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Empirical Modeling and Forecasting of Monthly Transit Revenue for Financial Planning: A Case Study of SCRTD in Los Angeles

DAVID SKINNER, ROBERT WAKSMAN, AND GEORGE H. WANG

Time series revenue data from the Southern California Rapid Transit District (SCRTD) in Los Angeles are used as a case study to develop empirical models and forecasts of monthly transit revenue for financial planning. Seasonal time series models for the five major types of transit revenues collected by SCRTD are specified and estimated. For all five types, the observed variation in revenue during the estimation period fits well with the values obtained from the models, as is demonstrated by the relevant regression statistics and the behavioral characteristics of the model. A data split technique is used to determine the prediction capabilities of the model. A comparison of the forecasts with the actual data shows that the models perform well for forecasting purposes. Finally the models are used in a simulation mode to estimate the impact of the SCRTD June 1982 fare rollback on revenues for the next year and a half.

The purpose of this analysis is to (a) construct and estimate seasonal models for the five major types of transit revenues collected by the Southern California Rapid Transit District (SCRTD); (b) examine the forecasting capabilities of these revenue models; and (c) use these models to forecast revenues for 1.5 years ahead with and without the July 1982 fare rollback. The five types of transit revenues are farebox (or cash), regular pass, senior citizen and handicapped pass, express stamp pass, and student pass.

Forecasts of the sale of transit services are the principal data needed for predicting cash flow. They reveal to financial planners when and how much cash income can be expected during the period being studied. This information along with a forecast of expenses assists planners in determining future cash needs, planning for financing these needs, and exercising control over the cash flow of the transit authority (1).

A survey of recent financial forecasting techniques in the transit industry indicates that various types of fare elasticity and simple trend extrapolation methods are the most popular devices used by transit planners as tools for forecasting transit revenue (2). The use of fare elasticities calculated from annual time series data or by shrinkage ratios tends to produce poor forecasts of monthly transit revenue because these methods are unable to predict the seasonal and working day variation in the revenue series. Furthermore, these methods do not take into account (or do so in a highly judgmental manner) the effects of changes in variables other than fares, e.g., gasoline prices and overall growth trends (3).

To improve the forecasts of monthly transit revenues, empirical modeling using the regression time series approach is adopted in this paper. Within the framework of a model using empirical monthly data, the impact on transit revenues of changes in real fares and real gasoline prices can be examined. Furthermore, alternative forecasts (simulations) can be generated from these models for alternative assumptions about the behavior of independent variables in the model.

This paper presents (a) a description and recent history of SCRTD transit fares and revenues, (b) the construction of monthly models for transit revenue, (c) empirical results, and (d) model assessment and forecasting performance of the models.

DESCRIPTION AND HISTORY OF SCRTD FARES AND REVENUES

The SCRTD fare structure has many different fare categories and pass types. There is a base adult cash fare for local bus service and additional incremental fares for express bus service for each of up to five express zones. Transfers between buses are priced at a small percentage of the base fare price. The three separate fare structures for handicapped and senior citizens, elementary and high school students, and college students are cash fares, incremental express zone fares, and transfer charges. For each of these user groups there is a monthly pass for unlimited rides on local bus service, and monthly express zone stamps are added to the monthly pass for unlimited rides on express service up to the indicated number of zones.

As shown in Table 1, from July 1976 to June 1982 there was a steady nominal increase in cash fares and pass prices for all user groups. Effective in July 1982, there was a sizable rollback in fare and pass prices. The rollback was mandated by Proposition A, which allocated the revenues from a one-half percent increase in the sales tax in Los Angeles County for SCRTD use. One purpose of this paper is to forecast the revenue changes that will result from the fare rollback.

This analysis makes use of monthly cash fare and pass revenue data collected since July 1976. Monthly farebox revenue data are aggregated from daily records of total cash fares kept by SCRTD. Every day, after each bus pulls into the garage following its last run of the day, the farebox is removed and is taken to a central counting facility where it is unlocked and the contents emptied into an automatic coin counter. The sum of the farebox revenues from all buses represents the total farebox revenue collected that day. This revenue includes cash fares of all types and for all user groups, i.e., base fares, zonal increments, and transfers for adults, handicapped and seniors, and students because the fareboxes cannot differentiate between fare categories.

Monthly pass revenue by type is obtained directly from SCRTD records. Passes for a given month are sold at the end of the previous month and at the beginning of the pass month. Records are kept of the number of passes of each type sold each month and of the revenue taken in for each pass type. In this analysis, for the purposes of simplification and of modeling, only pass revenues that contribute substantially to the SCRTD total revenue are included. Pass revenues are disaggregated into the following four categories: regular pass revenue, express stamp revenue, senior citizen and handicapped pass revenue, and student pass revenue.

Figure 1 shows trends in SCRTD total transit revenue and in the relative proportion derived from pass revenues since July 1976. Several interesting points can be summarized from the figure.

1. SCRTD total transit revenue has risen steadily from 1976 to 1981 at a compounded rate of approximately 20 percent.

2. Seasonal fluctuations exist in both farebox revenue and total pass revenue.

3. Pass revenue as a percentage of total revenue remained fairly constant between July 1976 and July 1980 at about 25 percent (perhaps increasing slightly during that time) and then jumped to about 35 percent after the July 1980 fare increase.

CONSTRUCTION OF MODELS FOR MONTHLY TRANSIT REVENUE

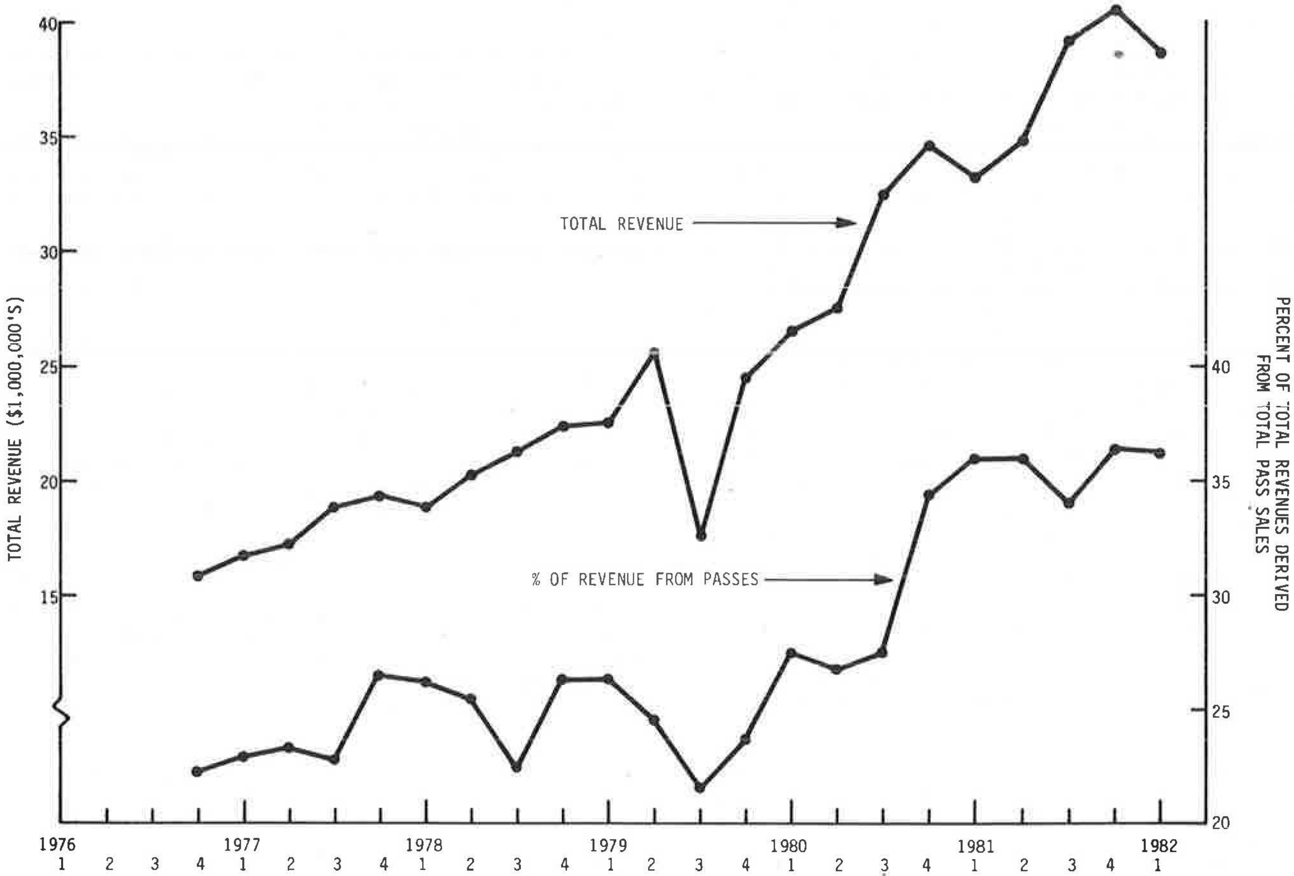
In general there are two approaches to modeling the level of transit revenue: (a) the direct approach, which uses revenue variables; and (b) the indirect approach, which first estimates ridership and then multiplies that ridership by an appropriate fare or average fare variable to obtain revenue. The choice of which approach to use depends on the relative availability--and quality--of the revenue and ridership data. The indirect approach was used by Wang, Ward, and Hassler (4) for modeling and forecasting New York City transit revenue. Ridership was regressed on a set of independent variables including (a) appropriate transit fares, (b) Consumer Price Index variables, (c) transit service variables, and

Table 1. SCRTD fare levels between July 1976 and July 1982 (dollars).

	July 1976-June 1977		July 1977-June 1978		July 1978-Oct. 1979		Nov. 1979-June 1980		July 1980-June 1981		July 1981-June 1982		July 1982-Present	
Fare Category	Cash	Pass	Cash	Pass	Cash	Pass	Cash	Pass	Cash	Pass	Cash	Pass	Cash	Pass
Adult base	0.35	14	0.40	18	0.45	20	0.55	20	0.65	26	0.85	34	0.50	20
Adult express zone increment	—[a]	—[a]	0.20	6	0.20	6	0.20	6	0.30	8	0.40	12	0.25	7
Adult with 1 transfer	0.45	14	0.50	18	0.55	20	0.60	20	0.85	26	1.00	34	0.60	20
Adult with 2 transfers	0.45	14	0.50	18	0.55	20	0.60	20	1.05	26	1.15	34	0.60	20
Adult with 3 transfers	0.45	14	0.50	18	0.55	20	0.60	20	1.70	26	2.00	34	0.60	20
Senior and handicapped	0.10	4	0.15	4	0.20	4	0.20	4	0.30	6	0.40	7.50	0.20	4
Senior and handicapped with 1 transfer	0.20	4	0.25	4	0.30	4	0.25	4	0.40	6	0.45	7.50	0.25	4
Student (thru high school)	0.25	—[b]	0.40	12[b]	0.45	14	0.45	14	0.50	16	0.65	22	0.20	4
Student (thru high school) with 1 transfer	0.35	—[b]	0.50	12[b]	0.55	14	0.50	14	0.60	16	0.70	22	0.25	4
Student (college)	0.25	—[b]	0.40	12[b]	0.45	—[c]	0.45[c]	—[c]	0.65	20	0.85	26	0.20	4
Student (college) with 1 transfer	0.35	—[b]	0.50	12[b]	0.55	—[c]	0.50[c]	—[c]	0.85	20	1.00	26	0.25	4

[a] Before July 1977 an additional 35 cents was charged for travel between two overlapping zones.
[b] Student pass not available until September 1977.
[c] Student pass not available to college students between July 1978 and June 1980.

Figure 1. Total revenue and percent of total revenue derived from pass sales by yearly quarter.



(d) variables representing seasonal and working day variation. Then, the estimated values for ridership were multiplied by a fare variable to give an estimate of revenue. This two-step approach, however, is not applicable to modeling SCRTD transit revenue because historical monthly pass ridership and transfer ridership data are not directly recorded, and the fare structure is quite complex as indicated in Table 1. Also, SCRTD cash fare revenue is not recorded by type. The only data available are total farebox revenue and pass revenue by pass type. For these reasons the direct approach of modeling transit revenue is adopted in this paper.

The direct approach is based entirely on empirical estimation of models using time series data. The initial statistical model for monthly farebox revenue is postulated as follows:

$$Y_t = B_0 + B_1X_{1t} + B_2X_{2t} + B_3X_{3t} + B_4X_{4t} + B_5X_{5t} + \sum_{j=1}^{m} \delta_j Y_{t-j} + \sum_{k=1}^{5} SS_{kt} + \sum_{k=1}^{6} SC_{kt} + WD_t + U_t \quad (1)$$

where

- Y_t = monthly farebox revenue (in $1,000s).
- X_{1t} = adult cash fare deflated by the Consumer Price Index for Los Angeles-Long Beach (5). This is a proxy variable for the general level of fares and serves to improve the predictive ability of the model and to evaluate the effects of changes in fares on farebox revenue.
- X_{2t} = monthly gasoline price (obtained from Oil and Gas Journal) (6) deflated by the Consumer Price Index for Los Angeles-Long Beach.
- X_{3t} = price of alternative methods of payment. This variable tests the effects of substitution; e.g., the price of a regular monthly pass would be a possible substitute for cash payment.
- X_{4t} = a linear trend variable representing change occurring over a period of years.
- X_{5t} = total monthly nonagricultural employment in Los Angeles-Long Beach (7).
- SS_{kt}, SC_{kt} = seasonal variation component of transit revenue (see Equation 2 for explanation).
- WD_t = working day variation component of transit revenue.
- Y_{t-j} = lagged dependent variables where j = 1, 2,. . ., m. These variables are used to capture the systematic effects in the data that cannot be explained by the X_t variables.
- U_t = stationary time series error term.

Ideally variables that measure the underlying supply of, and demand for, transit service over time should be included in the preceding model. Unfortunately some of these variables are not readily obtainable on a monthly basis. For instance, SCRTD has changed its routes and schedules considerably during the period of the revenue model estimation (1976 to 1982); yet, the resulting changes in daily scheduled vehicle hours and miles have varied by only 14 percent during the 6-year period. With such a small variability, neither scheduled vehicle hours or miles was considered to be a significant variable. Developing monthly values for alternative variables that reflect changes in the level of service provided by SCRTD would be a formidable task involving considerable subjective judgment and, hence, was not undertaken.

Total monthly nonagricultural employment in Los Angeles-Long Beach was considered an important proxy variable for demand of transit service because work trips and shopping trips by employed workers are a large percentage of all trips. Data on employment for this area of California are readily available and, importantly, are forecast by several econometric services.

Seasonal variation in the revenue time series is specified as follows:

$$SS_{kt} = \alpha_k \operatorname{Sin}(w_k \cdot X_{4t}) \quad \text{for } k=1,\ldots,5$$
$$SC_{kt} = \delta_k \operatorname{Cos}(w_k \cdot X_{4t}) \quad \text{for } k=1,\ldots,6 \quad (2)$$

where $w_k = 2\pi K/12$, and X_{4t} is defined as a trend variable.

Strong month-to-month variation in the revenue data is the result of working day variations. The reasons for the existence of these working day variations in the transit revenue data are as follows:

1. The level of ridership on weekdays is higher than that of weekends and holidays;
2. Monthly revenue data are an aggregate of daily data; and
3. Each calendar month has a different number of working days and holidays.

The specification of working day variation variables for transit series suggested by Wang (8) was adopted in this analysis. The set of working day variables are specified as

$$WD_t = \psi_1 WW2_t + \psi_6 WW6_t \quad (3)$$

where

$WW2_t = \overline{TD_t} - 5*(TD_{7t} +$ number of holidays in the t^{th} month), and

$WW6_t = TD_{6t} - (TD_{7t} +$ number of holidays in the t^{th} month).

ψ_1 is the coefficient of the weekday effect, and ψ_6 is the coefficient of the Saturday effect. The coefficient for the Sunday effect can be derived as $\psi_{sun} = -5\psi_1 - \psi_6$. TD_{it} denotes the number of occurrences of the i^{th} day of the week in month t. TD_{it} can take only two values, 4 and 5. $\overline{TD_t}$ represents the total number of working days occurring in month t. The number of holidays occurring on weekdays of month t has been subtracted. The inclusion of working day variables in the model permits us to perform a direct test on the existence of working day variation in the data and to estimate this variation directly from data.

The models for pass revenues are similar in specification to the farebox revenue model described previously except that variables representing working day variation are excluded. Separate models for each of the four types of pass payment methods were constructed to allow for differences in the behavior of the parameter values and functional forms of each revenue time series.

EMPIRICAL RESULTS

Cash Fare Revenue

The cash fare revenue equation was estimated using monthly data from July 1976 to April 1982. The estimated equation for cash fare revenue is presented in Figure 2 as are the estimated equations for the four types of pass revenue.

Figure 3 shows that the observed variation in cash fare revenue during the estimation period fits well with the values obtained from the equation. The coefficients for the real cash fare and the real gasoline price are both positive and significant at the 1-percent level. Thus, as the cash fare and gasoline prices in the Los Angeles area increased (decreased) in real terms during the estimation period, revenue increased (decreased). The positive coefficients for real cash fare and real gasoline price and their significance at the 1-percent level confirm the expectation that increasing fares (in the range of fares being examined) will lead to increased revenues and that there is some switch to transit as real gasoline prices increase.

Working day variation is present in the cash revenue data and the estimated equation accounts for it with the variables WW2 and WW6. This variation indicates that revenue alone will increase (decrease) as the number of working days within a month increases (decreases).

Figure 2. Estimated equations.

$$\bullet \text{REV.CASH} = -\underset{(-5.97)}{8880.92} + \underset{(8.31)}{18712.60}*\text{CASHFARE} + \underset{(4.69)}{7357.79}*\text{LAGR} + \underset{(4.06)}{2.22}*\text{LAEMP} + \underset{(4.88)}{29.41}*\text{WW2} - \underset{(-0.87)}{32.43}*\text{WW6} + \underset{(2.25)}{155.57}*\text{SS1}$$
$$+ \underset{(1.49)}{49.44}*\text{SS3} + \underset{(7.16)}{187.20}*\text{SS4} - \underset{(-1.38)}{31.16}*\text{SS5} - \underset{(-2.17)}{152.32}*\text{SC1} + \underset{(2.11)}{55.33}*\text{SC4} + \underset{(2.10)}{51.31}*\text{SC5} + \underset{(2.63)}{44.63}*\text{SC6}$$

$\bar{R}^2$ = .864 F(13/56) = 34.67 D-W = 2.11 GLS RH01 = 0.70 PERIOD: 7/76 TO 4/82

$$\bullet \text{REV.REGPASS} = -\underset{(-2.17)}{390.19} + \underset{(3.54)}{52.02}*\text{REGPASS} + \underset{(4.95)}{1396.23}*\text{LAGR} + \underset{(7.66)}{533.75}*\text{D80.7} + \underset{(8.97)}{0.50}*\text{REV.REGPASS(-1)} + \underset{(2.29)}{34.67}*\text{SS1}$$
$$- \underset{(-1.45)}{21.45}*\text{SS3} + \underset{(1.54)}{22.68}*\text{SS4} + \underset{(4.22)}{62.48}*\text{SC3} - \underset{(-2.18)}{32.50}*\text{SC4}$$

$\bar{R}^2$ = .986 F(9/60) = 544.19 D-h = 0.80 OLS PERIOD: 8/76 TO 5/82

$$\bullet \text{REV.S+H} = \underset{(0.84)}{33.43} + \underset{(7.05)}{65.09}*\text{SHPASS} + \underset{(0.81)}{61.68}*\text{LAGR} + \underset{(6.01)}{999.22}*\text{SHFARE} + \underset{(11.97)}{3.91}*\text{TTD}$$

$\bar{R}^2$ = .959 F(4/66) = 406.23 D-W = 2.10 GLS RH01 = 0.68 PERIOD: 7/76 TO 5/82

$$\bullet \text{LOG(REV.EX)} = \underset{(12.84)}{7.13} + \underset{(1.52)}{0.27}*\text{LOG(EXPASS)} + \underset{(6.64)}{1.28}*\text{LOG(LAGR)} + \underset{(4.52)}{0.01}*\text{TTD} + \underset{(3.08)}{0.54}*\text{LOG(EXFARE)} - \underset{(-1.66)}{0.02}*\text{SS3} + \underset{(1.89)}{0.02}*\text{SS4}$$
$$+ \underset{(2.07)}{0.03}*\text{SC3}$$

$\bar{R}^2$ = .943 F(7/51) = 140.65 D-W = 1.98 GLS RH01 = 0.35 PERIOD: 7/77 TO 5/82

$$\bullet \text{LOG(REV.STUDENT)} = \underset{(11.07)}{4.65} + \underset{(8.02)}{1.65}*\text{LOG(STUDPASS)} + \underset{(12.00)}{1.73}*\text{LOG(LAGR)} - \underset{(-2.23)}{0.12}*\text{DNC} + \underset{(3.22)}{0.10}*\text{SS2} - \underset{(-3.25)}{0.09}*\text{SS3} + \underset{(2.53)}{0.07}*\text{SS4}$$
$$- \underset{(-2.94)}{0.07}*\text{SS5} + \underset{(10.41)}{0.33}*\text{SC1} - \underset{(-5.60)}{0.17}*\text{SC2} + \underset{(7.12)}{0.20}*\text{SC3} - \underset{(-5.21)}{0.14}*\text{SC4}$$

$\bar{R}^2$ = .900 F(11/43) = 45.29 D-W = 1.95 GLS RH01 = 0.15 PERIOD: 11/77 TO 5/82

LEGEND

REV.CASH:	Cash revenue
REV.REGPASS:	Regular pass revenue
REV.S+H:	Senior and handicapped pass revenue
REV.EX:	Express stamp pass revenue
REV.STUDENT:	Student pass revenue
CASHFARE:	Real cash fare
REGPASS:	Real regular pass cost
SHPASS:	Real senior and handicapped pass cost
SHFARE:	Real senior and handicapped cash fare
EXPASS:	Real express stamp pass cost
EXFARE:	Real express stamp cash cost
STUDPASS:	Real student pass cost
LAGR:	Real gasoline price
WW2:	Weekday effect
WW6:	Saturday effect
LAEMP:	Non-Agricultural employment for Los Angeles-Long Beach
D80.7:	July 1980 fare increase dummy variable
TTD:	Trend
DNC:	Dummy variable for no college study provision: August 1978 to June 1980
SS1,...,SC6:	Seasonal effects

Figure 3. Actual and estimated cash fare revenue by month.

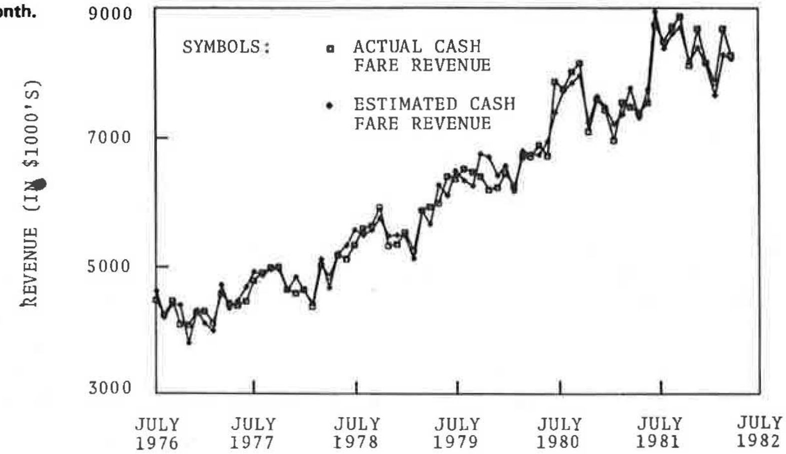
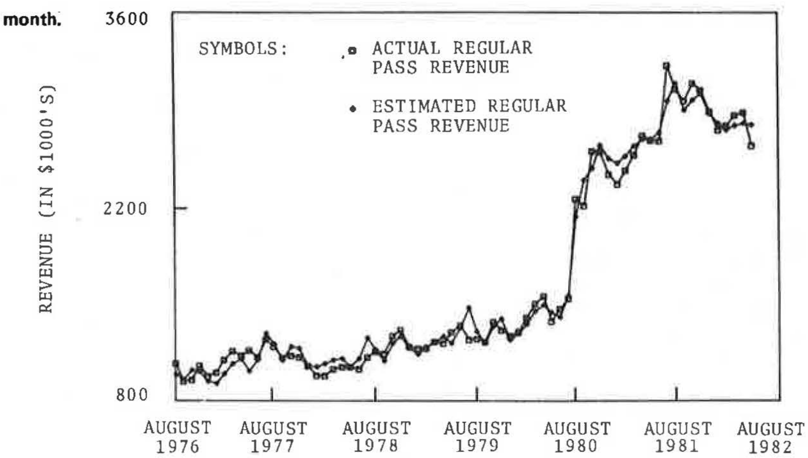


Figure 4. Actual and estimated regular pass revenue by month.



Regular Pass Revenue

The regular pass revenue equation was estimated using monthly data from August 1976 to May 1982 (see Figure 2). Figure 4 shows that the observed variation in regular pass revenue during the estimation period fits well with the values obtained from the model. The coefficients for the real price of the monthly regular pass and the real gasoline price are both positive and significant at the 1-percent level.

A dummy variable (D80.7) was included in the equation to measure the effects of the July 1980 fare change in which significant changes in the transfer provisions of cash-paying passengers made passes more attractive. The dummy variable has a positive coefficient and is significant at the 1-percent level.

Ordinary least-squares (OLS) is an appropriate estimation procedure for the regular pass revenue model even though the model includes a lagged dependent variable. The Durbin-h statistic (used instead of the Durbin-Watson statistic when the equation contains a lagged dependent variable) (9) of 0.803 indicates that the null hypothesis of no first-order autocorrelation cannot be rejected (critical value is 1.645). If such autocorrelation were present, OLS would not provide a consistent estimator and other consistent and asymptotic efficient estimation procedures would have to be used (10).

Senior Citizen and Handicapped Pass Revenue

The senior citizen and handicapped pass revenue equation was estimated using monthly data from July 1976 to May 1982 (see Figure 2). The coefficient for the real price of the senior citizen and handicapped pass is positive and significant at the 1-percent level. The coefficient of the real gasoline price is not significant even at the 10-percent level, possibly because this group is not as likely as others to have automobiles as an alternative mode of transportation. Senior and handicapped persons can pay for transit service in cash, if they desire, at a special cash fare. A variable for real senior and handicapped cash fare is included in the equation. It has a positive coefficient that is significant at the 1-percent level, indicating that revenues from senior and handicapped monthly passes increase as the senior and handicapped cash fare increases. This suggests a substitution effect between pass use and cash payment for this group.

Express Stamp Pass Revenue

The express stamp pass revenue equation was estimated using monthly data from July 1977 to May 1982, a shorter period than that of the previous models, because comparable express stamp passes were not available before July 1977 (see Figure 2).

The coefficient for the real price of the express stamp pass is positive and significant at the 10-percent level. The coefficient for the real gasoline price is also positive and significant at the 1-percent level. SCRTD passengers can pay for the express service in cash rather than purchasing the monthly pass. A variable for the real cash price of the express stamp is included in the equation (Figure 2). It has a positive coefficient and is significant at the 1-percent level, indicating that express stamp pass revenue will increase as the cash price of the express stamp increases. A substitution effect between express stamp pass use and cash payment is suggested by this relationship.

Student Pass Revenue

The student pass revenue equation was estimated using monthly data from October 1977 to May 1982, a shorter time period than that of the first four models because the student pass was not made available until October 1977 (see Figure 2).

The coefficients for the real monthly student pass price and the real gasoline price are both positive and significant at the 1-percent level. A dummy variable (DNC) was included in the equation (Figure 2) because student passes were not available to college students during the period July 1978 to June 1980. The coefficient for this dummy variable is negative and significant at the 1-percent level, indicating lower pass revenue during the period that college students could not buy student passes.

General Results

Seasonal variation is present in the data for four of the five types of revenue. Senior citizen and handicapped pass revenue is excepted because it does not exhibit much seasonal fluctuation from month to month. It should be noted that the seasonal revenue patterns are different for each of the variables; therefore, the disaggregated approach to modeling adopted in this paper is appropriate.

Before running any regressions, the dependent variables were interpolated for missing and low values due to transit strikes and service interruptions by using a seasonal time series regression model. Values for these periods with incomplete data were adjusted to reflect a complete set of data for that period. Adjusted values for cash revenue were estimated for August and September 1976 and for May, August, and September 1979. For regular pass revenue and senior citizen and handicapped pass revenue, adjusted values were estimated for September 1976 and September and October 1979. Adjusted values for express stamp revenue were estimated for September and October 1979, and student pass revenue was estimated for September 1979.

MODEL ASSESSMENT AND FORECASTING

It is well known that a high R^2 for a model estimation in the sample period does not necessarily imply that the model will predict well in the period outside the sample. For this reason, a data split technique is used to test whether the estimated model equations will be satisfactory for forecasting purposes. This is our model validation procedure.

The data are split into two parts: the first part is used for estimating the model equation. The second part, the last 6 months of data, is reserved to test the forecasting performance of the model. In this case, the values of the independent variables used to forecast revenue are known. A forecast so obtained is known as an ex-post forecast. Therefore, the forecasting errors can be attributed to the specification of the models. Following this rule, all five model equations were reestimated and the results are shown in Figure 5.

Forecasting accuracy may be evaluated by two standards: absolute accuracy and relative accuracy. The average absolute percentage error (AAPE) is used as a statistical measure of absolute accuracy in this analysis and is defined as

$$\mathrm{AAPE} = 1/N \sum_{t=1}^{N} |(A_t - P_t)/A_t| \times 100 \quad (4)$$

where A_t and P_t are the actual values and the forecasts, respectively, in period t (where P_t are ex-post forecasts), and N is the number of forecasting periods.

It should be emphasized that comparing a forecast with actual data is the equivalent of making the comparison with an entirely error-free forecast. This is a strong criterion and may be more stringent than needed in practice.

It is unrealistic to expect a forecast to be entirely error free. Thus, a more relevant criterion is how a forecast compares with other available forecasts. To do this, Theil's U-statistic for seasonal time series was used as a standard for relative accuracy. This statistic is defined as

$$U_{12} = \sqrt{\Sigma(A_t - P_t)^2/\Sigma(A_t - A_{t-12})^2} \quad (5)$$

where A_t and P_t are the actual values and the forecasts, respectively, in period t (where P_t are ex-post forecasts), and A_{t-12} are actual values lagged 12 months; and U_{12} represents a comparison of the sum of squares of the forecast errors with the sum of squares of a seasonal random walk model.

It is interesting to observe that when the forecasts are free of error, the value of U_{12} is zero. A value of U_{12} that is less than one implies that the nonnaive model performs better than the naive, random walk model.

Table 2 gives the forecast evaluations for both the absolute and relative accuracy standards. From this table, it is concluded that these models perform quite well for forecasting purposes. Therefore, the model equations estimated in the previous section (using the complete set of data from about July 1976 to May 1982) will be used for forecasting transit revenue by type of payment for the period May or June 1982 to December 1983 under the alternative assumptions of future fare policies.

The forecasting procedure consists of two steps: selecting forecasted values for independent variables under various assumptions and substituting these forecasted variables into the models. The forecasts rest on the assumption that the basic structural relationships among the variables will remain unchanged during the forecasting period. The forecasts for the monthly Consumer Price Index and labor employment were obtained from Chase Econometrics (11) and the gasoline prices from Wharton (12). The fare structure (fare rollback) implemented by SCRTD in July 1982 was input to the model. Two sets of forecasts were generated: the first was based on the fare structure actually initiated in July 1982, and the second was based on the fare structure that prevailed during the period July 1981 to June 1982.

The forecast for student pass revenue, given that the pass price dropped from \$24 to \$4, some 83 percent, was not judged to be reasonable. Hence, an alternative forecasting methodology was developed. The historical average number of passes sold (student pass revenue divided by nominal pass price) per month was regressed on corresponding real gasoline prices, seasonality, and a dummy variable (DNC) to take into account a period (July 1978 to June 1980) when student passes were available only to high school students. Using the estimated parameters, forecasted values of the average number of passes sold were obtained and multiplied by nominal pass

Figure 5. Equations for model validation.

$$\text{REV.CASH} = \underset{(-7.02)}{-8575.58} + \underset{(6.60)}{15565.30*\text{CASHFARE}} + \underset{(6.04)}{8110.48*\text{LAGR}} + \underset{(4.11)}{25.61*\text{WW2}} - \underset{(-0.64)}{24.44*\text{WW6}} + \underset{(4.92)}{2.24*\text{LAEMP}} + \underset{(1.94)}{126.87*\text{SS1}}$$
$$+ \underset{(1.35)}{45.49*\text{SS3}} + \underset{(6.56)}{178.92*\text{SS4}} - \underset{(-1.23)}{28.62*\text{SS5}} - \underset{(-3.35)}{230.24*\text{SC1}} + \underset{(1.26)}{33.70*\text{SC4}} + \underset{(1.93)}{48.08*\text{SC5}} + \underset{(2.80)}{48.46*\text{SC6}}$$

$\bar{R}^2 = .899$ F(13/50) = 44.31 D-W = 2.05 GLS RHO1 = 0.62 PERIOD: 7/76 TO 10/81

$$\text{REV.REGPASS} = \underset{(-2.28)}{-416.25} + \underset{(3.60)}{53.51*\text{REGPASS}} + \underset{(4.74)}{1431.99*\text{LAGR}} + \underset{(7.41)}{527.14*\text{D80.7}} + \underset{(8.31)}{0.50*\text{REV.REGPASS}(-1)} + \underset{(2.31)}{36.96*\text{SS1}}$$
$$- \underset{(-1.54)}{23.94*\text{SS3}} + \underset{(1.16)}{18.05*\text{SS4}} + \underset{(3.44)}{53.60*\text{SC3}} - \underset{(-2.36)}{36.99*\text{SC4}}$$

$\bar{R}^2 = .983$ F(9/54) = 417.84 D-h = 0.77 OLS PERIOD: 8/76 TO 11/81

$$\text{REV.S\&H} = \underset{(-0.30)}{-11.90} + \underset{(7.71)}{70.90*\text{SHPASS}} + \underset{(1.71)}{137.61*\text{LAGR}} + \underset{(5.69)}{978.46*\text{SHFARE}} + \underset{(10.21)}{3.64*\text{TTD}}$$

$\bar{R}^2 = .966$ F(4/60) = 448.66 D-W = 2.01 GLS RHO1 = 0.58 PERIOD: 7/76 TO 11/81

$$\text{LOG(REV.EX)} = \underset{(12.41)}{7.34} + \underset{(1.46)}{0.27*\text{LOG(EXPASS)}} + \underset{(5.67)}{1.44*\text{LOG(LAGR)}} + \underset{(2.52)}{0.01*\text{TTD}} + \underset{(3.20)}{0.57*\text{LOG(EXFARE)}} - \underset{(-1.65)}{0.02*\text{SS3}}$$
$$+ \underset{(1.45)}{0.02*\text{SS4}} + \underset{(1.59)}{0.02*\text{SC3}}$$

$\bar{R}^2 = .941$ F(7/45) = 119.64 D-W = 2.00 GLS RHO1 = 0.31 PERIOD: 7/77 TO 11/81

$$\text{LOG(REV.STUDENT)} = \underset{(8.53)}{4.68} + \underset{(5.80)}{1.64*\text{LOG(STUDPASS)}} + \underset{(11.05)}{1.72*\text{(LOG LAGR)}} - \underset{(-2.08)}{0.12*\text{DNC}} + \underset{(2.90)}{0.10*\text{SS2}} - \underset{(-2.80)}{0.09*\text{SS3}} + \underset{(2.22)}{0.07*\text{SS4}}$$
$$- \underset{(-2.60)}{0.07*\text{SS5}} + \underset{(8.94)}{0.33*\text{SC1}} - \underset{(-4.94)}{0.17*\text{SC2}} + \underset{(6.17)}{0.20*\text{SC3}} - \underset{(-4.76)}{0.14*\text{SC4}}$$

$\bar{R}^2 = .871$ F(11/37) = 30.57 D-W = 1.94 GLS RHO1 = 0.15 PERIOD: 11/77 TO 11/81

LEGEND

REV.CASH:	Cash revenue	STUDPASS:	Real student pass cost
REV.REGPASS:	Regular pass revenue	LAGR:	Real gasoline price
REV.S+H:	Senior and handicapped pass revenue	WW2:	Weekday effect
REV.EX:	Express stamp pass revenue	WW6:	Saturday effect
REV.STUDENT:	Student pass revenue	LAEMP:	Non-Agricultural employment for Los Angeles-Long Beach
CASHFARE:	Real cash fare		
REGPASS:	Real regular pass cost	D80.	July 1980 fare increase dummy variable
SHPASS:	Real senior and handicapped pass cost	TTD:	Trend
SHFARE:	Real senior and handicapped cash fare	DNC:	Dummy variable for no college study provision: August 1978 to June 1980
EXPASS:	Real express stamp pass cost		
EXFARE:	Real express stamp cash cost	SS1,...,SC6:	Seasonal effects

Table 2. Model validation: Values for percentage error, average absolute percentage error (AAPE), and relative errors (U_{12}).

Item	Cash Fare Revenue	Regular Pass Revenue	Senior Citizens and Handicapped Pass Revenue	Express Stamp Revenue	Student Pass Revenue
Absolute Percentage Error and AAPE					
Nov. 1981	-0.70	–	–	–	–
Dec. 1981	4.73	0.97	1.98	-4.02	-0.50
Jan. 1982	4.26	-1.3	1.40	-0.60	2.95
Feb. 1982	7.56	0.24	4.29	4.47	1.02
March 1982	11.46	3.22	4.17	8.82	10.18
April 1982	10.25	4.52	3.35	12.34	-6.28
May 1982	–	-3.87	1.10	-0.12	-4.56
AAPE	6.49	2.19	2.72	5.06	4.25
Relative Errors (time period: November 1981 to May 1982)					
Values for U_{12}	0.633	0.026	0.144	0.593	0.285

price to produce the desired revenue estimates. All of the forecasts are shown in Table 3. From this table the effects of the fare rollback on aggregate and disaggregate transit revenue can be seen.

Finally, it should be mentioned that no single forecasting method is uniformly better than all other methods at all times. Different approaches follow different philosophies to extract information from the available data. Therefore, the practical approach is to examine alternative forecasts by alternative approaches such as judgmental forecasts, time series forecasts, and causal model forecasts. Then, these forecasts can be combined into a single forecast by applying to each type of forecast weights based on different specific criteria. The flexibility of this approach lends itself to the incorporation of topical future events into the forecasts.

Table 3. Revenue forecasts with and without the July 1982 fare rollback ($1,000s).

Item	Cash Fare Revenue		Regular Pass Revenue		Senior and Handicapped Pass Revenue		Express Stamp Revenue		Student Pass Revenue	
	Without	With	Without	With	Without	With	Without	With	Without	With
July 1982	8,547	6,261	2,661	2,407	481	331	309	208	962	160
Aug. 1982	8,235	5,961	2,484	2,105	483	334	286	192	628	105
Sept. 1982	8,335	6,072	2,303	1,863	485	337	289	194	452	75
Oct. 1982	8,233	5,982	2,341	1,872	487	340	307	207	871	145
Nov. 1982	7,840	5,601	2,343	1,861	489	343	298	200	1,083	181
Dec. 1982	8,054	5,826	2,220	1,733	492	346	289	194	870	145
Jan. 1983	7,881	5,665	2,188	1,699	494	349	294	198	921	154
Feb. 1983	7,656	5,451	2,225	1,738	496	352	299	201	1,093	182
March 1983	8,273	6,080	2,270	1,784	499	355	307	206	1,099	183
April 1983	8,083	5,900	2,293	1,809	501	359	301	202	1,122	187
May 1983	8,133	5,960	2,236	1,753	504	362	292	196	1,064	177
June 1983	8,388	6,226	2,265	1,785	506	365	314	211	988	165
July 1983	8,374	6,224	2,383	1,905	509	368	323	217	947	158
Aug. 1983	8,386	6,248	2,302	1,827	511	371	300	201	618	103
Sept. 1983	8,361	6,236	2,173	1,700	513	374	306	205	449	75
Oct. 1983	8,289	6,174	2,241	1,771	516	378	328	220	873	145
Nov. 1983	7,920	5,814	2,262	1,794	518	381	320	215	1,090	182
Dec. 1983	8,087	5,991	2,153	1,687	521	384	313	211	881	147

CONCLUDING REMARKS

In this paper it has been demonstrated that an empirical regression model using the time series approach is appropriate for modeling seasonal farebox revenue and the four types of pass revenue generated in the SCRTD bus system. All empirical results confirm the a priori expectation about the empirical relationship between revenues and the real fare variables and real gasoline price variables.

