing the priority of a number of projects is essential. In this study a priority index for a transit district was defined as a function of rank order, level of transportation needs and success factors, and their associated parametric scores:

$$P_i = (W_j \times X_j) \quad (1)$$

where

P_i = priority index of the ith transit district,
W_j = average rank ordered weights for the jth variable, and
X_j = normalized scale score for the jth variable.

It was decided that the rank ordering of need as a transit success factor should be formed by the community representative, to ensure that the relative judgments of the community were reflected in the priority analysis process. A set of 14 transportation needs and transit success factors were identified to be subjected to priority ranking. A survey form was designed and sent to 52 local political jurisdictions within the study area with a request for them to rank the order of the 14 factors. A review of the rank ordering indicated that most of the communities spent considerable time weighing the importance of the factors as related to the transportation system requirements for their community.

The final step in the priority analysis process was the determination of the scores for the 14 factors. These absolute scores varied based on the transit district size. Instead of using the raw score for the 14 factors, the data were normalized into a scale from 1 to 10 to minimize the difference of the absolute scores among the districts. The rank of 1 indicated the highest priority and the rank of 14, the lowest priority. Thus, the mean rank used in the priority index functions was subtracted from 14 to be consistent with the priority index function.

CONCLUSION

The development of transit district service-area criteria by using travel demands for existing services is appropriate in this study area as well as in other areas in the state of Michigan. The service-area concept produced a total of 62 possible transit districts within the study area that are likely to support a small bus program. The priority ranking procedure used in this study considered community values and is considered extremely significant in the analysis process. The data base used for this study, although 10 years old, proved a valid basis for analysis, since limited tests indicated that associated economic and travel patterns in the study area followed similar trends. The priority analysis performed in this study will be updated continually as current trip and other data become available.

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