The regression model approach is superior to the elasticity approach because it rigorously takes into account changes in other variables, e.g., gasoline prices, seasonal effects, overall revenue trends, substitute payments, as well as the change in the fare variables. The models provide empirical relationships among the variables which test a priori expectations. Furthermore these empirical results perform quite well for predicting purposes; and these models can provide conditional forecasts of various types of transit revenues under varying assumptions about the economy, energy conditions, and fare structure. In practice, forecasts generated from this approach should be combined with judgmental forecasts because forecasts will be more accurate if based on a wide range of information.

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Abridgment

Assessing Software to Meet the Financial Planning Needs of Transit Operators

THOMAS DOOLEY AND DAVID SPILLER

An evaluation of commercially available software products to meet the financial planning needs of transit operators is summarized, and the methodology used to establish functional and information processing needs of transit operators and to select potential products is reviewed. Four functional areas (ridership and fare analysis, cash management, tax revenue analysis, and expense estimation) are identified and the potential of two types of commercially available products (electronic spreadsheets and financial modeling languages) to address typical financial planning problems in these areas is described. The strong and weak points of each product type are identified.

Current economic conditions have increased the need for transit managers to do financial planning. Recent advances in microcomputer technology suggest that investments on the order of $5,000 in equipment and software could provide significant improvements in financial planning. Summarized in this paper is a staff study (1) that describes the extent to which commercially available microcomputer products requiring little programming experience can be used for financial planning.

METHODOLOGY

The methodology used is outlined below.

Activity	Output
Identification of current practice in financial forecasting	Current activities Promising solutions Constraints Needs
Financial management information processing activities	Inputs, functions, outputs Appropriate software
Review panel discussions	Feedback on activity definition Priorities Constraints
Product surveys	Currently available products Product capabilities
Problem scenarios and product capabilities	Issues Decisions Information processing requirements Match user requirements and product capabilities
Product assessments	Summary of product capabilities to meet user requirements

The first three steps identify the functional needs (2) and information processing activities (3) of transit managers. A review panel provided feedback on the ideas. Needs included ridership and fare revenue analysis, labor and maintenance expense estimation, tax yield and incidence estimation, and cash management. The financial planning activities required manipulation of small, high-quality data sets, model building, ad hoc inquiries of data bases, report generation, and continuous iteration. Table 1 identifies the functions, characteristics, and equipment requirements of financial planning within the context of all financial management activities.

Typical problem scenarios were defined based on the understanding of transit financial planning needs and activities. The problem scenarios were used to identify the key issues and decisions transit managers must make; this, in turn, established both the value of, and the need for, specific information processing requirements. Potential software products were first screened against these requirements; then, the ability of representative products to meet the requirements was documented.

Two types of microcomputer software were identified that appeared to have potential for financial planning applications and were inexpensive and easy to use. One type, the spreadsheet program, is a computer representation of a large piece of paper containing rows and columns that are displayed on the monitor. The program allows the user to create relationships between entries (such as the sum of a column) that are automatically recalculated when changes to the relevant entries are made. Labels, values, and formulas are typed in and appear on a portion of the spreadsheet shown on the display. The program remembers positional relationships so that changes (such as deleting or moving rows or columns) can be made without affecting what has been done before. A set of commands is available for printing what is on the screen. Compatible products include programs that plot, analyze, sort, or manipulate sets of data.

The second type, the financial modeling program, provides more flexibility in data manipulation and report generation than the spreadsheet program but takes longer to learn. Financial modeling programs generally handle more than one matrix, have more sophisticated logic such as branching and looping, and provide more commands for formatting and presenting output.

FUNCTIONAL AREAS

Expense Estimation

Expense estimation is vital to financial planning. Data on current expenses, service provided (e.g., platform hours), resources used (e.g., pay hours), and resource prices (e.g., wage rates) are captured and manipulated to determine the relationship between input and output variables. These models are then used to forecast future expenses based on changes in relevant variables. Reports are generated from either model results or data base inquiries. Various types of models described by Dooley and Spiller (1) include expense allocation, factor, resource estimation, and direct calculation.

Three scenarios were developed to typify expense estimation problems. The first required expense estimates for service changes by time of day, day of week, and route. The second scenario required estimates of the cost of various provisions in the labor contract (e.g., part-time labor), whereas the third required an investment analysis of articulated versus standard buses. Key information processing requirements derived from these cases included capturing data at the appropriate level of detail; linking to other data bases; doing arithmetic, logi-

Table 1. Financial management information processing activities.

Function	Information Processing Characteristics	Hardware and Software
Accounting and data base management		
Financial accounting and reporting	Well-defined procedures	Commercial software package
Accounts receivable and payable	Transaction processing	on time-shared mainframe or
Payroll and personnel	Periodic standard reports	stand alone minicomputer
Fixed assets		
Ridership sampling		
Accident and safety reporting		
Financial control		
Operator scheduling	Well-defined procedures	Customized software package
Vehicle maintenance management	Transaction processing	on time-shared mainframe or
Inventory control	Real time information	stand alone minicomputer
Vehicle scheduling	Standard reports	
Budget review		
Cash managment		
Financial evaluation and planning		
Performance analysis	Ad hoc inquiries	User programmed software or
Service planning	Nonstandard reports	models developed with commercial generic software on
Financial planning: pricing, investment, budgeting, and forecasting	Aggregated data	small, mini-, or microcomputers

cal, and statistical manipulation of data; modifying calculations based on changes in inputs; calculating expenses for multiple periods; doing logical branching and iteration; and generating multiple reports for multiple users.

For example, spreadsheets can be used to estimate the change in expenses associated with service changes. First, expenses (manually or machine entered) that vary linearly or are invariant to service parameters are allocated to those variables to derive unit costs. This can be done by manually entering the data on the work sheet and writing formulas in cells used to store sums and unit costs. To determine nonlinear costs, a separate work sheet could be used to record peak and off-peak pay hours and vehicle hours to adjust wage expense allocations by time of day. Some work sheets have regression packages that could be used to derive relationships from sample data. Spreadsheets can be used to calculate expenses using any set of equations that can be entered on the work sheet. Limited logic can be used by putting alternative formulas in a cell with Boolean operators. Each report must be laid out (what you see is what you get), so space (254 rows) is a limitation.

Financial modeling packages provide better data manipulation capabilities for estimating expenses. Because the data and programs are stored separately, branching is possible. For example, if different calculations are required for estimating driver requirements and then regular, guarantee, and premium hours for straight, split, and tripper runs, a modeling language would be easier to use than a spreadsheet. Modeling languages can also create a variety of reports from the same set of data. Modeling languages usually have graphics that are integrated into the package, whereas spreadsheets require that the data be transferred to another package. The two limitations of the financial modeling packages reviewed are the lack of an external interface (all data must be entered manually) and a relatively small data set capacity (2,000 cells).

Ridership and Fare Analysis

Transit ridership data and the relationship between ridership and fare and service are essential for monitoring existing transit operations, preparing fare revenue estimates for the budget, and forecasting the effect of future changes to transit services.

Three scenarios were developed to illustrate functional requirements in this area and the associated software information processing needs. The first problem scenario involved the monitoring of service and the assessment of performance to resolve allegations of insufficient and inequitable allocation of transit service on routes serving the central city. The second problem scenario addressed the need to consider alternative fare and service levels and their effect on ridership and fare revenue in preparing the transit agency's operating budget. The third problem scenario involved long-range transit planning to improve the central area circulation. Information processing needs derived from these problem contexts included area, time, and user windowing; linkage to nonridership data files; incorporation of user-defined models; and user-defined report and output file formats.

For example, spreadsheet programs could be used to provide a window for a preselected sample of routes serving the central city and outlying jurisdictions, respectively, to resolve allegations of insufficient and inequitable allocation of service. Aggregate ridership measures (e.g., total passengers served, total boardings per route-mile) and revenue and cost measures (e.g., revenue to direct operating cost ratio) could be computed for each sample of routes. Financial modeling software, however, could provide additional and more sophisticated modeling capabilities. Cumulative boarding and alighting counts (and graphics) could be developed. Occupancy profiles for each matched pair of routes in the two samples could be derived. Integration of graphics (for example, the occupancy profile) within reports is more easily done with financial modeling software. In addition, financial modeling software includes more sophisticated statistical routines that would permit ridership and fare revenue models to be calibrated. Both types of software are limited to small data sets. Automatically linking the preselected sample of city and suburban routes to other data files to compute, for example, service provided would be difficult (i.e., bus-hours per route and per sample, and scheduled and in-service frequencies).

Cash Management

Efficient cash management involves transit agency control of the disbursement and receipt of funds to yield maximum public benefit. Because high interest rates make the holding of excess cash expensive, determination of the optimal cash balance is a central component of cash management.

Three problem scenarios were developed to illustrate functional requirements of cash management activities. The first problem involved the need to develop a cash budget for a new demand-responsive service for the elderly and handicapped. The second problem scenario required simulation of the effects of a 1/2 percent increase in interest rates on long-term bonds to be used to finance the purchase of new buses. The last problem required a reconciliation of reported fare revenues versus expected revenues for four bus routes using a transaction log and detailed reporting of cash receipts for every bus run for the routes in question. Key information processing needs derived from the foregoing problem contexts included cash budget forecasting capability, what-if analyses, audit trail for sources of funds, user-defined models, transaction logs and processing, linkage to other software and data files, and a query capability.

For example, both spreadsheets and financial modeling software can be used effectively to prepare cash budgets or to conduct what-if analyses. Transaction processing and linkage to other software and data files, however, are not well supported by either type of software. Although financial modeling software provides additional financial operators and functions (e.g., lead and lag operators), user-defined models particularly when applied to determine optimal cash balances are not usually well supported.

Tax Revenue Analysis

Planning transit service requires the prediction of tax revenue yields that will be available to the operator to subsidize transit operations. Securing new revenue sources requires the prediction of both the effects (who benefits) and the incidence of the tax (who pays).

Three cases were developed to illustrate functional requirements in this area. In the first case it was intended to finance transit development in two intersecting corridors through a value capture policy, i.e., by taxing the incremental increase in property values. Projections of tax revenue yields during a 15-year planning period in each corridor were needed. The second case focused on determining tax revenue yields from alternative allocations. The third case required determining trade-offs between necessary cost savings and potential tax increases.

Information processing needs derived from these cases included user-defined models, geoprocessing of data, and a forecasting capability. Spreadsheets and financial modeling software could both support tax revenue models based on allocation formulas, the product of tax base estimates and tax rates, or fund dedication ratios. Financial modeling software often has additional statistical routines that would permit the calibration of models that relate a specific tax base to various economic and policy variables. If either a spreadsheet or financial modeling software product had strong data base operators (e.g., search and selection capabilities), the geoprocessing of tax records would be feasible (e.g., manipulation of property tax assessment data for census blocks that comprise the transit development corridors in question in case 1).

SUMMARY AND CONCLUSIONS

Two generic classes of microcomputer software that have been identified as meeting, at least to some degree, financial planning functional requirements and associated information processing needs are spreadsheets and financial modeling software. The software assessments of five representative commercial products documented by Dooley and Spiller (1) support the following conclusions:

1. Both the spreadsheet and modeling language software are most suitable for ad hoc analysis, querying of a small high-quality data set, and quick report and graphics generation.
2. None of the software products that were reviewed is suitable for work requiring transaction processing.
3. A major limitation in each of the software packages that were reviewed is its inability to communicate with other software; thus, integration with in-place financial information systems at transit agencies may not be easily resolved.

Although the success of the methodology described in this paper awaits validation in the field, it appears to represent a paradigm for making informed decisions about potential decision support and productivity improvement investments in software. The methodology is applicable to a wide range of transit information processing requirements.

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Abridgment

Information-Related Needs in the Transit Industry

DAVID DAMM

An analysis of discussions with representatives of more than 30 transit agencies is presented. This occurs in the context of the goals of the UMTA-sponsored Operations and Planning Support (OPS) Program to develop and promote tools that incorporate computer technologies to address problems faced in the transit industry across the full range of functional areas (finance and administration, maintenacne, service provision, and service development). Current and anticipated capabilities in each of the agencies as well as task-based needs for automatic data processing are assessed. The findings take into consideration constraints that exist among transit agencies that are likely to implement the proposed innovative management tools. It has become evident that both the attitude toward computers and the organizational setting are particularly important in determining the success of innovations and the kinds of needs designated as critical. A summary of informational concerns as well as actions to be taken is presented.

The purpose of this paper is to continue the dialog between the federal government and the American transit industry related to information needs. It is important to clarify what constitutes a need and to determine which needs would be most effectively meet through federal assistance. At this time, the Operations and Planning Support (OPS) Program, sponsored by the UMTA Office of Methods and Support is designed to promote the use of productivity-enhancing tools, both manual and automated, in the public transit industry. In the first section of this paper the background and motivation for the assessment of needs are presented. The remaining sections summarize conversations with individuals at various transit agencies about their needs for computer-based tools.

BACKGROUND AND MOTIVATION

It has become evident in recent years that the proper combination of circumstances for improving productivity in the transit industry exists for more agencies than those few that are innovative. In the face of indicators, such as declining passenger-revenue ratios, there has been a general push for greater efficiency. The industry is exploring the role of new, often computer-based, management tools in solving these problems.

Central to the discussion of new tools is a concern for handling large volumes of data so that managers can use resources more effectively. Because of the federal government requirement to collect and report specific items of data regularly, there is no longer any question whether agencies have data that would be useful to management. In addition, a number of agencies now routinely collect ridership, revenue, and maintenance-related data not required by the federal government but which they need to decide how to adjust the deployment of human and vehicular resources over time and space.

It has become evident, however, that most of these data are aggregated (e.g., one number for systemwide ridership for a month) never again to be used for a specific area or time of potential interest (e.g., a particular route in the off-peak hours). Often this failure to use data originating from a lower level of aggregation stems from not having the staff to sort through reams of paper stored in an inconvenient location. After data have been aggregated it is almost impossible to retrieve individual pieces (e.g., comparing ridership for a specific route over each of the past 365 days).

The speed with which data-handling equipment has become widely available is also a factor in the increased interest in management tools. The advent of small, cheap microcomputers with standardized components and peripheral equipment has made computers affordable by most transit agencies. They are especially attractive to managers in smaller operations who have been previously dependent on outside agencies or consultants when substantial volumes of data were to be processed and analyzed. For many agencies, payrolls have been the only operation that has been computerized to any great degree.

Microcomputers that can be configured with a larger system (minicomputer or mainframe) or stand alone, combined with the increased availability of software (i.e., sets of instructions used to process and analyze data in the computer) has created a receptive climate for proponents of new management tools. This climate is perhaps the most critical factor directing attention toward improved techniques.

Because no specialists are required, managers, particularly those in smaller agencies, do not have to be concerned about dependence on outside agencies or an inability to hire and pay for appropriate computer professionals. In short, a manager confronted with mountains of statistics who is willing to consider recently developed tools (e.g., microcomputers and associated software) would probably be willing to discuss and implement information management techniques.

In the OPS Program we have sought to support and take part in the development of tools that can be tailored to the needs of individual transit agencies. Nevertheless, we assume that it would benefit the industry as a whole to encourage the design of managements tools that are compatible with the current and anticipated needs and capabilities of most agencies.

NEEDS AND CAPABILITIES RELATED TO COMPUTER-AIDED TOOLS

This section includes documentation of developments related to computer-aided tools of transit management and is based on conversations held with representatives of more than 30 agencies during the fall of 1981. Agencies were contacted in every region of the United States, representing a wide range of sizes (from 12 to more than 1,000 peak-period buses), experiences with, and attitudes toward tools for managing information resources. For the most part, conversations were structured to gather explicit information from transit agencies about their current capabilities and recent experiences with computers. This section also highlights the primary concerns that the transit planners and managers who were contacted have about further data-related automation. Most were able to identify one or more functional needs that are inadequately met. By documenting needs and capabilities, a basis is provided for mapping out the boundaries and content of improved techniques. Such techniques obviously cannot be developed in isolation from agency experience or perceived future needs. The types of information sought from operators and a summary of the approach taken in contacting transit agencies are provided. This is followed by an overview of the findings from the discussions.

Focus of Discussions

Previous discussions with transit planners and managers revealed a number of useful insights. On the one hand, a small number of agencies (usually larger than most in terms of number of vehicles) have the appropriate combination of employees, organizational structure, and resources that have led to innovative handling of information. Most of these agencies have already investigated how new data-related technologies could help their agencies. On the other hand, because many agencies lack appropriate resources or have a rigid organizational structure, they may be wary of adopting tools that have not been fully tested.

As in other industries, a few agencies are in a position to go beyond theoretical support to actual implementation. After the concept has been tested and generally acknowledged as useful, most other agencies are likely to give it serious consideration. Earlier telephone discussions (1) also showed that, except for the industry's innovators, little time is devoted in most agencies to the use of data-intensive techniques. Most management of data is manual, and service and operating policies, for example, are often developed without the aid of any formal methods.

In the light of previous findings an attempt was made to obtain three types of information: current and anticipated activities related to data handling and processing, the receptivity of the agency to new approaches, and agency priorities regarding functional needs that are amenable to some degree to computer-based management tools.

Approach Taken

Four phases characterized the assessment of needs and interest in adopting computer-based management tools. The first two phases were designed to sort out information that exists elsewhere. First, prior general (i.e., industrywide) statements of needs and capabilities with regard to the creation and use of information were reviewed. Where possible, these were differentiated by types of agencies (e.g., size) and used as a basis for initiating conversations. Second, a number of innovative agencies were identified. It was assumed that previous interviews and discussions had already summarized most of what can be learned about traditional agencies.

In the first two phases, maximum use was made of key informants such as Service and Management Demonstration (SMD) evaluation monitors at the Transportation Systems Center (TSC), American Public Transit Association (APTA) officials, APTA committee members, and transit industry people. In phase three, questions to be raised during discussions were generated through several rounds of critique and entered onto a reference sheet used to guide telephone discussions, though only loosely and not in the form of an interview. In phase four operators were queried.

Summary of Findings

There is considerable interest among transit agencies in using computer-oriented tools for functions that have been performed manually. Although a few operators feel their manual systems of data management will remain sufficient, most view computers as a means to reduce handling of paper, cut costs, and generate more useful indicators more quickly than is currently the case. A surprisingly large number of transit agencies contacted are already in the process of actively exploring available computers, software, and consultants.

It was never evident what constituted a representative sample of operators for automation of management-related information, nor how to devise an unbiased sampling procedure. As a result, those contacted represent a sample of people who tend to favor innovative approaches and were, for the most part, quite receptive to having further discussions. The reader should therefore not interpret this summarization as necessarily valid for the entire transit industry. It has been assumed that innovations in transit information management have been and will be first introduced by a few leaders in the industry, tested, refined, and then adapted by the majority of agencies to their particular situations.

Three closely interrelated features of the transit agencies contacted warrant careful description. First, the organizational context in which a manager performs creates a framework for making decisions, defining issues as important, and resolving conflicts. Second, current requirements for data gathering and processing are often derived from the organizational context as well as individual inclination to use computer-aided tools in decisions concerning agency management. Third, and overlapping with the second item, agency receptivity to automation depends on the level of familiarity with available options as well as current requirements and projected needs to generate statistical results.

The organizational setting can be characterized by two dimensions: size and complexity. Simply stated, larger agencies tend to be more complex. It appeared at the outset that the larger, more departmentalized agencies would have the resources to try new tools and would have had more experience with computers. This did not hold to be true; although larger agencies are able to attract data-oriented professionals, they are not necessarily more innovative than smaller agencies. Often expenses for data-related items have to be approved by a separate data department. Requests may be received from more than one part of an organization; and because data processing professionals cannot possibly understand the content of each functional area request, decisions are not always made that satisfy area needs.

A further barrier to innovation is that larger organizations tend to get locked into a particular type of data processing. After a commitment has been made (in terms of hardware purchased, procedures developed, and personnel hired and trained), it is sometimes difficult to shift, particularly if a shift implies lessening the control data processing professionals have over data-related resources.

In small (fewer than 100 buses) and medium-sized (100 to 400 buses) operations, an inability to support a separate data processing staff can be seen as a hidden strength. Another agency or a service bureau can be consulted as needed and no commitment to a particular technology has to be made. Not all smaller agencies, however, have used this independence to their advantage. Some have used their inability to have a separate data processing staff as an excuse to avoid any large-scale manipulation of data or at least to restrict automation to the processing of payroll and accounting information.

The very small agencies (fewer than 50 buses) tend to be the least structured (their professional and administrative staffs may consist of only two to five people) and also the most flexible in using data resources. One professional in a small agency told of treating a request for a microcomputer, disk drive, and printer on a par with a request for office furniture. This is in stark contrast to larger agencies (more than 500 buses) where several layers of approval are required, often by people who do not understand the technologies or the problems confronting the department that submitted the request.

Nonetheless, smaller agencies may tend to be provincial and have less contact with the rest of the industry. Hence their managers are often less knowledgeable about cost-saving innovations than those in larger agencies.

The second major insight derived from the discussions is that there is a close relation between the data collected, the ability to process such data, and the ultimate use of the data in making operational and management-related decisions. Many agencies now collect financial and operating data as required by Section 15 of the UMT Act (as amended). It is evident, nonetheless, that these data are not often used in a manager's decision-making process.

A number of agencies appear to collect the data in whatever way satisfies the minimal requirement, whereas others integrate Section 15 items into a larger scheme, often collecting data disaggregated by routes, market segments, and times of day. Most of the agencies contacted are of the latter type, although it can reasonably be supposed that a majority of all agencies tend to be like the former.

There are two extremes in terms of capabilities to process and analyze data. The transit agencies whose staffs have access to equipment and data processing professionals and know how to use them to good advantage tend also to be the agencies that collect more usable data. The less ability there is to process data, the fewer items of data will be collected and subsequently used in the process of managing an agency's resources. For example, in response to the need to forecast revenues and costs for future years, many agencies would collect considerably more detailed data than they do now if they were able to play out "what-if" questions for any number of variables (e.g., fares and labor costs).

In a 30- to 40-minute telephone conversation, it is difficult to assess precisely what range of capabilities exists among the agencies contacted. It is safe to state, however, that those agencies that already collect or are anxious to collect and use more disaggregated data (e.g., maintenance data on individual buses or ridership by route) will be more likely to consider computer-aided management tools than those that do not.

The third primary insight generated from these conversations with operators is that manager familiarity with the range of options in automating various functions strongly colors willingness to discontinue manual processing of data. At one extreme managers are apprehensive about anything related to computers or mathematics and have made no effort to learn about automated systems that could improve their operations. At the other extreme are managers who have computer training or experience working with computers and have no hesitancy considering every reasonable means to increase the level of automation. In the middle, of course, are the majority of managers who are somewhat familiar with computer-related options but do not have time to evaluate them. Within the small group of managers who have already used computers widely it is interesting to observe that some perceive a strict division between technical staff as processors of data and themselves as consumers of summary reports and charts provided by the staff.

SUMMARY OF INFORMATION-RELATED NEEDS AND CONCERNS

It should be apparent from the previous section that an agency's organizational structure can create pressures to automate in a particular manner. Top management may identify serious problems in one sector of an agency and instruct technical employees to focus their attention on that sector. At the same time, the definition of information-related needs may be colored strongly by what tools have been recently, or soon will be, acquired. For example, several agencies were preoccupied with their new electronic registering fareboxes (Duncan) and wanted to adapt any functions to be automated to the data they would be able to collect with them.

Several needs were identified that were common to agencies of all sizes and organizational types. Many planners and managers believe that large volumes of data cannot be used well and would welcome any means to simplify the gathering and processing of the data. A sizable number of them focused primarily on these mechanical processes rather than on what could be done with them. Because speed is essential to the success of an information system, many complained of a long wait between gathering data and actually being able to use such data. For example, the service planners contacted expressed a strong need for a reliable means of evaluating the best routes and times of day or week to alter service. Surely, tools that would help generate disaggregated indicators before decisions for the next planning period are made would receive widespread attention.

Many operators in agencies of varying sizes mentioned an interest in automating maintenance and investory files. In a larger one, the person contacted pointed out the need to improve the scheduling of buses for repair and to have a better system for checking the status of outstanding work orders. A planner in a medium-sized agency said that costing maintenance jobs was important. A manager in a small agency went further: having a breakdown of costs by parts and knowing the availability of each part would improve his operation. Another manager in a smaller operation believed that automating maintenance records to allocate costs to different types of vehicles was his highest priority (higher than service planning). A manager in another smaller operation wanted to have an automated system that could be used to evaluate mechanic performance.

A common set of needs appears to exist across types and sizes of agencies. Differences tend to emerge based on previous experience with automation and the managers' attitude toward it. Although it cannot be claimed that a representative sample was identified, it appears that smaller agencies often have more freedom to proceed with those ideas that have a strong likelihood of improving efficiency. Larger agencies tend to be more structured and decisions are not always based on functional needs. This is often because of competing bureaucratic interests or because a board of directors (or similar supervisory group) perceived nontechnical or political goals as being more important than functional goals. For example, one agency was about to automate a large number of service planning functions when its directors decided on nontechnical (even somewhat emotional) grounds that "computers weren't needed."

If one or more persons in a small or medium-sized agency can make a convincing case for new methods, needs tend to be defined at a much more detailed level. It was observed that managers in less complex organizations tend to think out more thoroughly which functional needs could be met by computers. There may well be a correlation between smaller organizations and younger, more computer-literate people being in management positions. The following summary of discussions with managers in smaller agencies illustrates these points.

1. Automation should be applied to maintenance problems. For example, an accurate real-time answer to inventory could save a substantial amount of time

for the staff and mechanics. If the inventory list is also tagged with a minimum quantity number, this information can be flashed on a daily basis so that ordering would be facilitated.

2. In addition to improved data handling, there should be procedures for analyzing the marginal costs and revenues associated with various service options (e.g., routing, fare, headways). An information management system should contain functions so that the levels of service for an entire corridor can be managed in a timely fashion.

3. In addition to handling large amounts of data, it would be useful to match automatically evaluation criteria (for a route, bus, and so on) and the data that are collected on ridership, revenues, vehicles, and so on. A means of merging data from various sources in the agency would also be important.

4. Section 15 data should be used more carefully and extensively. In conjunction with these data and other types within the agency, there should be a mechanism to integrate demographic and economic data into more automated evaluations.

5. It should be possible to plot patterns of ridership over a range of temporal frames by routes--although it does not seem necessary to have sophisticated graphics to accomplish this.

What is essential or needed is still being defined. Some agencies have a set of functional needs that appear clearly related to daily operations (getting the buses on the street). Others have begun to reevaluate needs, spurred on by recent advances in computer technologies related to mini- and microcomputers. Still other agencies have begun to consider how to restructure their current organization of informational resources as a result of this survey. If the reactions of those transit operators contacted are indicative of trends in the industry, the OPS Program has been and will continue to be well received. To the extent that improved decision making and increased productivity are desired goals, automated tools will be implemented with increasing speed.

ACKNOWLEDGMENT

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Notice: The views expressed are those of the author and not necessarily those of the U.S. Department of Transportation.

Abridgment

Perceptions of Who Benefits From Public Transit

ROBERT CERVERO

Developing a cost-sharing program for public transit has been identified as one of the most critical issues in the transportation field today. Ideally the cost burden of public transit should be distributed among users and different tiers of government according to the share of total benefits each receives. Measuring, much less distributing, the full range of benefits, however, is almost impossible to carry out with any degree of precision. On the whole, empirical evidence suggests that the benefits of transit have been fairly modest, accruing primarily to users who live in large urban areas. The provision of improved mobility to the needy, relief of congestion, and improved land uses are the primary social benefits. Other benefits are of secondary importance. In the absence of suitable empirical data, knowledgeable state and local transit officials were surveyed to determine who benefits from transit services. There appeared to be a strong consensus that roughly one-half of the total benefits accrue directly to users, one-quarter to local residents in general, and the remaining one-quarter evenly to constituents of state governments and the federal government. This pro-rata distribution matches current expenditure patterns fairly well; however, there appears to be a common belief that the role of the user in sharing costs should be expanded somewhat and the role of governments should be contracted. This is quite consistent with current fiscal policy. Ultimately, however, any decision on transit cost-sharing must be political, keeping in mind what is currently known about transit benefits.

The fiscal plight of public transit sharply calls into question what the role of the transit user versus that of local, state, and federal governments should be in financing services. Because of the growing pressures to contain public spending and improve efficiency at all levels of government, the issue of cost-sharing can be expected to gain greater attention during the 1980s.

Most economists would argue that the cost burden of public transit should be spread among users and institutions based on the portion of benefits each receives. Measuring the full range of benefits, much less distributing them, is exceedingly difficult; thus this principle can rarely be practical in any precise manner. Rather, the ultimate decision on how transit expenses should be shared necessarily becomes a political one.

Examined in this paper are perceptions of the distribution of transit benefits and how this information might be used to develop a cost-sharing rationale. In the absence of suitable data for quantifying transit benefits in monetary terms, the perceptions of knowledgeable transit officials are used as a second-best strategy.

TRANSIT BENEFITS

A considerable number of benefits have come to be associated with public transit. The most obvious benefit, of course, accrues directly to users in the form of mobility, appropriately referred to as a user benefit. Other benefits enjoyed by all urban residents are often referred to as social benefits. Evidence on the social benefits of transit is summarized in the following sections.

Mobility for the Transportation Disadvantaged

Although most Americans enjoy the unparalleled level of mobility made possible by the automobile (e.g., 83 percent of all households have cars), many still depend on other forms of transportation (1). Termed the transportation-disadvantaged, these groups often include the poor, the young, the elderly, and the handicapped. Many argue that transit is necessary to ensure that these groups have equal access to employment and to educational and cultural activities. Even though these groups make far fewer trips per capita than the general population, they rely heavily on public transit for the few trips they make.

Relief of Congestion

The earliest arguments for improved transit hinged on its potential to relieve congestion (2). Studies of transit strikes in New York, Washington, D.C., and Los Angeles revealed that without transit services congestion increased significantly (3,4). In New York, for instance, work trips took more than twice as much time during transit workers strikes. In contrast, attempts to use transit to alleviate existing congestion have largely failed. Evidence shows that only a few motorists can be lured out of their cars by transit improvements and that their places on the highway are often taken by new drivers (1).

Land Use and Economic Development

The concentration of economic activities in central business districts and the containment of urban sprawl are usually considered to be desirable land uses that can only be supported by good public transportation. Although transit reinforces compact development, it is often incapable of promoting high densities where they do not already exist. Studies of the Toronto and San Francisco rail systems reveal that in the absence of pro-development land use policies, new rail investments have a marginal effect on density and property values (5).

Conservation of Land

Proponents of mass transit often emphasize its ability to conserve scarce urban land that would otherwise be needed for streets and parking facilities. Because transit can carry far more passengers per lane than the automobile, it can potentially make valuable downtown land available for a more profitable use, thus generating more tax revenues for cities. In New York City, it has been estimated that 565 additional lanes of streets and 256 extra lanes of freeways would be needed to carry peak-hour transit riders by automobile (2). Transit and the automobile have historically encouraged urban dispersal outside of central business districts (1). Public transportation, then, would appear to conserve land only in high density areas.

Energy Conservation

In recent years public transit has been highly touted as an energy-saver. One study concluded that transit can potentially conserve the nation's energy resources but that it does not necessarily do so in practice (6). Buses use far less energy per seat-mile than any other transportation mode; however, they usually consume far more energy per passenger than modes such as vanpooling because they are not used to capacity.

Most transit improvements fail to attract enough people from cars to have an energy savings payoff. New rail starts, in particular, have been shown to be net energy losers, at least in the short run (7). From a national perspective, many discount the energy-saving potential of transit because it accounts for less than 3 percent of total passenger-miles traveled in the United States (1). In general, public transportation can only be expected to save appreciable energy along high density corridors and in the long run when transit might effectively shape urban growth and travel patterns.

Environmental Quality

Because public transit reduces automotive traffic, it is often praised for reducing air pollution and ambient noise levels. It is true that buses emit fewer pollutants per seat-mile than automobiles; however, to date the proportion of urban trips served by public transit is not large enough to have a significant effect on air quality. Moreover studies have generally concluded that transit's overall effect on noise abatement has been inconsequential: it reduces traffic volume but carries former motorists in noisier vehicles (2).

Optional Mode of Travel

Public transit is often viewed as having option value--all persons have it at their disposal if they should ever need it because of inclement weather, limited parking, or a broken-down family car. From a national perspective, transit played an important back-up role during World War II when gasoline supplies were rationed (8). Moreover, transit could prove useful for mass evacuation in the event of a civil emergency. For example, New York City's civil defense plan relies on public transit to evacuate 29 percent of its population in the event of a citywide emergency (8).

Safety

Public transit has proved to be measurably safer than the automobile--0.07 fatalities per 100 million passenger-miles traveled (hmpmt) for buses versus 0.53 per hmpmt for automobiles (9). The rates for nonfatal accidents have not been significantly different among transportation modes. Public transit could be expected to improve safety only by increasing load factors and attracting appreciable numbers of patrons from the automobile.

Summing Up the Benefits of Transit

Overall, the social benefits of transit to date have been relatively modest, primarily because it accounts for only a fraction of the nation's urban trips and has been unable to win over significant numbers of motorists. Most of the documented benefits have arisen from the maintenance of current service levels rather than the provision of new services. Perhaps the major benefit has been the provision of essential travel opportunities to America's carless and low income populations.

PERCEPTIONS OF TRANSIT BENEFITS

In designing a cost-sharing program for transit, ideally benefits should be quantified and distributed among the user groups--i.e., constituents of local, state, and federal governments, and so forth. However, this would be a formidable or at least purely academic task, fraught with dubious assumptions. As a quasi-delphi approach, knowledgeable state and local transit officials were surveyed (10). Questionnaires were mailed to 252 transit policymakers: 50 state transit programs and 202 local public transit agencies throughout the United States. Surveys were received from 30 states and 99 public transit operators. Transit systems representing about 70 percent of total U.S. ridership were represented in the survey responses.

Importance of Benefits

Respondents were asked to rate the relative importance of the social benefits of transit. Figure 1 shows that for both government levels improving mobility of the transportation disadvantaged was considered to be the most important benefit, accounting for almost one-quarter of total social benefits. The effects of transit on increasing business activity, conserving energy, and reducing congestion were considered of secondary importance; each received about the same rating. The other four benefits were considered less important. Responses were remarkably similar at both the state and local (operator) levels.

Distribution of Benefits

Social benefits of transit were also subjectively distributed among the three tiers of government by respondents. Figure 2 shows how local officials (operators) perceive benefits to be distributed; this generally matched the responses of state officials. Constituents of local governments were considered to be the primary beneficiaries of improvements in land conservation, business activities, mobility, congestion, and environmental quality. The federal government was judged to receive most of the benefit from energy conservation and the value of an optional mode of transportation. Improved safety was perceived to accrue almost evenly to all levels of government.

Transit Cost-Sharing

Perceptions of the distribution of transit benefits were weighted by their relative importance, and summed, to determine the overall breakdown. This pooled, weighted average is given in Table 1 for operators, states, and all respondents combined. The data in the table show that operators, as a group, believe that over half of the social benefits accrue to the constituents of local governments and that federal and state constituents receive about 27 percent and 23 percent, respectively. State respondents, on the other hand, perceived a somewhat more equal distribution of benefits among government levels.

Respondents to the survey consistently believed that about one-half of all benefits go to users, with very little variation among responses. For the other one-half, representing social benefits, there was a general consensus that benefits accrue to local, state, and federal governments on about a 50-25-25 percent basis, respectively. Based on beneficiary principles, then, respondents appeared to be calling for a transit cost-sharing program whereby users pay one-half the expenses, localities cover one-quarter, and state and federal governments evenly split the balance. The data in Table 2, which compares respondent perceptions to actual 1980 intergovernmental transit expenditures, suggests that the cost responsibilities of users should be

Figure 1. Relative importance of benefits.

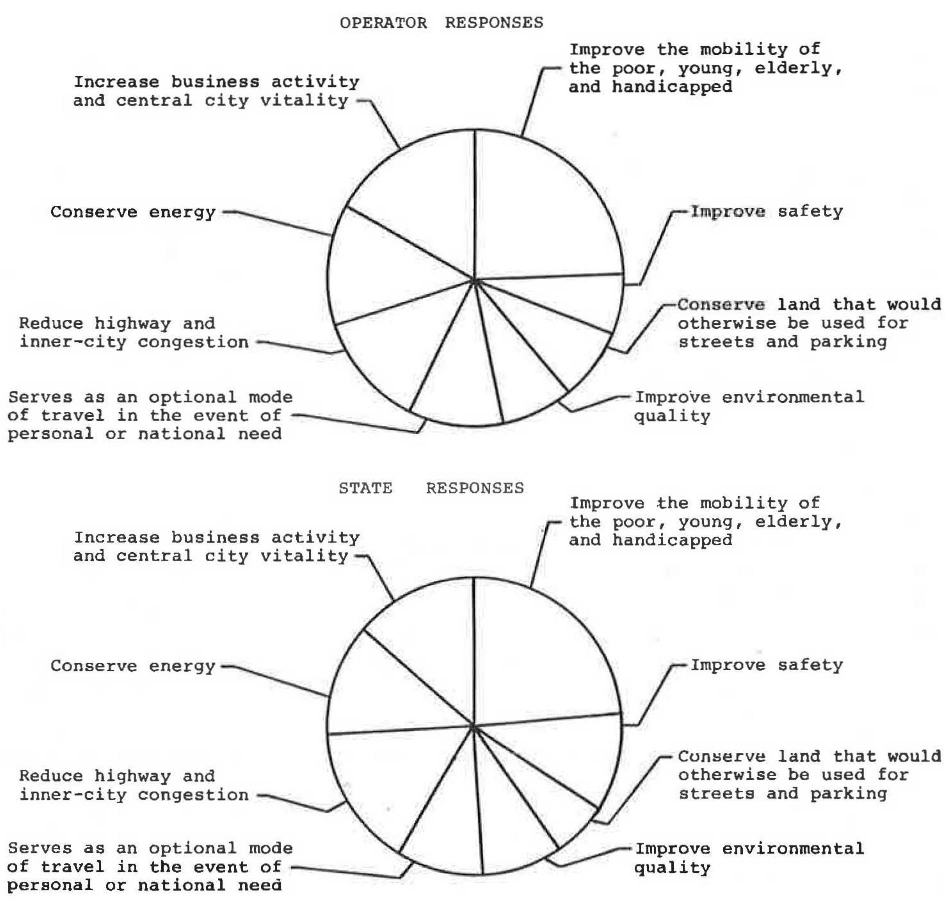

Figure 2. Distribution of benefits—operator responses: respondents' perceptions of the extent benefits accrue to the constituents of each level of government.

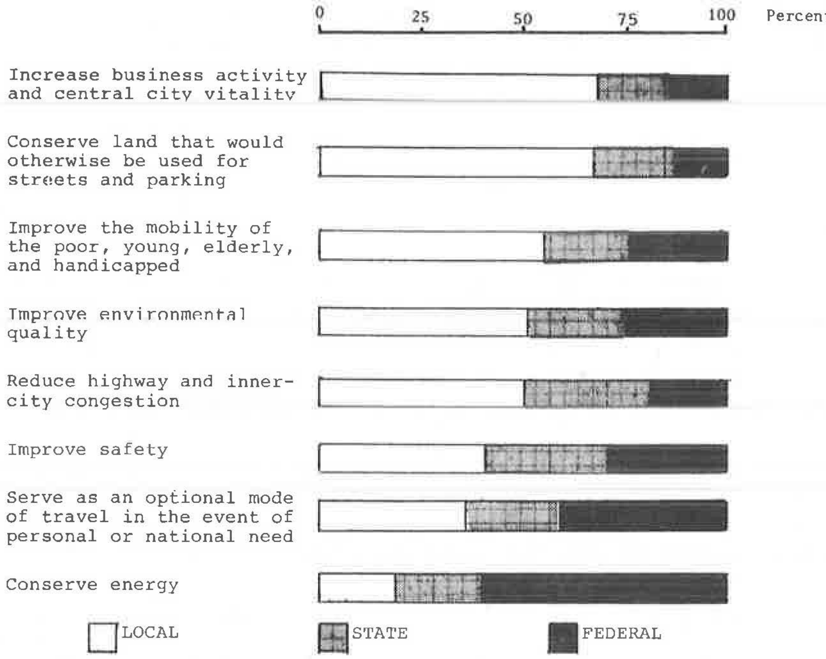

Table 1. Percentage distribution of total social benefits: pooled, weighted average of respondents' perceptions of how benefits are distributed.

Respondents	Local Interests	State Interests	Federal Interests
All	48.7	24.2	27.1
Operators	50.4	23.0	26.6
States	43.3	28.1	28.6

Table 2. Respondents' perceptions of distribution of transit benefits versus actual expenditures for transit (percent).

Item	Users	Local Governments	State Governments	Federal Government
Perceptions of benefit distribution	50.0	25.0	12.0	13.0
Actual expenditures (1980)	42.7	27.0	13.0	17.3

expanded and that the role of governments should be contracted.

CONCLUSIONS

In order to explore the transit cost-sharing concept, evidence on the benefits of transit was reviewed and the perceptions of knowledgeable observers as to how the benefits are distributed were surveyed. The survey of local and state transit policymakers disclosed that benefits are perceived to accrue primarily to users, followed by local governments, then state and federal governments. Specifically, respondents believed that about one-half of the benefits are enjoyed by users, and the remainder accrued to the constituents of local, state, and federal governments on an approximately 50-25-25 percent basis, respectively.

The question remains as to whether such perceptions could ever prove useful in designing a practicable cost-sharing program for public transit. Because it is impossible to distribute the full range of benefits among recipients with any degree of precision, this approach appears to have some intuitive merit. The perception that users should assume primary responsibility for covering transit costs appears indisputable. The allocation of one-half of the remainder to localities and the other half to states and the federal government may be regarded as straightforward and reasonable, particularly because this pro rata distribution closely matches the current distribution of the transit expense burden. Such a sharing program would increase the financial responsibilities of users and at the same time lower that of public entities, in particular the federal government.

Although it would be valuable to have the opinions and perceptions of knowledgeable transit officials, any fiscal program for transit must ultimately rely on more than subjective viewpoints. In the final analysis, it would be necessary for our representative form of government to gather the evidence on who benefits from transit before designing a sound and equitable program of transit cost-sharing.

ACKNOWLEDGMENT

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Abridgment

Managing Transit Coordination in the San Francisco Bay Area

HANK DITTMAR

The San Francisco Bay Area is served by seven major regional transit operators and a host of smaller intracommunity transit services. The Metropolitan Transportation Commission (MTC), the legislatively mandated regional transportation planning agency, is charged with overseeing the coordination of public transportation in the nine-county Bay Region. One approach the MTC has taken, in concert with the seven major operators, has been to encourage the development and promotion of a regional transit trunkline network rather than to force the integration of the separate local operations. In 1978 MTC and the transit operators identified essential transit corridors, the routes serving those corridors, and the transfer points connecting those routes. Following the adoption of this network, an ambitious cooperative public information project was undertaken to encourage the use of public transit for regional intercounty service. Although this approach has of necessity been incremental and although all the results are not in, the project has been successful in creating an awareness of regional transit. Just as important, a focus for coordination activities has been developed that is acceptable to local transit operators, their policy boards, and the regional agency.

METROPOLITAN TRANSPORTATION COMMISSION

The Metropolitan Transportation Commission (MTC) was created by the California state legislature in 1970 to provide transportation planning for the San Francisco Bay Area.

Over the years state and federal laws and regulations have expanded the role of MTC considerably. Today MTC directly allocates nearly $200 million per year primarily to help cover transit operating costs, as well as some capital costs. MTC has also received increasingly clear mandates from the California Legislature to oversee the coordination of transit services in the nine-county San Francisco Bay Area. In late 1977 the state legislature mandated in California Public Utilities Code, Section 2914.C, the establishment of a Transit Operator Coordinating Council "to better coordinate routes, schedules, fares, and transfers among the San Francisco Bay Area transit operators."

The nine-county region under MTC's jurisdiction includes four separate standard metropolitan statistical areas (SMSAs) and 93 cities. More than 5 million people reside within the 7,000-sq-mile region. Bay Area residents are served by seven major transit operators as well as numerous small intracommunity services. The regional system provides 103 million revenue vehicle miles of service annually and carries 1.4 million passengers on an average weekday. The seven major regional transit operators and their average passenger load for weekdays are described as follows:

The San Francisco Municipal Railway (Muni) operates within the city and county of San Francisco, carries approximately 650,000 to 700,000 passengers daily, and provides an estimated 15 million annual revenue vehicle miles of service with a fleet of approximately 1,000 vehicles: buses, trolleys, light rail vehicles, and cable cars. Muni service is within easy reach of every resident in San Francisco.

The Bay Area Rapid Transit (BART) District operates 4 regional routes over 71.4 miles directly connecting 4 counties and 15 cities, including San Francisco and Oakland. BART carries 191,000 passengers per day.

The Alameda-Contra Costa Transit District (AC Transit) provides subregional and local service to Oakland and the East Bay and provides direct transbay express service to San Francisco. The agency operates a fleet of 874 buses and carries 275,000 passengers per day.

Golden Gate Bridge Highway and Transportation District (GGBHTD) provides local and San Francisco bound commuter service for both Marin and Sonoma Counties. The District operates a fleet of 260 buses and 3 ferries, carrying 48,000 passengers per day.

Caltrans/Southern Pacific-Caltrain Service passenger commuter rail service is operated by Southern Pacific under contract with the California Department of Transportation to provide local and express operations between downtown San Francisco and San Jose. The 44-train-per-day service carries 21,000 passengers daily.

San Mateo County District (SamTrans) serves San Meteo County, just south of San Francisco on the peninsula, with a 267-vehicle bus fleet carrying 75,000 passengers daily.

Santa Clara County Transit District serves the 1.25 million people of San Jose and the surrounding area. It carries 114,500 passengers per day and is the fastest growing system in the region with a currently planned expansion to 750 buses.

REGIONAL TRANSIT ASSOCIATION

The major Bay Area transit operators joined together in 1977 to create the Regional Transit Association (RTA) of the Bay Area, a joint exercise of powers agency. The 1977 by laws for RTA state that it was created to undertake "cooperative projects of mutual interest." The general managers of the six member transit systems of the RTA (AC Transit, BART, Golden Gate Transit, Muni, SamTrans, and Santa Clara County Transit) sit as the Board of Control of the RTA. Among the identified priorities were service coordination, fare coordination, cooperative marketing and public information efforts, and regional contingency planning. Staff level committees were created to carry out cooperative efforts in each of the priority areas. One of the early committees of the RTA was the Services and Tariffs Committee, composed of planners from each of the six agencies and a representative of the Metropolitan Transportation Commission. In March 1977 the Services and Tariffs Committee Report recommended the study of four major issues:

1. Transfers and interface between the transit system--coordination, scheduling, proper physical arrangements to enable transfers to be made easily and quickly, the physical collection of fares, and so on;
2. New services and the financing of these services;
3. Fare policy; and
4. Service standards--study of the present overlap and duplication of service, among other things.

Activity Centers

Early committee efforts focused on transfer coordination and fare policy and the committee continued with these issues as its primary focus. In 1978 MTC staff and members of the RTA Services and Tariffs Committee sought to define major activity centers in the Bay Area and the corresponding regional transit corridors that linked these activity centers. By the end of 1978 the RTA committee had succeeded in defining three different levels of activity centers:

1. Regional centers: the cities of San Francisco, Oakland, and San Jose.
2. Regional subcenters and secondary subcenters: centers with a population in excess of 50,000 or areas with significant employment or other activity.
3. Airports: San Francisco, Oakland, and San Jose.

General guidelines were developed for the level of transit service that should be provided between the different categories of activity centers. Service connecting regional centers with other regional centers, with subcenters, and with airports was generally to be provided with hourly or better headways.

Trunkline System

By 1980 it was becoming obvious both to committee members and to the MTC staff that a more specific product was needed. In late 1980 the RTA coordinator was directed by the RTA Board of Control to develop a Regional Transit Trunkline System to focus interoperator cooperative efforts. Basic definitions of trunkline service were selected to facilitate designation of appropriate trunkline routes. The definitions are as follows:

1. Service should be intercounty service.
2. Service should connect major Bay Area activity centers on major travel corridors.
3. Routes should provide service from 6 or 8 a.m. to midnight or 1 a.m.
4. Headways should be 30 minutes or less.
5. The regional trunkline system should provide for travel between major trip origins and destinations in the Bay Area and connect with local transit service for other origins and destinations.

The routes that make up the regional transit trunkline system were selected by applying the criteria listed previously and by using common sense evaluations obtained from a telephone survey of the RTA Services and Tariffs Committee.

Public Information Project

The RTA Regional Trunkline System was adopted initially to provide a focus for the RTA Regional Integrated Transit Information and Support Project. This half-million dollar demonstration project had as its goal the development of a coordinated marketing and public information effort for the six transit systems of the RTA. The project was conceived by the transit agency marketing managers as a regional advertising compaign promoting the use of transit in general. The public information project was seen as ideally suited to the promotion and support of the regional transit trunkline network. A work plan was developed for the public information project that had the following four objectives:

1. Identify the regional trunkline formed by interfacing transit systems throughout the Bay Area.
2. Develop a public information program on the trunkline and key transfer points, i.e., inform residents how utilization could enable them to move freely by transit throughout the Bay Area and help offset the rising costs of automobile travel.
3. Train employees of participating transit agencies to communicate effectively the services offered by the regional trunkline network.
4. Measure the effect of the regional information program on ridership.

To meet these objectives, a consultant team composed of a public relations firm, a graphic design firm, and an advertising agency was selected to implement the $560,000 demonstration phase of the project. The consultant team developed a project work plan consisting of the following six program elements.

1. Without creating the appearance of a new transportation agency, an identity was developed for the Bay Area transit systems as one big, convenient transit network. This was done by creating a single Regional Transit Connection symbol that was adopted by every participating system. On signs the symbol identifies specially designated key city-to-city routes. On station maps the symbol shows travelers how to reach destinations via transit.
2. The program publicized specially designated key transit routes (regional trunklines) and connection points for city-to-city travel. This was done by creating and printing 500,000 copies of a regional map for free distribution.
3. The ease of city-to-city and intersystem travel was demonstrated by a series of promotions on recommended transit routes to weekend recreation destinations, to favorite holiday season destina-

tions, and to the Search for Alexander exhibit at San Francisco's De Young Museum.

4. News releases and radio public service announcements supported the program. A race between transit and an automobile dramatized connections to the Oakland airport. Unfortunately transit lost the race but by only 2 minutes.

5. The program provided detailed Regional Transit Connection information to employees of transit systems and gave them incentives to learn. Sixty percent of employees (and almost 90 percent of telephone information personnel) successfully answered test questions from an anonymous caller about regional transit travel.

6. Demonstration signs were placed in 11 key locations. About 575 additional permanent signs were delivered to participating transit systems to be installed at the discretion of the systems. About 2,000 all-weather decals were produced for application on existing signs.

EVALUATION OF THE RTA PUBLIC INFORMATION PROJECT

At the close of the demonstration phase of the project in February-March 1982, an evaluation was conducted of the effectiveness of the program in educating the public about the regional transit network. A telephone survey of randomly selected households indicated 45 percent awareness of the Regional Transit Connection concept among both users and nonusers of public transportation (1). An intercept survey of transit users at the transfer points where signs were placed during the program indicated that 80 percent of respondents found the signs useful (2). Clearly the RTA Regional Transit Connection project was successful in developing a cohesive and persuasive method of communicating the existence of a regional transit network. The project evaluation also clearly indicated the need for a continuing communications program, additional regional signs, and a more focused outreach effort to major Bay Area employment and activity centers.

OTHER PROJECTS SUPPORTING THE REGIONAL TRANSIT NETWORK

Late in 1981 MTC published the Regional Transit Guide, a 128-page booklet containing both regional transit information and information on popular regional destinations. The Regional Transit Guide both described the Regional Transit Connection sign program and identified the regional transit trunklines in a fold-out map.

A comprehensive transit information project is now underway at San Francisco's Transbay Terminal. The Transbay Terminal, which ranks second only to the Port Authority of New York in the number of transit routes serving it, will be overhauled to include a comprehensive regional transit information center. Graphics for the center will be coordinated with the graphics and signs already developed for the Regional Transit Connection project.

A grant application has been submitted to the Urban Mass Transportation Administration for a follow-up to the Regional Transit Connection project that will develop an intersystem package of regional transit information and transit passes and tickets. The project will focus on an outreach effort to major employers in the city centers of San Francisco, Oakland, and San Jose.

A committee of transit telephone information center personnel is meeting quarterly to share information about each other's systems.

FUTURE DIRECTIONS AND NEEDS

The need for a continuing regional public information effort to support the trunkline concept has been demonstrated.

Most RTA efforts have focused on improved information about the regional transit system. Of equal importance is the improvement of intersystem service in terms of fares and schedules. MTC and the transit operators are working to develop joint monthly passes and to develop a consistent rule for intersystem transfers. It is hoped that regional marketing and public information efforts will help to encourage better service coordination as well and that the resultant demand will increase intersystem use beyond the current 10 percent of all regional trips.

The regional transit trunkline system can provide a catalog of essential services to be maintained in emergency situations such as earthquakes, an energy crisis, or for capital programming in times of fiscal austerity. MTC has already directed some $5 million in regional discretionary funds toward improving trunkline service and transfer coordination.

IMPLICATIONS OF THE TRUNKLINE APPROACH

Although the Bay Area is unique in the number and variety of transit operating agencies serving the public, several other areas of the country have more than one operator serving a single geographical area. The approach described here allows the selection of manageable portions of service to coordinate and market. This approach could also be beneficial in large urban areas with complex networks of bus routes. Rather than attempting to market travel on the system as a whole, a transit operator might choose to identify high-volume routes to popular destinations for special attention in terms of schedule coordination and public information. This approach could be especially valuable for a city with a high volume of tourists or convention travel.

The efforts described for developing a regional network of transit routes have proven to be the most feasible approach for the Bay Area. Each operator serves the legitimate needs of a local community, yet all are beginning to recognize the responsibility to provide a system that allows convenient transit travel throughout the region. The lesson of the Bay Area approach to coordination is simple: if properly packaged, what once seemed an onerous task can become an opportunity.

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Abridgment

Review of Route-Level Ridership Prediction Techniques

H. ROBERT MENHARD AND GARY F. RUPRECHT

An important trend in the local transit planning field is away from large-scale, capital intensive planning toward low-cost operational planning. Because most major transit and highway facilities are in place, greater consideration is being given to making minor changes to improve the efficiency and increase the capacity of existing transit services. Transit managers need to predict the effect of proposed service changes on ridership for a variety of reasons: (a) to allocate vehicle and manpower resources, (b) to prepare budget requests for proposed service plans, and (c) as inputs into the detailed route planning and scheduling that must accompany new service plans. To perform these tasks adequately, route-level patronage models must be sensitive to service characteristics as well as to the more traditional socioeconomic characteristics of the area the route passes through. The service quality measures most often affected by the route-level service modifications made by most transit properties are headway adjustment, route extension and contraction, limited and express service, shortlining, branching, through routing, creating transfer opportunities, fare adjustments, and new hours of service. A review of techniques that are currently used in the industry for predicting route-level ridership is presented. This review is based on discussions with the planning staffs of 40 transit agencies. Seven criteria were selected for evaluating the various techniques: accuracy, sensitivity, range of application, analyst dependence, cost of application, technical sophistication, and transferability.

Route-level demand models are designed to estimate (a) the ridership along an existing route resulting from service modifications or (b) ridership resulting from the implementation of a proposed new route. In addition, such techniques could be used to project loading characteristics along the route to assure that adequate service capacity is provided.

This review of current modeling practices identified eight types of service changes that use ridership prediction techniques. These changes include

1. New routes,
2. Route extensions,
3. Route cutbacks or eliminations,
4. Changes in service hours,
5. Changes in route alignments,
6. Minor headway changes (5 minutes or less),
7. Major headway changes (over 5 minutes), and
8. Fare changes.

Most agencies that make ridership predictions use them primarily to evaluate, choose among, or justify major changes in their systems. These techniques are seldom used for route cutbacks or eliminations because most transit agencies consider that current ridership is an adequate source of information. Few agencies use modeling or forecasting techniques that can redistribute riders from discontinued routes to alternative routes and modes; instead the tendency is to assume that ridership loss to the system will be equal to the total observed for the route or route segment in question.

Similarly, specific changes in service hours, headways, or minor reroutings are seldom based on ridership predictions. Instead they are typically made in response to observed overcrowding, insufficient loading, passenger complaints, or to comply with changes in policy. Many agencies simply make such changes and evaluate them after they are implemented. Most agencies use ridership predictions only to determine headways and service hours for new routes. In these instances the predictions are used in conjunction with loading standards to determine what service levels will match the demand.

CURRENT PRACTICES

Of the agencies that do predict ridership, most use technically straightforward methods because they require the least time, cost, and technical sophistication. Many agencies are interested only in the potential performance of affected routes in the most general terms. The precision of the ridership estimates often is less important to the agency than having some assessment of the potential success of the new route or route change.

Survey methods are frequently used both by agencies with and without computer support. The processing of more extensive surveys is facilitated by computer support, but many surveys are quite limited (e.g., to a few employers in an unserved area or in the vicinity of a proposed route). Most agencies using statistical techniques have easy if not direct access to a computer and the appropriate software packages, although a few agencies use hand calculators to run simple statistical models. The development of formal models requires a significant level of technical expertise and a relatively large amount of information.

Many agencies use more than one technique to place bounds on the range of anticipated ridership. The approaches range from highly informal to highly complex. A brief description of the four most commonly used techniques follows.

Professional Judgment

Judgmental techniques rely on individual experience with the system and the community served to provide sufficient insight into the problem to make reasonably accurate predictions. There are virtually no restrictions on the types of analyses that can be performed.

Judgmental methods are attractive for a number of reasons. First, they are quick and inexpensive, especially if only readily available data and resources are used. Second, they can be used to analyze virtually any change that a transit agency might consider, as well as the impact of exogenous factors. Because this technique relies on the expertise of the analyst, however, the accuracy of any prediction is highly dependent on the knowledge and experience of the analyst. Even analysts with similar experience may predict significantly different results from the same information. Thus, the transferability of the results is limited.

The widespread use of judgmental methods by transit agencies may indicate that this technique can provide rough estimates and relative rankings needed by these agencies to make decisions about the service they provide.

Noncommittal Survey Techniques

Another conceptually straightforward approach for estimating demand for transit services is the use of the noncommittal survey. In this method, potential riders are asked directly if they would use a proposed service. Their responses to the survey form the basis for predicting anticipated patronage. The approach is called the noncommittal survey technique because of its reliance on the stated intentions of potential riders and not on their actual behavior.

Noncommittal survey methods offer an advantage over judgmental methods because they can provide information to the analyst who has no experience with an area or service change. Of course increased cost comes with this increased information. The survey also presents the opportunity to formalize the manner for analyzing the data thus enabling one service planner to replicate the work of another more easily. As with judgmental methods, the "what if" nature of the surveys used in this technique permits the planner to explore the effects of a wide range of service-related changes. This technique, however, may be limited because the analyst must be able to define clearly the changes of interest. Also, the level of technical sophistication required of the analyst may be higher especially when a large number of surveys and more complex types of analyses are involved.

This technique offers a higher degree of transferability to other situations than judgmental methods because service and population characteristics are obtained through surveys. Its major shortcoming is that the accuracy of ridership prediction relies on the individual respondent's stated intentions. The analyst of the survey results must estimate the likelihood that individuals will act accordingly. As a result, the accuracy of the noncommittal survey technique is to a large extent subject to the same uncertainties as the results of judgmental methods.

Models Based on Cross-Sectional Data

Many agencies find it useful to formalize the prediction of patronage changes by developing mathematical formulas based on characteristics of the route and the type of change being made. These are called cross-sectional models because they address several bus routes and examine the relationship between transit use and level of service, population characteristics, and service areas. The models are based on a comparison between the route under study and characteristics of other bus routes rather than on the effect of changes in a single route over time. Cross-sectional models range from simple comparisons of route characteristics to sophisticated statistical techniques.

The similar routes approach determines which route in a system is most like a proposed new or modified route and then bases the anticipated ridership for the new route on the patronage characteristics of that similar route. The cost of this method can be quite low for agencies that regularly maintain the data needed to classify routes and service areas. The accuracy of the technique is dependent on the service planner's ability to identify correctly a similar route, as well as the major determinants of transit ridership on that route, and to correct for any differences that might exist.

A more formal approach used by a number of transit agencies estimates expected ridership based on established rules of thumb. These rules can be developed from a variety of sources, including the analyst's familiarity with the system, results from other ridership prediction techniques, or from a study done outside the agency. Rules of thumb provide the transit planner with a simple and inexpensive method of predicting ridership along new routes or on new sections of routes. Data requirements are typically limited to readily available sources and the technique can be applied easily by even the most inexperienced analyst at almost any site. Rules of thumb, however, have significant drawbacks, specifically in terms of accuracy and sensitivity to decision variables. For example, these methods are not accurate when estimating the impact of routing and scheduling modifications on ridership when several service attributes are modified.

Multiple factor, trip-rate models represent a more sophisticated form of the simple rule of thumb. This method modifies a basic trip generation rate (based on population) by the factors that account for various levels of service characteristics of the route. Multiple factor, trip-rate models have a wider range of applicability and might be expected to produce more accurate results than simple rules of thumb. Because calibration can be derived from transit data that are regularly maintained, the cost of collecting data and applying the model should not be much greater than for rules of thumb. On the other hand a higher degree of technical sophistication may be required of the user. Also the basic models are generally transferable from one agency to another.

The most common application of formal statistical techniques is regression analysis. Linear regression techniques are used to determine the best mathematical fit between a dependent variable (e.g., ridership) and one or more independent variables (e.g., route or service area characteristics). Models of this sort can be developed to account for a wide variety of decision variables (representing choices open to the service planner) and exogenous factors (e.g., population, gasoline prices, employment, and land use) that directly affect transit patronage. The fact that many exogenous factors and service variables may be included indicates that such models may be applicable over a wide range of situations and may be potentially more transferable than other models. Unfortunately, few results are available for judging the accuracy of these models. Based on theoretical arguments, it appears that the specifications of the existing models leave much to be desired. Lack of a clear causality between independent and dependent variables and the potential for estimating the scheduler's decision rule instead of the response of potential riders to service quality changes are shortcomings found in those models used by transit agencies. From an operational viewpoint, aggregate regression models tend to be more difficult to apply and require a greater level of technical sophistication as well as greater cost.

Models Based on Time Series Data

Another approach to developing models of route-level demand is to estimate the effects of changes based on what happens to ridership on a single route (or group of routes) as service changes over time. These techniques are considered to be based on time series data. An example of such a model is encompassed in what is commonly called the Curtin Rule for the impact of fare changes (1). This model was developed by comparing before and after ridership statistics on a variety of transit systems when a fare change was implemented. This study led to the relationship that for each 1 percent increase (decrease) in the average fare charged, patronage would decrease (increase) by 0.3 percent.

Elasticity methods are a relatively simple form of analysis that can provide quick estimates of the change in ridership that will result from a specified change in the level of service provided along a route. The technique can be applied to a wide range of modifications to existing routes (assuming data are available) but not to predict ridership of new routes. Because the calculations are straightforward, the service planner is not required to have a high level of technical sophistication; and, given the same data, all analysts should obtain the same results. The accuracy of the results from this type of model is dependent on a number of factors, in-

Figure 1. Characteristics of modeling approaches.

	Accuracy[a]	Sensitivity	Range of Applications	Analyst Dependence	Cost of Application	Technical Sophistication[b]	Transferability[a]
Judgment		●	●	○	●	●	
Noncommittal survey		◒	●	◒	○	◒	
Similar routes		◒	◒	◒	◒	●	
Rules of thumb		○	◒	●	●	●	
Trip-rate model		◒	●	●	○[c]	○[c]	
Aggregate regression		●	●	●	○[c]	○[c]	
Elasticity		◒	◒	●	●	◒	
Trend analysis		○	○	●	●	◒	

● better than average; ◒ average; ○ worse than average

[a]Data not available.
[b]Good rating implies a need for limited sophistication; negative rating implies a high degree of sophistication.
[c]Negative rating assumes models would have to be calibrated by the service planner; application of methods requires average cost and technical sophistication.

cluding (a) how the dependent (ridership) and independent variables are affected by other factors and (b) the nature of the demand for transit services (i.e., the shape of the demand curve) and the magnitude of the change in the independent variables.

Sometimes a long-term change in the pattern of ridership may occur because of population growth or a number of other factors. Some transit agencies find it useful to model this underlying trend using a bivariate regression. If the trend is significant, this model can serve as a tool for predicting ridership. Trend analysis can be a useful tool for estimating ridership during periods when service and exogenous factors are not changing or are changing in a consistent manner. Because the technique is not sensitive to service or fare changes, it is not useful in most route planning contexts. The technique is inexpensive and relatively simple to use. It requires little more than a calculator with statistical capabilities--an estimate could be obtained by manually plotting the data.

CONCLUSION

Most transit agencies recognize the need to predict transit patronage at the route level and have adopted one or more techniques to perform such analyses. Yet, despite the widespread use of route-level demand models, few agencies can quantify the accuracy of their models or explain the contribution they make to planning processes. Most of these models are simplistic, easy to apply, and rely on minimal data; thus, they yield only ball-park ridership estimates. On the other hand, some techniques attempt to reflect the processes underlying the generation of transit ridership. A number of researchers have developed formal statistical models that account for a variety of factors that may affect ridership and have incorporated the effects of a number of decision variables available to the bus service planner. Unfortunately no existing model is totally adequate for the planning function; all have drawbacks and few have been shown to be accurate through before and after experimentation.

This review does not indicate that a single model or type of model is significantly better or more useful than any other model. Figure 1 illustrates the advantages and disadvantages of each approach. It does, however, illustrate the need for additional evaluations of specific models to determine their range of accuracy. In addition there appears to be a need to alleviate many of the theoretical drawbacks of the models being used.

ACKNOWLEDGMENT

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Possible Effects of Eliminating Federal Transit Operating Subsidies

ROBERT CERVERO AND GARY BLACK

The Reagan Administration's proposal to phase out federal transit operating subsidies by 1985 has prompted a range of forecasts, some predicting that the transit industry will become more efficient and productive while others portend a much grimmer future. The ultimate effects of the federal cuts depend largely on the actions transit agencies take to make up lost dollars—fare increases, service cuts, increased local/state financing, or in-house efficiency improvements. Probable fare, service, and equity effects of the federal cuts among different types of transit operators are examined. A national survey of 99 transit agencies is used to develop a scenario of how federal cuts will affect transit operators. Overall, it is expected that fares will increase about 7 percent, service will decrease approximately 3 percent, and ridership will decline approximately 6 percent because of the federal cuts. Moreover, the poor will bear the brunt of fare increases, service cuts, and increased local and state taxes caused by the phaseout of federal operating assistance.

Shortly after the 1981 inaugural, the Reagan Administration included the gradual phaseout of federal transit operating subsidies in its first round of budget cuts. As part of the Administration's Program for Economic Recovery all operating assistance is to be eliminated by 1985.

By all accounts, the President's planned actions represent a major retrenchment in the federal commitment to transit. In 1980 federal operating assistance was $1.1 billion nationwide, an increase from $300 million 5 years earlier (1). The Carter Administration had actually planned to expand support for transit by increasing Section 5 appropriations by more than 30 percent. Reagan officials maintain that eliminating subsidies will force operators to become more efficient and will shift some of the financial responsibility for transit to state and local governments. In particular, the opinion of the present administration is that as subsidies decrease managers will be able to take a harder line in labor negotiations and will begin to run their systems more like private businesses.

Opinions differ as to the probable consequences of eliminating Section 5 funding. The Reagan Administration contends that the transit industry will eventually become more productive and that ridership will be only marginally affected. Transit lobbyists, such as the American Public Transit Association (APTA), envision a more gloomy scenario. Another perspective of the probable effects of federal cuts to transit is provided in this paper. A nationwide survey requested transit managers to identify the actions they plan to take to replace lost federal dollars. Their responses were used to explore the probable effects of the Section 5 phaseout on fares, services, ridership, and equity. Overall it is estimated that the federal cuts will cause nationwide fares to increase approximately 17 percent, service to decrease about 3 percent, and ridership to decline approximately 6 percent. These probable effects are discussed in greater detail in the sections that follow.

PAST RESEARCH ON THE IMPACT OF FEDERAL CUTS

Several studies to date have attempted to gauge the probable effects of eliminating federal operating subsidies. One study, conducted by the Regional Plan Association of New York (RPA) (2), assumed that all lost revenue would be recovered through higher fares. RPA estimated that, nationwide, fares would increase 46 percent, from an average of 38.4 cents to 56.2 cents, and ridership would fall by 900 million trips annually. From these figures RPA further estimated that use of the automobile would increase by 2.4 billion miles and fuel consumption would rise by 167 million gallons per annum.

The one shortcoming of the RPA study is that options other than fare increases were not considered for recovering lost federal revenues--e.g., service reductions or increased local aid. In an attempt to gain a more complete picture, APTA surveyed its membership in 1981. The survey results indicated that 90 percent of the nation's operators will raise fares, 80 percent will seek increased local and state aid, and 67 percent will reduce service (1). A significant number of operators actually indicated they may be forced to go out of business, particularly in urban areas with populations of 500,000 or less.

Based on these survey results, APTA predicted that by 1985 there would be a nationwide fare increase of 88 percent, an average fare of 94 cents, and a ridership loss of 2.1 billion trips, or 26 percent. Although the study's methodology is not disclosed, in view of the RPA findings and expected increases in state and local aid, the APTA figures seem inflated. Because APTA is a political lobbying organization, it is probable that APTA projections should be regarded as a worst-case scenario. In the light of the shortcomings of earlier studies, then, alternative predictions of the effects of federal transit cuts appear in order. The following analysis attempts to respond to this need.

METHODOLOGY

A survey was conducted to gather information on how U.S. transit operators may respond to federal cuts (3). Questionnaires were mailed to 202 local transit operators and 99 were returned (about 50 percent), which is considered adequate for statistical analysis (4). The respondents included 17 of the 20 largest transit agencies. Because of the high response of large operators, about 70 percent of total U.S. ridership was represented in the survey. The typical respondent (82 percent) was an administrator, manager, or financial officer involved in determining the fiscal policy for his agency.

Each operator was asked to identify the actions its policy board plans to take in response to the Section 5 phaseout, including raising fares, reducing services, increasing local and state aid, obtaining federal block grants, increasing productivity (e.g., improving scheduling), and implementing cost-saving programs (e.g., securing work rule concessions). It should be noted that the questionnaire did not elicit when these actions might take place. Because federal subsidies are to be phased out between 1983 and 1985, it can be assumed that the planned actions will occur sometime during that period. Nevertheless, the survey results cannot be used to predict the actual fares or service levels that will exist at a particular time.

One potential problem, common to all attitudinal surveys, is that respondents may have deliberately distorted their responses to portray as gloomy a future as possible--i.e., fare increases and service cutbacks. Some may have perceived it not to be in their best interest to suggest that federal funds could be easily replaced by increases in efficiency or increases in local aid. Comparison of these survey results with those of the APTA survey, however, shows a less pessimistic prediction of consequences. Thus, if the results are biased, they are at least less so than those of previous studies. It is possible, nevertheless, that this study overstates the impact of proposed federal cuts.

Elasticity Measures

This analysis allows the transformation of survey responses into predictions of changes in fares, service, and ridership and hinges on demand-elasticity estimates. Fare elasticity is defined as the percentage change in ridership resulting from a 1 percent change in service level. The typical formulas for estimating fare or service elasticity are

$$\eta_f = [(Q_2 - Q_1)/Q_1]/[(F_2 - F_1)/F_1]$$

and

$$\eta_s = [(Q_2 - Q_1)/Q_1]/[(S_2 - S_1)/S_1] \quad (1)$$

where

η_f = fare elasticity,
η_s = service elasticity,
Q_2 = ridership after,
Q_1 = ridership before,
F_2 = fare after,
F_1 = fare before,
S_2 = service after, and
S_1 = service before.

Curtin (5) found in his work on fare elasticities that on the average a 10 percent increase in transit fares will produce a 3 percent decrease in ridership--i.e., a fare elasticity of -0.3. Although this rule-of-thumb has proved to be remarkably reliable at the national level, elasticities can vary significantly among operators, user groups, and types of service. For example, rush-hour transit riders are known to be less sensitive to fare changes than midday or weekend patrons.

Ecosometrics, Inc. (6) recently summarized fare and service elasticity estimates from around the world. The estimates used in this analysis and given in Table 1 are based largely on the Ecosometrics compendium. These estimates show that operators in smaller urban areas usually experience greater ridership losses for a given increase in fares or decrease in service than those in larger urban areas. This is because the automobile is a stronger competitor to public transit in smaller, less dense settings.

Calculations of Fare, Service, and Ridership Changes

By merging the operating, financial, and elasticity information summarized in Table 1 with survey responses, it was possible to estimate fare, service, and ridership changes resulting from federal cuts. The estimation procedure basically relied on the line elasticity measures given in Equation 1. Each operator indicated how much lost federal revenue would be recovered by fare increases. This amount was added to the existing fare revenue to derive the total fare revenue the operator would need to generate. From this the average fare necessary to achieve the required revenue and the resulting ridership level was calculated using fare elasticity estimates.

Next, the ridership loss caused by cuts in service was deducted. Survey responses and information on current federal funding levels disclosed the amount of cost reductions that can be expected from cutting services. Using the average cost per vehicle hour of service, the service cuts necessary to achieve those cost reductions were calculated. Service elasticity estimates were then used to translate service cuts into ridership losses. These were then subtracted from the ridership remaining after fare increases to yield a total ridership loss.

Thus, this methodology amounts to a simple recursive procedure, first calculating the impact of fare increases, then the impact of service cuts, ignoring possible simultaneous influences. Equations used to estimate the effects on ridership are summarized in the next section.

Effect of Fare Increases on Ridership

$$R_2 = (C \cdot J \cdot P_f) \quad (2)$$

where

R_2 = target fare revenue, after fare increase,
C = total operating cost, assumed equal to total existing fare revenue (R_1),
J = proportion of revenue received from the federal government,
P_f = proportion of federal cuts recovered by fare increases; thus,
$(C \cdot J \cdot P_f)$ = additional fare revenue that must be generated to make up revenue lost from federal cuts.

Table 1. Performance and financial data: elasticity estimates for U.S. transit operators (1, 6).

Parameter	Urban Area Population: Less than 100,000	100,000-250,000	250,000-1 Million	More than 1 Million	U.S. Total
Total operating expenses ($ millions)	39.5	153.4	443.8	4,225.3	4,862.0
Fare revenues ($ millions)	11.5	45.9	159.2	1,777.3	1,993.9
Linked passenger trips (millions)	43.0	126.9	447.6	5,451.4	6,068.9
Revenue vehicle-hours (millions)	2.1	6.9	17.6	78.7	105.3
Fare elasticity	-0.35	-0.35	-0.32	-0.24	-
Service elasticity	0.80	0.72	0.58	0.40	-
Federal share of total revenue (%)	33	33	31	18	-
Number of operators	57	91	71	105	324

Note: Figures are totals for all operators in the category.

$$(Q_2 - Q_1) = [(F_2 - F_1)/F_1] \cdot \eta_f \cdot Q_1 \quad (3)$$

where

Q_1 = ridership before fare change,
Q_2 = ridership after fare change,
$Q_2 - Q_1$ = absolute change in ridership due to fare increases,
F_1 = average fare before fare change,
F_2 = average fare after fare change, and
η_f = fare elasticity.

Both Q_2 and F_2 are unknown. But the identity $R_2 = F_2 \cdot Q_2$ allows Equation 3 to be solved, substituting R_2/F_2 for Q_2.

Effect of Service Cuts on Ridership

$$S_2 = [C - (C \cdot J \cdot P_s)]/C/S_1 \quad (4)$$

where

S_2 = reduced service level necessary to cut costs to make up lost federal assistance,
P_s = proportion of federal cuts recovered by service reductions, assuming increases in efficiency will offset the impact of service cuts by 50 percent,
S_1 = service level before service cutbacks,
C/S_1 = cost per vehicle hour of service; thus,
$(C \cdot J \cdot P_s)$ = absolute reduction in costs necessary as result of federal cuts.

$$(Q_3 - Q_2) = [(S_2 - S_1)/S_1] \cdot \eta_s \cdot R_1 \quad (5)$$

where

η_s = service elasticity, and
Q_3 = final absolute ridership after fare increases and service cuts; thus,
$(Q_3 - Q_2)$ = absolute change in ridership due to service cuts.

EFFECTS OF FEDERAL CUTBACKS ON ANTICIPATED FARE, SERVICE, AND RIDERSHIP

An Aggregate Picture

The 99 transit operators responding to the survey collectively indicated that lost federal revenue will be recovered predominantly by increasing fares and cutting service (see Table 1). In contrast, operators estimate that only a small amount of revenue can be recovered by improved efficiency, cost savings, or federal block grants. A summary of survey respondents indicated that the following percentages of lost federal revenue are expected to be recovered by various actions.

Action	Revenue Recovered (%)
Increase fares	22
Decrease service	18
Increase local support	17
Increase state support	17
Federal block grants	11
Increase efficiency and productivity	8
Cost saving measures	7

Table 2 shows that these actions can be expected to result in a 17 percent fare increase nationwide, from an average fare of 38.4 cents to 44.9 cents, in 1979 dollars. Service can be expected to decrease 3 percent, from 105 to 102 million vehicle hours. Although these changes appear to be minor, especially when spread over the 3-year span of the Section 5 phaseout, they could reduce nationwide ridership by more than 6 percent, approximately 370 million trips annually, provided all other factors (e.g., extreme gas shortages) remain constant.

Patronage losses resulting from federal cuts could be much larger if local and state governments fail to increase their aid. Table 3 indicates that if operators are forced to rely solely on fare increases because of the failure of states and localities to bail them out, ridership losses could total 935 million trips annually, a reduction of about 15 percent. For some operators fare increases alone could not compensate for the federal cuts because too many riders would be priced off the system. Thus, the worst case given in Table 3 represents the maximum fare increases possible, and service reductions make up the remainder of the lost federal dollars.

The data in Table 3 further show that the exclusive reliance on service reductions to offset federal losses would have less effect on ridership than on fare increases. If operators receive the increases in state and local aid they expect, the use of these funds to compensate for withdrawn federal dollars, in combination with selective cuts in service, could be expected to result in a ridership loss of only 3 percent. This would represent the best possible scenario from the standpoint of minimizing ridership losses.

These findings suggest that the failure of states and localities to increase their support of local transit systems could cause nationwide ridership to decline significantly; however, this may be exaggerated somewhat. In particular, all fare increases and service reductions need not be across the board. Cervero, et al. (7) have shown that selective distance-based and time-of-day pricing could increase transit revenues by as much as 70 percent with as little as a 4 percent decline in ridership. Currently there appears to be a trend away from flat fares; and to the extent that federal cuts encourage this trend, ridership losses might be less than those indicated in Table 2.

Although it is uncertain what form fare increases will take, it is highly unlikely that service reduc-

Table 2. Expected responses at the national level to federal cuts.

Item	Average Fare (constant 1979 cents)	Service Level (million veh-hr)	Ridership (billion trips)
Existing	38.4	105.3	6.37
Future	44.9	102.1	5.99
Change (%)	+17	-3	-6

Table 3. Total expected ridership loss under different revenue recovery schemes.

Revenue Recovery Scheme	Ridership Loss (millions of trips)	Ridership Loss (%)
Expected actions: combined fare increases, service cuts, and increased state and local aid	371	6
Worst case: fare increases only	935	15
Next worst case: service cuts only	431	7
Best case: service cuts and state and local aid	204	3

tions will occur unilaterally (e.g., a simple increase in average headways). Hemily and Meyer (8) suggest that most operators will reduce service in such a way that ridership loss is minimized. They argue that operators will first eliminate night-owl service (midnight to 6 a.m.), followed by Sunday service, evening service, Saturday service, and so on. An even more prudent way to reduce costs might be to examine routes systematically, eliminating those found to be most unprofitable. In any event, by assuming across-the-board service cuts, the service-induced ridership losses given in Table 2 are probably exaggerated somewhat.

A Disaggregate Picture

Considering only the nationwide impacts of federal transit cuts masks the hardships that will be experienced by certain groups of operators. For example, an operator receiving 50 percent of its revenue from the federal government will probably be severely hurt by the cuts, no matter what actions it takes.

Central to a more disaggregate analysis is the issue of how best to group operators that will be similarly affected by the cuts. Peer groups of operators are typically defined in terms of size, e.g., number of revenue vehicles. The amount of federal dollars received, as well as the actions contemplated, however, were not found to vary significantly among operators of different sizes. Federal subsidies were found, however, to vary significantly in terms of various operating characteristics of transit agencies as well as by metropolitan population and density. Regression Equation 6, computed using data from 65 of the agencies surveyed, indicates that the operators who rely on federal aid the least tend to be concentrated in large, densely populated cities. Moreover, the most productive (i.e., more hours of service per employee) and efficient (i.e., least costly service per hour of operation) transit agencies also rely on federal subsidies the least. These points are illustrated in the equation that follows where the coefficient of determination (R^2) equals 0.51 and the number of cases is 65.

$$\text{FEASSIST} = 42.5 - 0.00\,120\ \text{METROPOP}^{**} - 0.320\ \text{OUTPUT}^{**} - 2.07\ \text{DENSITY}^{**} - 0.338\ \text{LAPRO}^{*} \quad (6)$$

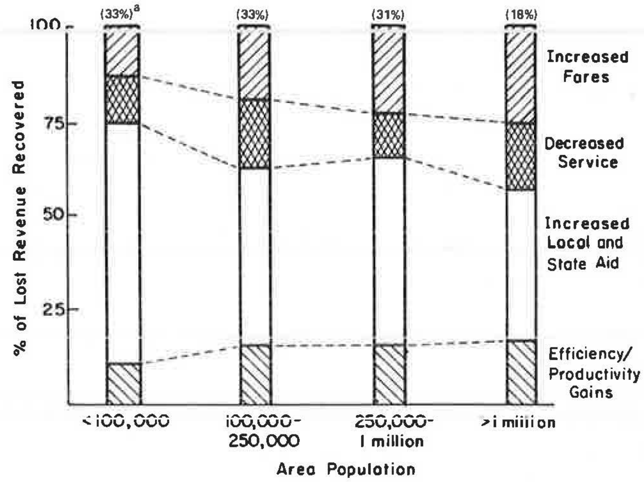
where

FEASSIST = federal share of operating revenue (expressed as a percentage),
METROPOP = metropolitan area population (in thousands),
OUTPUT = operating expense per vehicle hour (in dollars),
DENSITY = metropolitan area population density (coded 1 through 5, low to high), and
LAPRO = revenue vehicle hours per employee.
**significant at the 0.01 level
*significant at the 0.05 level

From Equation 6, METROPOP was found to have more explanatory power than any other variable. METROPOP alone explains more than 30 percent of the variance in FEASSIST suggesting that the best way of exploring how federal cuts might affect different peer groups of operators is to break data down by metropolitan population size. Four groups of transit operators, therefore, are used in the following analysis: those located in metropolitan areas with populations more than 1 million; 250,000 to 1 million; 100,000 to 250,000; and less than 100,000.

Figure 1 shows how operators in metropolitan areas of different sizes are planning to respond to

Figure 1. Percentage of revenue recovered, grouped by operator response to eliminating Section 5.



a(%) = Percentage of operating revenue received from federal sources.

federal cuts, as well as the percentage of total revenue they will lose from the Section 5 phaseout. Although the anticipated actions do not vary significantly by metropolitan area size, a pattern does emerge.

Operators in small metropolitan areas will probably rely more on increases in state and local aid, whereas those in large cities can be expected to increase fares and cut service. These results are not surprising because operators in small metropolitan areas usually receive a relatively large share of their revenue from the federal government. Operators in small cities would be hard pressed to recover lost revenue solely through fare and service changes even though the total federal dollars received by these operators nationwide is fairly small.

In contrast, operators in large metropolitan areas stand to lose only 18 percent of their total revenue because of federal cuts; however, the absolute amount of dollars involved is substantial (i.e., operators in areas with populations of more than 1 million received a total of $760 million in federal operating aid in 1979). In general, transit operators in big cities can recover lost revenue more easily with fare increases or service cuts than by seeking large increases in state and local aid. Operators in small cities, on the other hand, will be at the mercy of local and state treasuries.

Effects in Large Urban Areas

For the most part, whatever happens to operators in large urban areas happens to the U.S. transit industry as a whole. This is because America's transit services and ridership are concentrated in large urban areas. Although there are more transit operators in smaller urban areas, 85 percent of the nation's ridership is in areas with populations greater than 1 million.

Transit agencies in large cities generally receive a relatively small proportion of their total income from federal grants. Of the ten largest operators, all but two (those located in Los Angeles and Detroit) receive less than 20 percent of their operating revenue from federal sources. Operators in New York City, alone accounting for nearly 35 percent of U.S. ridership, receive only 6 percent of their revenue from the federal government.

Because large operators stand to lose a relatively small proportion of their revenue, the impact of federal cuts should be minimal. The data in Table 4 show that fares are expected to increase about 15 percent, from an average of 32.6 cents to 37.5 cents; and service levels can be expected to fall by only about 3 percent in areas with populations more than 1 million. The result will be an estimated 5 percent decline in ridership, a loss of 250 million riders annually in the largest cities. Thus, with few other travel options, residents of big cities will probably continue to patronize transit even when fares rise sharply.

Although large urban areas will be the least affected by federal cuts, in absolute terms the ridership losses could be significant. More important, these operators are also counting on a $280 million increase in state and local aid. If this aid is not forthcoming, the loss in transit ridership could run as high as 14 percent (see Table 5).

Effects in Smaller Urban Areas

Most small-city operators rely as heavily on federal subsidies as on the farebox; some receive as much as one-half of their income from federal funds. Figure 1 shows that operators in smaller urban areas (i.e., populations less than 1 million) are counting heavily on replacing federal grants with increased state and local aid. Nonetheless, some fare increases and service cuts will occur. The data in Table 4 show that fares can be expected to increase 31 to 48 percent in areas with less than 1 million population with concurrent service cuts of 3 to 6 percent. The total ridership loss in small urban areas is expected to reach 93 million passengers annually, and the largest impact is expected to be in areas with populations of 100,000 to 250,000.

Unlike operators in large urban areas, many transit agencies in smaller cities will be wholly dependent on increased state and local aid to keep their systems solvent. The data in Table 5 show that, without the increased state and local aid, many will suffer substantial ridership losses as a result of drastic fare increases and service cuts.

It appears likely that a large number of operators in areas with less than 100,000 population would be forced to cease operations as services begin to fall below the threshold necessary to maintain political support. Consequently, operators that can afford to run buses only a few hours a day, or only on hour-and-a-half headways, may eventually be forced out of business as policymakers find other ways to meet the travel needs of their constituents. It may be, however, that such an outcome could prove beneficial over the long run as taxi companies and various other private service providers fill the void left by discontinued public transit services.

Table 4. Expected response of urban areas to federal cuts (by population area).

	Urban Area Population			
Parameter	Less than 100,000	100,000-250,000	250,000-1 Million	More than 1 Million
Percentage of total U.S. transit ridership	1	2	7	90
Fare increase (%)	31	48	35	15
Service decrease (%)	3	6	3	3
Existing ridership (millions of trips)	43	127	448	5,450
Ridership loss (millions of trips)	6	27	60	252
Ridership loss (%)	13	21	13	5

Table 5. Expected ridership loss in urban areas under different revenue recovery schemes (by population area).

	Ridership Loss by Urban Area Population (%)			
Revenue Recovery Scheme	Less than 100,000	100,000-250,000	250,000-1 Million	More than 1 Million
Expected actions: fare increase, service cuts, and local and state aid	13	21	13	5
Worst case: fare increase only[a]	48	39	28	14
Next worst case: service cuts only	24	20	15	6
Best case: service cuts and local and state aid	6	9	6	3

[a]Ridership loss resulting from maximum possible fare increase. Some service cuts would still be necessary because withdrawn federal funds could not be recovered with fare increases alone.

Summary

These results indicate that federal cuts will probably have only a minor impact in large metropolitan areas but could be devastating in smaller cities. Large cities would be relatively unaffected because they receive only a small share of their revenue from federal funds. Agencies in small cities, on the other hand, are highly dependent on federal assistance. Because many already have marginal service levels, there are fewer opportunities for raising fares and reducing service. Thus, if compensatory state and local aid is not forthcoming, the elimination of operating subsidies could force many small-city transit agencies into bankruptcy.

OTHER EXPECTED IMPACTS OF FEDERAL CUTBACKS

Environmental and Energy

Because transit accounts for only 3 percent of urban passenger trips, the effect on environment and energy as a result of ridership losses will be imperceptible on a national scale. Assuming a net reduction of 343 million transit trips annually, the Section 5 phaseout could increase automobile travel by 1.3 billion miles (0.13 percent) and fuel consumption by 93 million gallons (0.13 percent).

Equity

Federal cuts will affect some income groups more than others. Clearly, fare increases induced by federal cuts will be a greater strain for the poor than for the wealthy. The impact on the poor could prove pervasive because they rely much more on transit than the wealthy. In 1970, for example, Americans with incomes below $5,000 used transit for 13.7 percent of their trips, whereas those with incomes above $15,000 relied on transit for only 5.8 percent of their trips (9).

Service cuts will probably also hurt the poor the most, particularly those living in smaller cities. Because they own fewer cars than other income groups, the poor will more likely be forced to forego trips because of federal cuts. The loss of travel opportunities to the poor will be particularly burdensome if service reductions focus on night-owl, Sunday, and other off-peak services. Nationally, a high percentage of off-peak patronage is made up of lower-income persons; wealthier riders tend to ride during peak periods (10).

Finally, the replacement of the more progressive federal income taxes by the more regressive state and local sales and property taxes could place an increasing tax burden on the poor. If some localities chose more progressive taxes, such as a stock transfer tax (11), to help pay their transit bill, wealthier residents of those areas would be effectively making up the loss in federal assistance.

In summary, federal cuts may hurt the nation's poor in multiple ways. They will probably suffer the most from higher fares and reduced service and can also be expected to bear the brunt of tax increases to support transit. User-side subsidies, perhaps administered through various human services programs, should therefore be considered for lessening the impact of federal cuts on the poor.

Political

Federal transit cuts are likely to spark some major political confrontations. Battles will surely be fought between managers seeking selective service cutbacks and fare increases on the one hand, and boards trying to maintain their political support via low fares and extensive routing, on the other. Efforts to introduce zonal and peak-period fares, for instance, can be expected to be opposed by users, labor, and politicians. Similarly, confrontations over service cuts will heighten, perhaps pitting suburban taxpayers who lose their services against those in areas where service levels are maintained.

Labor

Federal cuts may also hurt transit labor. Most fundamentally, as services are scaled down, some transit workers may be furloughed. In areas where unemployment is already high, such as the industrial Northeast, this could impose significant hardships on workers that have been laid off.

SUMMARY AND CONCLUSIONS

This research suggests that the wholesale withdrawal of all federal operating assistance could have a significant effect on the American transit industry. Nationwide, federal cuts can be expected to cause fares to increase on the order of 17 percent, service to decrease about 3 percent, and ridership to decline approximately 6 percent. The impact of cuts will be most severe in smaller urban areas because of their relatively heavy reliance on federal aid. Ridership losses will probably average about 15 to 20 percent in these areas, and a number of agencies, perhaps as many as 50 nationwide, may be forced to cease operations.

Should massive federal cuts occur, ridership losses can be minimized by reducing service instead of increasing fares. The selective elimination of unprofitable routes coupled with the introduction of distance and time-of-day pricing offer the best opportunities for meeting costs while also minimizing ridership losses. Most operators are also counting on substantial increases in local and state aid to lessen the impact of federal cuts. Should this assistance fail to materialize, nationwide ridership could decline as much as 15 percent. In general, the poor will bear the brunt of the future fare hikes, service cuts, and state and local tax increases that will result from federal cuts.

The findings of this research appear to provide ammunition for both sides of the argument. Federal officials expect the Section 5 phaseout to prod operators into becoming more efficient and to shift some of the transit cost burden to state and local governments. Operators will, indeed, strive to become more efficient as they cut unprofitable routes, raise fares, and generally tighten their belts. The result will be an estimated 15 percent increase in the nationwide farebox recovery ratio from the existing 0.41 to an expected 0.47.

However, the script written for the future by opponents of the federal cuts probably also holds some truth. The cuts will be devastating to some areas. If localities and states fail to make up some of the lost federal revenues, many operators in smaller urban areas will have no option other than to scale down services radically or completely cease operations. The danger of shifting the transit financial burden to states and localities is that they, too, may reexamine their programs and eventually cut back. It is doubtful that even the largest transit systems could survive on passenger fares alone. A trend away from operating subsidies could easily plunge transit into a period of gradual attrition similar to that before the 1970s, which brought the industry to the brink of financial collapse.

Given some of the possible deleterious effects of eliminating all federal operating assistance to transit, several alternative courses of actions are recommended. First, all governments should rely increasingly on user-side subsidies that allocate aid specifically to the disadvantaged. A well-designed subsidy program providing travel vouchers to the poor, elderly, and handicapped could also stimulate greater competition among various service providers and encourage more innovative paratransit modes to emerge. Second, efficiency objectives can probably be better achieved through subsidy allocation strategies rather than the complete withdrawal of public support. Governments can encourage the types of efficiency improvements desired and bring escalating costs under control through various incentive programs and the adoption of performance standards. Tying subsidies to improvements in cost recovery or labor productivity could offer greater hope for strengthening the industry than simply eliminating operating assistance.

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An Analysis of Local Taxpayers' Willingness to Finance Transit

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A strong commitment of local tax dollars will be necessary to sustain transit service in many U.S. cities in the 1980s. Limited research has been completed on willingness to pay local taxes for transit. Factors that influenced support for a proposed special property tax millage in Council Bluffs, Iowa, are examined. Council Bluffs is a moderately low income, blue collar community within a metropolitan area of half a million people. An analytic technique known as the Automatic Interaction Detector (AID3) is applied to survey data collected through telephone interviews of 770 households in Council Bluffs. AID3 sequentially partitions a data set on the basis of maximum differences in the means of the resultant groups. Each respondent is assigned to one and only one subgroup. Results of the analysis indicate that home ownership is a major factor in the willingness to pay a local transit tax; home owners are distinctly less willing to pay than renters. Older persons are also less supportive of an additional property tax. Among homeowners, personal transit use or use by another household member is an important factor in support. The attitudes that business within the city is stimulated by transit, that low income persons are enabled to get or keep jobs, and that local government is generally performing well are highly related to willingness to pay a transit tax. The conclusion is drawn that it is important to provide transit service that conforms to the objectives of local taxpayers as well as to demand by users of the service. If these taxpayers believe that transit is making a useful contribution, they are much more likely to support a local property tax to help finance it, even if they are not making personal use of transit.

Recent policy shifts in the federal government are gradually transferring the burden for financing transit operations to the local level. With the phaseout of UMTA Section 5 operating assistance, the entire cost of operating transit must be defrayed by fares, state assistance, and local funds. Fares have been increasing quite rapidly in the early 1980s (an average of 18 percent from 1980 to 1981) and probably will continue to do so (1). Concern exists, however, that too rapid an increase in fares could bring about significant ridership losses and, in some instances, reductions in total revenue. State transit operating assistance is provided by only about half of the states, and the level of this assistance is rarely high (2,3). A strong commitment of local tax dollars to subsidize transit operations may often be the only alternative to major reductions in or even termination of service.

Limited research has been conducted in the area of local transit financing. A growing literature is emerging on the efficiency and equity implications of alternative financing strategies; Pucher (4), for example, and the probable responses to fare changes (5). Few studies have addressed the issue of local willingness to pay local taxes for transit (6-8). An earlier analysis by Forkenbrock (9) examined the relationship of various user and nonuser benefits to transit support, but the case study city of Ann Arbor must be regarded as somewhat atypical.

This analysis is an attempt to extend what is known about factors influencing willingness to pay a local tax earmarked for transit. The data used in the analysis were collected as part of a study of citizen preferences regarding transit financing. The fundamental questions explored in this paper are the relationships between (a) personal transit use, situational attributes, and individual attitudes; and (b) willingness to pay a local property tax for transit.

CASE STUDY AND RESEARCH METHODOLOGY

The Case Study City: Council Bluffs, Iowa

Council Bluffs, Iowa, purchases transit service from Metro Area Transit (MAT) which serves the greater Omaha region (570,399 population). Costs are assigned to Council Bluffs on the basis of service hours provided on a monthly basis. As the hourly charge by MAT increased and the amount of federal Section 5 operating assistance began to diminish, the concern of city decision makers heightened. Alternatives ranged from terminating service to levying a local tax to help defray the burgeoning deficit.

Iowa law enables a local government to institute a special property tax assessment of not greater than 2 mills to provide for transit. In Council Bluffs a 2 mill assessment would generate approximately $350,000 annually. Although state law does not require a referendum to establish a new tax, the mayor and city council decided that a large-scale household survey would be prudent. Such a survey would enable them to determine whether the citizenry would favor an increase in property taxes to help pay for transit.

The city council's concern over public support for a transit tax stemmed in part from the difficult economic circumstances of the city. At the time the increase was being contemplated, the city had a 9 percent unemployment rate. Most of the labor force is blue collar, and the average household income of $17,870 is well below the national average of more than $21,000. The median educational level is 11.8 years. In short, Council Bluffs is a lower middle income, blue collar community whose economy is not particularly strong.

In November 1981, a telephone survey of 770 Council Bluffs households was designed and carried out. Considerable media coverage characterized the survey as an informal referendum. A random digit dialing mechanism was used to select households, and a randomizing table was used to identify the person 18 years or older who was interviewed. If this person was not available, an appointment was made to call again. The result is a representative sample of households with a telephone and a random selection of respondents within these households. Less than 2 percent of Council Bluffs residents do not have a telephone.

The dependent variable to be explained in this analysis is willingness to pay either a 2 mill or a 1 mill property tax to be earmarked for transit.

Table 1. Variables included in the analysis.

Name	Description	Category	Distribution of Responses: No.	Distribution of Responses: Percent
Situational variables				
SUPPORT	Support for either a 2 mill or a 1 mill property tax	0 = No	214	31.8
		1 = Yes	459	68.2
		Missing data	(97)	
INCOME	Household income of the respondent	1 = Low, $0-$9,999	207	33.0
		2 = Middle, $10,000-$24,999	282	43.6
		3 = High, $25,000+	157	24.3
		Missing data	(124)	
AGE	Age of the respondent	1 = Young, 18-25 years	133	17.3
		2 = Middle aged, 26-59 years	401	52.1
		3 = Older, 60+ years	235	30.6
		Missing data	(1)	
EDUC	Education of the respondent	1 = Low, 1-11 years	202	26.4
		2 = Medium, high school	462	60.5
		3 = High, some college+	100	13.1
		Missing data	(6)	
SEX	Sex of the respondent	0 = Male	258	33.6
		1 = Female	511	66.4
		Missing data	(1)	
TENURE	Tenure of the respondent's household	0 = Rent	219	29.5
		1 = Own	523	70.5
		Missing data	(28)	
Behavioral variables				
USER	Transit usage by the respondent	1 = Nonuser	374	48.8
		2 = Previous user	277	36.1
		3 = Current user	116	15.1
		Missing data	(3)	
OTH USE	Transit usage by other members of the respondent's household	1 = No use	650	84.5
		2 = Occasional use	53	6.9
		3 = Frequent use	66	8.6
		Missing data	(1)	
Attitudinal variables				
STIM BUS	"Public transportation in Council Bluffs helps stimulate business in the city."	1 = Strongly agree	334	43.9
		2 = Agree somewhat	264	34.7
		3 = Neither agree or disagree	74	9.7
		4 = Disagree somewhat	52	6.8
		5 = Strongly disagree	37	4.9
		Missing data	(9)	
DIS AUTO	"The use of private cars should be discouraged."	1 = Strongly agree	36	4.7
		2 = Agree somewhat	97	12.7
		3 = Neither agree or disagree	79	10.3
		4 = Disagree somewhat	186	24.3
		5 = Strongly disagree	368	48.0
		Missing data	(4)	
IMP TRANSIT	"We should improve public transportation so it will be used more."	1 = Strongly agree	313	41.1
		2 = Agree somewhat	246	32.3
		3 = Neither agree or disagree	114	15.0
		4 = Disagree somewhat	57	7.5
		5 = Strongly disagree	31	4.1
		Missing data	(9)	
POOR TO JOB	"Public transportation in Council Bluffs helps low income people find or keep jobs."	1 = Strongly agree	408	53.5
		2 = Agree somewhat	208	27.3
		3 = Neigher agree or disagree	66	8.7
		4 = Disagree somewhat	39	5.1
		5 = Strongly disagree	42	5.5
		Missing data	(7)	
TRAN POOR	"Public transportation should exist mainly to help low income people."	1 = Strongly agree	139	18.1
		2 = Agree somewhat	125	16.3
		3 = Neither agree or disagree	36	4.7
		4 = Disagree somewhat	158	20.6
		5 = Strongly disagree	308	40.2
		Missing data	(4)	
SAVE FUEL	"Public transportation should be used, rather than private automobiles, in order to conserve fuel."	1 = Strongly agree	179	23.4
		2 = Agree somewhat	287	37.6
		3 = Neither agree or disagree	79	10.3
		4 = Disagree somewhat	119	15.6
		5 = Strongly disagree	100	13.1
		Missing data	(6)	
SAT SERV	"Overall, how satisfied are you with the job being done by city government officials and bureaus?"	1 = Very satisfied	67	9.3
		2 = Somewhat satisfied	457	63.2
		3 = Somewhat dissatisfied	159	22.0
		4 = Very dissatisfied	40	5.5
		Missing data	(47)	

Specifically, respondents were asked the following question:

> In Iowa, a city council can vote to add a property tax up to 2 mills to help finance public transportation within the city. A 2 mill tax would cost about $16 per year for a family living in a house worth $30,000 or about $32 per year for a family living in a house worth $60,000. Do you favor Council Bluffs' city council passing a 2 mill property tax for transit?

If the respondent opposed the 2 mill tax, the following question was then asked:

> A 1 mill property tax for public transportation would cost one-half this amount. It would cost $8 per year for a family living in a house worth $30,000 or about $16 for a family living in a house worth $60,000. Do you favor Council Bluffs' city council passing a 1 mill property tax for transit?

It is worth noting that respondents were told how much the property tax would cost them. Had this information not been provided, the issue would have been too hypothetical for a meaningful answer to be given. In the case of renters, an estimate of the property tax likely to be paid on their unit was furnished, based on two assumptions: (a) the rent is approximately equal to 1 percent per month of the market value, and (b) the property tax is ultimately paid by the tenant.

To construct the dependent variable a favorable response to either question was coded as a one, and a negative response to both was coded as a zero. Actually, 43.4 percent of the sample favored a 2 mill tax and another 24.8 percent would be willing to pay a 1 mill tax. It should be stressed that the analysis is restricted to willingness to pay a property tax millage. The support for an alternative local tax, such as one on income or sales, may differ both in level and nature.

The variables included in the analysis are listed in Table 1. There is a total of five situational variables (household income, age of the respondent, education of the respondent, sex of the respondent, and housing tenure); two behavioral variables (use of transit by the respondent and use by other members of his or her household); and seven attitudinal variables (six statements with which the respondent could agree or disagree and a measure of general satisfaction with local government). Descriptions of the ordinal response categories and the associated distribution of responses are also shown in Table 1.

The variables for transit usage require a brief explanation. Respondents were asked whether they had ridden on a MAT bus during the previous 30 days; if they had, a code of three was assigned. Those who had not but who had done so during the previous 3 years were assigned a two. Finally, respondents who had not made use of transit service during the previous 3 years were assigned a one. Table 1 shows that only 15.1 percent of the sample had used transit in the previous 30 days and slightly less than half (48.8 percent) had not used transit in 3 years.

The Nature of the Analysis

The primary objective of this research was to examine how willingness to pay a local tax for transit varies among persons in different situations, having dissimilar usage patterns, and holding different attitudes regarding transit. A variety of analytic techniques exist for predicting a given outcome (such as willingness to pay for transit), including multiple regression and analysis of variance. Regression, however, requires intervally scaled predictor variables; survey data are almost exclusively ordinally scaled. Analysis of variance explains how much of the variance is accounted for by each predictor, but it requires the rigid condition that the effects of each predictor be measured over the whole sample, even though in reality these effects may differ substantially among subgroups of the sample.

The analytic technique used in this analysis is the Automatic Interaction Detector, or AID3 (10,11), developed at the Survey Research Center of the University of Michigan. It asks the question, "What dichotomous split on which single predictor variable will give us a maximum improvement in our ability to predict values of the dependent variable?" (11, p. 2). Through a series of binary splits, AID3 divides the sample into a series of mutually exclusive subgroups. Each observation, then, becomes a member of one and only one of these subgroups. Thus, each survey respondent is assigned to a specific group.

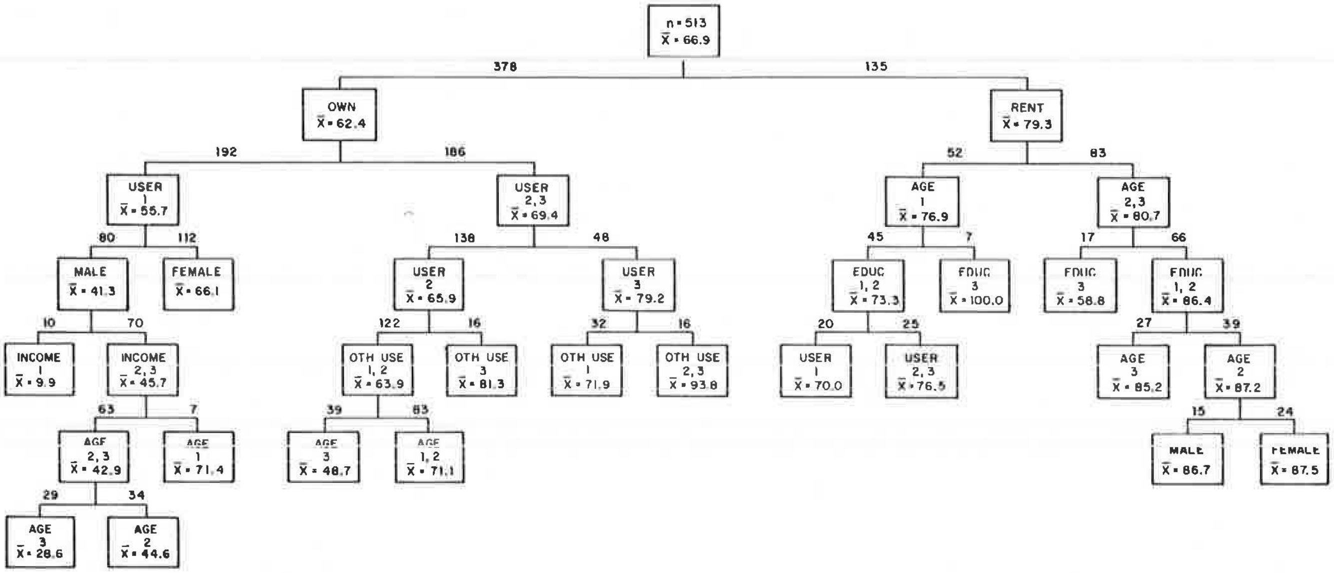
Assignments to groups are made such that at each step in the procedure the two new means account for more of the total sum of squares than would the means of any other possible pair of subgroups. That is, the means of the two subgroups defined at each step differ from each other maximally. In this case the means in question are those of the zero-one willingness to pay measure. For example, if two-thirds of a subgroup favored the millage, the mean for that subgroup would equal 66.7 percent.

A particularly attractive characteristic of the AID3 procedure is that the divisions of the sample into subgroups occur in a series of separate steps. The result is a tree-like definition of subgroups of ever decreasing size as the analysis proceeds. At each step there is a one-way analysis of variance for all possible splits (i.e., each category of each eligible variable) to determine the groups that will vary from each other the most. It should be noted that not all of the 770 observations could be included in the analysis because some respondents declined or felt unable to answer all questions. Only cases with valid responses to all variables can be processed by the AID3 program. Because the procedure divides a data set by looking at the competitive possibilities for each split, the probability of exactly replicating the whole process is remote. (The probability of getting the same sequence of splits is the product of the probability of getting the first multiplied by the probability of making the same second one, and so on.) Statistical significance tests are therefore inappropriate and not provided by the AID3 program.

In the interest of clarity, two separate analyses will be presented; both are intended to shed light on the central question of willingness to pay a local transit tax. The first analysis includes the five situational and two behavioral variables. This analysis will help explain who favors a tax for transit and how strong support is among various subgroups of respondents. The second AID3 analysis includes the seven attitudinal variables. The objective of the latter analysis is to determine which views are most strongly associated with willingness to help finance transit. Are people who possess a certain set of attitudes toward transit and its benefits more likely to favor the tax than those with opposing views?

The attitudinal analysis is particularly intriguing from a policy perspective. Knowing the kind of feelings that exist regarding what transit should contribute to society and how strongly these feelings are related to a willingness to pay for transit enables policymakers both to modify existing ser-

Figure 1. Groups formed by situational factors affecting support for a transit tax ($\bar{X}$ is given in percent).



vices and to market these services more effectively. As noted earlier, transit must not only attract riders; it also must be supported by local taxpayers who are willing to help pay for it.

FOUNDATIONS OF LOCAL WILLINGNESS TO PAY FOR TRANSIT

Situational Analysis

An AID3 analysis was performed to investigate the relationships between the five situational and the two behavioral variables and willingness to pay a local property tax for transit. Figure 1 depicts the resultant partitioning of responses. Each box contains the abbreviated variable title (see Table 1), the response categories included in that partition, and the mean value for the dependent variable within the subgroup. The number of respondents in a specific subgroup appears on the branch leading to the box for that subgroup.

The strongest measure for explaining differences in support for a transit tax is housing tenure. On the average, almost 17 percentage points separate renters from homeowners in favoring either a 1 or a 2 mill tax for providing transit. Apparently, because the property tax is far more visible to homeowners and average values are higher (and, hence, higher taxes) for owner-occupied homes, owners are less willing than renters to endorse a higher millage rate.

Among renters, the young are less likely to favor a transit tax. The data in Table 1 show that persons aged 26 years and older are somewhat more supportive of the increase than those aged 18-25 years. Within the two older age categories, those with no more than a high school education are substantially more apt to support a millage for transit; almost 28 percentage points separate the two groups. Those aged 26 through 59 are proponents of a transit tax slightly more often than those 60 years and older. Likewise, women are a little more supportive than men. Overall, 87.5 percent of the women who are 26 to 59 years of age, have a high school education or less, and live in a rented house or apartment will support a transit tax. The lowest level of willingness to pay a transit tax among renters is, surprisingly, persons with at least some college who are 26 or more years old. Interestingly, use of transit does not emerge as a major factor influencing support for a transit tax among renters.

Within the ranks of homeowners, personal use of transit is the most important factor. For users of MAT services the support is 69.4 percent compared to 55.7 percent for the nonusers. Furthermore, current users are over 13 percentage points more likely to favor the tax than are those who have not used transit within the past 30 days. Those who have used transit recently and who live in households where other persons also use transit are particularly likely to support an earmarked millage. Fully 93.8 percent of this small group support the tax.

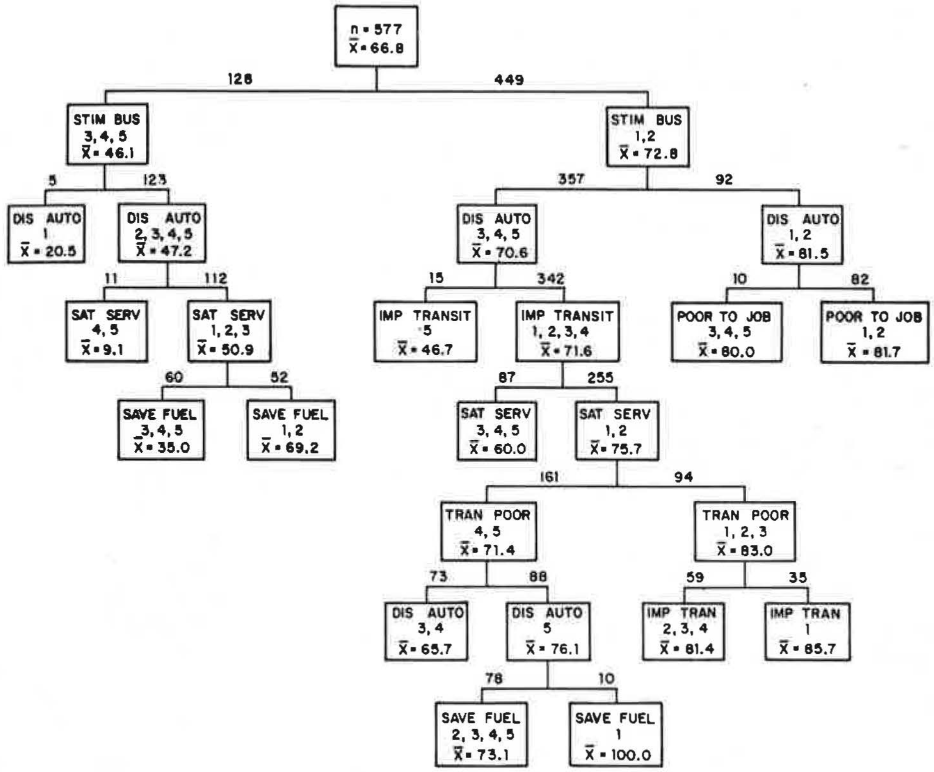
Respondents living in owner-occupied residences who do not personally use transit, are male, and have low incomes are typically not strongly favorable toward a tax for transit. Less than 10 percent of this group support such a tax. Nonusers who reside in owner-occupied housing, are male, have higher incomes, and are relatively young, however, are quite supportive. Our analysis reveals that 71.1 percent of this group favor a transit tax.

In summary, renters are stronger supporters of a local transit property tax than are homeowners. Among homeowners personal use or use by another household member is an important consideration in willingness to pay a transit tax. This suggests that those for whom the property tax is most visible feel most strongly that they must get their money's worth. Elderly persons generally are somewhat less willing to see their property taxes raised. That many of them have fixed incomes undoubtedly has a bearing on their support for a transit tax.

Attitudinal Analysis

Next the role played by personal attitudes in support for a local transit tax is considered. Figure 2 shows that certain combinations of attitudes lead to very high fractions of group members who are willing to pay a property tax for transit. The attitude most strongly related to support for such a tax is that transit helps stimulate business within the city. As noted earlier, the city of Council Bluffs was experiencing an economic downturn in

Figure 2. Groups formed by attitudinal variables affecting support for a transit tax ($\bar{X}$ is given in percent).



November 1981 and respondents undoubtedly had the local economy on their minds. It is noteworthy that 449 of the 577 respondents (for whom data existed on all variables included in the analysis) strongly agreed or at least agreed somewhat that transit helps stimulate business. This belief is clearly one of the strongest bases for support in the case study city.

Agreement with the statement that use of private cars should be discouraged is strongly related to willingness to pay a transit tax among those who believe that transit fosters business activity. Eleven percentage points separate those who wish to see automobile use discouraged from those who do not. Among those preferring to see automobile use discouraged, respondents who also believe that transit helps low income persons find or keep jobs are slightly more likely to favor a transit tax. Of this group, 81.7 percent support the tax.

Those who disagree with the proposition that automobile use should be discouraged may still support a tax, provided they have certain other attitudes. For one thing, believing that transit should be improved so that it will be used more appears to be important. (MAT services in Council Bluffs have been reduced in recent years because of fiscal shortages.) Similarly, a general satisfaction with city government is a significant factor in support for a transit tax; over 15 percentage points separate those who are satisfied from those who are not. Among those satisfied with urban government, respondents who see transit mainly as a service to help low income people are 12 percentage points more likely to favor a transit tax than those who are less convinced of the income redistributional value of transit. Within this group, those with the strong belief that improvements in transit will increase its use are even more prone to favor an earmarked millage; 85.7 percent of this group favor a transit tax.

Returning to the top of the tree diagram, the 128 respondents who are unconvinced that transit helps stimulate business are unlikely to prefer automobile restrictions (the few who do are not transit supporters). Among those in this group who are at least not dissatisfied with city government and who believe that transit can help conserve fuel, 69.2 percent actually favor a millage. This is slightly higher than the percentage for the overall sample.

What the AID3 attitudinal analysis shows is that each of a series of attitudes leads to or diminishes support for a local transit tax. When certain combinations of positive attitudes are held, a high fraction of these persons will be inclined toward raising the property tax to help finance transit. The analysis also shows that certain views are particularly important to transit support. These attitudes include the belief that business is stimulated, that transit should be improved so that it will be used more, and that local government is generally performing adequately. Lacking these perspectives, one is quite unlikely to favor higher taxes to finance transit.

CONCLUSIONS AND POLICY IMPLICATIONS

It is commonly recognized that more local taxpayers are willing to pay taxes for transit than actually make personal use of the service. Less well understood is how extensive this support is, who the willing persons are, and what factors motivate them. The two AID3 analyses have made it possible to break down a reasonably large sample of local residents faced with a choice of whether or not to support a new tax to finance transit service within their community. The resulting subgroups often vary considerably in their support. A comparison of the two AID3 analyses shows that an individual's situation in life and his or her attitudes have rather similar effects on willingness to pay a transit tax. More detailed analyses than those presented here reveal tendencies for those with particular life situations to possess certain attitudes, but these are only tendencies and considerable variation exists.

Several policy implications emerge from this research. Renters are seen to be more likely to favor a property tax earmarked for transit even if they do not use it. Homeowners must be convinced they are getting their money's worth because of the visibility of their tax burden. For both groups, belief that transit helps business is exceedingly important (the 449 persons who believe that it does include many renters and homeowners). A positive image of local government in general is vital as well.

These conclusions suggest that transit planning and marketing need to be carried out so that preferences of taxpayers as well as users are taken into account. If local citizens believe that objectives important to them are being pursued, this analysis leads to the conclusion that they will support a local transit tax even in periods of economic scarcity.

When the results of the citizen survey were presented to the Council Bluffs city council, it voted to initiate a transit tax. This action ensured continued service which without this commitment was in considerable jeopardy.

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How to Avoid the Impending Disaster in Public Transportation Financing

JON E. BURKHARDT

The imminent withdrawal of federal funding for operating assistance to public transportation agencies creates a crisis in funding. Total system deficits will rise to more than $100 million per state in a number of states in 2 or 3 years. Funding sources, cost containment strategies, and the relative political consequences of these strategies are reviewed, and questions of how much fares can be raised and how much services can be cut are examined. A composite approach to dealing with potential revenue shortfalls is presented that may provide sufficient relief in the short run.

It is no secret that finding enough revenue to cover costs continues to be a problem for those responsible for providing public transportation; and the problem would be worsened by the withdrawal of federal funding for operating deficits. Because the existence of numerous transportation systems is threatened, it is important that plans to avoid financial catastrophes be made as soon as possible. The factors considered to be significant are as follows.

Enactment of the Surface Transportation Assistance Act of 1982: This historic legislation, signed by President Reagan on January 6, 1983, provides a significant and welcome step away from previous legislative proposals that could have led to financial disaster for many transit agencies. This law provides a dedicated source of revenue for transit funding, continues federal support for operating expenses while putting a cap on subsidies, initiates a better allocation of formula grant funds, and continues a commitment to federal participation in new transit starts.

Proposal to eliminate operating assistance to public transit: The Reagan Administration remains opposed to operating assistance for transit. It proposed a reduction in assistance to 62 percent of the FY 1982 level in FY 1983, a reduction to 27 percent in FY 1984, and elimination of assistance in FY 1985. Whether or not this philosophical stance will continue after the passage of the Surface Transportation Assistance Act of 1982 remains to be seen. The key test will be the appropriations levels for transit in FY 1984.

Continually rising transit costs: Inflation continues to affect the transit industry substantially as labor costs, fuel costs, and the price of transit vehicles continue to increase. In particular, the price of vehicles is increasing rapidly.

Substantial opposition to new taxes: The well publicized taxpayers revolt that started with California's Proposition 13 has seriously affected the ability of local governments to raise taxes for any cause. This political climate, added to the conservative approach of many states to public spending, may make it difficult to replace federal subsidies with state subsidies.

Increases in transit patronage: On a national basis, transit ridership increased every year from 1972 until 1981, when it declined 3.4 percent from the previous year. The number of public transit and ridesharing systems has increased substantially during the last decade; however, a number of these systems now face highly uncertain futures.

Classical problems of public transportation systems: Transit continues to suffer from a severe peak-loading problem; this leads to higher labor costs (because the peaks cannot be contained within an 8-hour day) and underutilization of the fleet and related personnel during off-peak periods. Many patrons are captive riders who because of income, age, or other problems do not have access to any other transportation mode. Also, in some areas public transportation programs still have the image of offering second class service.

These and other factors demonstrate the complexity of providing a stable, long-term financial base for public transportation.

The approach to these issues begins with an analysis of which major funding sources can be tapped for more funds. The next step involves the opposite side of the coin--how much is currently being spent--and necessitates an analysis of cost containment strategies. The third step is to develop a process for deciding which strategy produces enough money with relatively few consequences, especially in the political sense. Finally, consideration is given to what would constitute something approaching an ideal situation under the current constraints.

FUNDING SOURCES

Numerous potential sources of funds exist for public transportation services. Passenger fares, federal cash grants and reimbursements, local cash grants and reimbursements, and state cash grants and reimbursements provide the bulk of funding for most systems.

Table 1 gives overall national averages for transit funding, but there are large variations in the proportion of funds from each source. In Virginia, for example, fares are always an important source of funds, but their importance varies from that of providing the vast majority of funding to providing less than one-sixth of the total (1). State cash grants and contributions play only a small role in all Virginia systems, but the roles of the federal and local cash grants and contributions again vary widely. These sources play a greater role when passenger fares contribute less of the total.

Passenger Fares

Passenger fares were the predominant, if not the only, source of funds for most public transportation systems until the 1960s. As it became more and more difficult to finance public transportation solely from the farebox, municipalities and other public authorities assumed the ownership and responsibility of privately owned companies. The federal government began to provide greater and greater assistance to meet the deficits created by increasing costs and declining revenues.

Problems associated with reliance on fares as the major source of income include

1. A major decline in the number of persons using mass transportation since the period of greatest use during World War II,
2. A reluctance to raise fares among those responsible for regulating the operations of the then privately owned companies,
3. Perception of public transit systems as inferior goods that needed to be priced substantially below other modes to attract riders, and
4. Recognition that a substantial portion of transit riders were a captive market in that they could afford no other option (meaning that any fare increase would constitute a special economic hardship for them).

Some of these problems were explicitly recognized in the UMTA legislation of 1974 that, for the first time, provided federal funds to subsidize operating losses incurred by transit authorities in urban areas. This assistance was explicitly provided so that localities could maintain fares as low as possible and thus attract more riders.

These issues have now changed slightly. Transit ridership has been increasing since the early 1970s, and the new equipment and services operated by many transit agencies have dispelled much of the negative image associated with riding transit. But there is still a large captive or transit-dependent submarket, and this consideration makes fare increases politically sensitive and difficult.

Fare Increases: Rationale and Reactions

Part of the rationale of the Reagan Administration's opposition to federal subsidies of operating deficits for public transportation is said to be the notion that public services that benefit specific localities should be paid for by those localities. Congress appears likely to endorse--at least partially--the Administration's philosophy of greater fiscal contributions from localities.

The loss in federal operating dollars has most often been met by increasing fairbox revenues and reducing operating costs to maintain the balance between revenue and cost. Typically in the wake of

Table 1. Percent of transit system revenues from various sources (all properties—FY 1979) (14).

Revenue Source	Percent
Passenger fares for transit service	40.9
Other transportation revenues	1.6
Nontransportation revenues	1.8
Taxes levied directly by transit system	5.8
Local cash grants and reimbursements	19.8
Local special fare assistance	2.1
State cash grants and reimbursements	11.7
State special fare assistance	1.0
Federal cash grants and reimbursements	14.9
Subsidy from other sectors of operations	0.4
Total	100
Total revenue	4,861.9
Number of transit systems reporting	315
Total number of transit systems	324

subsidy shortfalls, fares are arbitrarily increased and service levels reduced so that available revenues cover the operating expenses after all remaining operating subsidies are committed. Although such decisions can provide temporary solutions to financially troubled transit companies, more rational short-range policies that fit into a long-term approach to transit financial planning should be adopted if transit companies are to remain solvent and maintain the political support they require.

Aside from determining how high the fares should be with respect to the subsidy level (i.e., what percentage of total operating revenues should come from the farebox), the principal problem with transit planning today is that fare and service level decisions are seldom jointly planned and considered despite the intrinsic relationship between fares and service levels. If a greater proportion of operating revenues must come out of the farebox with minimum losses of ridership, these fare levels will have to be determined in conjunction with the quantity, quality, and cost of the service provided.

How High Can Fares Be Raised?

Most major transit systems--including New York, Chicago, Boston, Los Angeles, St. Louis, and many more--have recently increased their basic fares substantially. Base fares on some transit systems are $1.00 or more for a one-way trip. Although fare increases will always result in fewer riders, the percent decrease in patronage is usually much less than the percent increase in the fares charged. In economists' terms, this means that the demand for transit service is inelastic with respect to price (i.e., that the numerical value of the price elasticity is less than -1.0). Experience has indicated that an overall price elasticity for transit services is probably about -0.35, meaning that for every 1 percent increase in fares, there will be a 0.35 percent decrease in ridership (2). This suggests that even though fewer people will use transit after the fare increase, the transit agency will be better off financially after the fare increase because net revenues will have increased.

If this were true in all circumstances, transit agencies could increase fares higher and higher and continue to raise greater revenues despite declining ridership. However, it is suspected that fare elasticities are not constant over all fare levels and that at some higher level of fare, further fare increases are met with much greater declines in patronage to the point where the percent decline in patronage will equal the percent increase in fares (i.e., the elasticity will equal -1.0 and no net revenue increase will result). At this point, further fare increases will result in losses of both ridership and farebox revenues.

Previous analyses of fare changes (3,4) have not revealed a clear link between fare elasticity and fare level. This is partly because previous estimates of elasticities were usually based on relatively small fare changes, both in percentage and absolute terms. Findings of several analysts of demand, nevertheless, suggest that the demand for transit is nonlinear with respect to fares. At what point will further increases in fares cause so many riders to abandon transit that the net result will be a decrease in revenues?

Following the formulation of their model of transit demand based on the Transit Authority of Northern Kentucky (TANK) base fare increase from $0.25 to $0.40, Knudson and Kemp (5) computed the fare level that would have maximized gross revenues in 1976, provided all the other variables remain constant. The model predicted a fare on the order of $1.30 to $1.35 compared to the $0.40 fare riders were paying. In 1982 dollars, the fare would probably have to be about $1.50 to maximize revenues.

For other transit agencies the exact figure will depend on the specific system in question and the nature of its trips and riders. For example, it appears that the demand for transit service in small cities is often more elastic than in large urban areas. This means that persons in large urban areas will tolerate a much higher fare before switching to another mode of travel than will persons in small towns.

Previous work on elasticities (6) indicates that, in addition to this overall or average effective limit to fare levels, different subgroups of riders will respond differently to particular fare increases. It was found that

1. Off-peak riders are more sensitive to fare increases than peak-period riders,
2. Shoppers are more sensitive to fare increases than commuters,
3. Riders who have a choice in their mode of travel are more sensitive to fare increases than those who do not, and
4. Short-distance riders are more sensitive to fare increases than long-distance riders.

The behavior of other categories of passengers is more difficult to predict. On the one hand, low income and elderly persons would be expected to be more sensitive than others to fare increases; on the other hand, they are much more often captive riders--they have no other mode available--so their travel behavior might not change significantly.

Therefore, it is possible to predict with great detail how much revenue can be generated by specific fare increases for specific transit systems. It is also possible to show how much ridership will decline as a result of the fare increase and which particular groups of riders will be most affected. To make the predictions it is necessary to know current and future proposed fare levels, the proportions of riders by category of rider for each transit system, and locally observed fare elasticities (alternatively, these can be estimated). It is important to remember, however, that commonly observed fare elasticities from the past may not always be appropriate for the fare levels now being observed across the United States.

How Frequently Should Fares Be Raised?

Another issue facing many transit managers concerns the size and frequency of fare changes. During the 1970s, many transit agencies did not raise fares for 5 or 6 years; and most agencies reduced their fares. Today, however, inflation is escalating costs and the growth in deficits is not being offset by the subsidies provided. Because the fare level is being reviewed more frequently as a means of filling this gap, answers are being sought to the following questions: Is there any evidence that would favor semiannual, annual, or biannual fare reviews? Do riders respond differently to frequent small fare increases than to infrequent large fare increases?

Many analysts again argue that the greater the fare increase, the greater the rate of decline in transit riding. They argue that because the value of transit should increase over time with inflation, small fare increases that keep up with the cost of living should result in no significant change in the fare elasticity over time. Other analysts contend that even the large but infrequent fare changes should not affect the elasticity over time and thus should not affect ridership and revenue response.

Frequent fare changes, however, should be avoided because most evidence on fare elasticities suggests that it takes 6 to 9 months for the fare increase to affect patronage. In general, transit riders will not change their travel habits in the short term. Although many factors will affect the decision on when to implement a fare change, this short review suggests that time is not a major factor.

State and Local Revenues

Many state and local sources of revenue for public transportation are the same, and some of these sources are also available to transit authorities that are organized as independent political subdivisions with their own taxing powers. Which agency or level of government is legally empowered to use these sources depends primarily on the state constitution and legislation.

A useful classification of sources (7) has been established as

1. Benefit-related taxes and charges,
2. Broad-based taxes, and
3. Other sources.

The following sources are in the first group: (a) real estate value increments, (b) motor fuel and vehicle user charges, (c) parking, (d) tolls, and (e) employer payroll taxes. In the second group are (a) property taxes, (b) sales taxes, (c) general income taxes, and (d) employee payroll taxes. An example of the third group--other sources of taxes--are excise taxes; those on public utilities produce two-thirds of all excise tax revenues (other major excise taxes are those on alcohol and tobacco).

By ranking all these sources by yield potential, administrative problems, economic effects, equity, relation to benefits, and political acceptability, L.C. Fitch et al. (7) ranked the broad-based taxes as generally superior revenue sources to the benefit-related taxes and other sources like excise taxes. The following paragraphs describe these sources.

Broad-Based Taxes

Property taxes have been a common way of financing local public programs for many years. An advantage of levying property taxes is that they are easy to understand, familiar, and easy to collect. On the other hand, property taxes are currently unpopular because of the rising burden they place on property owners and the growing demands placed by all other governmental programs on the revenue that such taxes generate.

Sales taxes generate revenue by taxing goods or services that are sold within a political subdivision. The most common sales tax levied for transit is a tax (local or state) on the sale of gasoline or other transportation related items.

Another means of providing funds for transit is an income tax. This is not a common source of funds for local programs because the ability to impose such a tax is often restricted by state or local laws. One advantage of an income tax is that theoretically the burden falls most heavily on those that can most afford to pay. Unfortunately, an additional tax on income would probably be politically and legally difficult to implement in small urban and rural areas.

Another category is taxes on payrolls of employees for work performed within the political subdivision of the transit operation. This type of tax has the advantage of placing some of the burden for the subsidy of local transit on local employers. It may, however, be politically difficult to impose such a tax.

Consumption of a utility in a political subdivision can be taxed to raise funds for transit operation. Utilities have the advantage of having a built-in collection system (utility bills) but the disadvantage of the potitically unfavorable aspect of increasing, yet again, already high and increasing utility bills.

Other types of taxes can be levied to help subsidize a transit system. These include such taxes as the so-called wheel tax which is levied for every automobile in the area. The disadvantage of these separate taxes is that because they are often levied independently, they are more visible and therefore more unpopular.

Which Source?

A major task is to determine which state and local sources of revenue currently used in specific areas are applicable for financing public transportation needs. Many states provide financial assistance to public transportation through the general funds of the state. A recent survey (8) notes, however, that transit systems that have a source of dedicated revenues are often stronger financially than those systems relying on general revenues from state or local governments. The most common forms of state and local financing for transit operations are property and sales taxes; each of these sources was used by 34 percent of the respondents to the American Public Transit Association (APTA) survey. There is a greater use of sales taxes in larger cities (more than 200,000 persons) and a greater use of property taxes in smaller cities.

Examples of state revenue sources that have been dedicated to support public transportation are given below.

Source	State
Benefit-related taxes and charges	
Motor fuel	Michigan
Vehicle registration	Washington, Wisconsin, Michigan
Broad-based taxes	
Sales taxes	Florida, California
Other sources	
Cigarette taxes	Massachusetts
Lottery	Pennsylvania, Arizona

Examples of revenue sources used to support public transportation at the local level are as follows.

Source	State
Benefit-related taxes and charges	
Motor fuel	Wisconsin, Michigan, California, Hawaii, Illinois, Florida
Parking	California, Illinois
Tolls	New York, Pennsylvania, California
Employee payroll taxes	New Jersey, California
Broad-based taxes	
Property taxes	Arizona, California, Colorado, Illinois, Indiana, Iowa, Kansas, Massachusetts, Michigan, Nebraska

Source	State
Sales taxes	Indiana, Florida, California, Georgia, Missouri, Michigan, Illinois, Ohio, Colorado, Kansas, Texas
General income taxes	Maryland, Pennsylvania, Ohio, Kentucky, Michigan, Alabama, New York, New Jersey
Employee payroll taxes	Oregon, Pennsylvania, Ohio
Other sources	
Utility taxes	Washington, Louisiana

These localities obviously create a starting point for one investigation of additional funding sources. In addition to these sources, there are a variety of unique or special taxes. Examples of these taxes and the state or locality using this source are given below.

Source	State or Locality
Business license tax	Washington, Oregon
New income tax	Oregon
Bank and savings and loan tax	Lafayette (Indiana)
Profits from gas and electric companies	Springfield (Illinois)
Mortgage taxes	Albany, Syracuse
Oil company receipts tax	New York, Buffalo, Rochester

Apparently, funding sources are limited primarily by the imagination (and, after that, by the ability to get approval by the state legislature).

The Issue of Equity

All the issues mentioned previously in the evaluation of various funding sources--and in particular, potential yield and political acceptability--must be considered carefully in fashioning a new program for financing public transportation systems. Still, the issue of equity deserves careful attention because it has generated (and will again generate) considerable controversy.

In a study of alternative sources of transit subsidies in the Chicago area, Rock (9) found that property taxes, income taxes, and vehicle excise taxes would have the least effect on poor households; particularly burdensome taxes for the poor would be a household tax, cigarette tax, lottery, or vehicle registration fees. Rock suggests that "virtually any funding source will be better for the poor than increased fares." Webber (10) contends that local sales and property taxes used to finance the Bay Area Rapid Transit (BART) system in San Francisco strongly favored the rich over the poor.

Cervero (11) holds that governmental subsidies based on income taxes (e.g., federal aid for operating expenses) redistribute income from the rich to the poor, that fares generally transfer income from the transit dependent to those with higher incomes, and that those traveling shorter distances (generally the poor) provide a substantial subsidy to those traveling longer distances (generally those with higher incomes).

Because of the political implications, the issue of equity cannot be ignored. A basic precept of funding schemes is that they should not in general take money from the poor to provide money for trips for the rich. It may be preferable, however, to recommend a less equitable source--for example, sales taxes or property taxes--when more equitable sources (such as an income tax) have less political or administrative acceptability.

Bonds Issued by Transit Operators

Some transit operators may be independent political authorities with the ability to issue bonds. In general, there are two types of bonds (12): revenue bonds and general obligation bonds. Revenue bonds are issued when the transit system is revenue producing. The bonds are paid off with farebox revenue. The money collected in the farebox is placed in a sinking fund for repayment of the bonds. The interest rate on revenue bonds is generally higher than that on general obligation bonds because the bond holder is taking more risk. (In these days of rapidly increasing costs, it is a large risk to assume that farebox revenue will be high enough to repay bonds as well as keep the system afloat.)

General obligation bonds are backed with the full faith and credit of taxing power of the issuer. In other words, if a transit operator issues a general obligation bond, the bond holders will have, as their assurance that it will be repaid, the ability of transit authorities to raise money from a variety of sources, including taxes. The advantage of a general obligation bond is that without the emphasis on farebox revenue for repayment, less pressure is placed on the farebox. The disadvantage of this type of bond is that, in many cases, voters must approve its issuance (and voter approval may be difficult to obtain).

Federal Grant Programs

A great variety of grant programs exists, but no one source is currently adequate for capital and operating costs as well. Many of the federal sources involve large amounts of red tape and coordination can be difficult. But by far the most serious problem with federal funding has been its extreme uncertainty: although operating assistance for public transportation will apparently continue, the total funding levels are likely to decline as shown by the trend in Table 2.

In addition to the U.S. Department of Transportation sources, there are a variety of other programs that can fund transportation services. Most of these are client-based programs whose funds are more applicable to paratransit and to small urban and rural operations than to major transit systems (13).

Other Sources of Funds

On occasion, the other sources of funds can play a significant role for certain types of systems. For example, in Virginia, four systems derived more than

Table 2. UMTA funding over time.

	Appropriation ($ millions)			
Category	FY 1977	FY 1980	FY 1982	FY 1983
Administrative expenses	NA	22.2	23.8	86.5
Research, development, and training	63.7	65.5	51.6	
Urban discretionary grants (Section 3)	1,255	2,190	1,449.5	1,606
Urban formula grants (Section 5)	623	1,445	1,265	1,200
Nonurbanized formula grants (Section 18)	0	72.5	68.5	68.5
Block grant (Section 9)	NA	NA	NA	NA
Total (all UMTA programs listed)	1,985	4,660	3,495	3,739.5

half of their 1980 revenues and one more system received 30 percent of its total revenue from school and charter services (1). For the most part, however, passenger fares, state and local sources, and federal sources will provide the bulk of the funding.

COST CONTAINMENT STRATEGIES

Much more work has been done on funding services than on cost containment strategies. There are at least two factors responsible for this situation. First, transit funding grew substantially in the 1970s so that cost containment was not a major issue. Second, it is difficult to obtain substantial cost reductions--equivalent to the possible losses in federal operating assistance--without drastic changes in service structure (and even these have limited cost-effectiveness).

There are two basic strategies or approaches to cost containment: efficiency measures and service reductions. Efficiency measures relate to finding ways to provide essentially the same services at reduced cost. The corollary of efficiency is productivity, which would focus on generating more trips at current expenditure levels; however, if the total budget is the most severe constraint, the system could become more productive and still have made no progress in solving its budgetary problems.

For example, if the marginal costs of additional trips equaled the average cost (which is generally not a valid assumption), a particular transit operation would lose money for each additional trip it provided, suggesting that the budget problem would be worsened by providing more trips. More trips should be provided only if the marginal revenues from these trips exceed the marginal costs. This is often possible if the system's ridership can be increased by getting additional passengers on vehicles that are now partly empty. Adding new routes, drivers, or vehicles, however, would not appear to be prudent unless special conditions prevailed. Service reductions are an attempt to save money by providing less service. Each of these strategies has its benefits and problems.

Efficiency Measures

At the outset, it is useful to categorize the cost-containment techniques associated with efficiency as follows: (a) reduce capital expenditures, (b) reduce overhead and administrative expenditures, (c) reduce direct costs, and (d) improve financing and cash flow. Which strategy is most useful depends on the specific characteristics of an individual transit system and the current expenditure pattern.

First the largest categories of expenditures are examined to determine the kinds of reduction that can be made. For example, data from an unpublished survey by the Virginia Department of Highways and Transportation (VDH&T) gives the following pattern for operating expenses in 1981.

Expenses	Percent
Administrative	20-30
Ridesharing	0-8
Maintenance	7-20
Fuel	15-20
All other operating expenses (e.g., wages)	35-50

Obviously there is a greater impact from saving half of all other operating expenses than saving half of maintenance expenses. Therefore an initial strategy might involve investigating labor costs, work rules, and the use of part-time drivers as ways to reduce the all other operating expenses category.

Much can be gained by examining the ways individual systems vary from the norm in their expenditure patterns. For example, again using the VDH&T December 1981 survey data and projected FY 1983 figures, the city of Staunton was found to have the highest proportion of operating expenditures in the all other operating expenses category (60.6 percent). In the Public Transportation in Virginia report (1) Staunton is shown to have a higher maximum hourly wage for vehicle operators than the other small transit systems. This probably explains, in part, the high proportion of other operating expenses and suggests that a possible cost containment strategy for the Staunton system could involve a decrease in wage rates. (There may, of course, be factors that would make such a strategy difficult.)

Similarly, the Pennisula Transportation District Commission (PTDC), Bristol, James City County, Colonial Beach, and Blacksburg all appear to have administrative costs that are well above the averages for other comparable Virginia systems. Are cost savings possible here? Similarly, Roanoke and Bluefield have substantially higher than average fuel costs. Can money be saved by different purchasing plans? An analysis of such cost data will help understand the systems and provide insights for detailed investigations at each transit agency.

How Far Can Services Be Cut?

The response of most transit managers to reductions in subsidy levels is to increase fares and reduce transit service. The effect of fare increases on ridership and revenues has been discussed. The effects of service reductions on ridership and costs, however, are unclear because most studies have focused on service expansions instead of service reductions. It is possible, nevertheless, to provide guidelines on the degree to which transit services can be cut before they become self-defeating; that is, to the point where ridership and revenue losses exceed the operating cost savings of further service cutbacks.

As shown in the Ecosometrics study of transit demand elasticities (6), passengers are more sensitive to service changes than they are to fare changes. For most users reliable and frequent service is important to the point where they would be willing to pay more to maintain or improve these services. The impact of changes in transit service on demand, however, is not as high as might be expected. All the studies of transit service have not been able to find a sufficient number of instances where the proportional change in passenger demand is greater than the proportional change in transit service (transit service elasticities are therefore said to be relatively inelastic or less than unity). Transit service elasticities, however, are often numerically larger than fare elasticities. The net effect is that reductions in transit service will have a greater impact on ridership and revenues than increases in transit fares.

There are situations, however, where transit service is quite inelastic and where service reductions will drastically reduce operating costs without seriously affecting overall passenger demand. For example, it is known that service elasticities (vehicle miles or headway elasticities) vary by time of day and that ridership is more sensitive to changes during the off-peak period than to changes during the peak period. In addition, service elasticities are numerically larger (implying a greater passenger response) for suburban services than for central city and central-business-district oriented services.

Perhaps a more important finding in this study of passenger demand is that as service levels are cut

Table 3. Evaluation process for alternative funding strategies.

Benefit	Problem	Resolution	Further Problem
Raise fares			
Significant increase in revenues	Ridership declines as fares increase	Predict results carefully	
Users bear a greater proportion of costs	Many users are low-income; fare increases create economic hardship for them	Create user-side subsidy programs	Small proportion of those qualified will sign-up for the program
		Differential fares (peak/off-peak and distance-based) help remove some inequities	Many experiencing hardships are not qualified for social programs
	Nonusers also get significant benefits from transit	Raise revenues from nonusers through taxes	
Increase local taxes to pay for operating deficits			
Significant increase in revenues	Most citizens believe taxes are too high already	Earmark tax revenues for transportation so people can see how taxes are used	People may not favor transportation if it increases taxes
Indicates support of entire community	Nonusers bear a greater proportion of costs		
	Some forms of taxation focus on only a portion of population	Use broad-based forms of taxation	
	May be statutory limitations to changes in taxation	Change the laws	

back, service elasticities increase (that is, ridership decreases). Elasticities for several transit systems (6) show that further reductions in service where headways are already long will result in massive ridership (and revenue) losses that may be greater than the savings in operating costs. Some transit agencies may already be reaching this point on some routes because of recent reductions in service to contain costs.

Therefore, if services are to be cut, they should be cut selectively, keeping in mind the true marginal cost for the service, the costs of providing alternative service (such as the successful peak-period vanpool program in Norfolk, Virginia), and the demand elasticities of the transit riding population. The extent to which transit service can be cut is limited.

Evaluating Alternative Financing Strategies

The process of deciding how to choose a best strategy or best combination of strategies needs to be as complete as possible to avoid problems or surprises. There are two particular problems that should be avoided:

1. A shortfall of expected revenue from the funding sources chosen, and
2. The inability of the chosen funding source(s) to obtain the necessary political approvals.

To avoid the first problem, detailed estimates of the amount of revenue expected from each source should be developed. Optimistic, pessimistic, and probable estimates should be developed in order to have a range of anticipated revenues for each source.

To avoid surprises in the political arena, positive and negative consequences should be identified for various groups of people. Then an action plan should be developed that identifies the persons in authority and committees whose approval is necessary to obtain the legislative or regulatory approval for this financing source.

Interviews with key individuals or reports of their positions on key issues can identify the issue with the individual. It is then possible to evaluate the extent to which a particular funding strategy resolves, exacerbates, or has no effect on these key issues. Finally, a high, medium, or low probability of obtaining the approval of this individual for this funding strategy can be developed. The same kind of approach can be used when issues are to be placed on a ballot to be voted on by the general public.

The process of identifying positive and negative consequences of various strategies deserves some elaboration. A full list of consequences should be developed. Table 3 gives the beginnings of this process for several key issues. As the data in the table show, each strategy will have benefits and problems; each should be identified so that its importance can be assessed.

For example, raising fares produces substantial new revenues but hurts some of the people most dependent on transit, the poor. One way to soften the blow somewhat is to subsidize those users who are particularly needy through a user-side subsidy program. Among the problems with this approach are the administrative hassles and the fact that some eligible individuals are too proud to participate in what appears to be a welfare program. It has been argued, however, that this approach is more equitable than the alternative, which is to subsidize fares to the extent that the base fare is affordable for the poor.

This approach demonstrates that some of the indirect consequences of a particular strategy may be as important as the direct revenue and ridership implications. It shows the need for considering who is affected by a particular strategy and, in certain instances, indicates the desirability of devising second-order strategies to deal with the side effects of programs to increase income.

AN OVERALL APPROACH TO FINANCIAL VIABILITY

It is probable that a mixture of strategies will be required to generate enough money to continue the operations of public transportation systems in the face of substantial reductions in federal funding.

The most effective strategies probably will require a great deal of flexibility at both state and local levels and achieving this flexibility will probably require political skill and compromise. Without precluding the variety of possibilities that are available, the components of an optimal financial structure would probably include

1. An increase in the amount of state funds provided to localities for public transportation with no restrictions on the proportions to be spent for capital, operating, or administrative purposes.
2. A distribution of state funds to localities based on a local match of the funds as well as on incentives for the performance of the local transit system. (For example, it was recommended at the American Public Transit Association conference, Transit at the Crossroads, in Denver, January 7-8, 1982, that cost recovery ratios of 40 to 50 percent from fares were reasonable. It was also recommended that the general public should consider the other one-half as a benefit to the community as a whole and expect to pay for it through federal, state, and local taxation.)
3. State programs of assistance for new or experimental programs.
4. An increase in transit system revenues from passenger fares. The impact of the increase on disadvantaged subgroups should be partially offset by imposing distance-based fares, peak off-peak fare differentials, and user-side subsidies to qualified individuals.
5. An increase in local tax revenues; specific sources would be determined locally from a variety of potential taxes.
6. An aggressive cost-cutting program for transit authorities, which could go as far as substituting ridesharing or paratransit programs for conventional mass transit operations in some of the smaller and less densely populated communities and rural areas.

This is probably the strongest program that can be devised. It assumes both that there will be a reduction in the proportion of federal funding for operating and capital assistance and that state and local authorities will have a strong commitment to public transportation and the flexibility to allow programs to be tailored to local conditions at the state and local levels.

Political conditions at local, state, or national levels may force compromises to this program. The program that actually results will probably be less than ideal. But these kinds of suggestions for strengthening public transportation systems form the basis of financial viability.

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Factors Influencing Transit Use in European and U.S. Cities

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Insights into the underlying factors influencing urban transit travel in the United States and Europe are provided. Transit use in European and American cities was analyzed through regression analysis and by comparing conditions in three cities of similar size. Regression equations were developed using transit usage intensity, transit supply, metropolitan area density, and car ownership. These equations revealed significant differences between U.S. and European cities. Such differences were related to dissimilar economic, social, and cultural factors in the two continents. The influences of these factors on transit usage are discussed, and a conceptual model is presented showing how they affect choice of transit mode.

The purpose of this paper is to provide some insights into the underlying factors that influence the use of transit in European and U.S. cities.

The approach consists of (a) a statistical analysis of the variables that explain transit use: quantity of transit available, car ownership, and population density in the service area; and (b) an examination of socioeconomic, environmental, and cultural factors that affect the use of transit in European and U.S. cities.

STATISTICAL ANALYSIS

Separate regression analyses were performed for bus systems in the cities identified in Tables 1 and 2 (data availability was a major reason for selecting these cities) relating transit ridership and the three variables mentioned previously.

The results of the regression analysis tabulated in Table 3 point to several interesting observations:

1. The coefficients and the constant in the regression equations are generally higher in the equations for European cities. In addition, the constant, which is generally positive for European cities and negative for U.S. cities, reflects the differences in attitudes towards the use of transit in the two continents. These coefficients also express the much higher ridership obtained in Europe for the same values of the explanatory variables.
2. Contrary to U.S. experience, in European cities there is no significant correlation between car ownership and level of transit ridership.
3. The transit supply variable explains most of the variance in ridership for bus systems for both continents. In European cities, however, there is an even higher sensitivity to supply of transit service than in U.S. cities.

Differences in the results of the regression analysis are not negligible. European and U.S. choices of certain travel modes are affected by a number of factors that influence attitudes and behavior.

SOCIAL, ENVIRONMENTAL, AND CULTURAL FACTORS

Attitudes Toward Car Ownership

A comparison of European and American regard for the automobile points out some differences. In Europe the automobile is often a zealously guarded possession, it receives great attention and care, and it is more intensively used for recreation and for personal pleasure. Its use for commuting tends to be lower to avoid (a) driving in congested conditions, (b) decreasing the car's life, and (c) increasing maintenance costs. It is often a major investment and is highly taxed, mainly through gasoline taxes.

Americans regard the car as a more essential possession. It is viewed as a means to achieve personal independence and mobility, it allows avoiding crowds and contacts with socially marginal (or so considered) elements, and it often provides the privacy and comfort of the living room. In addition, especially when traveling at off-peak hours, it provides greater security than mass transit, and it is relatively inexpensive to operate.

Use of the Car

In major European cities, contrary to most cities in the United States, use of the car in downtown areas

Table 1. Transit travel variables for U.S. cities (1).

City	Transit Supply (annual veh-km/ capita)	Metropolitan Area Density (persons/ km^2)	Car Ownership (persons/ car)	Annual Transit Trips/ Capita
Albany, N.Y.	13.8	1,249	2.75	29.8
Atlanta, Ga.	28.7	1,041	2.30	53.9
Baltimore, Md.	23.8	1,970	3.22	75.4
Baton Rouge, La.	7.2	1,581	2.24	9.6
Chicago, Ill.	35.3	2,030	3.18	65.2
Cincinnati, Ohio	18.0	1,280	2.61	27.7
Dallas, Texas	24.7	1,227	2.10	39.1
Detroit, Mich.	37.4	4,232	2.53	64.5
Harrisburgh, Pa.	13.7	1,187	2.48	20.3
Los Angeles, Calif.	13.5	2,095	2.15	28.1
Miami, Fla.	17.4	1,821	2.45	40.2
Minn.-St. Paul, Minn.	16.0	912	2.48	34.3
Portland, Oreg.	22.9	1,194	2.20	29.6
San Diego, Calif.	10.9	1,238	2.27	4.2
Washington, D.C.	28.3	1,937	2.60	44.0

Table 2. Transit travel variables for European cities (1).

City	Transit Supply (annual veh-km/ capita)	Metropolitan Area Density (persons/ km^2)	Car Ownership (persons/ car)	Annual Transit Trips/ Capita
Amiens, France	9.3	1,966	3.90	50.0
Brest, France	10.4	3,500	9.27	60.9
Dijon, France	16.3	1,614	3.35	82.6
Copenhagen, Denmark	41.3	7,291	3.12	199.5
Leeds, U.K.	55.8	3,046	6.59	265.9
Liege, Belgium	28.2	1,529	5.26	92.0
Lille, France	14.2	2,316	4.43	63.9
London, U.K.	26.7	4,645	2.79	199.5
Mulhouse, France	15.6	1,026	4.06	70.4
Nancy, France	15.7	1,284	3.74	88.8
Newcastle, U.K.	71.1	2,241	5.85	228.0
Plymouth, U.K.	41.7	3,059	5.04	143.8
Portsmouth, U.K.	37.7	5,463	5.38	175.7
Rouen, France	11.6	1,548	3.78	48.9
Valenciennes, France	11.1	903	5.74	51.8

Table 3. Results of regression equations (dependent variable: annual transit trips per capita) (2, 5, 6).

Cities	Constant	Transit Supply (veh-km/capita)	Density (persons/km^2)	Car Ownership (persons/car)	R^2	SE	%SE[a]
1. European	25	3.5	–	–	0.81	33	27
2. United States	-0.3	1.8	–	–	0.69	11	29
3. European	50	–	0.02	–	0.31	65	54
4. United States	17	–	0.01	–	0.26	18	47
5. European	47	–	–	16	0.06	69	57
6. United States	-58	–	–	38	0.43	15	40
7. European	5.3	3.10	0.012	–	0.88	27	22
8. United States	-1.5	1.73	0.002	–	0.69	12	32
9. European	76	3.97	–	-13	0.84	32	26
10. United States	-51	1.50	–	23	0.82	9	24
11. European	24	3.28	0.01	-4	0.88	26	21
12. United States	-52	1.40	0.002	23	0.83	9	24

Note: Columns Transit Supply, Density, and Car Ownership are Variables under Coefficients of the Regression Equations; R^2, SE, %SE are Regression Parameters.

[a]%SE = SE as a percent of the mean value of the dependent variable.

is discouraged by public authorities by providing zones that restrict automobiles, the placement and pricing of parking facilities, and strong governmental support for transit service.

Quality and Quantity of Transit Service

Transit service in European cities is generally cleaner, safer, and more attractive than that found in the United States. It is better coordinated and better integrated with the activity system; and it is viewed as a vital resource by all elements of society. In the United States transit tends to attract mainly large segments of the so called underprivileged.

Land Use and Transportation Policy

The tendency in most European cities to coordinate land use development with transportation policy has resulted in higher densities along transit service areas. This results in higher use of transit. In the United States less emphasis is placed on this approach to urban development partly because developers and the public view the automobile (not transit) as the major resource for maintaining urban mobility and providing access to the economic activity system.

Economic Factors

The economic growth of the 1960s and early 1970s increased both personal income and the price of petroleum. The impacts of these changes were different from country to country. They were much greater in countries (a) more dependent on a foreign oil supply, (b) with serious problems of balance of payments, and (c) with lower GNPs. They were less dramatic in developed economies and in oil producing countries. Also, the changes in relative prices in different countries were quite different (see Table 4). The possible impact on life-styles, the decisions regarding travel and the means of traveling were also quite different.

A COMPARISON OF THREE CITIES

The influence of economic factors on transit ridership is analyzed using three cities of similar size: Baltimore, U.S.A.; Munich, West Germany; and Lisbon, Portugal. These cities were chosen because they are significantly different in terms of the socioeconomic and cultural indicators discussed earlier but are somewhat similar with respect to population size and the supply of transit service.

For each city, Table 5 gives selected descriptors of transit supply and transit use, area and economic characteristics, and measures of automobile and transit travel costs.

Baltimore Versus Munich

For similar levels of transit supply (Table 5, lines 4 and 5) transit use is much higher in Munich (Table 5, line 6). The results of the regression analysis showed that transit supply is the most important

Table 4. Selected economic indicators for various countries (current dollars) (2, 5, 6).

Economic Indicator	Year	France	Italy	Portugal	West Germany	U.S.A.
GNP per capita	1970	3,715	1,959	653	4,778	4,809
	1975	6,032	2,921	1,690	7,216	7,197
	1978	7,933	3,776	1,856	9,727	9,668
Premium gas (retail price per gallon)	1970	0.90	0.74	0.99	0.91	0.31
	1975	1.69	1.71	2.07	1.34	0.65
	1978	2.38	2.25	2.15	1.76	0.71
Gallons per GNP per capita	1970	4,600	2,600	660	5,300	15,500
	1975	3,500	1,700	820	5,400	11,100
	1978	3,300	1,700	860	5,500	13,600

Table 5. Selected travel indicators for Baltimore, Munich, and Lisbon, 1978 (2, 4, 5, 6).

Indicator	Baltimore	Munich	Lisbon
Metropolitan area population (000s)	1,601	1,800	1,315
Metropolitan area density (persons/km^2)	2,000	4,200	4,000[a]
Persons/automobile	1.90	3.46	4.24[a]
Annual transit veh-km			
Surface (10^6)	44.4	42.6	47.0
Subway (10^6)	–	10.5	6.9
Transit network density (km/km^2)	1.6	1.7	2.0
Transit trips/day (000s)	217	607	903
GNP/capita (dollars)	9,644	10,443	1,856
Price of premium gasoline (dollars/gallon)	0.71	1.76	2.15
Average transit fare (dollars)	0.40[a]	0.53[a]	0.09[a]

[a]Authors' estimate.

variable in explaining transit ridership in both European and U.S. cities (Table 3, lines 1 and 2). Although car ownership was found to be a significant explanatory variable in U.S. cities, it has no correlation with transit ridership in European cities (Table 3, lines 5 and 6). Also the effect of aggregate population density on transit use is only marginal in both continents (Table 3, lines 3 and 4). Thus, the large difference in transit ridership between Munich and Baltimore cannot be attributed to differences in car ownership and population densities between the two cities.

Although the price of gasoline in Munich is about 2.5 times that of Baltimore, and Munich's transit fare is also approximately 25 percent higher (Table 5, lines 8 and 9), these differences in price are not likely to explain differences in transit ridership because (a) the level of personal wealth (measured in GNP per capita) is similar for both cities (Table 5, line 7), (b) the effect of higher gasoline prices in Munich is partially neutralized by the higher fuel efficiency of European cars, and (c) the higher transit fare in Munich is generally associated with a superior level of transit service.

These observations lead to the conclusion that in Munich social and cultural factors that are different from those prevailing in Baltimore tend to create an environment much more conducive to transit use by the general population. Munich's higher quality of transit service and strong commitment to transit development and maintenance at all levels of government could be cited to support this conclusion.

Munich Versus Lisbon

Transit ridership in Lisbon is approximately 50 percent higher than that of Munich. Both cities, however, have similar levels of transit supply. Environmental, social, and cultural factors are also similar and perhaps even more favorable to transit in Munich than in Lisbon (7). Also, the densities of the two cities are quite similar, although the physical structure of Lisbon (located in the inner bank of a river bend) is more favorable to transit operations. Economic indicators, however, are significantly different and are among the underlying causes of the higher transit ridership in Lisbon.

The GNP per capita for Lisbon is about one-sixth of that for Munich; and gasoline prices are 22 percent higher for Lisbon than for Munich (Table 5, lines 7 and 8). Therefore, the effective gasoline purchasing power in Lisbon is approximately one-

Figure 1. Trend of transit ridership and gasoline purchasing power: Lisbon, Portugal.

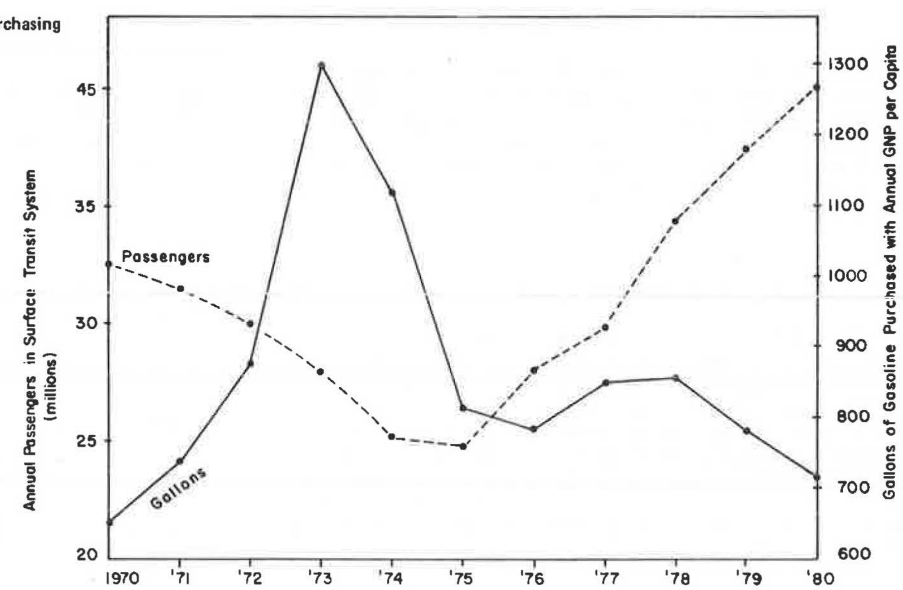
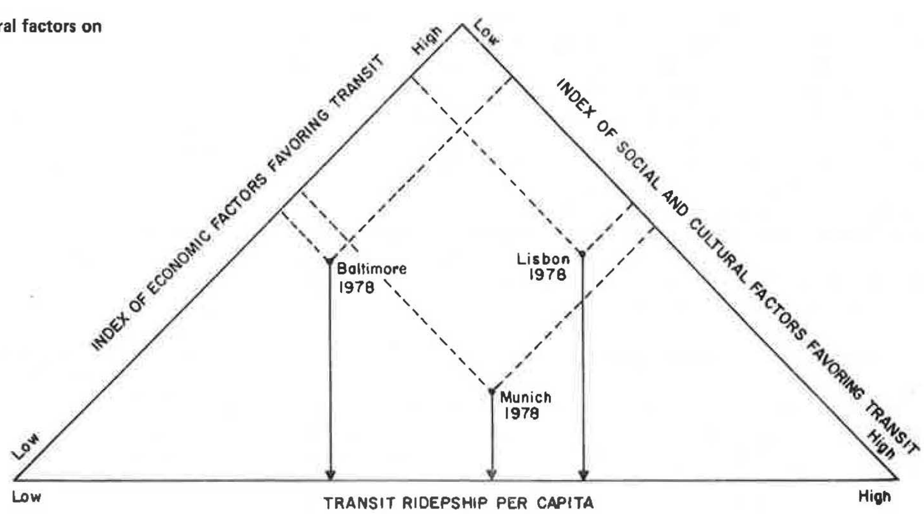


Figure 2. Influence of economic, social, and cultural factors on transit ridership.



seventh of that for Munich (in Lisbon 863 gal of gasoline can be purchased for each GNP per capita: $1,856 ÷ $2.15/gal; the comparable figure for Munich is 5,527 gal: $9,727 ÷ $1.76/gal). This factor together with the equivalency in transit fares in the two cities tends to explain the higher transit use in Lisbon. (Lisbon: GNP per capita ÷ transit fare = $1,856 ÷ $0.09 = 20,622 transit trips; Munich: GNP per capita ÷ transit fare = $9,727 ÷ $0.53 = 18,353 transit trips.)

This conclusion tends to contradict the findings of the regression analysis with regard to the independence of transit use and levels of car ownership in European cities. In the case of Lisbon, however, (where effective automobile travel costs are much higher than other European cities included in the regression analysis) the prevailing cost of automobile travel acts as a policy constraint to automobile use and induces correspondingly higher use of transit. An illustration of how transit ridership has responded to gasoline purchasing power in Lisbon is shown in Figure 1.

CONCLUSIONS

In the last two decades transit ridership has experienced changes caused by the economic, social, political, and cultural evolution that has taken place world wide during this period. These changes have been substantially different in the United States and Europe.

The regression analysis showed that for both U.S. and European cities transit supply is the variable that correlates most closely with transit ridership (R^2 of 0.69 and 0.81, respectively). In addition, and most important, for the same level of transit supply, transit ridership in European cities is expected to be twice as large as in U.S. cities.

The regression analysis also showed that car ownership has no significant influence on transit ridership in Europe but that it is a valid explanatory variable in the United States. On the other hand, urban density was shown to have more influence on transit ridership in Europe. Other factors--economic, social, and cultural--play an important role in explaining these differences. This role was analyzed by comparing transit ridership levels in three cities of similar size. The results of this comparison were consistent with the results of the regression analysis.

The relative influences of socioeconomic and environmental factors on transit ridership should, however, be investigated further. A conceptual model is presented in Figure 2. The key problem in the actual development of this model is, of course, calibration of the variables and determination of the respective scales for universal application.

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Public Transit's Survival and Prosperity in the 1980s: Effective Marketing Management Can Lead the Way

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Fiscal pressures caused by rising operating costs, limited farebox revenues, and reductions in government operating subsidies are forcing public transit agencies to seek changes in the way they do business. Survival and future growth will depend on selection of a management approach that will help public transit adapt to changes in environmental conditions. Effective marketing management has proven in the business world to be a trademark of many longstanding successful companies. A study of how the tools and practices of modern marketing management can be harnessed by the public transit industry to help weather the current fiscal crisis and prosper in the late 1980s and beyond is presented. First, the need for a change in transit management philosophy—from the traditional operations view to that of marketing—is established. Then, a structured analysis of the marketing management process interwoven with public transit applications is described.

Presented in this paper is an analysis of how modern marketing management, a strategic approach to management used by many successful corporations, can be applied realistically in the U.S. urban public transit industry. The literature of the 1970s and early 1980s is reviewed to (a) identify major gaps between what is being done and what ought to be done in managing public transit agencies and (b) highlight some potential opportunities for transit in the remainder of the 1980s and beyond. The intended audience for this paper is transportation and business professionals with some background in marketing management principles who have a desire to further the interests of public transit.

The approach taken in this paper on the subject of transit marketing differs from most. It emphasizes the view of the business community and uses language common to businessmen and marketing professionals. This is in contrast to an approach where traditional transit management methods and terminology are used to describe marketing management processes adapted to public transit. The approach used reflects the current trend toward more businesslike operation of public transit and an increase in the number of business professionals entering the transit industry.

The paper begins with a description of recent trends and problems facing public transit operators, focusing on the need for a greater orientation toward marketing management. The analysis section defines and discusses marketing management in the context of a public transit operation. The analysis framework is somewhat similar to that used by Kotler in his widely studied marketing management textbook (1). Following the analysis conclusions and recommendations are presented.

THE STATE OF PUBLIC TRANSIT IN THE UNITED STATES

The following is an excerpt from a recent U.S. Department of Transportation study (2):

> The decade of the 70's was, for the transit industry, a period of expansion. As the demand for transit rose, in part due to the rising costs and intermittent shortages of gasoline, coverage was extended to more outlying areas of urban regions and service hours were increased. Ridership and revenues increased, but not as fast as operating costs. Deficits were covered by both the Federal government, who initiated the Section 5 operating assistance program, and by local and state sources, who appeared willing to increase their support to transit. In general, there was not a strong incentive for most operators to vigorously seek ways to improve productivity and keep costs to a minimum.
>
> Now, a new conservatism, spearheaded by the new administration, has led to changes in transit operating philosophies and the need to review and revamp the service provided. Financially hard-pressed local areas can no longer support rapidly rising operating costs and must accept cutbacks in service and fare increases. The phaseout in Federal operating assistance over the next few years will also hurt, particularly small and medium size properties. . . .
>
> Transit operators have never had the appropriate tools to be able to plan and operate service at a high level of efficiency. Further, they have rarely had even the information required to make good decisions consistently. In the present planning and operating environment, the ability to forecast the results of possible service and operations changes may be essential to the survivability of many operators in the coming lean years. As an example, most operators cannot estimate the net revenue impact of an operating change, or even in some cases whether the impact might be positive or negative.

The preceding excerpt highlights two major issues: (a) transit agencies must learn to operate more like businesses with less reliance on public subsidies; and (b) agencies are, by and large, ill equipped to adapt to the changing environment. Many transit agencies are responding to this situation by seeking ways to maintain or reduce their expenses by improving operations efficiency or by eliminating unproductive services. Passenger ridership is viewed by these agencies as being affected, probably negatively, by these cost-cutting measures; but it is hoped that the result will be increased net revenues. This traditional focus on the operations or supply side of the problem, even though it may reduce operating budgets in the short term, may prove to be the demise of many public transit systems over the longer term as riders leave or are forced off the system.

The lack of a consumer, or marketing, orientation is the heart of the problem. The basic premise of modern marketing management theory is that successful firms strive to maximize satisfaction of consumer needs in a way that is consistent with the objectives of the organization. Whereas the priorities of many transit agencies lie with supply (operations and cost) management, marketing management centers on demand (ridership and revenue) management. A key value of marketing management is that it provides a strategic framework for cost-effectively adapting products and services to changing consumer needs and environmental conditions.

A change in emphasis from an operations to a marketing management orientation was begun by the transit industry in the 1970s. This change was initiated principally by support from the federal government. The Urban Mass Transportation Administration (UMTA) has sponsored several demonstrations, including major projects in Nashville, Tennessee, and Baltimore, Maryland, (3), of strategic marketing techniques as a way to meet public transit needs more effectively. This movement has, however, progressed slowly.

A recent survey (4) of small- to medium-size transit operators (75 to 473 buses) indicated that generally only 2 to 4 percent of sales (farebox revenues) was spent on marketing activities. This compares with 10 to 20 percent of sales for manufacturing firms. This lack of emphasis on marketing will have to change if transit agencies hope to prevent a severe downward spiral of service cuts and reduced patronage. The time is ripe for the transit industry to renew its efforts to adopt the tools and practices of modern marketing management.

Significant barriers that remain to wide adoption of the marketing approach to management by the transit industry include (a) lack of concrete evidence (in monetary terms) of the benefits of instituting such an approach, (b) misconceptions about what marketing management is, and (c) the belief that management tools developed for private industry cannot be used by public sector agencies. The analysis that follows sheds light on the latter two problems and leaves the first, and most elusive, problem to future study.

ANALYSIS OF MARKETING MANAGEMENT FOR PUBLIC TRANSIT

Transit Marketing Management Defined

Marketing management is a concept unfamiliar to many. The term marketing is often confused with advertising and selling instead of its broader purview. The modern concept of marketing entails activities directed at satisfying human needs and wants through an exchange process. For public transit agencies, this concept would correspond roughly to "the satisfaction of public needs for mobility through an exchange of fares and subsidies for transit services." This definition, although useful for academic purposes, is much too broad to be operational. This gives rise to the concept of marketing management.

Marketing management is marketing conducted within the framework of an organization that considers specific goals and objectives and the means for obtaining desired responses from outside parties to achieve those objectives. In the context of a public transit organization, marketing management consists of all activities related to creating, building, and maintaining mutually beneficial exchanges and relationships within target markets (i.e., groups of travelers within a transit agency's designated service area) to achieve national and local transportation, socioeconomic, and environmental goals as well as specific transit agency organizational objectives. The activities of transit marketing management include analysis of traveler needs, perceptions, and preferences and the planning, implementation, and control of programs (i.e., services, fares, and promotions) tailored to the needs of specific target markets.

Marketing Management Tasks

In simple terms marketing management is demand management. There are many possible states or conditions of consumer demand for a product or service such as public transit. These states change dynamically within a given transit system. Transit marketing managers must define for each demand state a strategy that will maximize achievement of agency objectives. In particular, Kotler (1) has defined eight demand states and corresponding marketing management tasks or strategies. Five of these demand states and tasks seem particularly germane to public transit as described in the following paragraphs.

Negative demand and conversional marketing.--In many cities a large portion of the population has a poor image of transit as a means of transportation; efforts are needed to reverse these negative attitudes.

Faltering demand and remarketing.--Ridership gains achieved in the late 1970s by many transit agencies are beginning to slip away due to both lowered gasoline prices (cheaper automobile travel) and to general service degradation. Actions can be taken to revitalize demand through promotional efforts and careful redesign of services to more closely match the needs of particular markets.

Irregular demand and synchromarketing.--Matching services to the double-peaking pattern that characterizes demand for daily transit is costly. Because of the projected fiscal squeeze, an increasing effort should be made to synchronize demand with the supply of service.

Latent demand and developmental marketing.--There are substantial numbers of commuters (e.g., intersuburban trip makers and affluent commuters) who would use transit if services were available to meet their needs. Actions can be taken to develop services where these market opportunities appear to be profitable.

No demand and stimulational marketing.--There may be a sizable market that is either unaware of available transit services that could meet their needs or does not consider transit as a viable mode for certain trip purposes. Attempts can be made to create demand in these markets through communications and service changes.

The process for ascertaining current and future demand conditions and for formulating and implementing appropriate strategies in response to those conditions is described in the next section.

The Strategic Transit Marketing Management Process

As discussed previously, marketing management is a strategic approach to operating a business. The process for executing this approach consists of two integrated parts: strategic management and strategic marketing. Each of these parts is described in the following paragraphs.

Strategic Management

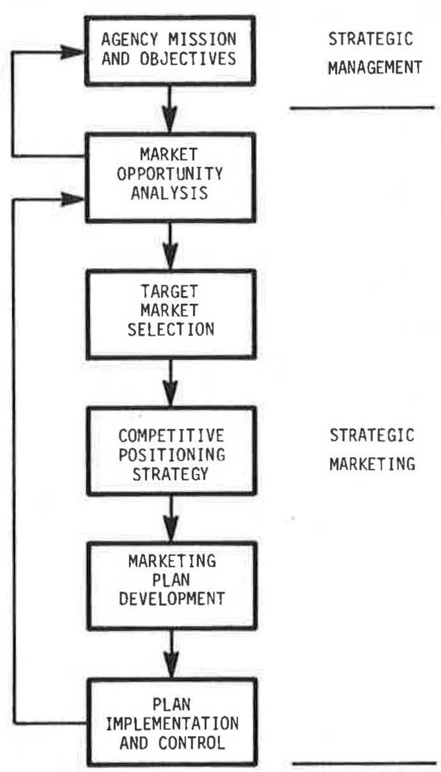
If public transit is to survive and grow, long-term strategies must be developed for adapting to and taking advantage of environmental conditions (e.g., public subsidy reductions, changes in local travel patterns, and gasoline price fluctuations). These long-term strategies are the product of the strategic management process that establishes the mission, objectives and goals, growth strategies, and business portfolio plans for the agency. The process provides the framework for carrying out the various functions of an agency including marketing. Figure 1 shows how strategic marketing (discussed later) links with strategic management to form the marketing management process.

The components of the strategic management process are described in the following paragraphs.

Agency mission.--Many transit operators do not have a stated mission. Instead, an externally established set of goals and objectives is relied on that does not present a clear picture of the agency's opportunities and competition. For example, if a transit system sees itself (myopically) as a public transit provider or, even more narrowly, as a low-priced, fixed-route transit operation it will probably act as a monopoly whose major market is low-income passengers who are dependent on public transportation. However, by broadening the definition to, say, transportation provider, the system recognizes that it faces competition from other transportation modes and also opens itself to a wider range of services and markets.

Goals and objectives.--As described in Smerk (5), the traditional public goals of mass transit have been to provide mobility to all citizens, improve the environment, conserve energy, and sustain and enhance economic growth and vitality. The latter three goals are based primarily on diversion of travel from private automobiles. These goals, which are established mostly by governing boards and regional planning agencies, have formed the basis for public funding of transit at the federal and local level.

Figure 1. Marketing management process.



To attain these basic goals and other locally established community goals, specific organizational objectives are defined. This is where transit managers come into the picture. Increasingly, objectives aimed at maximizing revenue (versus simply ridership), minimizing costs, or otherwise reducing the need for public funds must be, and are, receiving attention. Trade-offs between costs and effectiveness in achieving general goals are being made more explicit.

This is consistent with the practices of private, profit-oriented businesses and has two major implications: (a) the tools of modern marketing management are indeed applicable to public transit and (b) concentrated, targeted approaches to providing service are called for. The latter point refers to the need for, and effectiveness of, identifying specific markets. For example, in meeting the general goal of providing mobility, services should be aimed at specific groups versus the entire population. This need has been identified by numerous researchers [for example, Lovelock (6) and Woodruff et al. (7)] who assert that transit objectives should be defined by (or for) transit managers in terms of encouraging use by specific population segments.

Growth strategy.--For many transit operators, survival is the greatest concern right now. Even these operators, however, should develop growth strategies to demonstrate the viability and future directions of the system.

There are three major classes of growth opportunities: intensive, integrative, and diversification (1). Of these three, intensive growth, which entails the exploitation of opportunities latent in an agency's service area, is the most appropriate strategy for most public transit agencies. In light of the transit industry's historical production orientation, declining service quality, and low market share of urban transportation, there appears to be much room for growth within current services and markets. Therefore, the full complement of intensive growth strategies--market penetration (increase ridership and revenue for existing services and markets through aggressive marketing); market development (increase ridership and revenue for existing services by appealing to new market segments); and service development (increase ridership and revenue by developing new or improved services for existing markets)--can be fruitfully pursued by most transit operators.

Portfolio plan.--Although for smaller transit operators (less than 50 vehicles) the concept of dividing services into a portfolio of multiple strategic business units (SBUs) may seem like overkill, it has relevance to all size transit systems. SBUs can be split out according to major technological or operational differences (e.g., rail versus bus services), service definition differences (e.g., long-haul express commuter bus versus local bus service), or in some cases by individual routes. Various special services (e.g., charter bus and dial-a-ride) can also be considered as SBUs for purposes of separate marketing efforts and responsibility accounting and cost accounting. The portfolio approach can help the transit manager in assessing overall agency performance, identifying areas of strength and weakness, and guiding the allocation of future resources.

Strategic Marketing

Strategic marketing is a process of analyzing market opportunities and developing marketing positions, programs, and controls to serve company (or agency) missions and objectives. The process is carried out within the strategic management framework described in the previous section and diagrammed in Figure 1. Each of the five strategic marketing steps shown in Figure 1 is discussed below as it relates to public transit.

Market Opportunity Analysis (MOA)

The search for and development of attractive opportunities for the agency is the first step in the strategic marketing process. The MOA activity is also the major link with the strategic management process because it provides key information for the formulation of long-term agency plans. MOA is therefore the catalyst for the entire transit marketing management process. It represents an ongoing search for ways to maximize achievement of agency goals and objectives. The tasks of MOA, as summarized by Kotler (1), include environmental analysis, market analysis, consumer behavior analysis, market segmentation analysis, and demand measurement and forecasting. The focus here will be on environmental and market segmentation analysis.

What are some of the major environmental opportunities for and threats to public transit in the 1980s? In terms of sociodemographics, a recent analysis of U.S. spatial trends by Perin (8) indicates the following:

> The new wave of suburbanization expected during the rest of this century could exacerbate current and chronic operating deficits of transit systems now serving low-density dispersed markets. By 1990 suburban development accommodating new populations could double in extent, following the same multicentered pattern now characterizing most metropolitan areas. Although the automobile will continue to be the most cost-effective mode for certain types of trips, this new population could precipitate demand for services that are usually inefficient in lower density areas. . . . Despite reductions in operating assistance, energy shortages, inflation, and recession, the possibility of new users and new constituencies for public transit in low density areas may have to be acknowledged.

This trend presents the threat that existing services, which are predominantly fixed-route, downtown-centered, will be less synchronized with emerging travel patterns and behavior than they are today. However, it also offers opportunities for developing new services, such as intersuburban services that would use efficient minibus or paratransit technologies.

Because of the increasing numbers of people making work trips over the next two decades [50 percent, according to Perin (8)], chronic peak-period congestion, with all of its negative side effects including higher transit costs and lower productivity, will intensify. Efforts to develop opportunities for synchronizing demand with the supply of service (synchromarketing) should thus be a high priority for transit agencies. Analysis of population segments that may travel during off-peak periods will help to develop these opportunities. For example, the elderly population, which is increasing, accounts for a substantial portion of off-peak transit use. However, there is evidence that public transit is presently not designed to adequately meet the needs of this group, as suggested by Perin (8):

> Living alone, as they are increasingly doing, the elderly appear to use tripmaking as an integral feature of their social life. . . . Clearly the reliance on friends and relatives rather than on public systems for transportation services, as revealed by this study, is of great significance

> in considering future transportation systems for this population. . . . Many elderly participate in informal transportation networks that provide them with not only convenient and inexpensive mobility opportunities, but social benefits as well. Conventional public transportation competes poorly against these networks.

This indicates that attractive opportunities exist if new forms of transit service can be developed to meet the social needs of the elderly. Other studies have shown that attractive, viable opportunities exist for transit service to regional shopping centers (9) and for affluent consumers (10).

The foregoing discussion indicates that market segmentation is an integral part of the transit MOA process. This has been widely recognized by transportation researchers over the past decade, as evidenced by the substantial literature on the subject. A particularly good summary of the benefits of market segmentation is given by Engal et al. (11). Lovelock (6) presents a good example of how transit objectives can be related to segmentation variables. Basically, segmentation analysis is performed to identify groups within a community that appear likely to represent an opportunity for transit tailored to their needs. The segmentation concept assumes that (a) consumers are different, (b) differences in consumers are related to differences in market behavior, and (c) segments of consumers can be isolated within the overall market.

Woodruff et al. (7) present a summary of the literature on market segmentation for public transit and conclude that most studies to date have been ad hoc; they have not discussed segmentation within the broader context of MOA. Woodruff et al. do, however, discuss segmentation within the MOA process. The approach they suggest seems practical and systematic and ought to be considered for adoption by transit marketing managers.

The first step is an in-depth analysis of various secondary information sources describing community characteristics relevant to use of transportation (e.g., population census, route maps, and planning studies). This provides an information base for the market segmentation study.

The segmentation study identifies promising, potential market segments that can be matched with the transit mode or system type most likely to be competitive with modes currently being used (mostly the private automobile). One or more segments that appear to present an attractive opportunity can then be subjected to further analysis to provide information concerning preferences for specific attributes of a mode and service. This consumer behavior information is intended to aid in designing a proposed system or service.

The final step is an analysis of the probable response of the consumer segment to the proposed service. Concept testing, despite its limitation of discontinuous innovation, was recommended by Woodruff et al. as a more applicable approach to testing market acceptance for new transit services than product use testing or market testing.

Target Marketing

The second step in the strategic marketing process is to choose a strategy for responding to the market structure and the associated opportunities revealed in the MOA. Three broad approaches exist.

1. Undifferentiated marketing--appeal to the entire market with the same marketing mix.
2. Differentiated marketing--appeal to the entire market with different marketing programs for different market segments.
3. Concentrated marketing--appeal to one or a few market segments with different marketing programs.

The first approach, which assumes that the service has universal appeal and that the market is homogeneous, has proven through the years to be inappropriate for transit. The second approach, even though it recognizes the heterogeneity of the marketplace, is costly to implement. The last approach, concentrated marketing, attempts to gain a good market position in a few well-selected segments. Because of the limited resources of most transit operators, the latter approach seems most appropriate for transit at this time.

Competitive Positioning

After a target market has been established, a general idea must be developed of the type of service to offer that market in relation to the competition. There is little question that the private automobile is transit's prime competitor, and the automobile is the kingpin. Successful positioning requires a thorough knowledge of the perceptions, attitudes, and behavior of the target market with respect to both the automobile and transit.

For many people price and quality are two salient attributes that differentiate transit from the automobile. The relative values of these attributes differ for different market segments. For example, individuals in affluent segments will usually view quality of service as much more important than the price differential. For these markets, higher priced (i.e., fare), higher quality services can be designed to compete with the automobile. Based on various research studies, however, it appears that transit cannot yet compete with the quality of service provided by the automobile. Thus, until high quality services (both actual and perceived) can be developed by a transit agency, its positioning strategy should probably focus on the price differential as the major competitive advantage. The eventual rise in gasoline prices, currently (in early 1983) at depressed levels, will serve to strengthen this relative price advantage.

Strategies that complement the use of the automobile, such as offering park-and-ride facilities and express services, also hold promise because they provide superior transportation service over the entire trip of a commuter who does not want to be completely forced out of his or her car.

Marketing Plan Development

A marketing plan is developed as the fourth step in the strategic marketing process. The major thrust of this plan is to define a marketing strategy that establishes the objectives and policies of the marketing effort. Clear objectives for the marketing strategy must be established so that the success of the effort can be measured. A marketing effort is defined by the mix of marketing variables and associated resource allocations and levels of effort. The remainder of this section focuses on the elements of the marketing mix.

The marketing mix consists of four elements--product, price, place, and promotion. These are often referred to as the four Ps. Three of these marketing mix elements--product, price, and promotion--are sufficient for defining a transit service. The fourth P, place (i.e., product distribution), is subsumed by the product (i.e., transit service). Together these three elements form the package that consumers in the various market segments buy or reject.

The product, or service, can be defined in terms of type (e.g., regular fixed-route or special and charter services), quality (e.g., reliability, comfort, safety, available seating, driver courtesy, travel time), and access (i.e., stop spacing and walking distances). These service attributes can be manipulated by routing and scheduling, vehicle and bus stop design, and construction of facilities (e.g., park-and-ride lots).

Pricing (fares) is an important part of the marketing mix, as discussed in the competitive positioning section of this paper. Correct pricing of service is crucial because fare revenues are increasingly becoming the life blood of transit.

Smerk (5) provides a good summary of transit pricing considerations. He points out that the fare must be consistent with the service offered. Whether the fare is judged high or low usually depends more on the quality of service than on the consumer's ability to pay (e.g., low-cost, high-value versus high-cost, low-value package). Past research has shown that people are willing to pay for good service. Thus, a program of differential fares for special services tailored to the needs of different segments could simultaneously maximize revenues and service to the public.

Another important use of differential fares is the encouragement of off-peak transit use. Peak-pricing is an area of synchromarketing that has received focused attention over the past few years and is now being tried by several transit agencies.

Promotion of the transit system is the third element of the mix. The four basic tools of promotion--advertising, personal selling, sales promotion, and publicity--are all applicable to the marketing of transit services.

Advertising can be used to expose the public to particular transit services and to maintain public awareness, to attract riders by stimulating a desire to satisfy local transportation needs through transit service, and to develop and project a favorable image of the transit agency to the public.

Personal selling occurs as part of the public information and community relations functions of a transit agency. Meetings with outside groups (e.g., Jaycees and Golden Age Club) can be used as opportunities for personal selling of transit. Likewise, providing transit information or fielding complaints via a telephone information service can be used as opportunities for personal selling.

Sales promotion activities could include discount fares for new services, free service in conjunction with the opening of a major convention, or discount coupons for transit service to a rock concert.

Publicity is an important means of promotion because (a) it is free, (b) it often requires little effort because the media are usually agreeable to promoting stories of public service, and (c) it has the potential for reaching a wide audience.

In assembling the marketing mix for a particular service and target market, an attempt should be made to systematically match the attributes of the mix with those attributes that would appeal to the target market. This is similar to the process used in defining and analyzing marketing opportunities. The major steps in this process include (a) defining the attributes of feasible service alternatives, (b) defining the attribute preferences and preference levels of the target market, (c) matching the service to the target market, (d) evaluating the cost feasibility of matched services, and (e) selecting the most feasible service mix. Excellent examples of how steps a and b can be carried out by a transit agency are provided by Woodruff et al. (7) and Wegmann et al. (12). Figure 2 illustrates step c.

Plan Implementation and Control

After the marketing plan has been developed, the remaining tasks are to carry it out and monitor performance. The actual response of consumer attitudes, revenues, expenses, and ridership levels to the transit marketing program should be measured and compared with the objectives of the plan. This last step in the strategic marketing process essentially closes the loop by feeding information back to the initial marketing opportunity analysis step (Figure 1).

Administration of the marketing program requires assignment of task responsibilities and deadlines to organizational units. It also requires effective and continuous communication up, down, and across the organization. The following two sections delve into these two areas: the transit marketing organization and the marketing information system. These two ingredients provide the means for effectively implementing the marketing management process.

The Transit Marketing Organization

As indicated by current industry practice, transit is still organized as a production-oriented enterprise. Most transit agencies consider marketing as merely advertising and community relations. However, there are a few transit agencies that have reorganized into a more comprehensive marketing structure.

An analysis of alternative marketing organizations for transit is described in Organizing the Marketing Function (13). The analysis compared four basic organization structures: product (service), market-territory, market-customer, and functional. The study concluded that the functional organization was the most appropriate structure because transit services are relatively homogeneous, the market is highly localized, and transit marketing resources are limited.

An example functional transit organization structure is shown in Figure 3. A more detailed, exemplary transit organization model can be found in Organizing the Marketing Function (13). As depicted in Figure 3, the marketing function must be considered at least equal in status to the other major organizational functions for the marketing, or consumer-oriented, philosophy to permeate the organization. The organization structure shown in Figure 3 covers the major aspects of marketing management, including marketing research, which is discussed in the next section.

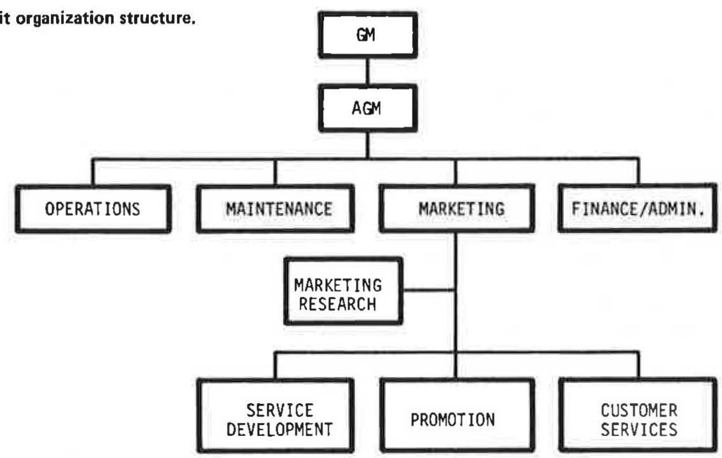
The Marketing Information System

As indicated in the problem statement, transit operators have generally lacked the concrete information needed to make intelligent management decisions, particularly decisions pertaining to planning future transit services. To support the transit marketing organization in carrying out its strategic marketing tasks, a marketing information system must be established. A marketing information system consists of at least three basic components: internal accounting, marketing intelligence, and marketing research. These three components provide information for the following uses: monitoring trends (i.e., service usage, revenues, costs) and evaluating actual performance against planned performance; identifying and analyzing transit marketing opportunities, competitive positions, and marketing mixes;

Figure 2. Matching transit marketing mixes to market segments.

MARKETING MIX VARIABLES	MARKET SEGMENTS SEGMENT 1	SEGMENT 2	SEGMENT 3
SERVICE			
ROUTES	FIXED	FIXED	VARIABLE
.	.	.	.
.	.	.	.
.	.	.	.
PRICING			
FARES	FULL	DISCOUNT	PROMOTIONAL
.	.	.	.
.	.	.	.
.	.	.	.
PROMOTION			
FOCUS	SERVICE QUALITY	LOW PRICE	FLEXIBILITY
.	.	.	.
.	.	.	.
.	.	.	.

Figure 3. Functional transit organization structure.



and forecasting performance under various assumed conditions.

Internal accounting and intelligence systems that provide ongoing evaluative and formulative information do exist, albeit often at a fairly aggregate level, in most transit agencies. All transit operators have a ridership (disaggregated by population segments) and financial accounting system in place because it is a requirement for receiving federal funding assistance. Some internal accounting information can be derived from this system. A description of the types of information and data sources for ongoing transit service monitoring and evaluation can be found in Sinha (14), Wegmann (15), and Attanucci (16).

Abundant sources of information are available for marketing intelligence. The American Public Transit Association (APTA) holds frequent conferences and publishes a weekly journal, Passenger Transport, that provides relevant information on happenings at various transit agencies, legislation, and technological innovations. Regional planning agencies are another useful source of local environmental information. Telephone operators providing customer assistance and transit vehicle operators are other important sources of ongoing intelligence.

Transit Marketing Research

The biggest information deficiency in transit today is market analysis and performance forecasting information. This kind of information is obtained primarily from marketing research activities. Marketing research is an off-line information support function as shown in Figure 4. It provides answers to specific management questions on an as-needed basis. The needs for marketing research are apparent throughout the strategic marketing process described earlier in this paper (i.e., analysis of market characteristics, segments, and potentials; consumer perceptions, attitudes, and preferences; and forecasted responses to service, price, and promotion mix).

Marketing research tends to be a technically complex activity. The basic marketing research methodology is shown in Figure 5. Further discussion of this methodology can be found elsewhere, such as Cox (17).

Several specialized marketing research tools that are used in the methodology shown in Figure 5 have been developed to assist businesses in assessing marketing strategies and plans. For example, PIMS (18), a tool used by many large corporations, can

Figure 4. Marketing research and the marketing information system.

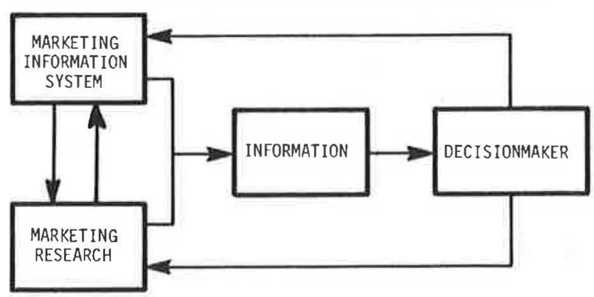
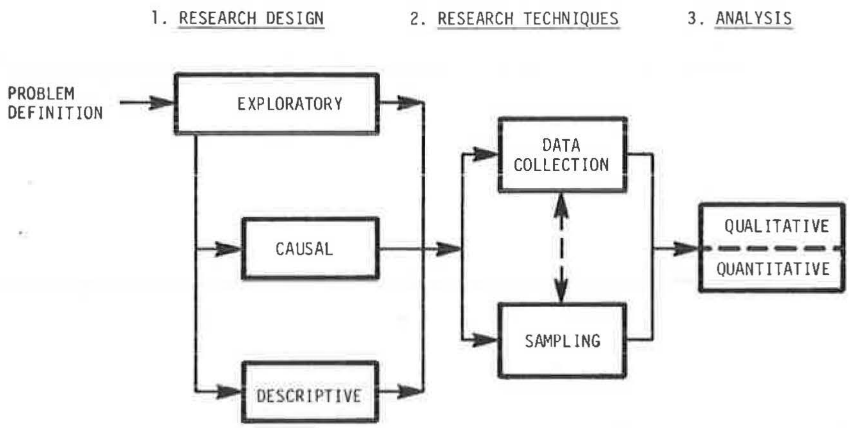


Figure 5. Marketing research methodology.



provide, via a set of statistical models, information on expected profit performance for various marketing strategies and sets of environmental conditions. Likewise, in the transit arena, techniques have been developed for analyzing consumer behavior and for estimating ridership responses to service and pricing programs. Notable among these efforts are the emerging tools that are being implemented on microcomputers, which makes them both more affordable and less intimidating to their users. Two such tools, developed at Cornell (19) and Dartmouth (20), can provide, via a dialog with a desktop computer, guidance on service design and pricing policies for either a single transit route, a group of routes, or an entire transit system. But tools such as these are seldom found in use in the transit industry.

Suffice it to say that other than at the largest transit agencies, the expertise and funds to do proper marketing research are not currently available. Because of the value of this activity to effective marketing management, filling this gap in the transit industry will be one of the major challenges in the coming years.

CONCLUSIONS

The discussion in this paper has shown how modern marketing management can be applied in the public transit industry. In addition major areas of deficiency and opportunity for public transit have been identified.

The question now is: Where does public transit go from here? First, the orientation of transit organizations must change to that of marketing versus operations. This means fundamental changes in organizational structures and systems, which is not a simple task. Strong support for this change must come from the top of the organization, starting with the Board of Directors and General Manager, if it is to succeed. In addition, the costs and benefits of this changeover must be made explicit if it is to be accepted by both the citizens and transit agency personnel. The federal government can provide help here by documenting case studies of successful marketing programs, such as the ones reported by Savage in Toronto, Ontario (21), and by Young in Davenport, Iowa (22).

Implementation strategies must be carefully designed and executed if a marketing culture is to take firm hold within a transit agency. Organizational behavior concepts relating to change should be considered. Implementation of a management information system (MIS) with a strong marketing emphasis can aid and direct the change process. The role of an MIS in bringing about organizational change is discussed in depth by Keen (23). The availability of low-cost microcomputer technology makes automated MISs now cost feasible for any size transit agency.

Finally, the tools of marketing research will have to be adopted by transit operators. As the changeover to a marketing orientation evolves, it is hoped that the benefits will become obvious and expenditures on marketing research activities and staff will increase.

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Low Cost Planning Techniques for Assessing Rural Transportation Needs

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As many local planning departments face lower departmental budgets, hiring freezes, and consolidation of various planning functions, the creative application of traditional planning techniques specifically to small-scale rural transportation projects becomes increasingly important. It is necessary in continuing to provide the informational support needed to compete for reduced program funds against an increasing pool of fundable projects and to distribute those funds fairly throughout a large and often diverse rural population. The purpose of this study was to find low-cost ways to apply those traditional planning techniques to the specific needs of a rural community. The low-cost application presented uses secondary data that are available from published sources to rank communities in a political jurisdiction according to their transportation needs. Ranking such areas according to the proportion of the population that is transit dependent is a first step in the political decision-making process to be followed by an actual estimate of transit ridership using demand models specifically calibrated for rural areas. The technique was used in preparing the transit element of the County of Rock, Wisconsin, Transportation Study.

THE NEED FOR MODIFIED PLANNING TECHNIQUES

There are a number of conditions common to rural areas that require the adaptation of traditional planning techniques. The planning technique discussed in this paper is needs assessment. The purpose of needs assessment in this context is to establish priorities for transportation needs within a political jurisdiction. Commonly, this technique involves collection of original data on current patterns of transit use and/or citizens' predictions of their future use of a proposed service as defined broadly at the preplanning stage. This collection and analysis of original data requires a large amount of time and a large number of staff hours as well as specialized skills in survey and statistical research. Even so the technique often yields predictions of high use areas with low correlation to actual use.

Planning for the transportation needs of rural areas requires modification of the traditional technique for establishing priorities in geographical subareas to accommodate conditions common to such areas. Those conditions include population size and characteristics, geographical size and diversity, land use patterns, local administrative and legislative structure, and the area's status within a larger political jurisdication.

Size and Land Use

Size and land use are major factors in determining the planning and program resources available to the area. The small population and predominantly agricultural land use of rural communities provide a small tax base (both property and income). Local revenues, therefore, often can support only a small planning staff. Recent economic conditions have further restricted that staff.

For instance, local tax relief initiatives and federal income tax and spending reductions have reduced local revenues. Reduced revenues have been compensated for by reducing overtime, increasing the use of part-time employees, reducing positions through attrition and layoffs, and eliminating certain planning and program functions.

In addition, the Comprehensive Employment Training Act (CETA) and other sources of federal support have been curtailed. Thus, staff, members are often performing more than one planning function or are combining planning and program functions and have little support staff to perform original data collection tasks.

Competition for Funds

The reduction in program funds--local, state, and federal--has created other dilemmas for local planning departments. At the local level there is increased competition for funds within planning departments both among the various planning functions, including transportation, and between planning and program functions. There is also competition among various programs at the regional and state levels. This increased competition for funds requires a convincing presentation of information to support the need for, and planned equitable distribution of, program funds.

Political Structure

In many instances, the structure of the local legislative body is one that requires legislators to perform administrative as well as legislative duties. Thus legislators examine and take action on the managerial details of proposed projects in addition to their legislative function of appropriating funds for specific projects. Therefore, the results of a needs assessment must be presented in a convincing and understandable form for legislators who may be unfamiliar with planning techniques.

Diverse Development Patterns

Land use and development patterns common to rural areas create a situation that must be considered in establishing priorities within a geographic area based on transportation needs. This situation is the combination of small towns or cities and large sparsely populated rural areas within a single political jurisdiction that has both centralized and decentralized services. Priorities therefore must be based on which subareas are most transit dependent (i.e., have the highest ratio of needy to the population of the subarea) as well as which areas have the highest concentrations of needy (i.e., have the highest ratio of needy to the population of the entire area). In that way, both the urban and rural areas will be considered. This method of establishing priorities is likely to be politically palatable because it ensures that both rural and urban areas will be taken into consideration.

Special Interests

These priorities must also consider a number of special interests in the region that often conflict with each other. One such issue is the preservation of decentralized services (e.g., the rural general store) while considering the practicality of providing transit to and from centralized service areas. Other conflicting special interests are the simultaneous provision of work trips, medical trips, and shopping trips--all preferred during peak hours.

USE OF MODIFIED PLANNING TECHNIQUES

The feasibility study for Rock County, Wisconsin, (1) identified and recommended a number of options for general public transportation. These options were developed on the basis of the following planning elements:

1. Data collected on population characteristics, existing service, and major trip generators;
2. Needs analysis;
3. Goals and objectives set by the advisory committee;
4. Estimates of ridership demand;
5. Cost and revenue analysis; and
6. Consideration of the effect on users and implementation issues.

The focus of this paper is on the needs analysis element. A number of aspects of the needs analysis technique used in the Rock County study accommodate the uniquely rural conditions described in the previous section and are particularly suited for use by local planning departments. These aspects are presented in detail in this section.

A New Application of a Traditional Technique

The needs assessment technique described in this paper is not new; however, this application of the technique is a useful alternative to the more typical common sense or ad hoc approach to assigning priorities to subareas within a rural jurisdiction. Its purpose is to give rural transportation planners the tools for encouraging local legislators to combine their parochial interests with more objective data when establishing priorities.

It provides more specific information than the common sense approach to politicians and administrators making decisions on transportation service delivery. It provides a low-cost, expedient basis for fair distribution of resources countywide and for presenting results to policymakers in a clear, concise form. Establishing those priorities county or regionwide becomes more and more crucial as available funds decline.

Using an extensive collection of demographic and geographical data instead of "a few statistics and some common sense" to assign priorities often gives policymakers additional insights. For example, when a subarea is described in terms of its transit dependent residents, policymakers can consider the types of funds earmarked for service to those people. Without more extensive information, funds for the elderly or poor, for example, might never be considered; or if they were considered, no data would be available to support the use of those funds for a given subarea.

Methodology

The needs analysis used in the Rock County study is based on predictions of high transit use as implied by the proportion of transit dependent in each geographical subarea. Identifying needs is not the same as estimating demand or documenting community interest in public transit. It is used to describe gaps in service and identify geographical areas that are most likely to generate ridership based on the characteristics and size and density of the population in those areas.

Demand was estimated later by using models calibrated with data from hundreds of rural systems nationwide specifically for a number of transit options. Community interest was not specifically addressed by this study, but several surveys of county residents were included as appendix material. They indicated a perceived lack of transportation opportunities in areas outside the two major cities of Janesville and Beloit.

Assessing Relative Need

The method of needs assessment used for this study began with developing a measurement of each subarea's relative need for transportation in terms of geographical area, type of user, and trip purpose. The relative need was analyzed by applying a test based on the proportion of transit dependent in each subarea. Transit dependent, for the purpose of this study, is defined as those most likely to rely on public transit because they are young or transportation handicapped (i.e., elderly or handicapped) or low income or carless.

All 28 subareas (i.e., 20 townships, 5 cities, and 3 villages) were ranked from one to 28 for each of the four factors. For each subarea the four ranks were then added together and divided by four to calculate an average rank for each subarea. A combined rank was established for each subarea based on the highest proportion of transit dependent.

An additional factor was added for the first two categories--young and transportation handicapped. That factor takes into account the actual number of young or transportation handicapped in each subarea. Therefore, a second combined rank was calculated based on the highest numbers of transit dependent. The two sets of highest combined ranks produced a list of three areas that are in the top 25 percent of both lists and four more in the top 25 percent of the first list and four more in the top 25 percent of the second list. Thus, the following were identified:

1. Subareas with the highest proportion of transit dependent (i.e., those seven of the 28 subareas that are in the top quartile of combined ranks, three of which are also in category 2).
2. Subareas with the highest number of transit dependent (i.e., those seven of the 28 subareas that are in the top quartile, three of which are also in category 1).
3. Subareas with both the highest proportion and highest number of transit dependent (i.e., those three subareas common to categories 1 and 2).

Assigning Priorities to Subareas Based on Need

For the highest ranked subareas, needs were further defined in terms of users and geographic area. Even though the highest ranked all had high combined ranks, not all of their individual four factors are high when examined separately. Therefore, the four transit dependence factors were reexamined individually to target the particular transit dependent population in each high-need subarea.

The high-need subareas were also reexamined in terms of specific geographical areas presumed to generate the greatest need for transit. The following factors were considered:

1. Population size,
2. Population density,
3. Location of an urban service area within the township or nearby,
4. Location of rural development centers--both commercial and residential,
5. Access to incorporated areas, particularly those where major trip attractors are located, and
6. Location within the urbanized corridor between Janesville and Beloit.

Other Data Used to Assign Priorities to Subareas

Trip Purposes

In addition to analyzing where the most transit dependent live, needs were also analyzed in terms of where passengers might need to go. Contacts with social service agencies and county planners were used to identify reasons for trips and their probable destination. The following reasons were identified: medical, employment, shopping, higher education, and human service facilities.

Existing Service

An inventory of existing transportation services was made. In-person and telephone interviews were conducted. Additional data were obtained from other recently completed studies on file in the county. Existing transportation services are

1. Municipal transit systems,
2. Human service agencies providing direct transportation service,
3. Taxi companies,
4. Intercity buses, and
5. Other private companies.

In the analysis of these services particular emphasis was placed on those elements of each service that address either general public transportation or the transportation needs of a specific population dependent on public transit. Those elements include

1. Service restrictions (geographical, user eligibility, or trip purpose),
2. Hours of operation,
3. Fares,
4. Type of service and level of passenger assistance,
5. Trip purposes (and specific trip) served and their relative frequency,
6. Types of users served, and
7. Geographical areas served.

Implementation Concerns

The role of (a) existing providers in a countywide transit system, (b) potential funding issues, and (c) local barriers to implementation were also examined. Potential roles for existing providers were explored by examining those operational and administrative characteristics of existing systems that might inhibit or enhance implementation and analyzing how they could be integrated to provide a comprehensive package of countywide transit. Those characteristics examined included fleet size and type, operating hours, type of service, current clientele, service area, and trip served.

The potential funding issues examined include requirements and realities of available funding, and considerations in securing funds to match federal and/or state funds.

Local barriers to implementation that were examined included willingness of providers to participate, regulations, insurance, labor, and local concerns.

Subarea Profiles

A one page profile was prepared for each of the 28 subareas. The profile describes the population characteristics, development pattern, population density, location of major trip generators, and existing transit services. This profile provides a concise description of unmet transit needs within a particular subarea. It is well suited for use by local committee members and legislators. The profile for Milton Township is given as an example.

Needs Profile for Milton Township

> Milton Township, in north central Rock County, was ranked fourth along with Avon Township. Of the four individual "transit depen-

dence" factors, only one, vehicle/household was in the highest quartile. One other, percent under age 18, was in the second quartile. The other two, percent transportation handicapped and per capita income, were in the second lowest "need" quartile.

Milton is the eleventh largest subarea (the sixth largest of the eight incorporated areas) with a population of 2,306 at a density of 68.8 per square mile. Its rural residential center, Clear Lake, has 318 residents in the west central portion of the township. In addition, the rural development center is surrounded by urban service areas both in the town of Milton (i.e., the City of Milton and the Consolidated Koskonong Sanitary District) and in the town of Fulton to the west (i.e., the City of Edgerton) and the towns of Janesville and Harmony to the south (i.e., the City of Janesville).

The cities of Milton and Edgerton are the sources of major facilities for the township. The township is served by trip attractors such as the Milton Medical Center and both Mercy Hospital in the City of Janesville and Memorial Community Hospital in Edgerton, each within 8 miles of the City of Milton. Major employers within the City of Milton include the Burdick Corporation (250 employees) and Kenemetics, Inc. There is a nutrition site at St. Mary's Church on Parkview Drive at the southeast edge of the City. Milton College, also in the City of Milton, serves approximately 630 students.

A number of factors increase the Township of Milton's claim to high priority in terms of need. They include the large areas of development, both as sources of trip attractors and as concentrated population centers; the large population (especially when the City of Milton is included); and the proximity of and highway access to both the City of Janesville and the City of Edgerton.

Any system designed for this township would need to acknowledge that although the City of Milton is a major source of trip attractors, it is in the third quartile (next to lowest) of combined ranks and, therefore, not to be counted on for concentrations of "transit dependent." Also, for the Township of Milton, carlessness is in the highest quartile so a system dependent on part of a trip being taken by car would be inappropriate.

USE OF THE TECHNIQUE IN ROCK COUNTY, WISCONSIN

Rock County, Wisconsin, by request of the County Board of Supervisors, was the subject of one of eight feasibility studies funded by the Wisconsin Department of Transportation on Public transportation in a number of rural areas throughout the state. The Board of Supervisors had two goals for the study:

1. To assess the potential for countywide public transportation, and
2. To prepare the public transportation development plan [as part of the County of Rock Transportation Study (CORTS)].

The eight studies were funded through the Federal Highway Administration's Section 18 rural transportation program, which was administrated by the Wisconsin DOT as technical assistance to local governments in the state. Rock County is considerably more urban than the other seven areas in the study and has a municipal transit system that is more developed. The county also has begun limited consolidation of social service agency transportation and administers a program specifically to provide general purpose trips throughout the county to elderly and handicapped residents without regard to agency affiliation. The Rock County study, therefore, focused on the feasibility of establishing a countywide transit system for the general public as an addition to the existing municipal and special needs transportation systems already in place.

The needs assessment technique discussed in this paper was used to identify subareas of potential high transit use by assessing unmet transit needs. This was acomplished by determining the geographical subareas with high proportions and/or high numbers of transit dependent residents, the major trip attractors (i.e., typical origins and destinations) in the area, and the transit services currently serving specific geographical areas, specific types of users and specific types of trip purposes. That assessment of unmet needs was used as the basis for the rest of the study. The needs assessment established priorities for areas of high need. Then, the Advisory Committee established goals for public countywide transportation, and transit options were developed based on the identification of unmet transit needs, available funding, potential barriers to implementation, and the Committee's goals and objectives. The options were evaluated in terms of goals, costs, revenues, estimated ridership, and the potential for implementation. Recommended options were presented to a subcommittee of the local legislature.

Ranking the Subareas

Table 1 shows the rank of each subarea for each of the four transit dependence factors and gives the combined rank for each subarea. Table 2 indicates which quartile the four individual factors fell into for the seven subareas with the highest combined rank. Materials were also prepared showing the population rank, population density, and location and population of rural development centers and urban service areas. Other materials show the geographic areas served by existing providers and the trip purposes served by existing providers.

SECONDARY DATA SOURCES USED IN THE NEEDS ASSESSMENT

The needs assessment technique discussed in this paper represents a low-cost method of fairly and expediently establishing priorities for unmet transit needs in a rural jurisdiction. It is low-cost basically because it depends on the use of secondary data rather than on the collection and analysis of original data. The data sources used in the Rock County study are commonly available nationwide.

Population Characteristics

Population, per capita income, age under 18, and age over 65 are available for 1980 from the U.S. Census Bureau, Department of Commerce. By fall 1982, printed material is expected to be available for all subareas. For areas not classified as urbanized (i.e., based on population density), the data are available for individual towns, which are sometimes further divided into enumeration districts (i.e., an area of about 200 housing units). Urbanized areas are subdivided into census tracts (i.e., containing about 4,000 residents).

In addition, state or local agencies, particularly those that serve the elderly and poor, esti-

Table 1. Rank of subareas by transit dependence factor and all ranks combined.

Subarea	Percent Transportation Handicapped	Percent Under 18	Vehicles per Household	Income	Total	Average	Combined Rank
City							
Beloit	8	23	7	16	54	13.50	8
Edgerton	4	27	10	27	68	17.0	24
Evansville	6	24	12	26	68	17.0	24
Janesville	14	14	8	28	64	16.0	21
Milton	7	25	16	12	60	15.0	14
Village							
Clinton	3	26	17	24	70	17.5	26
Footville	9	17	18	19	63	15.75	19
Orfordville	5	15	20	8	48	12.0	4
Town							
Avon	12	10	24	2	48	12.0	4
Beloit	16	22	4	21	63	15.75	19
Bradford	11	12	26	13	62	15.5	17
Center	17	8	25	2	52	13.0	7
Clinton	25	13	28	14	80	20.0	28
Fulton	10	20	1	25	56	14.0	10
Harmony	28	2	19	9	58	14.5	12
Janesville	1	28	9	6	44	11.0	3
Johnstown	27	3	22	18	70	17.5	26
La Prairie	21	7	14	15	57	14.25	11
Lima	20	19	15	5	59	14.75	13
Magnolia	13	4	11	1	29	7.25	1
Milton	15	11	2	20	48	12.0	4
Newark	26	5	23	7	61	15.25	15
Plymouth	19	1	21	23	64	16.0	21
Porter	18	21	13	12	62	15.5	17
Rock	2	16	3	11	32	8.0	2
Spring Valley	24	6	27	4	61	15.25	15
Turtle	22	18	5	22	67	16.75	23
Union	23	9	6	17	55	13.75	9

Note: The subarea ranked first has the highest overall transit dependency, the subarea ranked second has the next highest transit dependency, and so on.

Table 2. Summary for subareas with highest combined rank.

Subarea	Combined Rank	Percent Transportation Handicapped	Percent Under Age 18	Vehicles per Household	Per Capita Income
Magnolia	1	2nd quartile	highest	3rd quartile	highest
Rock	2	highest	3rd quartile	highest	2nd quartile
Janesville	3	highest	lowest	2nd quartile	highest
Orfordville	4	highest	3rd quartile	2nd quartile	2nd quartile
Avon	4	2nd quartile	2nd quartile	lowest	highest
Milton Township	4	3rd quartile	2nd quartile	highest	3rd quartile
Center	7	3rd quartile	2nd quartile	lowest	highest

Note: Individual ranks have been divided into quartiles as follows:
1-7—highest quartile (most need)
8-14—2nd quartile
15-21—3rd quartile
22-28—lowest quartile (least need)

mate the population characteristics for other than census years by factoring in growth projections. The accuracy of those off-census-year estimates depends on how evenly the growth of an area is distributed throughout that area, because growth projections are usually made at the county or regional level.

In Wisconsin, data on automobile ownership were available by minor civil division from the State Department of Transportation, Division of Motor Vehicles. This may vary from state to state.

The percentage of transportation handicapped is derived by using a formula based on incidence rates in other rural areas. As shown in Table 3, an incidence rate for moderately handicapped and an incidence rate for severely handicapped is applied separately to three age groups.

Land Use and Development Patterns

The location and size of rural developments and urbanized service areas was available in Rock County in the Farmland Preservation Plan prepared by the county planning department. In other areas the data may be available in local economic and community development or land use plans.

Existing Transit Service

Data such as fleet size and type, fares, hours, routes, type of service, and ridership eligibility are often collected and published annually. Sources for data on service in small urban areas are included in the 5-year Transportation Development Plans (TDP) and annually in federal, state, or local applications for transit assistance. In addition, public transit systems are required to keep monthly or quarterly records if they receive federal transit assistance.

Data on specialized transit services are available in grant applications for local, state, or

Table 3. Incidence rates of transportation handicaps by age and severity of handicap (2).

Age	Moderately Transportation Handicapped	Severely Transportation Handicapped
10-59	0.005	0.0107
60-64	0.0322	0.0344
65+	0.114	0.1818

federal funds. In addition transportation often is a separately recorded item in social service agency annual reports. Coordination studies and other local plans are typical sources of information on specialized transit services.

SUMMARY

The needs assessment technique discussed in this paper determines unmet transportation needs using a method that is low-cost and expedient, provides a basis for fair distribution of resources countywide, and makes it possible to present the results to local legislators in a clear, concise form. The use of secondary data reduces both cost and time. The use of proportions, as well as total numbers, of transit dependent within a subarea for assigning priorities to areas of need encourages a fair distribution of funds countywide. A one page profile for each geographical subarea provides an effective method of communicating the results to local legislators. The approach also provides an extensive data base for use in future planning efforts as well as in implementing the proposed service. The data profiles are also well suited to periodic updating for reintroduction at the next legislative session, if necessary.

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Computerized Management Information Systems for Transit Services in Small Urban and Rural Areas

JOHN COLLURA, RUTH BONSIGNORE, AND PAUL McOWEN

Before 1980 few transit properties in small urban and rural areas used computer-aided information systems. In the last several years, however, these transit agencies have begun to use computers to assist in tabulating information related to operations; administration; billing and accounting; and planning, monitoring, and evaluation. This increased use can be attributed to advances in computer technology as well as to the belief that such computers can improve efficiency and the delivery of transit service. The primary purpose of this research was to review nine automated management information systems (MISs) with respect to their hardware and software characteristics, initial and ongoing costs, and capabilities. This review is carried out within an evaluation framework that facilitates the conduct of a systematic, comprehensive review, in such a manner that transit professionals with little or no computer experience will understand major differences among the MISs and the various options available to automate the processing of information. Other issues regarding the implementation of MISs are also addressed, including staff requirements and available sources of funding for both fixed and recurring costs. The major conclusions of the research are (a) most efforts to computerize transit information systems in small urban and rural areas focus on paratransit services; (b) a comprehensive, low-cost, easy-to-use MIS is needed for fixed-route and fixed-schedule services in small urban and rural areas; and (c) steps should be taken to ensure that the national computer directory to be developed under the direction of NCTRP addresses the need of transit providers in small urban and rural areas.

Current fiscal constraints imposed on public transportation providers across the United States have increased the importance of efficient information management. As a result the use of automation is becoming more prevalent at many levels of transportation management to satisfy a wide range of information needs.

The purpose of this paper is two-fold: (a) to identify a variety of computerized management information systems (MISs) presently used by transit authorities and operators primarily in small urban and rural areas, and (b) to develop and apply an evaluation framework to compare and contrast these MISs.

An overview of the management information needs of small urban and rural operators is provided along with a summary of existing MISs in terms of their service characteristics, software and hardware components, costs, capabilities, and other factors. The review of the automated management information systems in this paper illustrates the diverse application of computer technology to the field of transportation management and should be especially useful in improving the understanding of computers among transportation professionals, particularly professionals involved in the planning and development of MISs for transit services in rural and small urban areas.

AN OVERVIEW OF MANAGEMENT NEEDS

Efficient management of information and finances is essential for an effective program of rural, coordinated public transportation (1). Because of present funding limitations, managers of regionwide transit services must take advantage of existing knowledge and use available technology to maximize productivity and cost-effectiveness. Innovative concepts in transit management are unfolding with new and improved methods of gathering, processing, reporting, and analyzing management information.

Every transit or paratransit system handles a wide range of information that is considered essential for day-to-day operations. These include financial, service-delivery, capital, maintenance, personnel, and service-user data. This information comprises a data base that management can use to perform various functions. These MIS functions for small-scale transit operators include (a) administrative; (b) operations; (c) planning, monitoring, and evaluation; and (d) billing and accounting. Proper monitoring of important management information provides a basis for ongoing evaluation of program administration and service delivery as well as for formulating short- and long-term planning strategies. The size of the data base and sophistication required for data processing correlate with the scope of the particular transit service, the number of different public and private funding sources involved in the program, and their respective data requirements.

Management information needs often vary with the type or mode of transportation service provided. Significantly more information is involved with demand-responsive services as opposed to fixed-route, subscription, or charter services because the demand-responsive programs often deal with client-specific data and multiple funding sources (2). Management needs for demand-responsive service also vary between coordinated systems that involve several different operators and consolidated systems that use a single operator and dispatch facility (3).

The time, effort, and cost of managing information have been identified as barriers to improving the efficiency and cost-effectiveness of rural and small urban public transportation services. Some success has been achieved in reducing institutional barriers by coordinating public funding sources at the state level and standardizing the related data requirements. Even with reduced or streamlined administrative data tasks, however, the volume of service delivery in most regional transit operations still presents a pressing need for new tools and approaches to information management. As a result various approaches have been implemented at the local level to manage information more efficiently, reduce costs, and improve transit services. The case studies in this paper examine nine different approaches to transportation management information systems.

After a preliminary review of all nine sites, it became clear that each case study had unique characteristics and that the functions of information management were weighted differently from site to site. Consequently, the computerization of these functions varied considerably. An evaluation framework was developed to aid in a comprehensive review of the existing management information systems.

The framework was to serve three major functions: (a) to describe in a systematic and organized manner the computerized MISs currently in use at these sites; (b) to assist in comparing and contrasting these MIS packages; and (c) to aid in identifying deficiencies of existing MISs in meeting the information needs of small urban and rural transit managers and operators.

EVALUATION FRAMEWORK FOR MISs

The framework, shown in Figure 1, consists of several major elements. These elements include the characteristics of the service area and the transit service being offered; the characteristics of the MIS, such as the hardware, software, cost, and ease of use; the source data; and the capabilities of the MIS with respect to operations and administrative assistance, planning, monitoring and evaluation, and billing and accounting.

During the evaluation of MISs it became evident that a closer examination of a number of aspects of each element would be necessary. As a result, each element of the framework was expanded, described in more detail, and presented in a table with headings corresponding to the various subelements. Information for the tables was obtained from discussions with persons at the sites and from additional documentation that was forwarded to the research team. The data provided a basis for the evaluation and for identification of deficiencies in the MISs. The results of the evaluation are presented in Tables 1-7 and are discussed briefly in this section.

Case Study Sites

The nine sites were chosen primarily because of the potential applicability of their MIS for use in small urban and rural areas. An effort was also made to select a group of sites that used MISs with different characteristics and provided different types of transit service.

The sites selected vary significantly in both geographic location and characteristics of the transportation service provided. They range from Barnstable County on Cape Cod in Massachusetts to Orange County in southern California. The operations surveyed range from the seven vehicles in Denton County, Texas, to the 600 buses in Orange County. The types of services administered include demand responsive, fixed route, subscription, and charter. A brief introduction to each operation follows. In addition, some characteristics of the sites and service provided are given in Table 1.

Cape Cod Regional Transit (CCRTA): CCRTA administers a demand-responsive service to 14 towns in Barnstable County, Massachusetts. Barnstable is a rural county with a year-round population of 140,000 and a summer population of about 450,000. The dial-a-ride service requires a 24-hr advanced reservation, uses 25 vehicles, and delivers 12,000 one-way trips per month. The CCRTA currently uses a minicomputer to assist with its scheduling and dispatching procedures, to generate reports, and to invoice clients monthly for services. The total monthly operating costs for the CCRTA is $85,000.

Community Responsive Transit (CRT) of Greater Cleveland: CRT operates a dial-a-ride service for the elderly and handicapped residents of Cuyahoga County, Ohio. The demand-responsive service requires a reservation one business day in advance and provides 38,000 one-way trips each month. When the scheduling of 83 vehicles to 18 different neighborhoods became a nightmare, the CRT investigated and implemented a computer-aided scheduling and dispatching system. The automated system also provides the CRT with many needed reports.

Delaware Specialized Transit Authority (DAST): DAST is located in Dover, Delaware, and provides an advance-reservation, demand-responsive service for the entire state. DAST operates 48 vehicles and services 58 towns and 39 agencies with a population of about 650,000. Because of their complex nature, the accounting, billing, and payroll functions of DAST have all been automated. The package operates on a microcomputer and includes both off the shelf and customized software programs.

Kansas City Transit Authority (KCTA): KCTA administers a fixed-route transportation service to the 1,200,000 residents of Kansas City and 10 surrounding towns. Approximately 2.3 million trips per month are delivered by a fleet of 303 vehicles. The total monthly operating cost is $2.3 million. The KCTA has a minicomputer that was programmed by the

Figure 1. Evaluation framework.

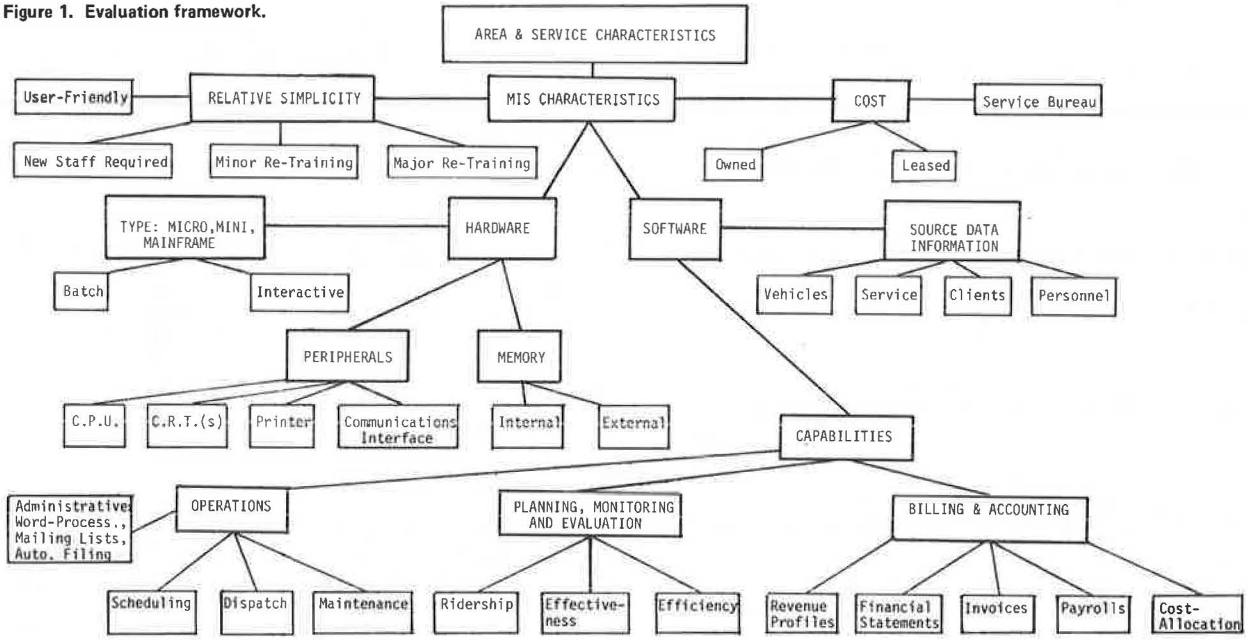

Table 1. Site and service characteristics.

NAME OF PROJECT & TYPE OF LEAD AGENCY	CENTRAL LOCATION	NUMBER OF PARTICI-PANTS:		MAJOR FUNDING SOURCES	POP. OF SERVICE AREA	SERVICE AREA (Sq. Mi.)	# OF VEHICLES		MONTHLY RIDER-SHIP		METHOD OF COLLECTING FARES OR USER FEES		BASIS OF FARE		NUMBER OF DIFFERENT OPERATORS	NUMBER OF DIFFERENT DISPATCH CENTERS	MONTHLY SYSTEM OPERATING COSTS ($)	
		TOWNS	AGENCIES				DEMAND RESPONSE & SUBSCRIPTION	FIXED ROUTE & CHARTER	DEMAND RESPONSE & SUBSCRIPTION	FIXED ROUTE & CHARTER	DEMAND RESP. & SUBSCRIPT.	FIXED ROUTE & CHARTER	DEMAND RESP. & SUBSCRIPTION	FIXED ROUTE & CHARTER			DEMAND RESP. & SUBSCRIPTION	FIXED ROUTE & CHARTER
SPAN (Private, Non-profit)	DENTON TEXAS	5	--	T. III,XIX CITY/ CTY. DONATIONS	150,000	900	7	--	2700	--	NONE	--	NONE	--	1	1	10,500	-
DAST	DOVER DELAWARE	58	39	CONTRACTS, UMTA,STATE	ENTIRE STATE	ENTIRE STATE	48	--	8740	--	AGENCY BILLS	--	ZONES or HOURLY	--	2	3	95,000	-
ORANGE COUNTY TRANSIT DISTRICT	GARDEN GROVE, CALIF.	26	--	UMTA, STATE, CITIES	2,000,000	420	130	477	70,000	2.4 mil	ON-BOARD	ON-BOARD	$1.00 ZONE	.60	4	1	.5 mil	5 mil
KANSAS CITY TRANSIT AUTHORITY	KANSAS CITY	11	--	UMTA, LOCAL SALES TAX & GENERAL REVENUE	1,200,000	350	--	303	--	2.3 mil	--	ON-BOARD	--	.40	1	1	--	2.3 mil
OATS	COLUMBIA, MISSOURI	88 COUN-TIES	11	T. XX, T. III, SEC. 18, SEC. 16B-2	3,004,983	53,056	147	--	37,000	--	ON-BOARD	--	UNIT RATE	--	6	6	190,000	--
CAPE COD REGIONAL TRANSIT AUTHORITY	BARNSTABLE MASS.	14	1	SEC. 18, T. XX, T. III	140,000	394	25	--	12,000	--	CLIENTS BILLED MONTHLY	--	PASS MILES & TRIPS	--	1	1	85,000	--
SANTEE WATEREE TRANSIT AUTHORITY	SUMTER, S. C.	--	15	T. XX, T. XIX, CONTRACTS	167,000	--	50		22,000		NONE	ON-BOARD	NONE	ZONES	1	1	75,000	
COMMUNITY-RESPONSIVE TRANSIT OF GRTR. CLEVELAND	CUYAHOGA COUNTY, OHIO	81	48	UMTA SEC.5 STATE & LOCAL SALES	1,700,000 ≈ 250,000 eligible	495 18 SERVICE AREAS	83	--	38,000	--	CASH, TICKETS, FARE CARDS, TRANSFERS	--	25¢ BASE 40¢ PEAK	--	2	1	235,000	
OZARK TRANSIT	SPRING-DALE, ARKANSAS	4 COUN-TIES	5	SEC. 18, T. XX, COUNTY, CITY CONTRACTS	125,000	2600	21		--	--	ON-BOARD	ON-BOARD	--	--	1	1	25,000	

in-house staff primarily for the purposes of billing and accounting. The computer package also includes programs for vehicle maintenance.

The Older Adults Transportation Service, Inc. (OATS): OATS was established in 1971 and offered door-to-door transportation to the elderly and handicapped residents of eight Missouri counties. Today OATS provides service to the residents of 88 of Missouri's 114 counties and has seven area offices across the state. The program operates more than 147 buses and delivers 37,000 trips per month. OATS has an in-house minicomputer to maintain its financial information as well as a telephone hookup with the University of Missouri-Columbia computer network for billing and statistical summaries. This system provides OATS and its funding sources information when it is needed (4).

Orange County Transit District (OCTD): OCTD is the largest transportation service investigated in this paper. The OCTD, located in Garden Grove, California, provides the 2 million residents of Orange County with three types of transportation service: fixed route, demand responsive, and subscription. The fixed-route service uses 477 vehicles and provides 2.4 million trips per month. A fleet of 130 vehicles for the demand-responsive services delivers 70,000 trips per month. The total operating cost for all service is $5.5 million. The OCTD has a variety of computer packages that operate on two minicomputers.

Ozark Transit: Ozark Transit operates out of Springdale and provides transportation service to 125,000 residents in four rural counties of Arkansas. The service includes fixed route, demand responsive, and a recently implemented commuter park-and-ride service. Ozark runs 21 vehicles and has a total monthly operating cost of $25,000. To simplify the billing of agencies, financial accounts, and payroll, Ozark uses a financial package on a timesharing basis with a local computer firm.

Santee Wateree Regional Transit Authority (RTA): The Santee Wateree RTA is located in central South Carolina. The RTA provides transportation services to four rural counties with a combined population of 167,000. Four types of services are administered: fixed route, demand responsive, subscription, and charter. The total monthly operating cost for Santee Wateree is $75,000. To address its broad management information needs, the RTA uses a minicomputer and a specially developed software package. The package includes financial, passenger accounting, personnel, scheduling, and vehicle maintenance programs (5). Development of this MIS was sponsored by the South Carolina Department of Highway and Public Transportation.

SPAN. SPAN operates a demand-responsive transportation service in Denton County, Texas. Denton, a rural county in the northeastern region of the state, has a population of 150,000. The service delivers about 3,000 one-way trips monthly at a total monthly cost of $10,500. When SPAN began investigating the automation of certain components of its MIS, the key concern was routing, scheduling, and dispatching. Today, SPAN has a complete online computer-aided scheduling and dispatching system for its seven-vehicle transit operation. The system uses customized software and a North Star microcomputer.

MIS Characteristics

The MISs in use at these nine sites vary widely because of differences in the size and characteristics of the service and the respective funding mechanisms. The MISs illustrate many of the automation options using different types and brands of computers, both off-the-shelf and customized software, and many types of peripherals.

There are three general types of computers--determined by their size, structure, storage capacity, and processing speed. The newly developed microcomputer is a compact office machine with advanced capabilities. These small computers usually allow for the use of only one cathode-ray tube (CRT-keyboard and visual display screen) at a time for data entry; however, some advanced models allow for multiple CRTs. They primarily use floppy disk storage but can also use hard-disk external storage. Microcomputer hardware can be purchased for as little as $5,000 to $10,000. This equipment usually has an 8-bit word size and internal memory capability in tens of thousands of bytes. The SPAN program in Denton, Texas, uses a microcomputer with 64,000 bytes of internal memory for a small fleet of seven paratransit vehicles.

The minicomputers represent a medium-sized range of equipment. These machines are designed to handle larger volumes of data with greater speed and more sophisticated logic than the microcomputers. Minicomputers generally use hard-disk storage and have the capability to enter data simultaneously from multiple CRTs. Some minicomputers are expandable by adding additional memory storage. Most automated management information systems at the public transit sites surveyed use minicomputers. The cost of the minicomputer hardware for these sites ranged from $38,000 to $300,000 per computer. Minicomputers typically have 16-bit word size and internal memory capacity of hundreds of thousands or even millions of bytes of storage.

The larger computers are known as mainframes because they can be expanded internally by adding component frames of memory. This equipment has been the standard of the computer industry until the development of mini and microcomputer technology. Mainframe computers are very fast, sophisticated, and expensive. Many require special air-conditioned rooms and have annual maintenance costs of tens of thousands of dollars. These large computers can perform many different processing tasks at the same time, using scores of CRTs simultaneously. For the most part, transit systems that use mainframe computers use either batch processing (i.e., data are keypunched onto cards) at an off-site facility or an interactive time-sharing arrangement with the use of a terminal at the transit site. Both the Ozark MIS in Arkansas and the OATS MIS in Missouri use off-site mainframe computers.

Most of the software used by the transit sites was written by in-house staff or an outside programming firm. The major exception is the use of off-the-shelf financial packages by the OATS system, Santee Wateree RTA in South Carolina, and DAST in Delaware. Most of the programs, both off the shelf and customized, are written in BASIC.

Because many transit systems may not employ computer-knowledgeable staff, another important MIS characteristic to consider is "user friendliness." This term is used to indicate the degree of difficulty that may be encountered by transit staff in comprehending and using the automated MIS. A review of the MIS characteristics of all nine case study sites is presented in Table 2.

MIS Cost

There are three major financing options to consider with an automated MIS. The hardware can be (a) owned and operated by the transit system, (b) leased and operated by the transit system, or (c) owned and operated by a service bureau that provides data pro-

Table 2. Management information system characteristics.

NAME OF PROJECT	MODE		FACILITY		HARDWARE														SOFTWARE				STAFF SUPPORT		
								BRAND-MODEL					MEMORY		CAPACITIES										
	BATCH ENTRY	INTERACTIVE	ON SITE	OFF SITE	MICRO	MINI	MAINFRAME	CPU	CRT	PRINTER	TERMINALS #	WORD SIZE (BIT)	HARD DISC	FLOPPY DISC	INTERNAL	EXTERNAL	COMMUNICATIONS INTERFACE	GRAPHICS DISPLAY	LANGUAGE(S)	OFF SHELF	CUSTOM PROGRAM	PROGRAMMING FIRM(S)	NEW STAFF REQUIRED	MINOR STAFF RETRAINING	CONSIDERABLE STAFF RETRAINING
SPAN	--	✓	✓	--	✓	--	--	NORTH STAR HORIZON	HAZELTINE 1420	T.I. 810	1	8		✓	64K	720K	--	--	BASIC	--	✓	TRAN.COMP. GROUP	--	--	--
DAST	--	✓	✓	--	✓	--	--	NCR	NCR 12"	NCR	1	8	--	✓	64K	720K	--	--	BASIC	--	✓	NCR PA.	✓	--	✓
ORANGE CTY.	--	✓	✓	--	--	✓	--	2, FRAME 750's	80 M42 LEAR ZIEGLER	DEC WRITER	16	16	✓	--	2.5 MGBT	300 MGBT	E SYSTEMS DIGITAL COMM.	TEXTRONICS 4027	COBOL FORTRAN RPG M.I.T. ALGORITHIM	--	✓	TRANSMAX	--	--	--
KANSAS CITY	--	✓	✓	--	--	✓	--	IBM 34	IBM	IBM	8	8	--	✓	128K	720K	--	--	RPG 2 FORTRAN	--	✓	IN-HOUSE STAFF	--	--	--
OATS	✓	✓	✓	✓	--	✓	✓	J KARD J 100	J KARD	DIABLO	3	16	✓	--	14 MGBT	--	✓	--	BASIC	✓	✓	CAL-TYPE	--	--	--
CCRTA	--	✓	✓	--	--	✓	--	DATA GEN. NOVA	DATGEN 6053	DATGEN LP 2	4	16	✓	--	64K	120 MGBT	--	--	BASIC	--	✓	CROSSBRO BROCKTON	--	--	--
SWRTA	--	✓	✓	--	--	✓	--	WANG 2200	WANG 2236	WANG 2231	2	--	✓	--	--	80 MGBT	--	--	BASIC	✓	✓	--	--	--	--
CRT	--	✓	✓	--	--	✓	--	BASIC 4 730	BASIC 4	BASIC 4	12	8 **	✓	--	192K	150 MGBT	--	--	BASIC	✓	✓	COMPUTER DYNAMICS	--	✓	--
OZARK	--	✓	✓	--	--	--	✓	*	ADDS REGENCY	T.I.									BASIC				--	--	--

* Ozark timeshares on a mainframe computer but owns on-site equipment. ** 16 for some functions.

cessing for a fee. The Kansas City system leases its equipment at an annual leasing expense of $81,000 and is financed, in part, by UMTA operating subsidies. The Cape Cod Transit Authority financed its MIS under a lease-purchase agreement with the help of UMTA Section 18 rural operating subsidies. None of the systems surveyed employ a service bureau to handle their data needs.

Regardless of which financing option is selected, there are still software development costs. The total software costs of the automated systems studied ranged from $1,500 to program the North Star microcomputer for the SPAN project to $800,000 to develop the programs for the two Prime minicomputers serving the Orange County MIS.

Total system costs for both the hardware and software at the transit sites reviewed ranged from $10,000 for the SPAN paratransit program to approximately $1,400,000 for the OCTD, which coordinates 607 vehicles in a combination of fixed-route and demand-responsive service.

The most common sources of funding for these systems were UMTA capital grants. Other sources of MIS funding included local and state taxes and U.S. Department of Health and Human Services (HHS) and sources such as Title III, Title XX, and Title XIX. The associated costs and sources of funding for these automated systems are given in Table 3.

MIS Source Data Elements

The sites surveyed that provide demand-responsive transportation services--SPAN, DAST, CCRTA, SWRTA, and OATS--maintain detailed client information such as client ID number, address, phone number, funding eligibilities, disabilities, frequency of service use and, in some cases, socioeconomic information.

Vehicle files are maintained with both demand-responsive and fixed-route systems in order to monitor vehicle mileage, service hours, seating capacity, downtime, and accident records. These data files can be used for automated routing functions, preventive maintenance, scheduling, and for assessing vehicle use.

Most of the transit systems surveyed keep some trip or service-delivery information such as passenger trips, passenger miles, trip purposes, origin and destination of trips, or other special service data. Again, there is a greater need for this type of data with demand-responsive service than with fixed-route service. Four of the systems studied use their computer to keep personnel data such as employee history, attendance, wages, hours, and benefits. The Santee Wateree RTA and the Cape Cod RTA maintain data files for most of the data elements mentioned. Data tabulated and processed by the nine sites are given in Table 4.

MIS Capabilities

Operations and Administrative

Some of the automated systems studied used their computers for scheduling passenger trips, for dis-

Table 3. Management information system costs.

(Note: Costs should be considered in relation to the functions performed in Tables 4, 5, 6 & 7)

NAME OF PROJECT	MIS FUNDING SOURCES(S)	OWNED SYSTEM				LEASED SYSTEM		SERVICE BUREAU		ANNUAL MIS COST ÷ ANNUAL PROGRAM BUDGET (%)
		INITIAL		ONGOING						
		HARDWARE	SOFTWARE	ANNUAL MAINTE-NANCE	ANNUAL SUPPLIES	ANNUAL LEASING COSTS	SOFTWARE DEVELOPMENT COSTS	ANNUAL PROCESSING CHARGES	SOFTWARE DEVELOPMENT COSTS	
SPAN	T. III	7,800	1,500*	--	250	--	--	--	--	--
DAST	UMTA, State	13,000	7,000	3,500	--	--	--	--	--	--
ORANGE COUNTY	UMTA	300,000 @	800,000	4,500 @	--	--	--	--	--	--
KANSAS CITY	UMTA, LOCAL TAXES	--	--	--	--	81,600	80,000	--	--	--
OATS	MID CONTINENT FED. REG. COUNCIL - COMM. ON TRANS., H.H.S. $	--	--	--	--	13,150.68	--	14,245	--	1%
CCRTA	SEC. 18	38,000	12,000	--	--	--	--	--	--	--
SWRTA	S.C. DEPT. OF HIGH-WAYS & PUBLIC TRANS.	40,000	45,000	--	--	--	--	--	--	--
CRTA	UMTA SEC. 5, STATE & LOCAL SALES	--	--	--	5,000	36,000 includes maintenance	12,000 three increments	--	--	(1.5%) 42,000
OZARK	NR**	NR**	NR**	NR**	NR**	--	--	--	--	--

* Software has been upgraded and is being marketed.
** Not reported.

Table 4. Management information system capabilities: source data elements.

NAME OF PROJECT	CLIENT SPECIFIC INFORMATION						TRIP INFORMATION							VEHICLE-SPECIFIC INFORMATION								PERSONNEL	
	PASSENGER I.D. NUMBER	ELIGIBILITIES	SERVICE USAGE	SOCIO-ECONOMIC	DISABILITIES	OTHER AGENCY-SPECIFIC	BY CONTRACT OR TOWN OR ROUTE.	PASSENGER TRIPS	PASSENGER MILES	TRIP PURPOSES	RIDER CATEGORIES	TRIP INFORMATION SAMPLING DR	TRIP INFORMATION SAMPLING FR	VEHICLE INFORMATION SAMPLING DR	VEHICLE INFORMATION SAMPLING FR	SEATING CAPACITY	DOWN TIME	MAINTENANCE HISTORY	FUEL CONSUMPTION	VEHICLE MILES	VEHICLE HOURS	WAGE & HOURS	EMPLOYMENT HISTORY ATTENDANCE RECORD ACCIDENT RECORD COMPLAINTS, DISPLN SICK DAYS & VACATION TIME USED
SPAN	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	100%	--	100%	--					✓			
DAST	✓					✓		✓				Sample	--	Sample	--							✓	
ORANGE COUNTY	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	Sample		Sample		✓	✓	✓	✓	✓	✓	✓	
KANSAS CITY					✓	✓						--	--	--	--		✓	✓	✓	✓		✓	✓
OATS	✓	✓	✓		✓	✓	✓	✓	✓	✓		100%	--	--	--	✓			✓	✓	✓		✓
CCRTA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%	--	100%	--	✓	✓	✓	✓	✓	✓		
SWRTA	✓	✓	✓		✓	✓		✓	✓			--	--	--	--	✓	✓	✓	✓	✓	✓	✓	✓
CRT	✓	✓	Spec. Cases		✓	Spec. Cases	Serv. Type & Area	✓		✓	✓	100%	--	100%	--	✓	✓	✓	✓	✓			
OZARK												--	--	--	--							✓	✓

patching vehicles, and for assisting with maintenance operations. All of these sites except OATS, Kansas City, and Ozark have developed automated scheduling assistance.

The MIS used by the Cape Cod RTA system provides an example of computerized trip booking assistance for a rural public paratransit service (6). When a client phones the central dispatch office to request a ride, the dispatcher enters the caller's ID number on the CRT. The screen automatically displays the client's name, address, eligibilities, handicaps, and other related information from the external hard-disk memory. When the dispatcher knows the approximate time and location of the pickup, the vehicle schedule that might be able to handle the trip request can be identified on the terminal. The trip can then be booked immediately on the CRT and made part of the permanent schedule. At the end of the day the computer can automatically print out all vehicle schedules or driver stop-lists--eliminating the need for dispatchers to prepare driver schedules by hand.

Many demand-responsive systems require that reservations be made 12 to 48 hours in advance in order to schedule trips efficiently. These systems may also have standing reservations for those clients who regularly ride at the same time every day or week, such as to a meal program or place of employment. These trips are entered automatically by the computer without the need for the dispatcher to reenter the trip request manually each day.

Fully automated scheduling and dispatching are the most complicated tasks accomplished by the transit-system computer. This level of sophistication has been accomplished only by large transit systems serving dense populations within relatively small geographic areas. The Prime minicomputer used by the Orange County system actually suggests the best vehicle to handle the request for service by taking into account such factors as time, route, distance, and traffic.

Maintenance programs studied included custom packages and standard software programs. The Kansas City system developed an extensive maintenance and inventory program using an IBM 34 minicomputer. In addition to preventive maintenance, information about repair frequency and cost can be stored for each vehicle and reported by vehicle, fleet, or system wide.

Although many of the systems researched had the capability to use the computer to aid such administrative tasks as word processing, mailing lists, and filing, only a few of the sites actually used their computers for these purposes. The operational and administrative functions carried out at each site are summarized in Table 5.

Planning, Monitoring, and Evaluation

The information recorded and stored by the MIS computer can be used in a variety of ways to monitor the services provided and the associated costs. Evaluation of this information can help management to formulate decisions that will make the service more effective and efficient (7). The specific evaluations include ridership analysis, vehicle performance, system productivity, routing analysis, and revenue generation. Examples of short-term indicators that could be useful include abnormal (and costly) fuel consumption, tire wear, and breakdown frequency.

Most systems expressed concern about planning, monitoring, and evaluation. The Cape Cod RTA, using a Data General minicomputer, generates the widest range of reports for this purpose. Most transit sites can use the more detailed and accurate information obtained from their automated management information systems to compare cost and service levels with the past month's or year's operations as well as with other transit systems. This improved capacity for evaluating services and costs can also greatly speedup the process of analyzing the effects of policy changes such as fare increases or reduced levels of service.

A review of the monitoring and evaluation capabilities of the sites surveyed is given in Table 6.

Billing and Accounting

Most of the computerized financial functions performed at the sites use off-the-shelf software. The availability and inexpensiveness of this software has made centralized transit bookkeeping an efficient and cost-effective component of the MIS. This capability also allows the bookkeeper to monitor system finances more accurately, generate reports to government funding sources, issue checks and invoices, and allocate costs among different towns, agencies, or contracts.

The Santee Wateree system has one of the most extensive financial software programs developed. Most of the elements of this financial software were purchased off the shelf. The Santee Wateree system is the only system in the survey that integrates the full utilization of its service data elements with the full utilization of its financial software elements on the same minicomputer.

The Cape Cod RTA system has developed an innovative method of sending monthly computer invoices directly to its paratransit clients. A flat fare is charged for certain trip purposes within the same town. Intertown trips charge a per-mile rate. The monthly invoice lists the trips taken during the month and is similar to a telephone bill. The rate per mile provides an incentive to riders to take shorter trips whenever possible. This new system has enabled the CCRTA to generate significantly greater fare revenues without any reduction in total monthly ridership. A review of the computer capabilities for billing and accounting functions is presented in Table 7.

Table 5. Management information system capabilities: operations and administrative assistance.

NAME OF PROJECT	SCHEDULING							INTERACTIVE CAPABILITIES WITH DRIVER	DISPATCHING		MAINTENANCE			ADMINISTRATIVE FUNCTIONS		
	MANUAL-COMPUTER ASSISTED	FULLY AUTOMATED	IMMEDIATE	ADVANCE	STANDING	WAITING	PRINTING STOP LISTS		MANUAL - COMPUTER ASSISTED	AUTOMATED TOUR BUILDING	PREVENTATIVE SCHEDULES	INVENTORY - TIRES, PARTS	REPAIR SCHEDULES	WORD PROCESSING	MAILING LISTS	AUTOMATED FILING
SPAN	✓			✓	✓		✓		✓							
DAST																
ORANGE COUNTY		✓	✓	✓	✓	✓	✓			✓	✓	✓	✓			
KANSAS CITY	✓															
OATS				✓										✓		
CCRTA	✓			✓	✓		✓		✓		✓		✓			
SWRTA				✓			✓		✓		✓		✓			
CRT	✓		✓	✓	✓		✓		✓		✓		✓	✓	✓	✓
OZARK												✓		✓		

Table 6. Management information system capabilities: planning, monitoring and evaluation.

NAME OF PROJECT	RIDERSHIP		ANALYSIS		VEHICLE-SPECIFIC PERFORMANCE				PERFORMANCE MEASURES: EFFECTIVENESS								PERFORMANCE MEASURES: EFFICIENCY					USER REVENUES				
	RIDERSHIP FLUCTUATIONS BY ROUTE	TARGET USER GROUP ANALYSIS	TRIP PURPOSE BREAKDOWN	SPECIAL REPORTS TO AGENCIES	FUEL EFFICIENCY	TIRE LONGEVITY	MAINTENANCE COST/ MILE/PERIOD	DOWN TIME/PERIOD	ANALYZED BY ROUTE	PASS TRIPS/TIME	PASS MILES / TIME	PASS MILES / TRIP	PASS TRIPS/VEHICLE MILE	COST / PASS TRIP	COST / PASS MILE	COMPARISONS WITH PRIOR PERIOD	ANALYZED BY ROUTE	VEHICLE MILES/ TIME	COST PER VEHICLE HOUR	COST /VEHICLE MILE	COMPAR. W/ PRIOR PERIODS	BY ROUTE	BY DAY	BY TIME	COMPARISON WITH PRIOR PERIOD(S)	COMPARISON WITH INCOME PROJECT
SPAN	✓	✓	✓	✓					✓			✓	✓													
DAST																										
ORANGE COUNTY	✓	✓				✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓				
KANSAS CITY	✓			✓		✓														✓						
OATS		✓	✓	✓						✓		✓	✓													
CCRTA	✓	✓	✓	✓					✓	✓		✓	✓	✓	✓				✓	✓						
SWRTA				✓					✓	✓		✓	✓													
CRT		✓	✓	✓	✓			✓	By area	✓			✓				By area	✓								
OZARK																										

Table 7. Management information system capabilities: billing and accounting.

NAME OF PROJECT	FINANCIAL STATEMENTS AND ACCOUNTS																	PAYROLL			COST ALLOCATION		INVOICING		
	EXPENSES BY FUNCTION CATEGORY	SECTION 15 CONFORMANCE	REVENUES SCHEDULES	CAPITAL SCHEDULES	CHART OF ACCOUNTS	AGENCY-SPECIFIC STATEMENTS	YEAR-TO-DATE STATEMENTS	ACCOUNTS RECEIVABLE/ PAYABLE	PROGRAM BUDGETING	BALANCE SHEETS	TRIAL BALANCE	GENERAL LEDGER	COMPARISONS TO BUDGET	COMPARISONS WITH PRIOR PERIOD	CASH FLOW PROJECTIONS	AGING OF ACCOUNTS	DOUBLE-ENTRY BOOKKEEPING	CALCULATE WAGES, TAXES, DEDUCTIONS	FRINGE BENEFITS ACCRUED	PRINTING CHECKS	AGENCIES	TOWNS	AGENCIES	TOWNS	CLIENTS
SPAN																									
DAST	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓		✓
ORANGE COUNTY	✓	✓	✓	✓	✓			✓		✓		✓													
KANSAS CITY	✓	✓	✓		✓			✓		✓		✓						✓	✓	✓		✓		✓	
OATS	✓	✓	✓	✓	✓		✓	✓		✓		✓	✓				✓				✓		✓		
CCRTA								✓*													✓	✓	✓	✓	✓
SWRTA	✓		✓	✓	✓			✓		✓		✓						✓	✓	✓	✓		✓		
CRT																									
OZARK												✓						✓	✓	✓					

* CCRTA has an accounts receivable program for its client invoicing system.

SUMMARY AND CONCLUSIONS

A review of nine transit management information systems currently in use is presented in this paper. This review will be of interest to the transit practitioners who are considering the development of automated MISs, particularly transit managers and operators in small urban and rural areas. The MISs are reviewed in a systematic, comprehensive manner so that individuals with little or no experience with computers can understand the major differences in computer systems in terms of size, scale, cost, and capability.

In addition to the site-specific MISs included in this paper, the authors have also identified and reviewed a number of software packages including SIMS (8) for maintenance and inventory functions and RUCUS I and RUCUS II (9) for run-cutting purposes. Also reviewed were several packages within the private sector such as Transmax, Transpac, TMIS, and Contax. These packages were designed primarily for transit agencies using mainframe or large minicomputers, which are typically not affordable or practical for use in rural and small urban areas.

It should also be noted that the Massachusetts Executive Office of Transportation and Construction

(EOTC) is conducting an experimental program to provide capital funding to a number of private nonprofit paratransit systems to purchase microcomputers. In addition, the U.S. Transportation Systems Center (TSC) in Cambridge, Massachusetts, is conducting similar research on the use of microcomputers in paratransit (2).

Based on the results reported in this paper, the following conclusions can be drawn:

1. Most efforts to automate management information systems in small urban and rural areas have focused on paratransit services rather than conventional fixed-route, fixed-schedule services. These MISs generally use microcomputers or minicomputers with initial hardware and software costs of between $8,000 and $85,000 and with annual recurring costs of less than 1.5 percent of the annual operating budget.

2. A comprehensive low-cost, easy-to-use MIS has not yet been developed for fixed-route, fixed-schedule systems typically in operation in small urban and rural areas (systems with fleet sizes of 30 vehicles or less). Such a MIS should be equipped to meet the operations, administrative, billing and accounting, and planning, monitoring, and evaluation needs of transit services at an affordable cost and should be designed so that it can be used by staff with little or no computer experience.

3. There is a need to assemble and continually update a directory of computer hardware and software suitable for transit services in small urban and rural areas. Although the directory (10) prepared by the American Public Transit Association (APTA) covered many transit systems across the United States, it did not include many MISs used in small urban and rural areas. The current efforts of the NCTRP and the ITE to develop such directories should help to address this need.

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Providing Innovative Rural Transportation Services Under Severe Budget Constraints

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Economic conditions in many areas of the country have forced severe budget cuts for many government services. This is especially true in rural areas, where local governments have been forced to examine critically the types and extent of services they provide. Two services being examined carefully are public and social agency transportation services. Some recent experiences are presented for planning public transportation services in a rural, four-county region in North Central Wisconsin (which currently has little public transit). The counties involved are all experiencing budget cuts and, thus, an initiation of public transit services was being considered within the context of rising costs, shrinking budgets, and skeptical local politicians. Although basic conditions in the area are not unusual, this planning process was unique in that (a) a service was planned that will require no local government subsidy, (b) agency transportation services were considered as an integral part of the regional public transit service, and (c) transit services were tailored to the origin and destination densities of the local area being served. The final plan involved opening up agency services to the public and charging a fare, establishing a carpool/vanpool program, and establishing a subscription bus service. Some general observations concerning rural public transportation today are also drawn from the project.

One of the groups most affected by the recent economic conditions in this country has been local governmental units. In these times of growing personal distress--unemployment, loss of purchasing power, and inability to cope with excessive interest rates--many counties, cities, and towns have faced increasing demands for social services within the context of shrinking budgets and increasing costs.

In one way this predicament has helped by forcing local governments to look critically at the services they provide and to make hard decisions about whether the services are meeting the needs they intended. Funds often are unavailable, however, to cover all necessary services. This means that even services that can be considered vital to the welfare of some parts of society are being cut.

These economic conditions, coupled with the current uncertainty of future federal funding for rural transportation programs, have had a devastating effect on the initiation of local transportation programs in rural areas. Local decision makers are understandably reluctant to commit funds and political support for establishing public transit services in these austere and uncertain times. At the same time, these same decision makers are questioning the expenditure of scarce social service moneys on transportation (which is often seen as a secondary service). Local social service agencies are being asked to cut overall budgets, and transportation budgets often bear the brunt of these cuts.

The purpose of this paper is to share experiences in determining the feasibility of initiating public transportation services in a rural area in North Central Wisconsin (1). The area examined covers four rural counties, with a few small urban centers, that currently have little public transportation services. The counties do have social agency transportation services for elderly, handicapped, and low-income persons. All of the counties are experiencing budget cuts, and considerations of new public transit services took place within the context of the rising costs of other governmental services. Needless to say, the counties' participation in the project began (and in some cases continued) with skepticism. Nevertheless, needs were identified, palatable solutions devised, and progress made.

In this paper the project is described and some general observations on what can be learned from the experience are offered.

STUDY BACKGROUND

This study investigated the feasibility of initiating public transportation services in Forest, Langlade, Oneida, and Vilas Counties, Wisconsin. This North Central Wisconsin region is rural and has about 77,000 persons living in the 3,842 square mile area (approximately 20 persons per square mile) (2). The region has four small cities ranging in size from 1,326 persons to 8,653 persons (one in each county).

The study was initiated by and funded through the Madison and District No. 7 Offices of the Wisconsin Department of Transportation. Policy decisions for the study were made by the Study Policy Advisory Committee which was composed of three persons from each of the four counties (ten County Board members and two County Transportation Committee members). Additional input was solicited from local businesses, agencies, and citizens through a Technical Advisory Committee and through a series of public meetings on the study that were held in each county. In addition, a report on the study was made to each County Board during October and November 1981. County Board members were kept up to date on the study progress through their respective representatives on the Policy Advisory Committee. Because the study determined that it is feasible to provide public transportation in the region, a program for implementing the service was also produced.

STUDY GOALS

One of the first tasks in the project was to establish a set of goals for providing public transportation in the study region. The goals were developed using advice from the Policy Advisory Committee, data on existing travel and demographic characteristics in the region, and data on existing transportation services in the region. Goals were set by first soliciting views on the need for public transportation from the Policy Advisory Committee, collecting and analyzing the data described previously, and preparing a draft statement of goals for discussion. These goals were reviewed by the Policy Advisory Committee, discussed, and made final.

Goal setting for feasibility studies has been traditionally thought of as the identification and specification of priority needs for services in an area (3). For the purpose of this study, however, it became necessary to express goals separately in terms of (a) the need for public transportation in the region and (b) the need for intelligent and systematic use of existing transportation services and resources in the region. A review of the list of goals in Appendix A shows that most of the goals dealt with the latter set of needs.

In general all the goals identified for the study dealt with making transit services operationally effective and efficient. The first goal stipulated that transit services will be provided only in areas with high demand by those dependent on transit (to fill up vehicles and make services efficient) and that these services will be targeted toward areas with the greatest need (to make services more effective). The second and third goals deal with making existing services more efficient and effective both by improving existing agency services and by minimizing capital investments by using existing public and private resources to the greatest extent possible.

But the goal that was considered by far the most important by the Policy Advisory Committee (and the goal that they would not consider compromising) was the stipulation that no additional local funds would be spent. Taking this into account from the onset of the project was important because it greatly affected how the remainder of the project was approached. The most significant effect on the study was that no alternatives were considered that would raise the level of local funding above that currently used to support the transportation efforts of local social service agencies. The study's final goal dealt with identifying and making recommendations for changing laws or regulations to remove constraints on making better use of existing resources.

DATA ANALYSIS

Data were collected on population and travel characteristics, existing transportation providers, characteristics of funding programs for transportation, and the local politics affecting public transportation in the study area. Based on the data analyzed, a number of major conclusions were drawn that influenced further development of the plan. These conclusions are given below.

First, in many parts of the region there is a demand for public transit to provide work trips during the peak hours. Additionally, there is a need to provide public transit to serve nonwork trips during off-peak hours in many parts of the region. Second, some areas have a higher density of origins and destinations which warrant fairly high-volume transit solutions (such as subscription bus services), whereas others have lower densities more suited to low-volume solutions (such as carpools).

Third, a wide variety of social service agencies are providing transportation services, primarily to their clients. Many of these agencies have excess capacity on their vehicles, and the hours and days they currently operate make them appropriate for the provision of nonwork trips during off-peak hours. Any provision of work trips by these agencies would entail starting new services. A number of private operators in the area can complement social agency services by providing services for work trips (some currently provide contract bus service to agencies in the region).

Fourth, funding was the only barrier to providing public transit in the region. The consensus of the Policy Advisory Committee was that no additional funds for public transportation will be available from county governments. Although this constraint did not preclude establishing public transit services in the region, it did limit the design of the services to (a) one within current subsidy levels contributed by the counties for specialized transportation services and (b) one in which the users bear the full cost of the service.

ALTERNATIVE SKETCH PLANS

Based on the data analysis, seven alternative sketch plans were developed for providing public transit services. The alternatives are nested and include four basic service concepts: (a) opening existing agency services to the public and charging a fare, (b) modifying existing agency services, opening them to the public, and charging a fare, (c) establishing a carpool program, and (d) establishing a subscription bus service. The two alternatives that involved modifying the routes and schedules of current agency services were eliminated early in the development process. The remaining five alternatives were carried on into the assessment phase. The five alternatives are

1. Do nothing.
2. Open existing agency services to the public.
3. Open existing agency services to the public and establish a carpool/vanpool program.
4. Open existing agency services and establish a subscription bus service.
5. Open existing agency services, establish a subscription bus service, and establish a carpool/vanpool program.

ASSESSMENT OF ALTERNATIVE PLANS

The five alternative plans were assessed in terms of the following sets of characteristics: (a) goal attainment; (b) financial characteristics (additional costs and revenues); (c) service characteristics (additional passengers (4) and local, political, and community acceptance); and (d) regulatory feasibility.

After reviewing the assessment of alternative plans, alternative 5 was chosen for further development because it provided the most service, increased efficiency and effectiveness of existing services the most, encouraged involvement of private operators, and maintained current subsidy levels for transportation in the region. Following is a description of the service elements in the recommended plan.

DESCRIPTION OF THE PLAN

The plan to be implemented includes three service elements: (a) opening selected agency services to the public and charging a fare; (b) establishing a subscription bus service; and (c) establishing a carpool/vanpool program. For easy reference, summary sheets on overall management and institutional arrangements and the three basic plan elements have been included in Appendixes B, C, D, and E.

The plan will be implemented and operated by the Regional Transportation Committee for policy overview and the Regional Coordinator for day-to-day management. The Regional Coordinator will be housed in an existing agency that will supervise the Coordinator's activities. (It has not yet been determined which agency will house the Coordinator but possibilities being discussed include the Wisconsin DOT District No. 7 Office, the North Central Wisconsin Regional Planning Commission, and Nicolet College.) See Appendix B for a summary of the administrative characteristics of the plan.

The estimated operating costs of the plan are approximately $177,000 per year (in 1982 dollars). These costs will be paid by the users of the service. The total costs include approximately $155,000 for operation of the subscription bus service and $22,000 for administrative costs ($11,000 per year for administration of the carpool/vanpool program and for technical assistance to agencies opening services to the public, and $11,000 per year for administration of the subscription bus service). Because the plan calls for subscription bus services to be provided under contract with a private operator or agency, operating costs for the service are based on current charter and contract service rates charged by operators in the area.

Funding for the project would come from a number of sources. The ongoing funding sources for the plan are as follows:

- Opening of agency services: No additional costs will be incurred in opening agency services to the public.
- Subscription bus service: Fares from riders will cover administrative and operating costs.
- Carpool/vanpool program: Operating costs will be shared by carpool/vanpool members. Administrative costs for the Coordinator's work on the carpool program will be sought from private local businesses and foundations. When it is fully operational, revenue from the subscription bus service is also expected to cover the cost of the Coordinator administering the carpool program.

During the implementation period, when services are not yet generating revenues, most of these funding sources will not be available. Basic costs during implementation include the Regional Coordinator's salary and office expenses. It was proposed that during implementation the salary for the Regional Coordinator be provided by Wisconsin DOT through a Section 18 technical assistance grant. The agency housing the Regional Coordinator will provide the Coordinator with office space and support as an in-kind contribution.

In addition, during implementation of the subscription bus service, a reserve fund of approximately $4,000 will be established to carry the project financing in case of an emergency. This amount would cover the average cost of operating three routes for 1 month. If these funds are not used during implementation, the fund will be continued as an emergency cash reserve. Moneys for the reserve fund will be solicited as contributions from businesses and local foundations.

Opening Agency Services to the Public

This element of the plan involves opening selected agency services to the public and charging a fare (from $1.50 to $1.75 per one-way trip depending on the county). Approximately 12 agencies, covering the entire region, have been identified as potential operators in this effort. The services will primarily accommodate the nonwork trip during off-peak hours and will have a county level geographical focus (because social service agencies are currently focused more on a county level). By opening services to the public, agencies will be able to generate revenues needed to keep agency services operating for their clients. See Appendix C for a summary of more specific characteristics of the plan element including detailed financial characteristics, the number of vehicles, and revenue characteristics.

Establishing a Subscription Bus Service

Concentrated demand for transportation to work and Nicolet College (the local technical college) will be served by a subscription bus service. Ten subscription bus routes are planned on a regional level to link high population concentrations with locations of major employment and Nicolet College. Services will be provided on prearranged routes with flag stops or checkpoints for passenger access or egress. Most riders will subscribe to the service on a monthly basis although extra riders will be picked up at flag stops for a fare (a passenger must make a reservation in advance to reserve a seat). Fares from riders will cover the cost of service (fares will average approximately $2.40 per trip depending on the length of the trip). Routes will be advertised in advance and only those routes with enough patronage to sustain themselves will be operated. See Appendix D for a more detailed summary description of the subscription bus service characteristics.

Establishing a Carpool Program

The implementation of the carpool program is based on the need for efficient transportation for long-distance trips and for trips from low-density origins. (The carpool program is intended to meet transit needs in areas of the region that do not have the density necessary to sustain the subscription bus service.) Low-density trips that occur in the four-county area are most often work trips, specialized medical trips, and school trips at off-peak hours.

For the carpool program, the Regional Coordinator will match riders and drivers with compatible origins, destinations, and travel schedules to form individual carpools on a regional basis. The Wisconsin DOT District No. 7 Office is currently engaged in promotional activities for the carpool program, but the Regional Coordinator will carry this a step further by actually matching riders to form the carpools. Once formed, carpools will be administered by their own members, who share the costs of operating the vehicles. For a more detailed summary of this element see Appendix E.

Summary of the Proposed System

The three components of the regional transportation program (opening selected agency services to the public, establishing a carpool program, and establishing a subscription bus service) provide a vastly improved level of transportation services for people in the four-county region. This is achieved without increasing taxes and without any new monetary commitment from local governments.

GENERAL OBSERVATIONS

Although it is impossible to generalize from one project, it is believed that a number of lessons can be learned from this project.

Specify Bottom Line Budget Early in Planning Process

Often when a planning study is initiated, services are designed based on the need or demand for such services. Little thought is given to either the cost or the financing of the services being planned until the alternative plans are evaluated or an implementation program developed. By this time, it may be too late. There is a great chance that no matter how good the designs are they will all be too costly for the community involved. It is important that some idea of what the community can afford be specified from the onset of any planning project. This will (a) prevent the designing of useless plans and (b) ensure that a feasible plan will emerge from the alternatives considered. (It is much easier to make adjustments to services and operations later on in the process than to have local communities magically conjure up funds they do not have.)

Gap Between Public Transit and Transportation for the Disadvantaged is Narrowing

Traditionally, public transit has meant fixed-route/fixed-schedule services with full-sized buses.

Transportation for many disadvantaged groups has meant specialized dial-a-ride or demand-responsive services. However, during the past few years a narrowing of the gap has occurred between these services, particularly in rural areas.

First, it has become apparent that whereas some disadvantaged groups need special service, many others just need transportation that is accessible to them. In many instances this service does not need to be as specialized (or as expensive) as it has been in the past. It has also become apparent that many of the so-called disadvantaged would be better off if they were not segregated from the rest of the population on a separate service.

Second, many newly developed public transportation services--particularly those in rural communities--are not the conventional type of fixed-route/fixed-schedule service seen in more urbanized areas. Services are often smaller, more flexible, and beginning to look more and more like many specialized services for the transportation disadvantaged.

Public transportation services provided by Section 147 and Section 18 projects (5,6) range from demand responsive to fixed route with numerous variations in between but with relatively few examples of either pure fixed-route or demand-responsive services. Thus, at least in rural areas, the operational gap between transportation services for the general public and special services for the transportation disadvantaged has narrowed considerably.

Unique Opportunity to be Innovative with Public Transit and Agency Transportation Services

Many transportation services (both for the general public and for special transportation groups) are facing major budget cuts. In rural areas where all resources are scarce there are unique opportunities to be innovative with public and agency transportation services. These experiences in Wisconsin showed that local decision makers are ready to make changes in the way they provide agency and public transit services. Because the scale of services is smaller, it is possible to look at specialized and general public transit services as a whole, examine whom and to what degree the services benefit, and how they complement each other. Often it will be possible to build new public transit services on existing specialized service provided by agencies--either by integrating the two or by sharing resources (including vehicles) among the services. In other instances it may be possible for social agencies to purchase services for their clients from public transit systems.

Use Ridesharing for Agency Services

Some of the most important transit services for the transportation disadvantaged, but also some of the most costly, are trips to medical facilities. In the four-county region, medical trips accounted for almost 37 percent of all money spent on agency transportation. One of the possibilities explored, which is being used in some areas of Wisconsin, is organized ridesharing for agency clients to medical facilities. This concept is particularly relevant in rural areas where distances to medical facilities are often quite long (much medical care is provided in regional medical facilities serving multiple counties).

The primary consideration in making this concept work is gaining the cooperation of the medical facility staff in scheduling appointments appropriately. In some areas an attempt has been made successfully to schedule appointments for persons from one county to one day and persons from another county on another day (e.g., Monday is River County day, Tuesday is Greene County day). Because the cost per trip for clients using personal transportation in the four-county region ranges from $25 to $35, savings realized with this type of ridesharing can be quite significant.

Serving the General Public on Rural Specialized Services May Keep These Services Afloat

As mentioned earlier, many local communities are faced with severe budget cuts. Social service programs are being cut in many communities; and unfortunately agency transportation often appears to be a luxury. Because of the relaxing of federal regulations that required a project to provide transportation to and from social services, many agency transportation programs are being discontinued or cut back (in terms of the number of days and hours services are offered, the types of clients served, and so on).

Another primary issue being questioned is the exclusivity of specialized transportation services. Especially in rural areas the question is being asked: Why allow only the elderly or the handicapped to ride when vehicles are half-full? One of the concepts this study explored, and included in the plan, is to allow agency services that were previously serving only clients to serve anyone. Services to clients will still be subsidized by the agencies involved (fares charged to clients will range from $.25 to $.50 per one-way trip), but nonclients will be charged a fare to cover the full cost of providing the service. This concept has some obvious advantages.

1. Revenues from nonclient user fares can be used to keep services afloat or service levels high for clients.
2. Agency services are often already in areas of highest demand by the general public and thus can attract other riders, especially for the nonwork off-peak trips.
3. Agency clients are exposed to members of the general public and vice versa.

Unfortunately there are also a number of problems that surface when this concept is considered.

1. Some agency vehicles are full for the hours they operate (in particular vehicles that operate during peak hours to transport clients to education and training centers for the handicapped).
2. Services by agencies often are provided only during nonpeak hours which makes them unsuitable for most work trips.

The solution to these problems was to open existing agency transportation services to the public to serve nonwork, off-peak trips and to use that service as a base for expanding into work trips during the peak hours (through the subscription bus service). To the extent possible, agency vehicles and other resources will be used to provide the subscription bus service in the region. It may be possible eventually to cross-subsidize the agency client trips with trips on the subscription bus service.

CONCLUSION

These experiences in Northern Wisconsin led to a number of observations about the changing nature of rural transportation. First, economic hard times are making it necessary for many rural areas to examine their role in providing both public transportation and transportation to special user groups. Because of this, more attempts are being made to cut costs and provide more effective and efficient services both to the public and to the transportation disadvantaged. In particular, agency transportation services in rural areas can be opened to the public to generate additional revenues from nonclient fares, and ridesharing can be used for client trips to medical facilities. Second, in planning transit services, it is important to consider at the onset what the community can or is willing to spend so that unrealistic alternatives are not carried into design stages.

Finally, in rural areas the relationship between public transportation and agency services can be and is being strengthened. The traditional gap between public transit and agency transportation is narrowing considerably, and it is now being shown that in many instances both types of service can be provided in conjunction. This creates financial and operational advantages for both user groups.

APPENDIX A: GOAL STATEMENT

1. Target services first toward geographic areas both with high need demand by the transit dependent (for work and nonwork types) and with high potential demand by choice riders for work trips. Then, to target services toward areas with either high need or demand by the transit dependent or areas with high potential demand by choice riders for work trips.
2. Improve the efficiency and effectiveness of existing service providers in the region (regardless of whether they operate vehicles, purchase service, or reimburse volunteers or clients) within the context of providing public transportation.
   a. Coordinate existing service providers to the maximum extent feasible and beneficial.
   b. Improve the cost efficiency of existing providers (cost per mile, cost per trip, cost per hour).
   c. Improve the operational efficiency and effectiveness of existing providers (trip per mile, persons serviced per service area population).
3. Promote the involvement of private operators in the provision of public transportation services in the region.
4. Minimize the operating deficit and required subsidy of the public transportation system by maintaining current subsidy levels (no additional local funds will be expended).
5. Initiate legislative or regulatory changes necessary to facilitate the accomplishment of other goals.

APPENDIX B: ADMINISTRATIVE CHARACTERISTICS

Regional Public Transportation Committee

The Committee will be responsible for overall policy decisions and direction of the regional transportation project and will be made up of two or three members from each of the four County Boards or County Board Subcommittees. Members of their Committees on transportation and social services would be the best choice.

Bi-monthly meetings will be held to review program activities, give policy level direction to the public transportation program in the region, and keep abreast of public transportation issues in the region. The Committee members also take information on regional transportation issues back to County Boards.

Regional Coordinator

The Coordinator is responsible for the implementation and administration of the regional transportation system including the subscription bus service, parts of the carpool/vanpool program, and assisting the agencies with opening their services to the public.

Duties of the Coordinator

1. Organize demand for the subscription bus, carpool, and vanpool services and assist agencies in attracting riders.
2. Promote the three services.
3. Select and manage the contract with the operator(s) of the subscription bus service.
4. Arrange for adequate maintenance, insurance, financing, record keeping, and accounting for the three services.

Organizational Placement and Supervision of the Coordinator

Coordinator will be sponsored by a consortium of the four counties (similar to the multicounty consortiums providing services to the developmentally disabled).

Coordinator ideally should be housed within an organization or agency with a regional focus that covers at least three counties. (Agencies being considered are the Wisconsin DOT District No. 7 Office, the Regional Planning Commission (RPC), and Nicolet College.) The actual placement of the Coordinator has not yet been decided.

Coordinator will be responsible to the Regional Public Transportation Committee.

Coordinator will be provided with overall supervision within the agency which houses this individual.

Financial Arrangements

The Coordinator function will cost approximately $1,820 per month: $1,580 in salary and fringe benefits plus $240 housing. It is planned that the Coordinator would be housed in an existing agency, and it has been assumed that this agency would provide space and support as an in-kind contribution at no cost to the project.

The Coordinator function will be paid for in a variety of ways. After the service is operating, the entire cost of the Coordinator function will be paid from the fares received by the subscription bus service. It is hoped that during the implementation period the Wisconsin DOT will provide the project with a grant from Section 18 technical assistance funds.

APPENDIX C: ROLE OF SOCIAL SERVICE AGENCIES

Concept

1. Current agency services continue to be operated in the same manner.

2. Selected agencies in the region will open their services to the public and charge members of the general public a fare (12 to 14 agencies have been identified as being potentially appropriate for opening their services to the public).
3. Opening services to the public will generate revenues needed to keep agency services operating for their clients.
4. Serves primarily nonwork trips.
5. Focused at the county level because this is current orientation of agency services.

Institutional Context

1. Services continue to be administered by the individual agencies; however, the Regional Coordinator will provide assistance to the agencies as needed.
2. Services continue to be operated by the individual agencies.
3. Functions such as maintenance and purchasing may remain the same; however, the Regional Coordinator will also be responsible for exploring the possibility of performing some of these functions jointly to decrease costs or increase efficiency.

Service Characteristics

1. Service characteristics remain the same with the exception that more trips will be provided--those trips taken by the general public.
2. Provides approximately 3,583 additional one-way trips per month to the general public: 172 in Forest County, 510 in Langlade County, 2,007 in Oneida County, and 894 in Vilas County.

Operational Characteristics

1. Includes 16 vehicles: 9 vans (capacity: 120), 5 minibuses (capacity: 98), and two small buses (capacity: 65).
2. Includes 26,224 vehicle-miles per month.
3. Includes 1,340 vehicle-hours per month.
4. Efficiency is increased by improving more trips for the same costs. Monthly passenger trips per service area population will be 0.04, and monthly passenger trips per total county population will be 0.03.

Financial Characteristics

1. No additional costs will be incurred in opening agency service to the public. The only exception may be increased cost of record keeping and accounting.
2. Fares from general public riders have been estimated at $5,717 per month: $275 in Forest County, $1,565 in Langlade County, $1,358 in Oneida County, and $867 in Vilas County.
3. Fares will be established on a county level based on the actual costs of providing the service.

APPENDIX D: SUBSCRIPTION BUS SERVICE COMPONENT

Concept

1. Serves work and Nicolet College trips.
2. Regional focus.
3. Links areas with high population concentrations with locations of major employment and college centers.

Institutional Context

1. Administered by the Regional Coordinator under the direction of the Regional Public Transportation Committee.
2. Housed with the Coordinator in a regionally oriented agency.
3. Operated by a private company or an existing social service agency with the appropriate capabilities.
4. Bus captains will be identified for each round trip route. In trade for reduced or free fares, captains will be reponsible for fare collection from nonsubscribing riders and for relaying needed information to the Regional Coordinator.

Service Characteristics

1. Provides approximately 5,702 one-way trips per month.
2. Ten routes with checkpoints along each route.
3. Riders must subscribe or have an advanced reservation (preferably on a monthly basis) to ensure a seat.
4. Checkpoints or flag stops will also be established along each route and persons without a standing reservation will be picked up there (schedules for arrival at each checkpoint will be published).
5. Routes will be advertised before starting operation and only those with sufficient demand will be initiated.

Operational Characteristics

1. Requires 12 vehicles (probably small buses or vans with capacities of from 10 to 20 passengers).
2. Requires 22,600 vehicle-miles per month: 19,000 revenue-miles and 3,600 deadhead-miles.
3. Requires 662 vehicle-hours per month: 482 revenue-hours and 180 deadhead-hours.
4. Monthly passenger trips per service area population will be 0.09.
5. Monthly passenger trips per total county population will be 0.07.

Financial Characteristics

1. Service will cost approximately $13,831 per month: $12,923 for operations and $908 for administration.
2. Fares from riders would cover administrative and operating costs.
3. Private company to operate the service would be chosen through a competitive bid process.
4. Fares will be established on the basis of a flat fare for origin-destination pairs.

APPENDIX E: CARPOOL/VANPOOL PROGRAM

Concept

1. Matches riders and drivers with similar origins, destinations, and travel schedules.
2. Serves work trips in sparsely populated areas or to small employers, school trips to Nicolet College, and intercounty medical trips.
3. Regional focus.
4. Serves trips in low-density areas, trips taken at off-peak hours, and long-distance trips with few people traveling at the same time.

Institutional Context

1. Partially administered by the Wisconsin DOT District No. 7 Office (primarily promotional activities).

2. Remainder of the functions administered by the Regional Coordinator under the direction of the Regional Public Transportation Committee (the actual rider matching, etc.).

3. Housed both within the Wisconsin DOT District No. 7 Office and with the Coordinator, ideally in a regionally oriented organization.

Service Characteristics

1. Services will be on a prearranged scheduled basis for ridesharing, the routes and schedules will be set up based on demand.

2. The number of trips will depend on need and demand for the service.

Operational Characteristics

1. Number of vehicles, vehicle-miles, vehicle-hours, and efficiency will depend on demand.

Financial Characteristics

1. Operating costs of the carpool/vanpool program will be borne by the users of the service.

2. Administration of the carpool/vanpool program will cost approximately $11,000 annually.

3. Some of the administrative functions of the carpool/vanpool programs are currently being performed by the Wisconsin DOT District No. 7 Office--these functions would continue to be funded in the same manner.

4. The portion of the Regional Coordinator's salary and overhead expenses that is attributable to the carpool/vanpool program will be sought from private local businesses and foundations, employers, and so on. Eventually it may be possible to cross subsidize these functions so that the Coordinator's entire salary is paid out of fares from the subscription bus service.

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